Assessing the Capacities, Gaps, and Needs of National Meteorological and Hydrological Services (NMHSs) and their National (multi-hazard) Early Warning Systems ((MH)EWS) including Regional and Global Support Mechanisms in Pacific Small Island Developing States (SIDS)

16th July 2021

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Final Report

Acknowledgements:

The assessment on multi-hazard early warning system capacities, gaps, and needs in Cook Islands, Fiji, Kiribati, Nauru, Niue, Tokelau, and Tuvalu have been conducted under the World Meteorological Organisation (WMO) funded project titled 'Assessing the Capacities, Gaps, and Needs of National Meteorological and Hydrological Services (NMHSs) and their National (multi-hazard) Early Warning Systems ((MH)EWS) including Regional and Global Support Mechanisms in Pacific Small Island Developing States (SIDS)'. The assessment process involved a number of online consultations with NMHS of Cook Islands, Fiji, Kiribati, Nauru, Niue, Tokelau, and Tuvalu and key regional organisation, especially SPC, SPREP, UNDP, UNDRR, FAO.

Asian Disaster Preparedness Center (ADPC) would like to extend its deepest appreciation to all key regional and national stakeholders who participated in this assessment process. ADPC would like to especially thank Mr. Bates Manea (Cook Island), Mr. Stephen Meke (Fiji), Mr. Thomas Zackious (Kiribati), Mr. Roy Harris, Mr. Graymea Ika (Nauru), Ms. Rossy Mitiepo (Niue), Mr. Mika Perez, Ms. Mile Fonua (Tokelua), and Mr. Alamoana Tofuola (Tuvalu).

ADPC is grateful for the significant contributions provided by the World Meteorological Organisation Head Office Team. Specifically, we would like to highlight the support and in-depth engagement of Mr. Cyrille Honoré, Mr. Moyenda Chaponda, Mr. Jochen Luther, Ms. Lina Sjaavik and Ms. Erica Allis.

The guidance and support of the World Meteorological Organisation Pacific Regional Team is highly appreciated. Specifically, we would like to highlight the support and in-depth engagement of Mr. Henry Taiki and Ms. Tessa Tafua.

A word of special thanks to Mr. Hans Guttman (Executive Director, ADPC) and Mr. Aslam Perwaiz (Deputy Executive Director, ADPC) for the guidance throughout the assessment process.

This assessment was conducted by three members team with experience in areas of meteorology, hydrology, disaster risk management, hazard risk assessment, early warning system design/development and climate risk management.

Document Summary:

Name of Project: Assessing the Capacities, Gaps, and Needs of National Meteorological and Hydrological Services (NMHSs) and their National (multi hazard) Early Warning Systems ((MH)EWS) including Regional and Global Support Mechanisms in Pacific Small Island Developing States (SIDS).

Client Name: World Meteorological Organisation (WMO)

Name of Document: Final Report

File Name: WMO MHEWS_Final Report_10032021_ADPC

Team Leader: Dr. Senaka Basnayake

Project Team: Lalit Kumar Dashora, G. A. Chinthaka Ganepola

Document Version: V1.0

Name of Organisation: Asian Disaster Preparedness Center (ADPC)

Total number of pages including cover: 146

Last Saved: 16th July 2021

16th July 2021

Citation:
Dashora, L. K, Basnayake, S., Ganepola, G. A. C., Jayasinghe, S., Luther, J. and Allis, E. (2021), “Multi Hazard Early Warning Capacities, Gaps and Needs Assessment of the Small Island Developing States in the Pacific”, Asian Disaster Preparedness Center.

Executive Summary

The Pacific region is prone to various hydro-meteorological hazards including cyclones, floods, and droughts. These hazards are becoming more and more intricate, complex and multi-faceted. The Pacific countries like Cook Islands, Fiji, Kiribati, Nauru, Niue, Tokelau, and Tuvalu are extremely vulnerable due to their unique geo-climatic locations in the Pacific Ocean.

National Meteorological and Hydrological Services (NMHSs) in these countries are mandated and accountable to provide short- and long-range weather forecast as well as early warning to institutions and communities. Recognizing the fact that the frequency and severity of hydro-meteorological hazards is on the rise in changing climatic conditions, capacities of national meteorological and hydrological services will not suffice. Due to unpredictability and increasing frequency of extreme weather events clearly require significant improvement in the capacities for weather monitoring and forecast and early warning in near future.

Although, early warning systems exist in these countries, they require timely upgradation and modernization of instruments as well as technology. In this report, an attempt is made to assess and highlight existing capacities of NMHS and their future needs.

Capacities, gaps and needs of Multi-Hazard Early Warning Systems (MHEWS) were assessed through online consultations (including key informant interviews with NMHSs, focus group discussions with regional organisations and shared learning dialogues with other project team members in the region) due to COVID-19 related international and national travel restrictions and health advisories.

The early warning system assessment was conducted in Cook Islands, Fiji, Kiribati, Nauru, Niue, Tokelau, and Tuvalu using online multi-hazard early warning system assessment matrix, which was developed based on four pillars for early warning system suggested by World Meteorological Organization (WMO), including i.) disaster risk knowledge, ii.) detection, monitoring and forecasting of the hazards and possible consequences, iii.) warning dissemination and communication and iv.) preparedness and response capability and one cross-cutting issue, governance.

Contents

Acronyms & Abbreviations

ADPC:	Asian Disaster Preparedness Center
AWS:	Automatic Weather Station
BIP-MT:	Basic Instruction Package for Meteorological (Observation) Technicians
BCP:	Business Continuity Plan (BCP)
BOM:	Bureau of Meteorology (Australia)
CAP:	Common Alerting Protocol
CBO:	Community Based Organisation
CCA:	Climate Change Adaptation
CIFDP-F:	Coastal Inundation Forecasting Demonstration Project Fiji
CIMS:	Cook Islands Meteorological Service
CliDE:	Climate Data for the Environment
COSPPac:	Climate and Oceans Support Program in the Pacific
CREWS:	Climate Risk and Early Warning Systems
DRR:	Disaster Risk Reduction
EAR:	Early Action Rainfall
ECCC:	Environment and Climate Change Canada
EDNRE:	Department of Economic Development, Natural Resources and Environment, Tokelau
EMCI:	Emergency Management Cook Islands
ENSO:	El Niño Southern Oscillation
EOC:	Emergency Operation Center
EWS:	Early Warning System
FAO:	Food and Agriculture Organisation of the United Nations
FGD:	Focus Group Discussions
FMS:	Fiji Meteorological Service
GCF:	Green Climate Fund
GFDRR:	Global Facility for Disaster Risk Reduction
HFA:	Hyogo Framework for Action
ICI:	The Ministry of Infrastructure of Cook Islands
ICS:	Incident Command Systems
IOC UNESCO:	The Intergovernmental Oceanographic Commission of UNESCO
IPCC:	Inter-governmental Panel on Climate Change

JICA:	Japan International Cooperation Agency
JMA:	Japan Meteorological Agency
JTWC:	Joint Typhon Warning Center
KII:	Key Informant Interview
KMA:	Korea Meteorological Administration
KMS:	Kiribati Meteorological Service
KOICA:	Korea International Cooperation Agency
LDC:	Least Developed Country
LDCF:	Least Developed Countries Fund
MFAT:	Ministry of Foreign Affairs and Trade New Zealand
MHEWS:	Multi-Hazard Early Warning System
MME:	Multi Model Ensemble
MOU:	Memorandum of Understanding
NAPA:	National Adaptation Programmes of Action
NCOF:	National Climate Outlook Forum
NDMO:	National Disaster Management Office
NES:	Ministry of National Emergency Services (Nauru)
NGO:	Non Governmental Organisation
NIWA:	National Institute of Water and Atmospheric Research
NMHS:	National Meteorological and Hydrological Service
NWP:	Numerical Weather Predication
NZAID:	New Zealand Aid Programme
PAGASA:	Philippine Atmospheric, Geophysical and Astronomical Services Administration
PDC:	Pacific Disaster Center
PICT:	Pacific Island Countries and Territories
PIF:	Pacific Islands Forum
PIMS:	Pacific Islands Meteorological Strategy
PMC:	Pacific Meteorological Council
PRCS:	Pacific Roadmap for Strengthened Climate Services
PTWC:	Pacific Tsunami Warning Center
RESPAC:	Disaster Resilience for Pacific Small Island Developing States

SFDDR:	Sendai Framework for Disaster Risk Reduction
SIDS:	Small Island Developing States
SMS:	Short Message Service
SOP:	Standard Operating Procedure
SPC:	Secretariat of Pacific Community
SPREP:	Secretariat of the Pacific Regional Environment Programme
SRDP:	Strategy for Climate and Disaster Resilient Development in the Pacific
UNDP:	United Nations Development Programme
UNDRR:	United Nations Office for Disaster Risk Reduction
UNEP:	UN Environment Program
UNESCAP:	United Nations Economic and Social Commission for Asia and the Pacific
UNFPA:	United Nations Population Fund
UNICEF:	United Nations Children’s Fund
WMO:	World Meteorological Organization

Glossary

Capacity

The combination of all the strengths, attributes and resources available within a community, society or organisation that can be used to achieve agreed goals.

Source: Adapted from UNDRR terminology https://www.undrr.org/terminology/capacity

Climate change

The Inter-governmental Panel on Climate Change (IPCC) defines climate change as: "a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcing, or to persistent anthropogenic changes in the composition of the atmosphere or in land use"

Source: Adapted from IPCC terminology https://www.ipcc.ch/sr15/chapter/glossary/

Disaster

A serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources.

Source: Adapted from UNDRR terminology https://www.undrr.org/terminology/disaster

Disaster risk reduction

The concept and practice of reducing disaster risks through systematic efforts to analyse and manage the causal factors of disasters, including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events.

Source: Adapted from UNDRR terminology https://www.undrr.org/terminology/disaster-risk-reduction

Early warning system

The set of capacities needed to generate and disseminate timely and meaningful warning information to enable individuals, communities and organisations threatened by a hazard to prepare and to act appropriately and in sufficient time to reduce the possibility of harm or loss.

Source: Adapted from UNDRR terminology https://www.unisdr.org/files/7817_UNISDRTerminologyEnglish.pdf

Forecast

Definite statement or statistical estimate of the likely occurrence of a future event or conditions for a specific area.

Source: Adapted from UNDRR terminology https://www.unisdr.org/files/7817_UNISDRTerminologyEnglish.pdf

Geological hazard

Geological process or phenomenon that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage.

Source: Adapted from UNDRR terminology https://www.undrr.org/terminology/hazard

Hazard

A dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage.

Source: Adapted from UNDRR terminology https://www.undrr.org/terminology/hazard

Hydro-meteorological hazard

Process or phenomenon of atmospheric, hydrological or oceanographic nature that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage.

Source: Adapted from UNDRR terminology https://www.undrr.org/terminology/hazard

Natural hazard

Natural process or phenomenon that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage.

Source: Adapted from UNDRR terminology https://www.undrr.org/terminology/hazard

Preparedness

The knowledge and capacities developed by governments, professional response and recovery organisations, communities and individuals to effectively anticipate, respond to, and recover from, the impacts of likely, imminent or current hazard events or conditions.

Source: Adapted from UNDRR terminology https://www.undrr.org/terminology/preparedness

Prevention

Activities and measures to avoid existing and new disaster risks.

Source: Adapted from UNDRR terminology https://www.undrr.org/terminology/prevention

Response

The provision of emergency services and public assistance during or immediately after a disaster in order to save lives, reduce health impacts, ensure public safety and meet the basic subsistence needs of the people affected.

Source: Adapted from UNDRR terminology https://www.undrr.org/terminology/response

Risk

The combination of the probability of an event and its negative consequences.

Source: Adapted from UNDRR terminology
https://www.unisdr.org/files/7817_UNISDRTerminologyEnglish.pdf

Risk assessment

A methodology to determine the nature and extent of risk by analysing potential hazards and evaluating existing conditions of vulnerability that together could potentially harm exposed people, property, services, livelihoods and the environment on which they depend.

Source: Adapted from UNDRR terminology
https://www.unisdr.org/files/7817_UNISDRTerminologyEnglish.pdf

Risk management

The systematic approach and practice of managing uncertainty to minimize potential harm and loss.

Source: Adapted from UNDRR terminology
https://www.unisdr.org/files/7817_UNISDRTerminologyEnglish.pdf

Vulnerability

The characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard.

Source: Adapted from UNDRR terminology https://www.undrr.org/terminology/vulnerability

1. Background

The World Meteorological Organization (WMO) has engaged Asian Disaster Preparedness Center (ADPC) to perform the services for a project entitled "Assessing the capacities, gaps, and needs of National Meteorological and Hydrological Services (NMHSs) and their national multi-hazard early warning system (MHEWS) including regional and global support mechanisms in Pacific Small Island Developing States (SIDS)".

The project is commissioned as part of the ongoing larger project of WMO titled "Strengthening Hydro-Meteorological and Early Warning Services in the Pacific" which is co-funded by the Climate Risk & Early Warning Systems (CREWS) initiative, (a multi-donor trust fund) as well as by Environment and Climate Change Canada (ECCC) as part of its contribution to CREWS[1].

It focuses on strengthening the capacities of National Meteorological and Hydrological Services (NMHSs) of SIDS in the Pacific including project countries i.e. Cook Islands, Fiji, Kiribati, Nauru, Niue, Tokelau, and Tuvalu.

Moreover, the CREWS Pacific supports strengthening early warnings of multiple hazards in the Federated States of Micronesia (FSM), Republic of the Marshall Islands (RMI), Palau, Samoa, Solomon Islands, Tonga, and Vanuatu. It seeks to enhance the capacity of NMHSs of these Pacific SIDS to predict extreme and high-impact hydro-meteorological events and assess associated risks in order to alert exposed populations and improve their preparedness[2].

CREWS is an international initiative launched at the United Nations Climate Change Conference in Paris in 2015. It aims to significantly increase the capacity of Least Developed Countries (LDCs) and Small Island Developing States (SIDS) to generate and communicate effective, impact-based, multi-hazard and gender-informed early warnings and risk information within strengthened national MHEWS[3]. CREWS is a partnership of WMO, the World Bank Group and its Global Facility for Disaster Reduction and Recovery (GFDRR), and the United Nations Office for Disaster Risk Reduction (UNDRR).

The CREWS initiative is currently funded by the governments of Australia, Finland, France, Germany, Luxemburg, the Netherlands, Switzerland and the United Kingdom. CREWS Pacific project aims to strengthen weather-, climate-, and water-related impact-based support services, to help protect lives and property.

1.1 Objective

The overall objective of the project is "to assess the MHEWS of the selected countries in the Pacific (especially from the perspective of the NMHSs) and document the respective capacities, gaps, and needs at regional, national and sub-national (local/community) levels, including existing assessments and recently completed, on-going, and planned capacity and technical cooperation interventions".[4]

[1] Implementation Agreement between WMO and ADPC (2020)
[2] CREWS Project, Assessed Online at https://www.crews-initiative.org/en
[3] CREWS Project, Assessed Online at https://www.crews-initiative.org/en
[4] Implementation Agreement between WMO and ADPC (2020)

The outputs of this project will be inputs for the CREWS Pacific project as well as future capacity development activities and provide recommendations with corresponding resource requirements to enhance the effectiveness of the MHEWS, including elements of updated draft Standard Operating Procedures (SOPs), for consideration by the governments of the beneficiary countries.

There are three major components of the project including:

- Desk assessment of ongoing/ recently completed MHEWSs and DRR programmes and projects at regional and national levels;
- Identification, analysis, and documentation of MHEWSs capacities, gaps, and needs at regional, national, and sub-national/ local levels;
- Preparation of regional report and country-specific technical briefs.

2. Introduction

A systematic approach towards managing risk through a well-established Early Warning System (EWS) can minimize loss of lives and adverse economic impact. An EWS backed with effective institutional capacities and arrangements can predict hazards in a timely and effective manner, thereby enhancing capacities of decision makers and empowering communities at risk. Acceptance of the Sendai Framework for Disaster Risk Reduction (SFDRR) 2015-2030 at the third United Nations World Conference in Sendai, Japan, on March 18, 2015 has led to a paradigm shift in disaster risk management from a post-disaster response to a comprehensive and strategic approach in disaster risk management encompassing preparedness and prevention strategies[5]. The SFDRR is the outcome of stakeholder consultations initiated in March 2012 and inter-governmental negotiations from July 2014 to March 2015, supported by the United Nations Office for Disaster Risk Reduction (UNDRR) at the request of the United Nations General Assembly.

The SFDRR is the successor global framework of the Hyogo Framework for Action (HFA) 2005-2015 which was aimed at building the resilience of nations and communities to disasters. The HFA was conceived to give further impetus to the global work under the “International Framework for Action for the International Decade for Natural Disaster Reduction of 1989[6]” and the “Yokohama Strategy and Plan of Action for a Safer World in 1994[7]”.

The **target ‘G’** of the SFDRR stresses to substantially increase the availability of and access to MHEWSs and disaster risk information and assessments to people by 2030. At a national level there is a growing reliance upon EWSs as more people and assets are being exposed to the hazards. This calls for functional MHEWSs or alert systems that have applicability for most hazards. Advancements in observation and monitoring, mathematical modelling, computing capabilities, communication technology and conduct of scientific risk assessment have allowed technical and disaster management agencies to timely disseminate accurate warnings and move people and assets from the harm’s way. Warning dissemination and staging response actions are as important as accurate forecasting and determining potential impact.

Any weak link in the elements of the EWS (even in case of previous well performing system) will result in under-performance or its failure. Hence, the assessment of EWSs is important. The assessment of the effectiveness of the EWS can be done during the event, post-event or during the lean period. This assessment of EWSs for Cook Islands, Fiji, Kiribati, Nauru, Niue, Tokelau, and Tuvalu is done during the lean period (pre-cyclone season). While it is important to have technical competence around a range of elements (forecasting, prediction, impact assessment), discussions with stakeholders emphasize that the EWS is more organisational and institutional process which works to reduce losses. The assessment investigates into conditions of the EWS governance, requirements of EWS users, core services provided by technical and disaster management agencies, coordination mechanism between technical & disaster management agencies and finally on issues centered around service delivery and feedback.

[5] Sendai Framework for Disaster Risk Reduction (SFDRR) 2015-2030, Assessed Online at: https://www.preventionweb.net/files/43291_sendaiframeworkfordrren.pdf

[6] https://undocs.org/pdf?symbol=en/A/RES/44/236

[7] https://www.preventionweb.net/files/8241_doc6841contenido1.pdf

The purpose of this assessment and report is to measure the existing capacities and future needs of the NMHSs and other national and regional agencies involved in design and implementation of EWSs for hydro-meteorological hazards in Cook Islands, Fiji, Kiribati, Nauru, Niue, Tokelau, and Tuvalu. The study aims to assess the existing early warning systems, through;

- Review of the technical design/structure and efficacy of existing EWSs; assessment of early warning agencies, communications networks, protocols for issue of warning, and transmission to the people; assessment of how the residents of the city access the information and how they act upon it.
- Review of the technologies involved in the EWS network design, technical specifications, up-time performance standards, connectivity and integration with all the important facilities and installations, emergency services, and the disaster management system in the city.
- Review of the mode of collecting information related to hazard events, monitoring, and transmitting it to other agencies, particularly by the provincial government and township/city administration.
- Review of the mode and reach of the warning especially last mile connectivity and dissemination plan through mass media, print and audio-visual.
- Review the messages disseminated through the EWS: on timeliness, appropriateness, accuracy, and simplicity parameters.
- Review of the service support for maintaining the EWS on a regular basis and ensuring hundred percent uptime.

This report also reviews the institutional mechanism and the decision making across the components of the EWS. The study used an EWS assessment matrix to assess the present level of competency in Fiji, Cook Islands, Kiribati, Nauru, Niue, Tokelau and Tuvalu. More focus was drawn towards hydro-meteorological hazard warning system, their current status, and capabilities and supporting disaster risk reduction (DRR).

2.1 Early Warning System (EWS)

Early warning in the usual context means some form of, either written or verbal indication of, an impending natural hazard event. Early warning in the disaster context implies the means by which a potential danger is detected or forecast and an alert issued. In this report, the following definition has been taken into consideration: "The provision of timely and effective information, through identifying institutions, that allows individuals exposed to the hazard to take action to avoid or reduce their risk and prepare for an effective response". (ISDR 2004[8]). Early warning is a major element of DRR. It can prevent loss of life and reduce the economic and material impacts of hazardous events including disasters. To be effective, EWSs need to actively involve the people and communities at risk from a range of hazards, facilitate public education and awareness of risks, disseminate messages and warnings efficiently and ensure that there is a constant state of preparedness and that early action is enabled. According to the UNDRR, an EWS is the set of capacities needed to generate and disseminate timely and

[8] UNISDR (2004), 'Terminology: Basic terms of disaster risk reduction', Assessed Online at: https://www.unisdr.org/2004/wcdr-dialogue/terminology.htm

meaningful warning information to enable individuals, communities and organisations threatened by hazards to take necessary preparedness measures and act appropriately with sufficient time to reduce the possibility of harm or losses (UNDRR 2009[9]). This definition encompasses the range of factors necessary to achieve timely warnings for effective response. A people-centered early warning system necessarily comprises four key elements: risk knowledge; monitoring and warning services; dissemination and communications; and response capability (UNDRR, 2009; Phaiju et al., 2010[10]).

The thematic key pillars / components of EWSs are presented in **Figure (1)** (WMO, 2017[11])**.** In addition to the key pillars, governance has also been assessed as a cross cutting component to support each pillar in order to have an effective and people-centric EWS.

Figure (1): Key Pillars of MHEWSs

Source: Modified after WMO (2017)[12]

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[9] UNDRR (2009), 'Terminology on Disaster Risk Reduction'. Assessed Online at: http://www.unisdr.org/files/7817_UNISDRTerminologyEnglish.pdf

[10] Phaiju, A., Bej, D., Pokharel, S. & Dons, U. (2010). Establishing Community Based Early Warning System: Practitioner's Handbook, 2010. Lalitpur, Nepal. Mercy Corps and Practical Action.

[11] WMO (2017), Multi-hazard Early Warning Systems: A Checklist. Accessed Online at: https://public.wmo.int/en/resources/world-meteorological-day/wmd-2018/multi-hazard

[12] WMO (2017), Multi-hazard Early Warning Systems: A Checklist. Accessed Online at: https://public.wmo.int/en/resources/world-meteorological-day/wmd-2018/multi-hazard

2.2 Key pillars of the MHEWS

Pillar I: Disaster risk knowledge

Risks arise from the combination of hazards, exposure of people and assets to the hazards and their vulnerabilities and coping capacities at a particular location. Assessments of these risks require systematic collection and analysis of data and should consider the dynamics and compounding impacts of hazards coupled with vulnerabilities resulting from unplanned urbanization, changes in rural land use, environmental degradation and climate change. The level of risk can change depending on the actual impacts and consequences of hazards. Therefore, the risk assessment must include an assessment of the community's coping and adaptive capacities. It is also important to gauge the perception of the level of risk faced by those who are vulnerable. Studies of human interaction and reactions to warnings can also provide insights to improve the performance of EWSs. Risk assessments should be used to identify the location of vulnerable groups, critical infrastructure and assets, to design evacuation strategies including evacuation routes and safe areas, and to expand warning messages to include possible impacts. For example, maps based on risk assessments help to motivate people, prioritize needs & interventions and guide preparations for disaster risk management measures, including prevention, preparedness and response.

Pillar-II: Detection, monitoring, analysis and forecasting of the hazards and possible consequences

Warning services lie at the core of an EWS. There must be a sound scientific basis to the system and reliable technology for (i) monitoring and detecting hazards in real time or near real time; and (ii) providing forecasts and warnings 24 hours a day, 365 days a year. It must also be monitored and staffed by qualified people. Continuous monitoring of hazard parameters and their precursors (when available for a particular hazard) is essential to generate accurate warnings in a timely fashion that allow sufficient time for the affected community or communities to enact their disaster management plans appropriate for that hazard. The systems used for detection and monitoring, which could be automated, should allow for strict quality control of the data under international standards when these are available. Warning services should have a multi-hazard perspective (e.g. heavy rainfall may not only trigger flooding but also landslides, the warning for which may come from a separate authority) and be coordinated whenever possible to gain the benefit of shared institutional, procedural, communication networks and capacities. Data, forecasts and warnings should be archived in a standardized way to support post-event analysis and improvements of the system over time.

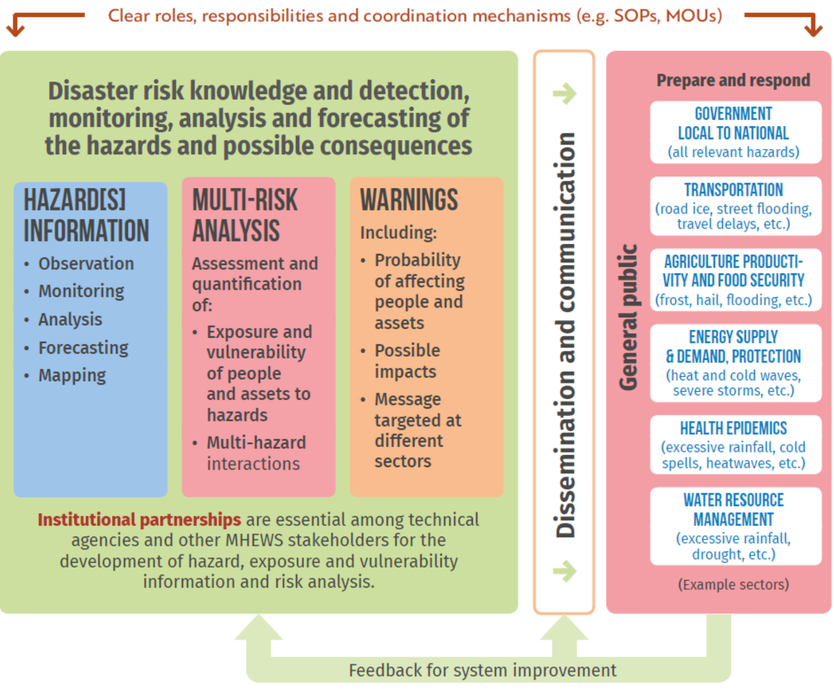
Pillar III: Warning dissemination and communications

Dissemination and communication systems (including the development of last-mile connectivity) ensuring people and communities receive warnings in advance of impending hazard events, and facilitating national and regional coordination and information exchange. Warnings must reach those at risk. Clear messages containing simple, useful and usable information are critical to enable proper preparedness and response by organisations and communities that will help safeguard lives and livelihoods. Trust is a big part of effective risk communication. If the information source cannot be trusted, those at risk may not respond proactively to the warnings – and it takes a long time to establish trust. Regional, national and local communication systems must be pre-identified and appropriate authoritative voices established. The use of multiple communication channels is necessary to ensure as many people as possible are warned, to avoid failure of any one channel, and to reinforce the warning message. There are numerous standards and protocols used by alerting authorities to transmit warnings. The Common Alerting Protocol (CAP) is an international standard format for emergency alerting and public warning, developed by the International Telecommunication Union and promoted by a number of agencies. It is designed for “all-hazards”, that is, hazards related to weather events, earthquakes, tsunamis, volcanoes, public health, power outages, and many other emergencies.

Pillar IV: Preparedness and response capabilities

Institutions and people are enabled to act early and respond to a warning through enhanced risk education. It is essential that people understand their risks, respect the national warning service and know how to react to the warning messages. Education and preparedness programmes play a key role. It is also essential that disaster management plans include evacuation strategies that are well practiced and tested. People should be well informed on options for safe behaviour to reduce risks and protect their health, know available evacuation routes and safe areas and know how best to avoid damage to and loss of property. **Figure (2)** represents schematic of a multi-hazard early warning system.

Figure (2): Schematic of a MHEWS



Source: Modified after WMO (2017)[13]

These four components need to be coordinated across many agencies at national to local levels for the system to work. Failure in one component or lack of coordination across them could

[13] WMO (2017), Multi-hazard Early Warning Systems: A Checklist. Accessed Online at: https://public.wmo.int/en/resources/world-meteorological-day/wmd-2018/multi-hazard

lead to the failure of the whole system. The issuance of warnings is a national responsibility. Thus, roles and responsibilities of various public and private sector stakeholders for implementation of EWS should be clarified and reflected in the national to local regulatory frameworks, planning, budgetary, coordination, and operational mechanisms.

Over the last decade, South East Asia has incorporated disaster reduction policies in its regional, national, social and economic development plans to establish effective preparedness measures and improve response capacities. The value of timely and effective warnings in averting losses and protecting resources/development assets becomes apparent. Countries like Fiji, Cook Islands, Kiribati, Nauru, Niue, Tokelau and Tuvalu are exposed to greater risk due to severe exposure of elements at risk. Some of the recent events show the rising trend in the number of people being affected by disasters, especially in these counties. Warning represents an added value and function in the overall disaster risk management/disaster risk reduction framework. There are three main abilities that constitute the basis of EWS.

- The first is technical capability to identify a potential risk or the likelihood of occurrence of a hazardous phenomenon, which threatens a vulnerable population;
- The second ability is the accurate identification of the vulnerability of a population to whom a warning has to be directed;
- The third ability, which requires considerable social and cultural awareness, is the communication of information to specific recipients about the threat in sufficient time and with sufficient clarity so that they can act to avert negative consequences.

Warning systems are only as good as their weakest link. They can, and frequently do, fail in both developing and developed countries for a range of reasons. There are significant decision points for the scientific/technical agencies and the disaster management agencies. These decision points coincide with the phases of the disaster management/emergency management decision stages (say, for hydro-meteorological event with sufficient lead time). A range of factors influence the hazard event phase and the emergency phase. They include:

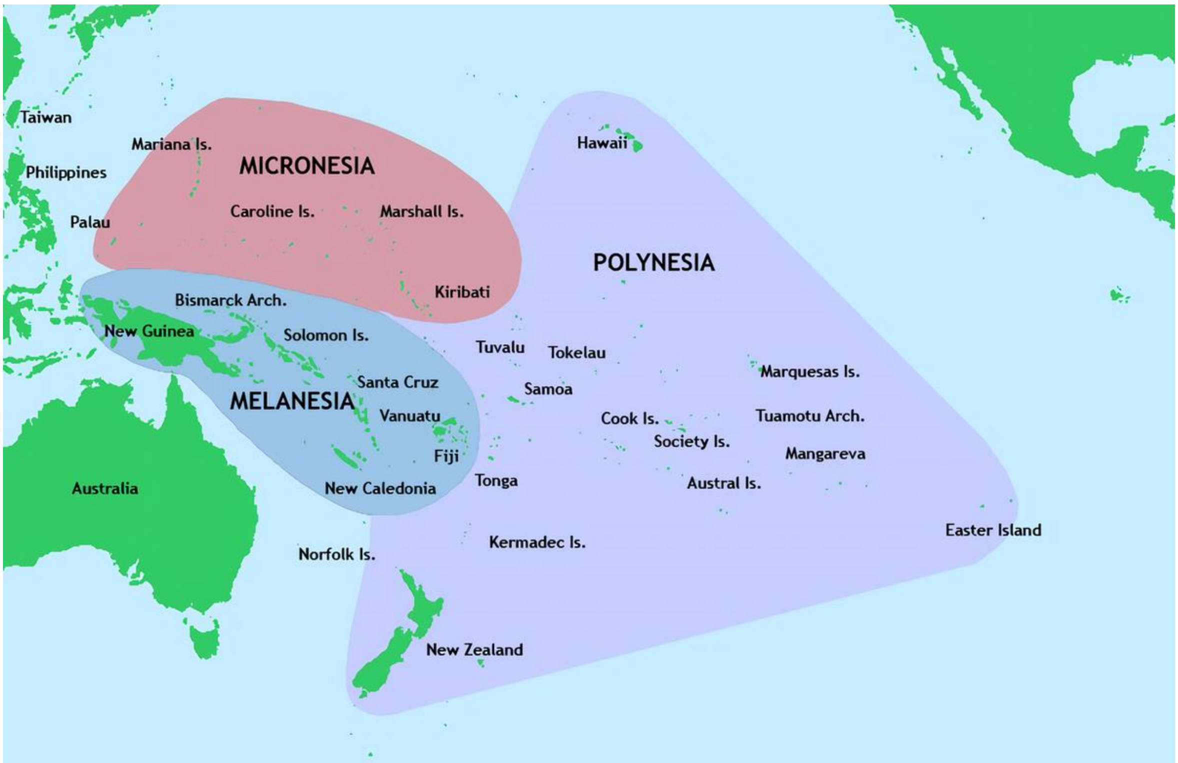
- Lack of standardized EWS framework, which is understood by both technical and disaster management agencies;
- Non-availability of warning information products and services at different temporal and spatial scales, and provision of same information content for various sectors/stakeholders;
- Warning message not being aligned in terms of societal impacts, lack of risk assessments and potential impact assessment being based on either individual understanding or on past experience & being non-scientific;
- Lack of systemization steps for emergency response based on event severity;
- Warning content unable to facilitate appropriate and timely decision actions at least to those people who are most immediately at risk or are under the influence of the hazard.

An effective EWS connect technical agencies that generate warning information with disaster management/emergency management institutions and finally with communities/people at risk.

3. The Pacific Region: Location, size, and distribution

The Pacific Islands cover nearly 528,090 km^2 of land (0.39%) spread throughout the Pacific Ocean, with a combined exclusive economic zone (EEZ) of approximately 30 million km^2 (Carlos et al. 2008) and a total coastline of 135,663 km. Islands are distributed unevenly across the Pacific basin, most being located in the western, especially in the south and western tropical regions, and the fewest in the northeastern quadrant (Nunn et al. 2016). The islands belong to a mixture of independent states, semi-independent states, parts of non-Pacific Island countries, and dependent states. The massive realm of islands of the tropical Pacific Ocean includes approximately 30,000 islands of various sizes and topography. In general, the size of the islands in the Pacific decreases from west to east. New Guinea, the largest island, accounts for 83% of the total land area, while Nauru, Tuvalu, and Tokelau have an area less than 30 km^2. Most Pacific Island nations are comparatively small with total areas less than 1,000 km^2. Pacific Island countries have been traditionally grouped along the lines of ethno-geographic and cultural lines as Melanesia, Micronesia, and Polynesia. **Figure (3)** represents maps of Melanesia, Micronesia, and Polynesia in the Pacific region**.**

Figure (3): Regional map of Pacific Island nations



Source: Pacific Community, n.d.

Melanesia is a subregion of Oceania located in the southwestern region of the Pacific basin, north of Australia, and bordering Indonesia to its east. The region includes the four independent countries of **Fiji**, Vanuatu, Solomon Islands, and Papua New Guinea and New Caledonia which is a French overseas territory. The dominant feature of Melanesia is relatively large high islands; it includes 98% of the total land area of the Pacific Islands and approximately 82% of the total population. Papua New Guinea is the largest among Melanesian countries as well as the largest country in the Pacific realm with total land area of 67,754 km^2 followed by Solomon Islands (29,675 km^2), New Caledonia (21,613 km^2), Fiji (20,857 km^2), and Vanuatu (13,526 km^2).

Micronesia consists of some 2,500 islands spanning more than seven million square kilometers of the Pacific Ocean north of the equator. Micronesia comprises only 0.3% of the total land area of the Pacific Islands and about 5% of the Pacific population. It includes **Kiribati**, Guam, **Nauru**, Marshall Islands, Northern Mariana Islands, Palau, and the Federated States of Micronesia (FSM). Kiribati is the largest country in Micronesia with an area of 995 km^2, followed by the Federated States of Micronesia (799 km^2), Guam (588 km^2), Northern Mariana Islands (537 km^2), Palau (495 $^{km2)}$, Marshall Islands (286 km^2), and Nauru, the smallest single island country of Micronesia with 23 km^2.

Polynesia is the largest region of the Pacific, made up of around 1,000 islands scattered over 8,000 km^2 in the Pacific Ocean. It is defined as the islands enclosed within a huge triangle connecting Hawaii to the north, New Zealand to the southwest, and Easter Island to the east. It encompasses more than a dozen of the main island groups of central and southern Pacific groups with large distances between them. Polynesia includes **Tuvalu, Tokelau**, Wallis and Futuna, Samoa (formerly Western Samoa), American Samoa, Tonga, **Niue**, **the Cook Islands**, French Polynesia, Easter Islands, and Pitcairn Islands. Polynesia comprises only about 1% of the total Pacific land area but more than 13% of the total population, excluding Hawaii. French Polynesia is the largest country with 3,939 km^2 followed by Samoa (3046 km^2), Tonga (847 km^2), Cook Islands (297 km^2), Niue (298 km^2), American Samoa (222 km^2), Easter Island (164 km^2), Pitcairn Island (54 km^2), Tuvalu (44 km^2), , and Tokelau with 16 km^2 area. **Table (1)** represents key statistics of project countries including Cook Islands, Fiji, Kiribati, Nauru, Niue, Tokelau, and Tuvalu in the Pacific.

Table (1): Key statistics of project countries

Country/group of islands	Number of islands	Total area of islands (km^2)	Average island area (km^2)	Average island maximum elevation (m)	Population (2016)
Cook Islands	15	297	20	73	15,200
Fiji	211	20,857	99	134	888,400
Kiribati	33	995	30	6	113,400
Nauru	1	23	23	71	10,840
Niue	1	298	298	60	1,520
Tokelau	3	16	5	5	1,400
Tuvalu	10	44	4	4	10,200

Source: Kumar et al., (2020)

Figure (4) represents maps of project countries including Cook Islands, Fiji, Kiribati, Nauru, Niue, Tokelau, and Tuvalu in the Pacific.

Figure (4): Map of project countries

Source: Pacific Community, n.d.

4. The Pacific Region: Climate change and natural hazards

As highlighted in previous sections, the Pacific island states are generally small in size with a limited and narrow range of natural resources. Due to their small sizes, generally low elevations and isolation, they are highly vulnerable to natural hazard events. Many of them fall directly in the paths of tropical cyclones. Floods, tropical cyclones, droughts and storm surges have become a part and parcel of these people. However, over many generations, inhabitants of these island states have adapted well to the natural hazard events that are quite regular and over which they have no control. The people of the Pacific have become accustomed to these, and now, such events are inseparable from their lives (Kumar et al. 2020).

The Pacific island states are one of the most disaster-prone regions in the world in terms of the recurrence, severity and scope of natural hazards. Natural hazards, ranging from hydro-meteorological (including cyclones to floods, droughts) and geological (including, earthquakes) frequently occur in the Pacific region. The pacific island countries (including Cook Islands, Fiji, Kiribati, Nauru, Niue, Tokelau, and Tuvalu) rank among the world’s worst affected in terms of casualties and people impacted by disasters (Kumar et al. 2020). This situation compounded due to climate change, the region is witnessing intense fluctuations in weather patterns, such as changing temperatures and precipitation patterns, severe storms and rising sea levels. Lack of economic diversification, remoteness from major trade centres and strong gender inequalities characterise many Pacific island nations and exacerbate their vulnerability to disasters. With a total population of 10 million people spread across a vast area, the death toll and number of victims of natural hazards may appear low in standard disaster statistics. However, the Pacific countries rank among the highest in casualties and people affected per number of inhabitants. Climate change is new entrant that is causing havoc in many small islands and is destroying lives and livelihood.

Climate change is one of the most serious challenges to the development aspirations of Pacific island states (Mote and Salathe, 2010, Keener, 2012). They are located in a region of the world with intense, frequent and increasingly impactful natural disasters. The vulnerability of Pacific island states to disasters is heightened due to their isolated geographic situation, insularity, ecological fragility and the social & economic disadvantages related to their small size. This vulnerability is compounded by the following factors: Small populations and high level of outward migration; economic stressors due to poverty; limited resources; markets unable to generate economies of scale; reliance on international trade; and costly public administration infrastructure which creates indebtedness and further susceptibility to global developments (Kumar et al., 2020).

The Pacific region has a highly variable climate, which is heavily influenced by the Pacific El Niño Southern Oscillation (ENSO). The region is mainly exposed to natural hydro-meteorological hazards such as cyclones, storm surge, droughts and floods (Walsh et al., 2012). On average, the region experiences four major weather-related disasters each year. According to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change[14], current

[14] IPCC AR5: https://www.ipcc.ch/report/ar5/syr/

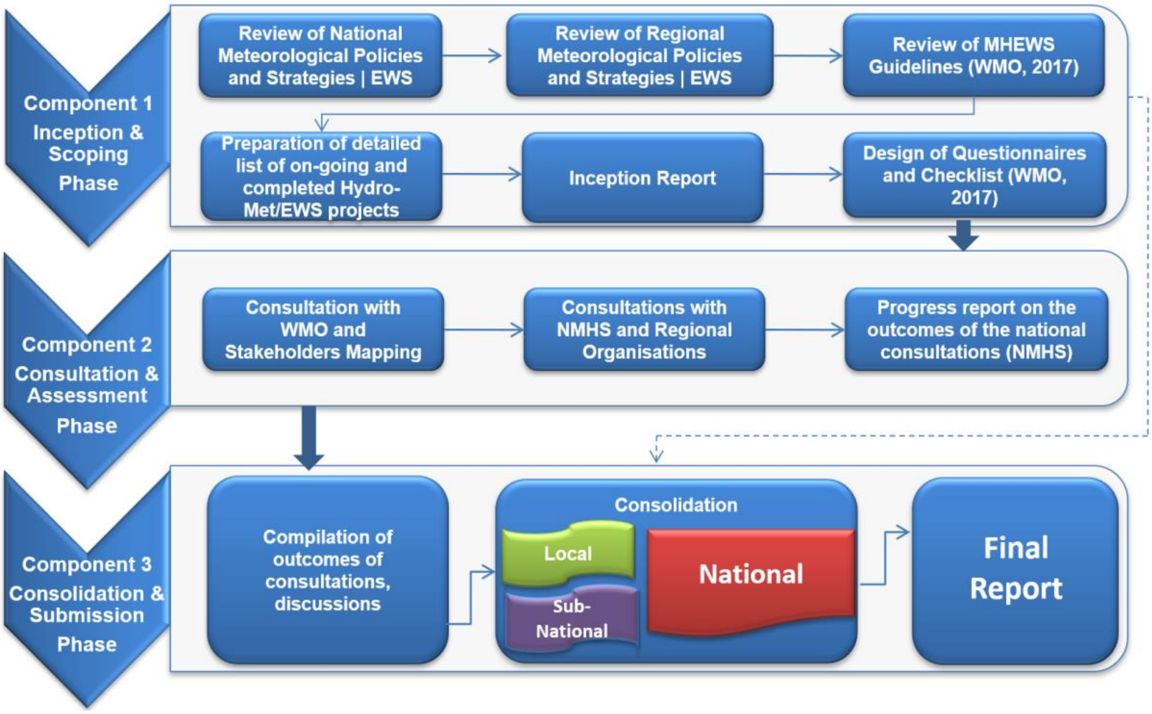
and future climate-related drivers of risk for SIDS in the 21st century are sea level rise (SLR), tropical and extra-tropical cyclones, increasing air and sea surface temperatures, and changing rainfall patterns (Allen et al. 2014).

Current and projected climate change for the Pacific islands will have severe impacts on geophysical, biological and socio-economic systems, livelihood and food production of the region. Furthermore, there will be an increased flood risk, salinization of water resources and loss of land in some areas. (Kumar et al., 2020, Wing, 2017). Impacts are cross-cutting, cumulative, depleting national budgets, and limiting development options.

5. Approach and Methodology

A systematic process was adopted by the project team to assess the MHEWS capacities, needs and gaps, particularly with respect to the systems for hydro-meteorological hazards in Cook Islands, Fiji, Kiribati, Nauru, Niue, Tokelau and Tuvalu. **Figure (5)** represents approach and methodology of the assignment.

Figure (5): Approach and Methodology



Source: ADPC, 2020

It is evident from previous discussion that the Pacific region is prone to various hydro-meteorological hazards including floods, droughts and cyclones. Natural hazards are becoming more and more intricate, complex and multi-faceted. The Pacific countries like Cook Islands, Fiji, Kiribati, Nauru, Niue, Tokelau and Tuvalu are extremely vulnerable due to their unique geo-climatic locations. NMHSs in these countries are mandated and accountable to provide short- and long-range weather forecast as well as early warning to disaster management institutions, island councils and communities.

Recognizing the fact that the frequency and severity of hydro-meteorological hazards is on the rise in changing climatic conditions, existing capacities of NMHSs will not suffice in future. Due to unpredictability and increasing frequency of extreme weather events clearly require significant improvement in the capacities for weather monitoring and forecast and early warning in near future. Although, EWSs exist in these countries, they require timely upgradation and modernization of technology as well as instruments.

In this project, an attempt has been made to assess existing capacities and future needs related to MHEWSs of NMHSs in the project countries. MHEWS capacities and needs of national level agencies have been assessed through key informant interviews and focus group discussions using structured questionnaires. MHEWS assessment involved a systematic flow of understanding the MHEWS structure at the regional, national, and island council levels. They include institutional mechanism & their roles within the elements of MHEWS; delivery of products & services by technical and disaster management agencies, as well as their coordination mechanism/operational cooperation; reviewing of existing mechanism of MHEWSs in countries; role of agencies in the MHEWS and their integration in the disaster management organisations framework; discussion with stakeholders, the gaps & needs in the EWS; capacities of institutions (technical agencies) engaged in EWS; operational cooperation of technical agencies with the emergency departments/functionaries at the district and city levels (emergency management structure and response capabilities); current status and future needs of observation & monitoring capabilities; data management systems; seeking information on pre-computed assessment of risks for various intensity of hazards (risk assessment), hazard analysis and prediction capabilities (threat assessment/potential impact assessment); warning formulation/issuance of guidance and potential outlook/provision of actionable early warning information/warning products; decision making, generation of tailored risk information & dissemination of risk information to at-risk communities or hot-spot locations (risk communication); information technology & telecommunication capabilities; preparation of response options; and institution/emergency responders & community response.

Due to COVID-19 related travel restrictions, all consultations were conducted using online tools, especially Key Informant Interviews (KII) with NMHSs and Focus Group Discussions (FGD) with regional agencies. ADPC prepared a Business Continuity Plan (BCP) with three different scenarios at commencement of the project in May 2020. ADPC was in a unique position to align its approach and methodology during COVID-19 based on these BCP scenarios. ADPC technical team have prior in-depth knowledge and understanding of early warning and related components and also have previous experience of implementation of early warning and hydro-meteorological systems projects in Asia and the Pacific.

5.1 Assessment matrix

MHEWSs have been assessed based on an assessment matrix. This matrix was developed by the ADPC technical team based on four pillars for early warning system suggested by World Meteorological Organization (WMO), including i.) disaster risk knowledge, ii.) detection, monitoring and forecasting of the hazards and possible consequences, iii.) warning dissemination and communication and iv.) preparedness and response capability and few cross-cutting issues such as governance etc. This matrix was tested in previous project in South Asia and South East Asia.

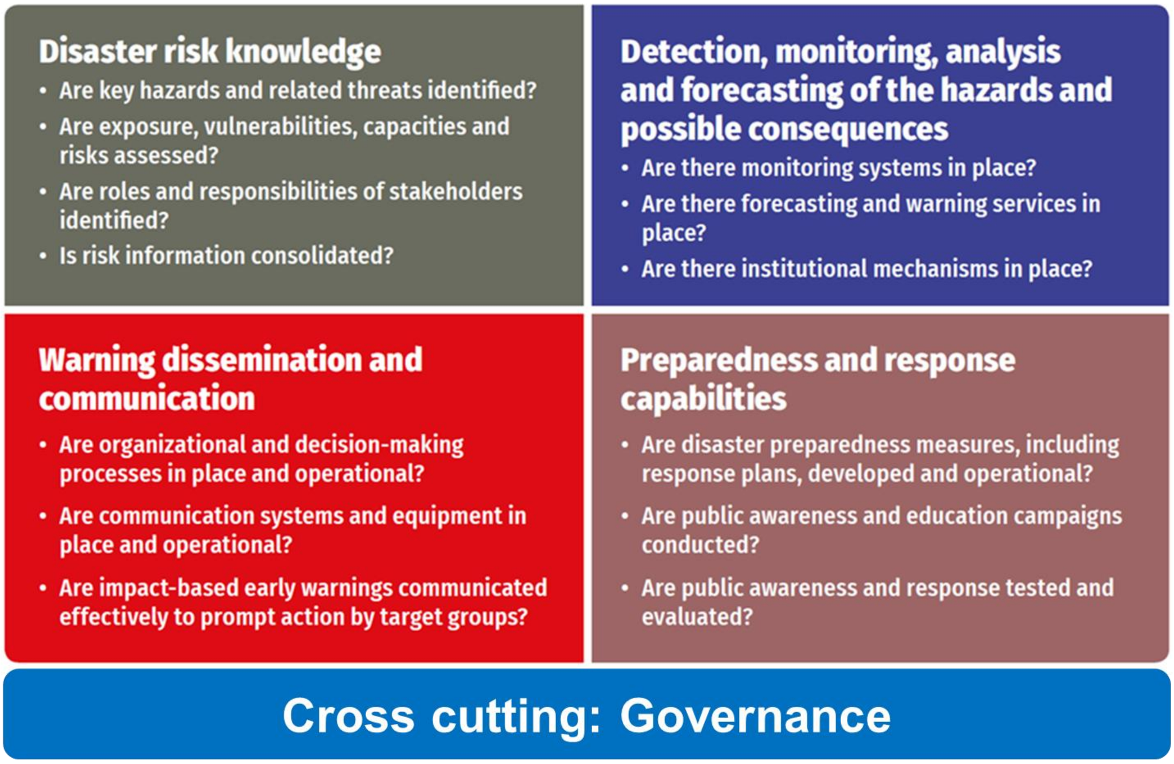
MHEWSs have been assessed through a scoring system ranging from 0-5 with inputs from key representative technical officials from NMHSs. The scores were assigned by the officials of NMHSs based on their experience, perceptions and opinions on existing EWSs at the national, island levels and community level.

The brief description of the scoring system is given below **Table (2).**

Table (2): Scoring system with the scale definitions		
Score	**Levels**	**Scale definition**
0	None	No information on early warning
1	Very Low	Rarely receives the warning messages
2	Low	Flow of early warning information is low
3	Medium	Flow of early warning information is medium
4	High	Quick flow of early warning information
5	Very High	Effective warning system
Source: Dutta et al., 2018[15]		

The thematic key pillars or key components of MHEWSs (WMO, 2017) are presented in **Figure (6)**. In addition to the four key pillars, governance has also been added and assessed as a cross cutting component to support each key pillar to have an effective and people-centric EWS[16].

Figure (6): Key pillars of EWSs



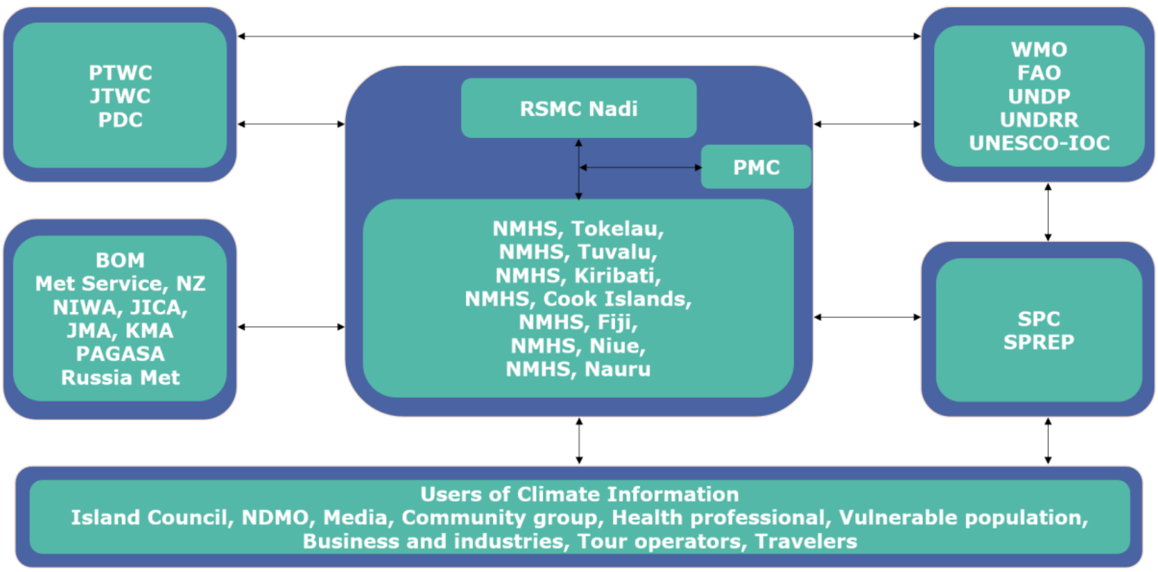
[15] https://pdfs.semanticscholar.org/d98a/e6bcc548ad3ad7168a821ddf5d16d0b0daf4.pdf
[16] WMO (2017), Multi-hazard Early Warning Systems: A Checklist. Accessed Online at; https://public.wmo.int/en/resources/world-meteorological-day/wmd-2018/multi-hazard

Source: Modified from WMO (2017)[17]

It is very essential that these four components need to be coordinated across many agencies at national to local levels for entire system to work. Failure in one component or lack of coordination across them could lead to the failure of the whole system. The issuance of forecast and warnings is a national responsibility; thus, roles and responsibilities of various public and private sector stakeholders for implementation of EWSs should be clarified and reflected in the national to local regulatory frameworks, planning, budgetary, coordination, and operational mechanisms.

MHEWS assessment was carried out with the regional organisations such as the Pacific Community (SPC), Secretariat of the Pacific Regional Environment Programme's (SPREP), Food and Agriculture Organization of the United Nations (FAO), United Nations Development Programme (UNDP) Samoa, United Nations Development Programme (UNDP) Fiji, The United Nations Office for Disaster Risk Reduction (UNDRR), The Intergovernmental Oceanographic Commission of UNESCO (IOC UNESCO) and NMHSs of Cook Islands, Fiji, Kiribati, Nauru, Niue, Tokelau and Tuvalu on current status of multi-hazard early warning system. Apart from these consultations, under the aegis of WMO Pacific Office, other consultations were held including consultation with Weather Ready Pacific Program from Bureau of Meteorology (BOM), Australia. **Figure (7)** represents schematic of interlinkages among MHEWS stakeholders in the project countries.

Figure (7): Schematic of interlinkages among MHEWS Stakeholders in the project countries



[17] WMO (2017), Multi-hazard Early Warning Systems: A Checklist. Accessed Online at; https://public.wmo.int/en/resources/world-meteorological-day/wmd-2018/multi-hazard

Source: ADPC Assessment, 2021

The assessment on MHEWS capacities, needs and gaps consisted of various key parameters, namely;

- *Existing governance and institutional arrangements;*
- *Existing hazard monitoring, forecasting, and mandates for warning development;*
- *Development of understandable, authoritative, recognizable and timely warnings;*
- *Warning dissemination mechanisms;*
- *Emergency preparedness and response activities (national to sub-national to local);*
- *Development of warnings and related products and services for the disaster risk management user community;*
- *Overall operational framework of EWSs.*

The FGDs involved in the assessment were carried out using a structured questionnaire form followed by an online questionnaire form (via Survey Monkey Platform). The structured questionnaire form included a list of key guiding questions which were shared with regional and national organisations before each consultation. The list of questions are as follows:

- What is NMHS mandate and role as a national organisation in your country (especially in climate services and multi hazard early warning systems)?
- What type of funding mechanism NMHS have for climate services and MHEWSs? What should development partners be aware of, and do differently when implementing programmes/projects, to really help strengthen the MHEWSs of Pacific Island Countries?
- What are the key projects NMHS is implementing related to climate services and multi hazard early warning systems?
- Which programmes/projects/activities are you currently undertaking to strengthen DRR/CCA in the context of hydrometeorological hazards, especially with regards to single and multi-hazard EWSs?
- What is the climate and early warning information sharing mechanism between NMHS and NDMO/Community Based Organisations (especially in climate services and multi hazard early warning systems)?
- How does NMHS enhance/build capacities of its experts in climate services and MHEWSs?
- What are the key challenges for NMHS related to climate services and MHEWSs? Where do you see the remaining gaps, needs and challenges (in which countries/islands, which components of EWSs/hydro-met service delivery chain) and for which hazards) in the Pacific? How can these be best addressed by development projects and which partners should be involved/are best placed to do so?
- What are the best practices (which other NMHSs can learn) of NMHS related to climate services and MHEWSs? Where do you see recent successes/achievements/good practices regarding early warning (which countries/islands but also which components of EWSs and for which hazards) in the Pacific?
- What type of support NMHS will need in future to enhance their capacity in climate services and capacity of MHEWSs?
- Have you conducted any detailed technical hazard, vulnerability and risk assessment in your country?

- Where are we in terms of achieving the targets set in the PIMS/PRCS and other regional frameworks? Where are the countries in monitoring and achieving Sendai Target G?
- How can the sustainability of project outcomes be achieved?

After each consultation, the link of the online questionnaire form (Annex II) via Survey Monkey Platform was shared among the participants, in order to collect further responses.

5.1 Limitations:

The findings of this study have to be seen in light of some limitations and that could be addressed in future projects in the Pacific region.

- ADPC technical team members were not able to travel in project countries, due to COVID-19 related travel restrictions. Keeping the travel restrictions and time constraints, ADPC completed all regional and national consultations online;
- The study originally planned in-country consultations and discussions with certain organisations and people (in KII and FGD mode). Due to the pandemic, ADPC technical team faced the problem of having limited access to these respondents. Due to this limited access, ADPC technical team redesigned/ restructured the consultation and discussion approaches and methods;
- ADPC technical team were only able to consult and discuss with one representative of NMHS from project countries for only an hour. In normal conditions, ADPC technical team allocate a full day or two for the discussion with NMHS to conduct MHEWS assessment in KII and FGD mode;
- Verification of views and inputs are very crucial in qualitative assessment. There was limited opportunity to verify the views and inputs from representative respondents of NMHS on MHEWS assessment;
- There was no opportunity to discuss with NDMO and other stakeholders such as island councils, NGO/CBO or communities. NDMO plays very crucial role in EWSs.
- There was no opportunity to take field notes and review many key documents such as past/ongoing project reports, polices, acts, guidelines, plans which are not available in digital format or not available online;
- There was no opportunity to capture some traditional knowledge of communities on early warning in project countries;
- There was no opportunity to observe the MHEWS infrastructure (including tools and technology) in physical conditions.

6. Country level MHEWS assessment

6.1 Regional collaboration

Regional organisations are well placed to strengthen regional coordination on hazard detection and analytical services for a range of hazards, particularly meteorological services. Both the Secretariat for the Pacific Regional Environment Programme (SPREP) and the Pacific Community (SPC) play a leadership role in managing weather and climate information in addition to obtaining and analysing geophysical information with other international and regional organisations such as UNDP, UNDRR, FAO.

The *Pacific Islands Meteorological Strategy 2012-21* (PIMS Strategy) provide a mechanism for improved donor coordination on future EWS or MHEWS investments. There are clear objectives to enhance regional MHEWS capacity in the PIMS. SPREP manages the PIMS through the Pacific Meteorological Council (PMC). There may be scope to organise development partner communities of practice through the PMC, to ensure investments are coordinated.

At the global level, the World Meteorological Organisation (WMO) provides a framework for coordination of NMHSs, setting standards and maintaining a regional centre in Fiji. The ultimate aim of the WMO regional programme is to support NMHSs to provide weather, climate and water information services to the various socio-economic sectors in their countries, and also to contribute to the regional and global observation system. The WMO recently launched a MHEWS initiative in support of the Sendai Framework.

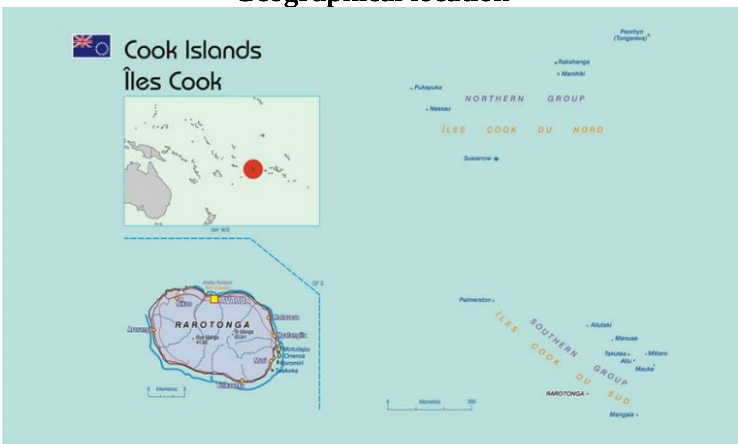
Both international and regional organisations are trying to move towards integrated systems for early warning across the Pacific. Despite some positive steps, it is not clear how this will be achieved without stronger cross-institutional collaboration and a clearer definition of roles and mandates across regional organisations. For example, SPC assists countries with geohazard and hydrological capacity building (flood, landslide, earthquake and tsunami), and coordinates disaster response activities, while SPREP provides significant leadership on climate and meteorological matters (climate change, drought, cyclone and storm surge). SPC also provides technical services to Pacific countries on a range of areas relevant to building capacity in MHEWSs. There is a need to clarify mandates to ensure alignment of effort.

Opportunities to clarify mandates may be provided by the draft Strategy for Climate and Disaster Resilient Development in the Pacific (SRDP). Another avenue may be through the PIFs, which has already brought Ministers together to agree to MHEWS as a priority. Yet, another option may be the newly established SPREP Pacific Climate Change Centre in Apia. Considering the number of options, further discussion aimed at how to coordinate work on EWSs would be beneficial.

While regional organisations have an important role to play in ensuring a coordinated approach in building EWS capacity, Fiji and Vanuatu play a leadership role in meteorological services. These countries have advanced national meteorological services which provide forecasting services and capacity building to smaller neighbouring countries. There is less capacity in countries such as Solomon Islands to provide advanced forecasting and warnings.

6.2 Cook Islands

Cook Islands is a group of the 15 islands and coral atolls are scattered over 2 million km² between American Samoa to the west and French Polynesia to the east. Nine of the islands are of volcanic origin and only 13 are inhabited. **Table (3)** represents country summary of Cook Islands.

<table>
<tr><th colspan="2">Table (3): Country profile: Cook Islands</th></tr>
<tr><td>Capital: Rarotonga</td><td rowspan="9">Geographical location


Source: Pacific Community[18]</td></tr>
<tr><td>Location: 21°12'S 159°46'W</td></tr>
<tr><td>Geographical area: 237 km²</td></tr>
<tr><td>Population: 15,200</td></tr>
<tr><td>Max height above sea level:
652 m</td></tr>
<tr><td>RSMC: Nadi</td></tr>
<tr><td>NMHS: Cook Islands Met Service
WMO member: October 1995[19]</td></tr>
<tr><td>Climate Risk Index Score: NA
Climate Risk Index Rank: NA</td></tr>
<tr><td>INFORM Risk Index: NA
INFORM Risk Class: NA
INFORM Risk Rank: NA</td></tr>
</table>

6.2.1 Overview of susceptibility to hazards:

The Cook Islands are highly vulnerable to natural hazards and the effects of climate change. Cyclones are the most frequently occurring disaster, causing casualties and severe damage to property and infrastructure. Rising sea levels, increases in extreme waves, tropical cyclones and storms, and changing rainfall patterns are exacerbating extreme coastal hazards. As a result, the ecosystems on which island population rely for their livelihoods are increasingly threatened and at risk of destruction.

Emergency Management Cook Islands (EMCI) is the government's full-time disaster risk management coordination office to manage crisis prevention, response and recovery. The role of EMCI is to strengthen Cook Islands resilience to the threats of disasters and climate change to achieve sustainable livelihoods. **Table (4)** represents susceptibility to natural hazards in Cook Islands.

[18] https://www.spc.int/our-members/Cook-Islands
[19] WMO: https://public.wmo.int/en/about-us/members

Table (4): Susceptibility to natural hazards in Cook Islands		
Natural hazards	**Hazard type**	**Susceptibility**
Cyclone	Hydro-Meteorological	High
Tsunami	Geological	High
Coastal flood	Hydro-Meteorological	Medium
Extreme Heat	Hydro-Meteorological	Medium
Earthquake	Geological	Very Low
Wildfire	Other	Very Low
River flood	Hydro-Meteorological	No Data
Urban flood	Hydro-Meteorological	No Data
Landslide	Geological	No Data
Volcano	Geological	No Data
Drought and Water Scarcity	Hydro-Meteorological	No Data
Source: GFDRR | ThinkHazard[20]		

6.2.2 National Meteorological and Hydrological Service (NMHS)

Cook Islands Meteorological Service (CIMS)

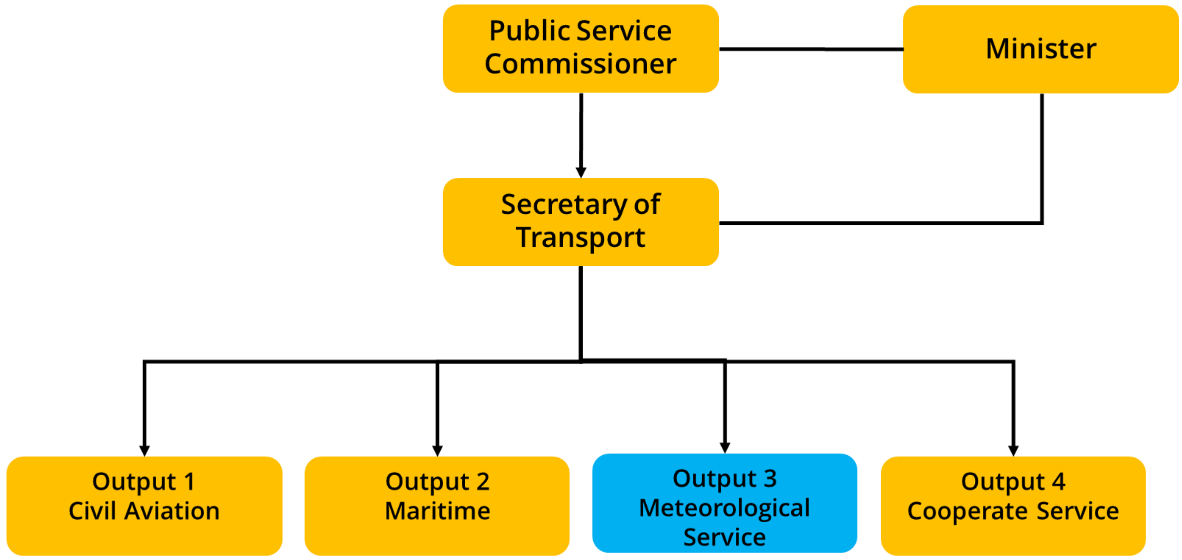
Cook Islands Meteorological Service (CIMS) is tasked with the responsibility of providing climate services and multi hazard early warnings to the stakeholders and the general public in Cook Islands. The met office provides daily weather forecasts based on the information received from RSMC-Nadi. The Ministry of Infrastructure of Cook Islands (ICI) handles water and hydrology services.

Organisation Structure

CIMS is a division of the Ministry of Transport and it operates under Cook Islands Meteorology Act 1995-96. **Figure (8)** represents organogram of CIMS in the Ministry of Transport.

[20] https://thinkhazard.org/en/report/60-cook-islands-n-z

Figure (8): Organogram of Cook Islands Meteorological Service



Source: Love et al., 2018

6.2.3 Key programs

Early Action Rainfall (EAR) Watch Program is implemented by the CIMS with the support of the Australia Bureau of Meteorology (BOM), International Federation of Red Cross and Red Crescent Societies and the SPREP.

The main aim of the EAR Watch program is to provide sectors with information on rainfall variation over the past 12 months and rainfall forecast for the coming months to help them better plan, prepare and respond (SPREP, 2019a).

CIMS installed three Automatic Weather Stations (AWSs) under The Disaster Resilience for Pacific Small Island Developing States (RESPAC) Project. Presently, there are total ten AWSs working at present in the Cook Islands.

The Green Climate Fund (GCF) Project titled "Enhancing Climate Information and Knowledge Services for resilience in 5 island countries of the Pacific Ocean"[21] will support Cook Islands in the field of climate-resilient sustainable development.

This project aims to support increased climate-resilient sustainable development of 100,000 beneficiaries in the Cook Islands, Niue, Palau, the Republic of the Marshall Islands and Tuvalu through the achievement of three outcomes, including (i) increased generation and use of climate information in decision making; (ii) strengthened adaptive capacity and reduced exposure to climate risks; and (iii) strengthened awareness of climate threats and risk-reduction processes.

[21] https://www.greenclimate.fund/project/fp147

6.2.4 Training and capacity building

CIMS consists of 13 technical and non-technical human resources. The met office provides a basic training to staff at the initial stages (Internal training). In addition, they receive advanced training via New Zealand Met Service and the Fiji Meteorological Service (FMS). CIMS seeks the guidance of (FMS) to improve its competency in aviation observations.

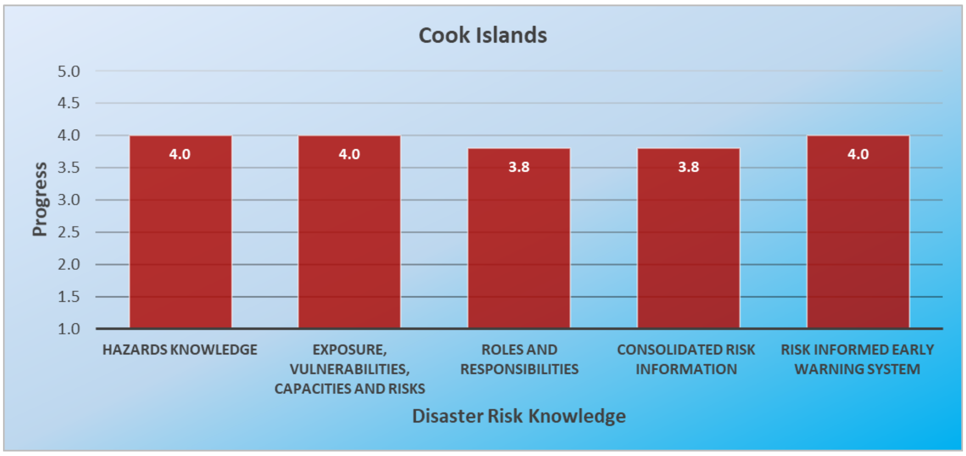
6.2.5 Present status of the MHEWS

Pillar 1: Disaster Risk Knowledge

Emergency Management Cook Islands (EMCI) is the government's full-time disaster risk management coordination office to manage crisis prevention, response and recovery which acts as the National Disaster Management Office (NDMO). The role of EMCI is to strengthen Cook Islands resilience to the threats of disasters and climate change to achieve sustainable livelihoods. Work related to hazard identification and risk assessments are carried out by EMCI.

All the major themes related to Disaster risk knowledge pillar have shown a major progress in their development. **Figure (9)** summarises the progress of different themes which fall under the 1st Pillar: Disaster Risk Knowledge.

Figure (9): Level of progress: Disaster Risk Knowledge



1-No progress; 2-Minimal progress; 3-Moderate progress; 4-Major progress; 5-Completed

Pillar 2: Detection, Monitoring, Analysis and Forecasting of the Hazards and Possible Consequences

CIMS develops weather forecasts based on the information received from FMS, National Institute of Water and Atmospheric Research (NIWA), and the BOM. Marine weather forecasts are mainly based on the weather products provided by FMS. Information on Tsunami warnings are received from Pacific Tsunami Warning Center (PTWC) in Hawaii. CIMS issues cyclone warnings in assistance with FMS. The met office does not use numerical weather products from BOM or New Zealand Met Service to produce localized weather products. They issue only generalise weather forecasting. CIMS has one manual weather station in Rarotonga, the capital city of Cook Islands. At the present time, the met office is equipped with ten AWSs. CIMS carry out upper air observations through a GPS sounding system. The Ministry of Infrastructure of Cook Islands (ICI) handles water and hydrology services in country**. Figure (10)** represents automatic weather station at Manihiki.

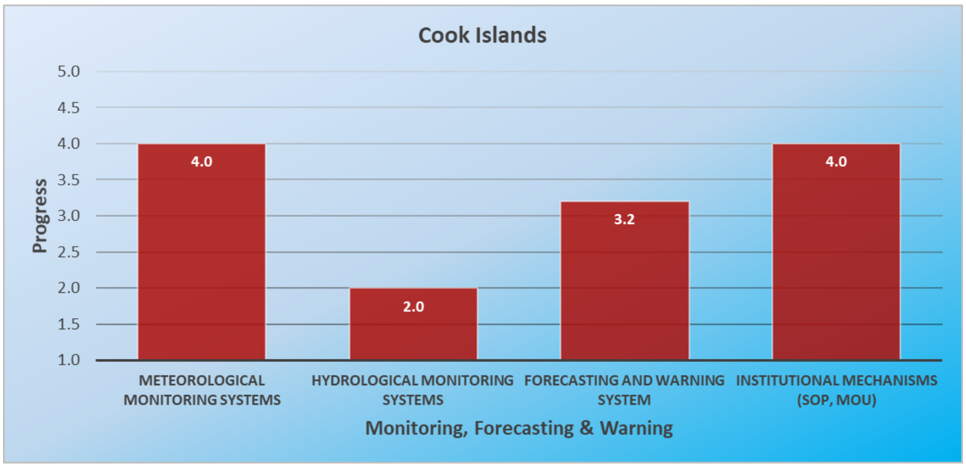
Figure (10): Automatic Weather Station at Manihiki

Source: Facebook Page[22]

The survey results indicate that the major themes under the pillar have shown a moderate to major level of progress except for one theme which is "Hydrological Monitoring Systems". It is the least developed theme and hence more work is need to be carried out for its improvement. **Figure (11)** summarises the progress of different themes which fall under the 2nd Pillar: Detection, Monitoring and Forecasting.

[22] https://www.facebook.com/cookislands.meteorological/?ref=page_internal

Figure (11): Level of progress: Detection, Monitoring & Forecasting



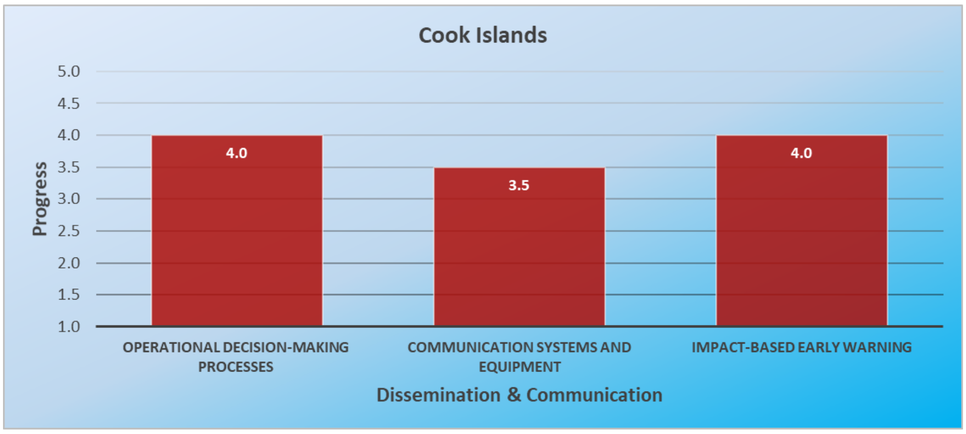
1-No progress; 2-Minimal progress; 3-Moderate progress; 4-Major progress; 5-Completed

Pillar 3: Warning, Dissemination and Communication

CIMS disseminates climate & weather information mainly through radio. In addition, different media such as television, social media (Eg: Facebook[23]) and CIMS website[24] are also used in information dissemination. The met office is conducting a segment at the latter half of the television news program on weather forecasts for Cook Islands. The internet and mobile phone coverage are improving in Cook Islands. At present 80-90% of the population has mobile phones. Hence, dissemination of weather/ climate information via social media can be considered as effective. The met office passes on weather/ climate information and emergency warnings to EMCI and the Disaster Council based at capital city in order to facilitate their operations. CIMS also provides weather/climate (forecasting) services to the tourism industry as well (Eg: Hotels). CIMS has shown a major level of progress with respect to operational decision-making process and impact based early warning. The theme "Communication Systems and Equipment" has shown a moderate to major level of progress. **Figure (12)** summarises the progress of different themes which fall under the 3rd Pillar: Warning, dissemination and communication.

[23] https://www.facebook.com/cookislands.meteorological
[24] https://www.met.gov.ck/

Figure (12): Level of progress: Warning, Dissemination & Communication



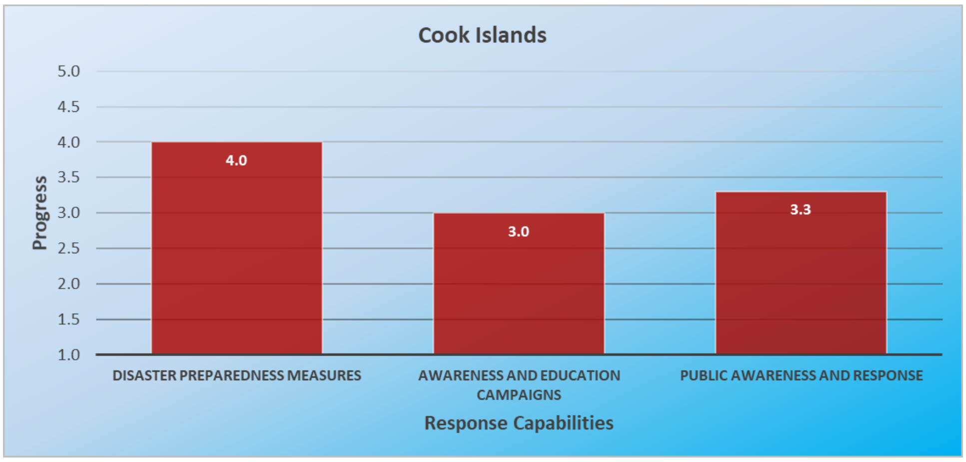
1-No progress; 2-Minimal progress; 3-Moderate progress; 4-Major progress; 5-Completed

Pillar 4: Preparedness and Response Capabilities

CIMS conducts monthly ocean climate outlook forums with the stakeholders. Community programmes are conducted to improve the awareness of local people on weather/ climate related subjects. Tsunami drills have also been conducted. EMCI which functions as the NDMO for Cook Islands is also engaged in community awareness programmes. Distribution of awareness materials such as brochures, leaflets etc. among the community and advertising awareness materials in TV are some of the activities conducted by EMCI.

The theme "Disaster Preparedness Measures" is the most developed theme with a major progress level. The other two themes "Awareness and Education" and "Public Awareness and Response" have shown a moderate to major level of development. **Figure (13)** summarises the progress of different themes which fall under the 4th Pillar: Preparedness and response capabilities.

Figure (13): Level of progress: Preparedness & Response Capabilities



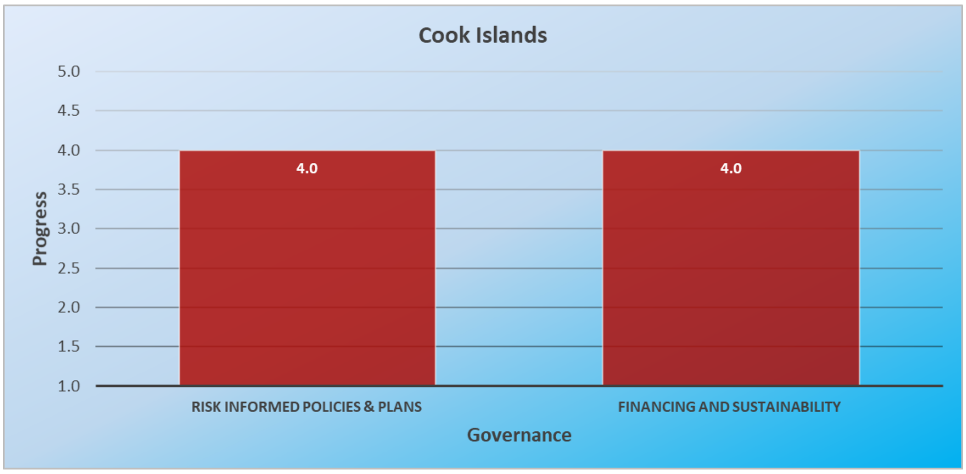
1-No progress; 2-Minimal progress; 3-Moderate progress; 4-Major progress; 5-Completed

Pillar 5: Governance

CIMS operates under Cook Islands Meteorology Act 1995 which defines its roles and responsibilities. The government of Cook Islands provides CIMS with a limited budget to cover up its operational requisites. CIMS receives other financial resources via different projects (Eg: RESPAC, COSSPac). CIMS highlights that the sustainability of project outcomes can be achieved by improving the capacity of staff in maintenance of high-tech equipment (AWSs).

If not, AWSs would not sustain in the long term due to lack of competency in maintaining them. CIMS staff turnover has stabilized due to increment in salaries and introduction of incentive packages. The survey indicated that the two themes under Governance, "Risk Informed Policies & Plans" and "Financing and Sustainability" have shown major level of progress. **Figure (14)** summarises the progress of different themes which fall under the 5th Pillar: Governance.

Figure (14): Level of progress: Governance



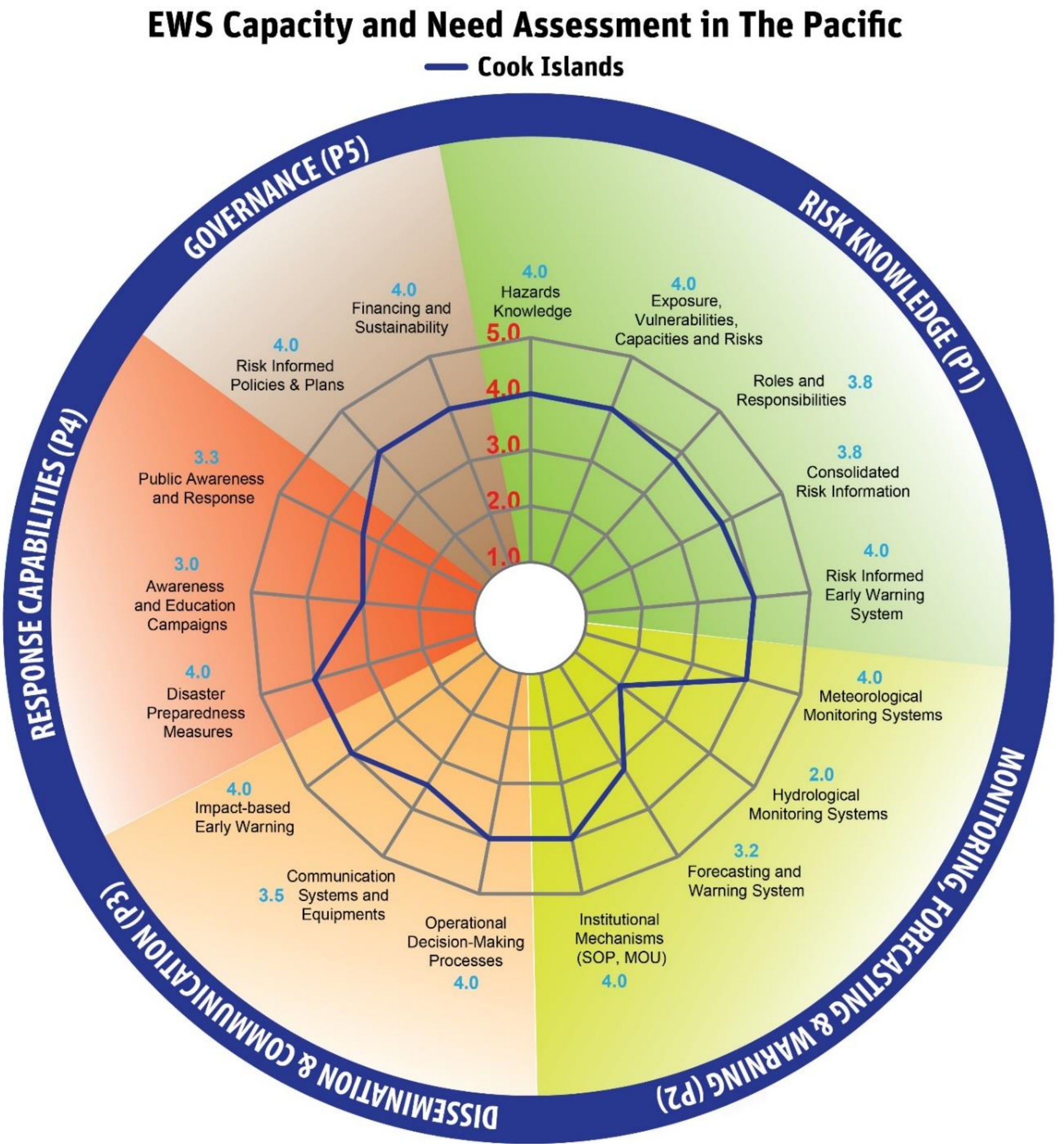
1-No progress; 2-Minimal progress; 3-Moderate progress; 4-Major progress; 5-Completed

6.2.6 Summary

Overview of the MHEWS

The spider web diagram presented in **Figure (15)** summarises the present status of the MHEWS in the Cook Islands which has shown a fairly good level of development. However, a major improvement is needed on the theme "Hydrological Monitoring Systems" which seems to be having a minimal level of development. In addition, further improvements on the themes "Forecasting & Warning System", "Awareness & Education Campaigns" and "Public Awareness & Response" would improve the overall functioning of the MHEWS.

Figure (15): Status of MHEWS in Cook Islands

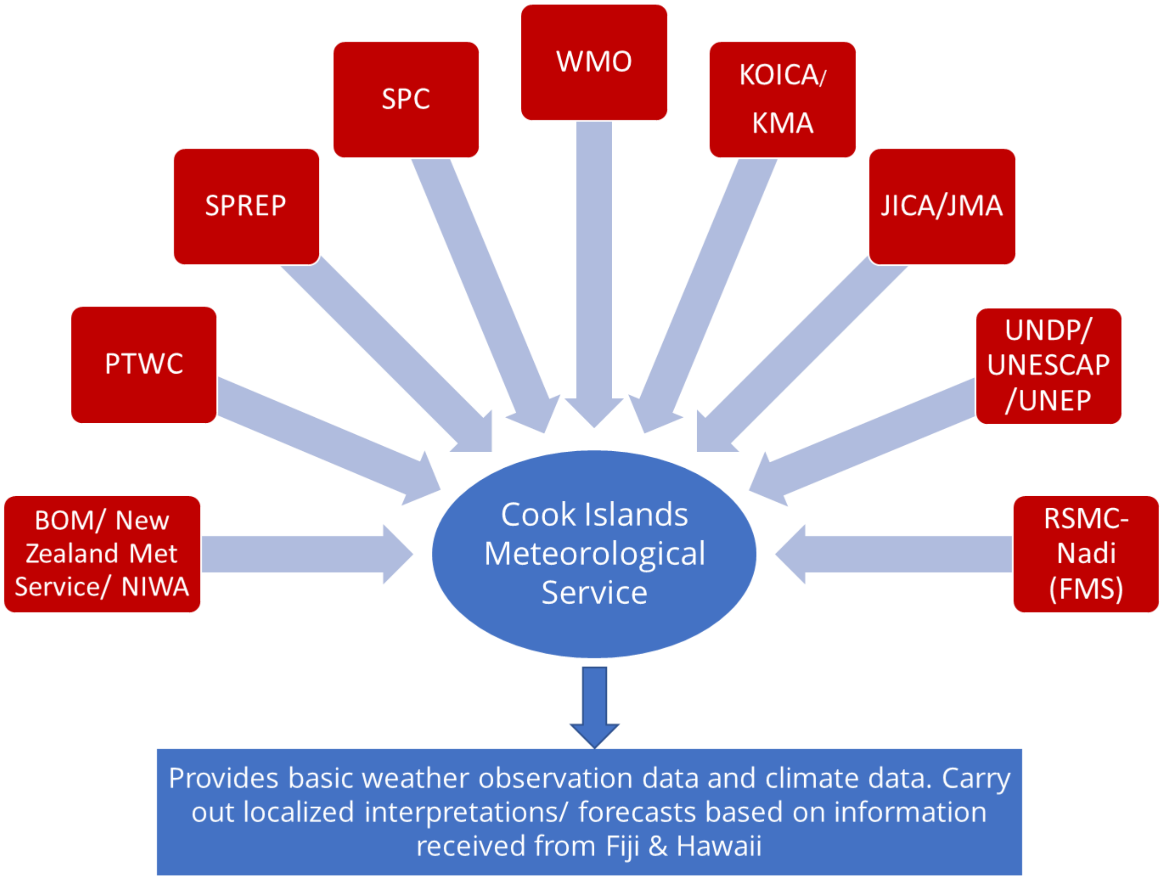


Source: ADPC assessment

Development partners

The development partners associated with CIMS in assisting to build their MHEWS is mapped in the **Figure (16).**

Figure (16): Linkages of CIMS with development partners



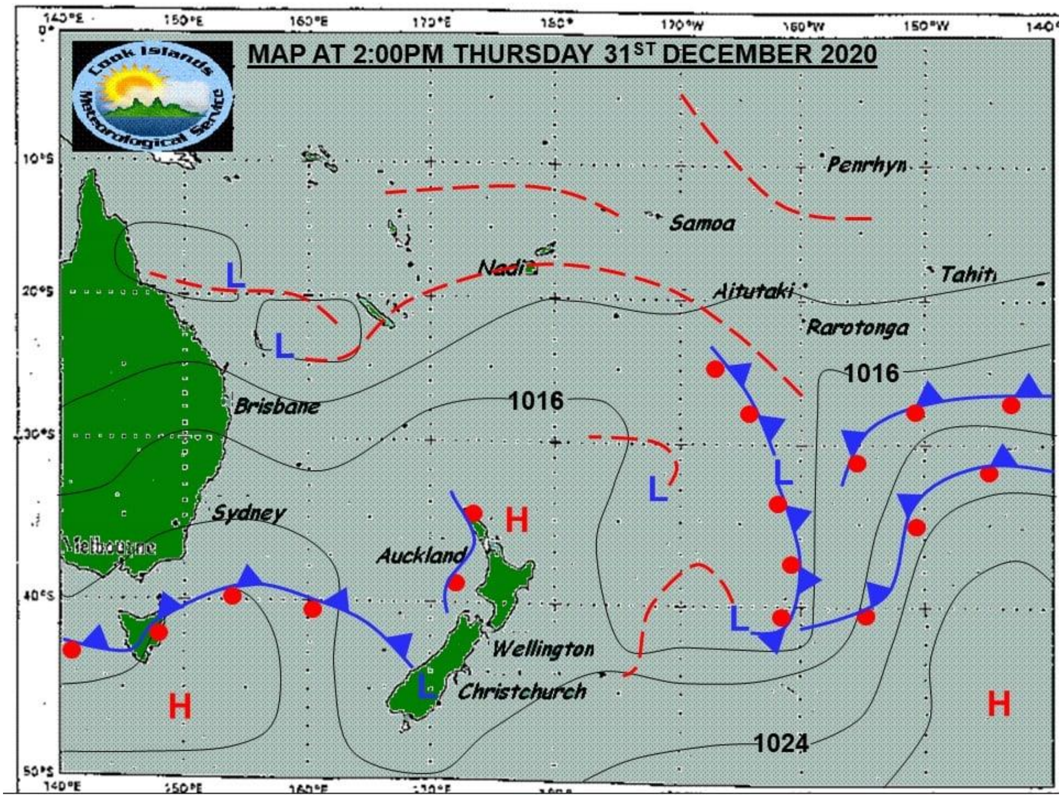
Source: NMHS consultation

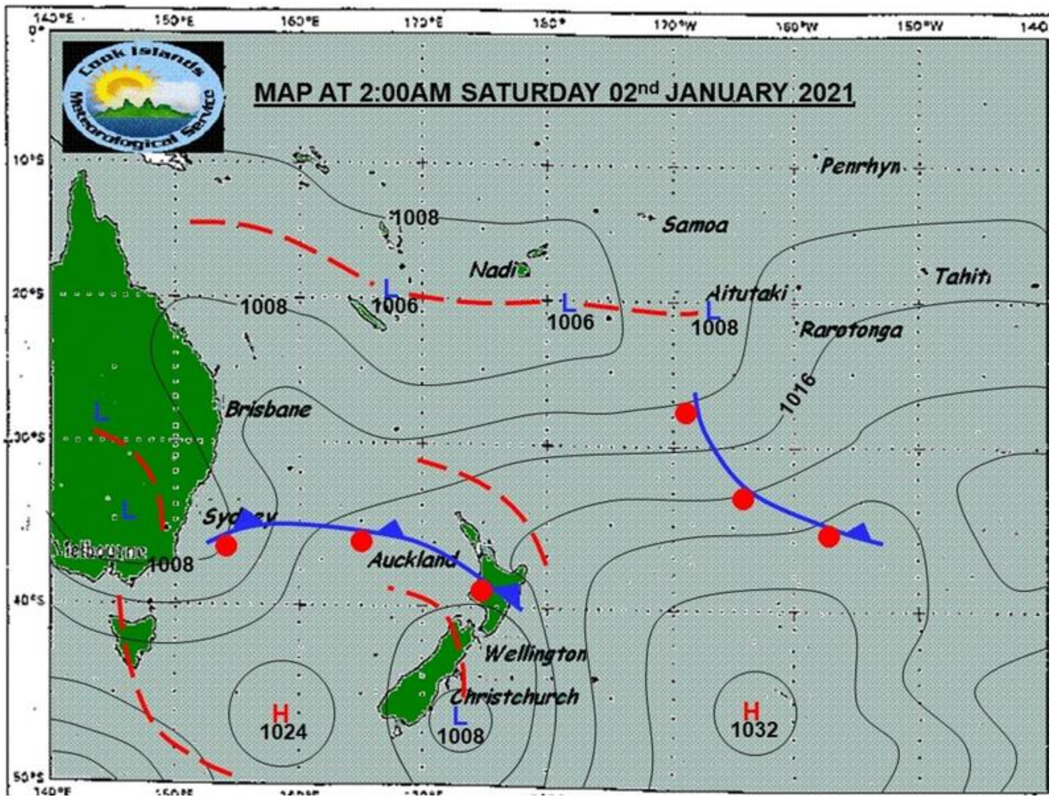
Best Practices

- Use of both scientific information and traditional knowledge to identify hazards;
- Awareness/education programs conducted by EMCI especially for the kids in the schools. As a result, people have a general awareness of the tropical cyclone season and have a basic preparation;
- CIMS issues daily Weather Bulletin for Northern and Southern Cooks Islands **Figure (17)** represents the Weather Bulletin issued by CIMS on 01st January 2021.[25]
- CIMS also issues Early Action Rainfall Watch with the help of BOM. **Figure (18, 19 and 20)** represents Early Action Rainfall Watch bulletin.[26]

[25] https://www.facebook.com/cookislands.meteorological/?ref=page_internal
[26] https://www.facebook.com/cookislands.meteorological/?ref=page_internal

Figure (17): Daily Weather Bulletin for Northern and Southern Cooks Islands





Source: CIMS Facebook Page[27]

[27] https://www.facebook.com/cookislands.meteorological/?ref=page_internal

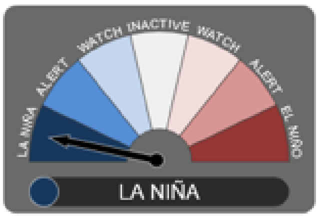
Figure (18): Early Action Rainfall Watch for Northern and Southern Cooks Islands

Cook Islands Meteorological Service
Early Action Rainfall Watch

The Early Action Rainfall Watch provides sector managers with a brief summay of recent rainfall patterns, particularly drought and the rainfall outlook for the coming months.

Issued: 07/01/2021

Current El Niño-Southern Oscillation (ENSO) status: The Australian Bureau of Meteorology's ENSO Outlook remains at **La Niña**. The event is near its peak, with a return to **neutral** expected in the late southern summer or early autumn 2021. La Niña is normally associated with above average rainfall in the southern Cook Islands and below above average rainfall in the northern Cook Islands (opposite during El Niño).



Status summary:
Penrhyn is now in "Meteorological Drought" for periods from one to six months, while remaining at Drought Warning for the past 12 months. Rainfall has also decreased at Rarotonga where "Drought Warning" is current for the past one and three months, while the six month total is only slightly above the Warning threshold.

Outlook summary:
For **January**, "High Chance Dry" alerts are in place for all northern Cook Island sites (Penrhyn, Rakahanga and Pukapuka), and most Southern Cook Island sites, the only exceptions being Rarotonga (Low Chance Dry), and Mangaia (No Alert).

For **January to March 2021**, "High Chance Dry" alerts are in place for all northern Cook Island sites (Penrhyn, Rakahanga and Pukapuka), and most Southern Cook Island sites, the only exceptions being Rarotonga (Low Chance Dry), and Mangaia (Low Chance Wet). See table/maps below for additional information. See status table below for potential impacts.

Rainfall status at the end of December 2020, Outlook to March 2021

Northern Cook Islands						
	Rainfall Status				Rainfall Outlook	
	Past 12 months	Past 6 months	Past 3 months	Past month	Next month Jan. 2021	Next 3 months to Mar. 2021
Penrhyn						
Rakahanga						
Pukapuka						
Southern Cook Islands						
	Rainfall Status				Rainfall Outlook	
	Past 12 months	Past 6 months	Past 3 months	Past month	Next month Jan. 2021	Next 3 months to Mar. 2021
Aitutaki						
Mauke						
Rarotonga						

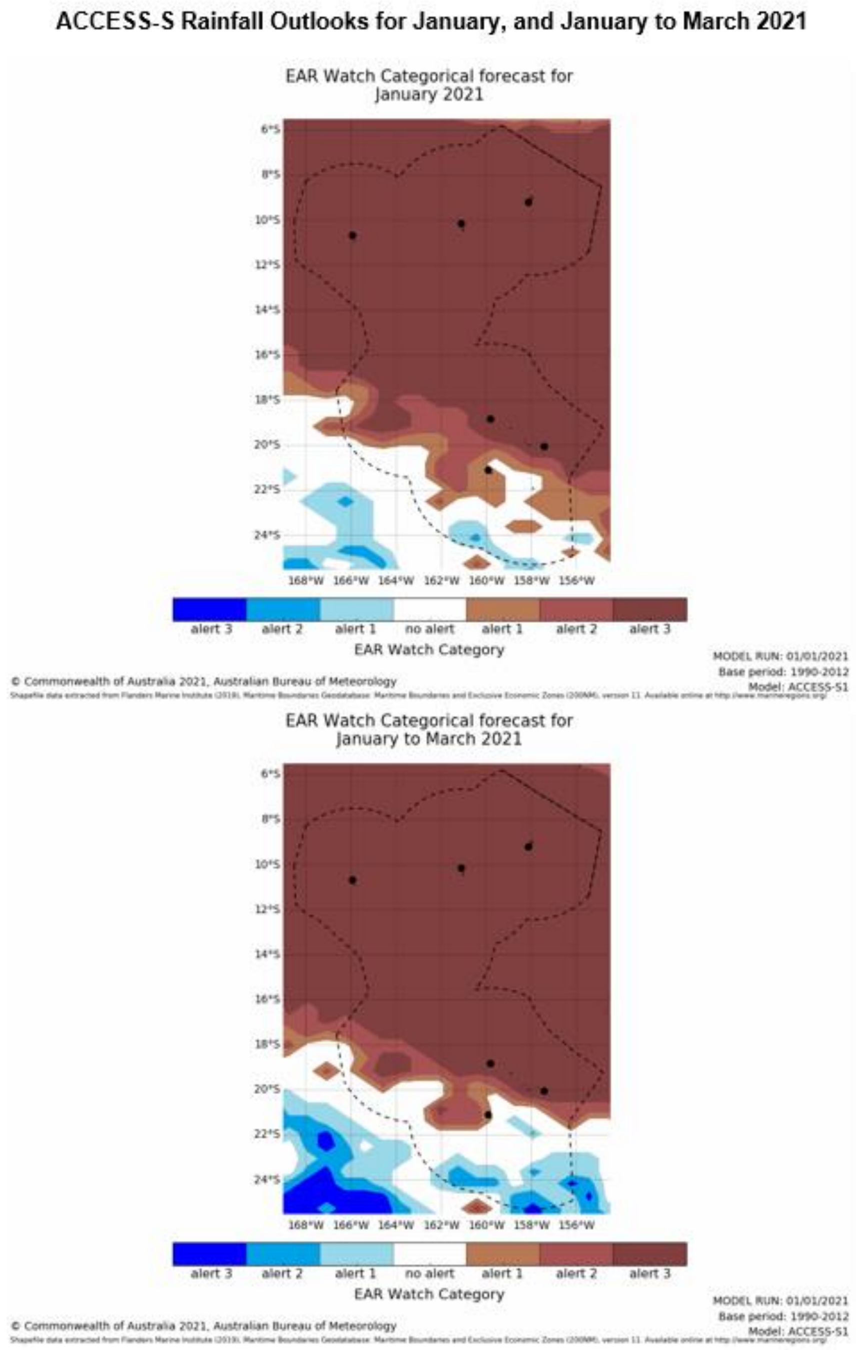
Rainfall status key	Meteorological Drought	Drought Warning	Drought Watch	Missing Observations	No Alert	Very Wet

Outlook Key	High Chance Dry	Medium Chance Dry	Low Chance Dry	Outlook not available	No Alert	Low Chance Wet	Medium Chance Wet	High Chance Wet

Source: CIMS Facebook Page[28]

[28] https://www.facebook.com/cookislands.meteorological/?ref=page_internal

Figure (19): Rainfall Outlook for Northern and Southern Cooks Islands



Source: CIMS Facebook Page[29]

[29] https://www.facebook.com/cookislands.meteorological/?ref=page_internal

Figure (20): Rainfall Outlook for Northern and Southern Cooks Islands

Rainfall status

The Percentile Index is used to assess rainfall status. Meteorological Drought is defined as drought assessed by rainfall data only. A station is assigned 'No Alert' when rainfall has been near normal for the period(s) in question.

After the specified period of below or above average rainfall, the following primary agricultural and hydrological variables and secondary socio-economic and health variables may to be impacted. Note the periods are estimates only. Allow for uncertainty associated with island size, topography, geology and soil type. Contact the relevant sector offices for further information on impacts.

Southern Cook Islands				
Sector	1-month period most relevant for	3-month period most relevant for	6-month period most relevant for	12-month period most relevant for
Water	Sanitation issues, household water supply	Low water pressure, water rationing, household water tanks, household water barrels, small streams, intakes, waterfalls	Medium to large streams, intakes, waterfalls, water transportation required	Wells, community tanks
Agriculture	Shallow rooted crops (e.g. tomato, watermelon and lettuce), crop pests and diseases,	Wet and dry taro, pawpaw, mango, oranges, banana, pineapple, raparapa		
Socio-economic and health	Shallow rooted plants (e.g. flowers)	Diarrhoea, increased reliance on imported food, school closure, reduced tourist numbers	Social conflict, water stealing	Livestock death
Northern Cook Islands				
Water	Household water levels reduced			
Agriculture		Loss of some crops		
Socio-economic and health	Health conditions e.g. diarrhoea	Reduced availability of coconuts for food, social conflict increase	Mental health issues e.g. stress and anxiety	Copra yield reduced

Source: CIMS Facebook Page[30]

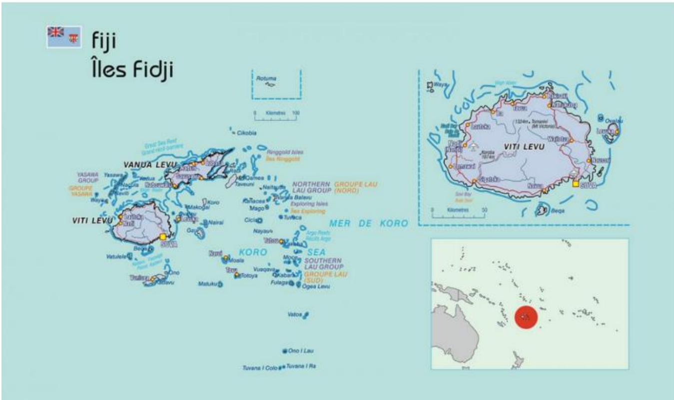
[30] https://www.facebook.com/cookislands.meteorological/?ref=page_internal

6.2.7 Needs and recommendations

Table (4): Needs and recommendations	
Pillar	**Needs and recommendations**
Disaster risk knowledge	• Steps to be taken to further increase the involvement of local communities (urban and rural) in hazard, vulnerability, exposure and risk assessments. • Need to increase the use of consolidated risk information in development of key sectors such as health, infrastructure and agriculture.
Detection, monitoring, analysis and forecasting of the hazards and possible consequences	• Capacity building of staff and more equipment is needed to interpret and derive weather forecasts. • • There is a need to improve on in setting up hydrological monitoring systems including fluvial/pluvial/coastal flood detection/monitoring. • It is essential to have a hydrological data management system and also to ensure that technical equipment is suited to local conditions as well as their routine maintenance. • It is necessary to ensure that forecast and warning system(s) are subjected to regular system-wide maintenance.
Warning, dissemination and communication	• The community expects the messages be disseminated in local language. But translations of some words in English is difficult, because such words do not exist in the local language. Hence, support is needed to generate clear early warning messages. • Need to ensure that communication and dissemination systems are tailored to the different needs of specific groups (urban and rural populations, women and men, older people and youth, people with disabilities, etc.).
Preparedness and response capabilities	• Need to put more efforts in providing public education on recognizing hydro-meteorological hazards in order to improve the community awareness.
Governance	• An increase in the operational budget is needed for maintenance of the equipment that are being installed under various projects.

6.3 Fiji

Fiji is one of the largest and most populated countries in the Pacific. It has a total of 332 islands with a combined land area of 18,000 km² and a sea zone of 1.3 million km². Fiji's population mainly lives on the two largest islands, Viti Levu and Vanua Levu. Suva, the political and business capital of Fiji which is also the regional hub of the Pacific, lies at the south-eastern side of the main island, Viti Levu (World Bank, 2017; Wing, 2017). **Table (5)** represents country profile of Fiji.

<table>
<tr><th colspan="2">Table (5): Country profile - Fiji</th></tr>
<tr><td>Capital: Suva</td><td rowspan="9">Geographical location

Source: Pacific Community[31]</td></tr>
<tr><td>Location: 18°10'S 178°27'E</td></tr>
<tr><td>Geographical area: 18,333 km²</td></tr>
<tr><td>Population: 888,400</td></tr>
<tr><td>Max height above sea level:
1324 m</td></tr>
<tr><td>RSMC: Nadi</td></tr>
<tr><td>NMHS: Fiji Meteorological Services
WMO member: March 1980[32]</td></tr>
<tr><td>Climate Risk Index Score: 22.50[33]
Climate Risk Index Rank: 10 Rank[2]</td></tr>
<tr><td>INFORM Risk Index: 2.9[34]
INFORM Risk Class: Low
INFORM Risk Rank: 124 Rank</td></tr>
</table>

6.3.1 Overview of susceptibility to hazards

Fiji is highly susceptible to natural disasters, particularly cyclones, floods, earthquakes, tsunami and drought. The cyclone/rainy season in Fiji is between November and April. Fiji has a long history of natural hazards such as Cyclone Pam (March, 2015), Tropical Cyclone Winston (February 2016), Tropical Cyclone Gita (February 2018) and Severe Tropical Cyclone Harold (April, 2020). Severe Tropical Cyclone Harold was a very powerful tropical cyclone which caused widespread destruction in the Solomon Islands, Vanuatu, Fiji, and Tonga during April 2020.10 **Table (6)** represents a summary of multi-hazards experienced by Fiji.

[31] https://www.spc.int/our-members/Fiji
[32] WMO: https://public.wmo.int/en/about-us/members
[33] CRI (2020): https://www.germanwatch.org/en/17307
[34] INFORM (2020): https://drmkc.jrc.ec.europa.eu/inform-index/

Table (6): Susceptibility to natural hazards in Fiji		
Natural hazards	**Hazard type**	**Susceptibility**
Cyclone	Hydro-Meteorological	High
River flood	Hydro-Meteorological	High
Urban flood	Hydro-Meteorological	High
Coastal flood	Hydro-Meteorological	High
Earthquake	Geological	High
Landslide	Geological	High
Tsunami	Geological	High
Wildfire	Other	High
Extreme Heat	Hydro-Meteorological	Medium
Volcano	Geological	Low
Drought and Water Scarcity	Hydro-Meteorological	Very low
Source: GFDRR | ThinkHazard[35]		

6.3.2 National Meteorological and Hydrological Service (NMHS)

Fiji Meteorological Service (FMS)

Fiji Meteorological Service (FMS) is responsible in making observations on regional weather & Fiji's climate and hydrological patterns and providing meteorological and hydrological services for the wellbeing of communities as well as assists economic activities. FMS delivers weather forecasts, warnings, projections and other related information in Fiji. In addition, FMS is engaged in providing weather forecasts, warnings and advisory services for other Pacific Island Countries.

FMS also functions as a Regional Specialized Meteorological Centre (RSMC) for tropical cyclones, under the World Weather Watch Programme of the WMO. The activities are conducted according to the guidelines of WMO.

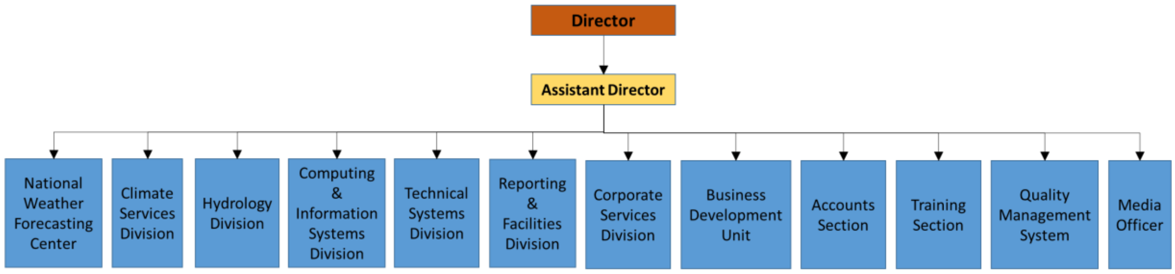
The RSMC is tasked with providing information on tropical cyclones in the South-West Pacific Ocean, such as present and forecast position, movement and intensity. (https://www.met.gov.fj/).

[35] https://thinkhazard.org/en/report/83-fiji

Organisation structure:

FMS is under the Ministry of Infrastructure and Transport and it is headed by a Director. **Figure (21)** presents the organogram of the Fiji Meteorological Service (FMS).

Figure (21): Organogram of Ministry of Infrastructure and Transport



Source: Government of Fiji

There are 12 divisions/ sections with the principal or senior officers in charge. The three output divisions—the Forecasting Centre, Hydrology Division and Climate Services Division—produce outputs and services catering to a wide range of users (government, NGOs, public and private sector agencies, general public at both local and international levels). These are also the largest divisions by staffing (Government of the Republic of Fiji. Department of Meteorology, 2019). The majority of financial resources, for carrying out the activities of FMS come from the Government. In addition, regional organisations such as UNDP, SPREP and SPC assist FMS in carrying out their activities especially with capacity building tasks.

6.3.3 Key programs

At present, FMS implements the “Coastal Inundation Forecasting Demonstration Project Fiji (CIFDP-F): Development of an Integrated Coastal Inundation Forecasting System in Fiji”. The project is funded by Korea Meteorological Administration (KMA). The other project partners are Korea Environment Institute, New Zealand Climate, Freshwater and Ocean Science (NIWA), Tonkin and Taylor, Secretariat of the Pacific Community (SPC), Environment and Climate Change Canada (ECCC) and Australian Bureau of Meteorology (BOM). The results of this project will provide critical information to improve forecasting, warning, and evacuation planning in coastal zones. The coastal residents (end users) in agriculture, fishery, tourism and other industries, disaster managers in central and regional governments (intermediary users) will substantially benefit from this project. In particular, improved forecasting services will serve greatly to ensure safe operation of tourism business, which is a major source of Fiji’s income (WMO, 2020).

6.3.4 Training and capacity building:

FMS ensures that their staff undergoes training on a regular basis. The met office send staff for overseas training at the institutes such as BOM in Australia and Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA). At present, Fiji met service is able to conduct training for observation teams. The Basic Instruction Package for Meteorological (Observation) Technicians (BIP-MT) is organized based on needs, typically once a year or every two years especially when new staff is hired in FMS (Government of the Republic of Fiji, Department of Meteorology, 2019).

The met office relies on WMO for training tasks related to forecasting as the office does not possess resource persons to conduct such trainings within the organisation. In addition, FMS provides trainings for participants and experts from neighboring countries.

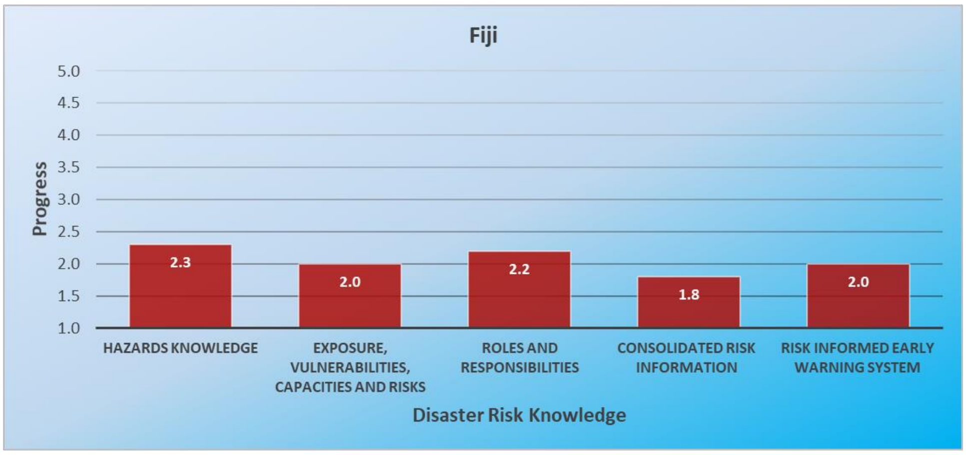
6.3.5 Present status of the MHEWS

Pillar 1: Disaster Risk Knowledge

Fiji National Disaster Management Office (NDMO) is the entity that carries out disaster risk assessments in Fiji. The study reveals that Fiji has a minimal to moderate progress in identifying key hazards and the respective roles & responsibilities of stakeholders. They have made minimal progress in carrying out disaster risk assessments which involve evaluating exposure, vulnerability and capacity. As a result, they lack the capacity in issuing impact-based forecast and warnings to relevant authorities. This is indicated, by showing a minimal progress for the theme "Risk Informed Early Warning System".

"Consolidated Risk Information" is the theme which is least developed under disaster risk knowledge pillar. Lack of a central standardized repository to store all event/disaster and risk information appears to be the major factor which has led to show very minimum progress under this theme. **Figure (22)** summarises the progress of different themes which fall under the 1st Pillar: Disaster Risk Knowledge.

Figure (22): Level of progress: Disaster Risk Knowledge



1-No progress; 2-Minimal progress; 3-Moderate progress; 4-Major progress; 5-Completed

Pillar 2: Detection, Monitoring, Analysis and Forecasting of the Hazards and Possible Consequences

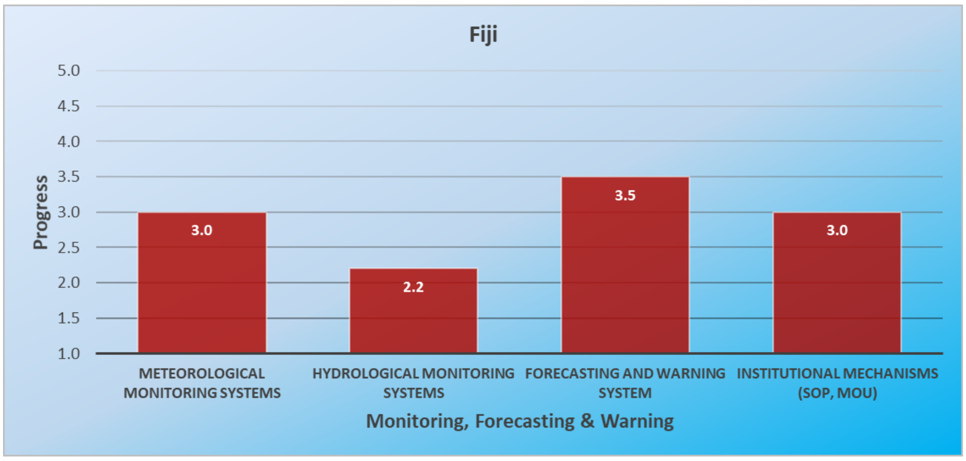
FMS is the main technical agency for detection, monitoring, analysis and forecasting of meteorological hazards. It also provides assistance in climate services to other Pacific Countries. They use global models such as Global Forecast System (GFS) to carry out weather forecasting. The forecasts cover a period of three days. They lack a downscaled weather model which would have permitted them to produce a seven-day forecast. Most of the weather products are developed manually by the forecasters of FMS.

Further, they provide meteorological forecast and warning services for aviation and international shipping in the tropical South-west Pacific waters, as per WMO and International Oceanic Commission requirements.

Flood forecasting and hydrology services are handled by the Hydrology Division under FMS. They have a system which assist them in terms of flash floods. However, they do not possess a flood model that could forecast flood especially in the major rivers.

In assessing the 2nd pillar "Detection, Monitoring and Forecasting", the assessment revealed that Fiji has achieved moderate to major progress with respect to the existence of Forecasting and Warning systems. Further, they have shown moderate progress in setting up meteorological monitoring systems and institutional mechanisms. Setting up of hydrological monitoring systems show a minimal to moderate progress. **Figure (23)** summarises the progress of different themes which fall under the 2nd Pillar: Detection, Monitoring and Forecasting.

Figure (23): Level of progress: Detection, Monitoring and Forecasting of the Hazards and Possible Consequences



1-No progress; 2-Minimal progress; 3-Moderate progress; 4-Major progress; 5-Completed

Pillar 3: Warning, Dissemination and Communication

FMS issues early warnings to the National Disaster Management Office (NDMO) through emails and telephone. NDMO is responsible for disseminating early warnings to the relevant authorities and wider public. FMS issues public weather bulletins, 5 times a day. All those bulletins are broadcasted out in radio to the general public. The agency also posts out messages through social media platforms such as Facebook and Twitter. Facebook[36] is the most commonly used platform. Further, FMS has developed a mobile app recently which would also be used in disseminating weather information to the public.

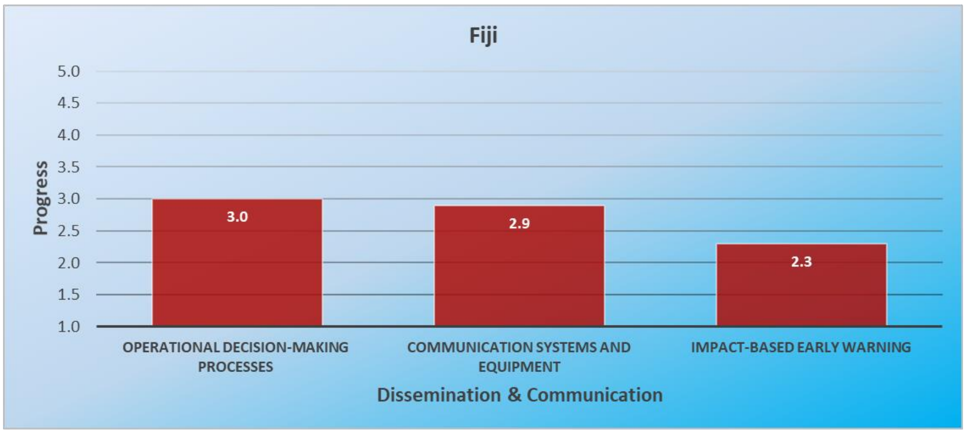
[36] https://www.facebook.com/FijiMetService

FMS has made moderate progress in setting up operational decision-making processes. Within this theme, a major progress has been made in establishing SOPs for early warning dissemination. However, there has been minimal progress in setting up feedback mechanisms to verify that warnings have been received by the end users. Currently, they request stakeholders such as Fiji Air ways to fill in survey forms in order to receive the feedback on the services provided. Such surveys are conducted biannually.

The progress made in establishing communication systems and its operations are close to the moderate level. Attention is required in creating communication and dissemination systems which are tailored to the different needs of specific groups.

The country has made minimum to moderate level progress in communicating effective impact based early warning. The lack of disaster risk assessments, the fact which is highlighted under Disaster Risk Knowledge pillar could be the factor hindering the development of this theme. **Figure (24)** summarises the progress of different themes which fall under the 3rd Pillar: Warning, dissemination and communication.

Figure (24): Level of progress: Warning, Dissemination & Communication



1-No progress; 2-Minimal progress; 3-Moderate progress; 4-Major progress; 5-Completed

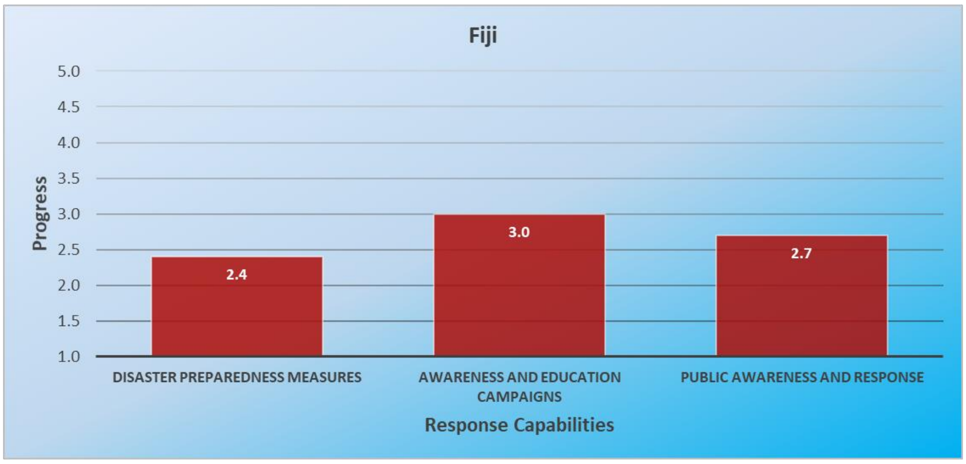
Pillar 4: Preparedness and Response Capabilities

FMS conducts awareness programs among the communities explaining the general public about the weather information issued. The met office also conducts education programs on tropical cyclones. National Disaster Management Office (NDMO) is the entity which carries out simulations and drills (Eg: Tsunami drills).

Under "Preparedness and response capabilities pillar", FMS has shown moderate progress in conducting awareness and education campaigns. With reference to the theme "Public Awareness and Response", there is a progress close to moderate level. Among the three themes, the least developed is "Disaster Preparedness Measures".

Figure (25) summarises the progress of different themes which fall under the 4th Pillar: Preparedness and response capabilities.

Figure (25): Level of progress: Preparedness and Response Capabilities



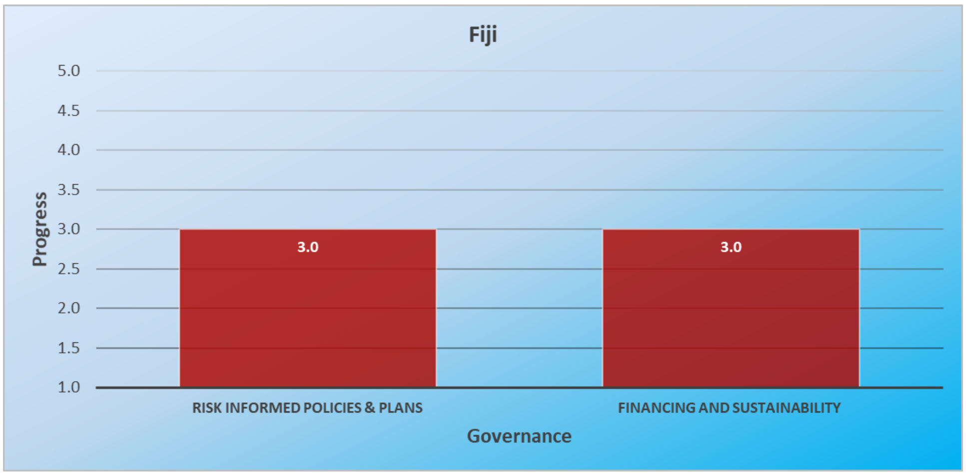
1-No progress; 2-Minimal progress; 3-Moderate progress; 4-Major progress; 5-Completed

Pillar 5: Governance

The two themes under Governance, "Risk Informed Policies & Plans" and "Financing and Sustainability" have shown moderate progress. At present, an act for Fiji meteorological service is under establishment and is in the draft phase. The act will outline the duties and responsibilities of FMS.

FMS receives financial resources from the Government of Fiji. In addition, it receives external funding from agencies such as UNDP, SPREP and SPC especially for capacity building related tasks. In Fiji, AWSs and their systems are installed by different manufactures. This situation is unsustainable for Fiji, as there are incompatibilities between different systems, difficulties in data collection and equipment maintenance. **Figure (26)** summarises the progress of different themes which fall under the 5th Pillar: Governance.

Figure (26): Level of progress: Governance



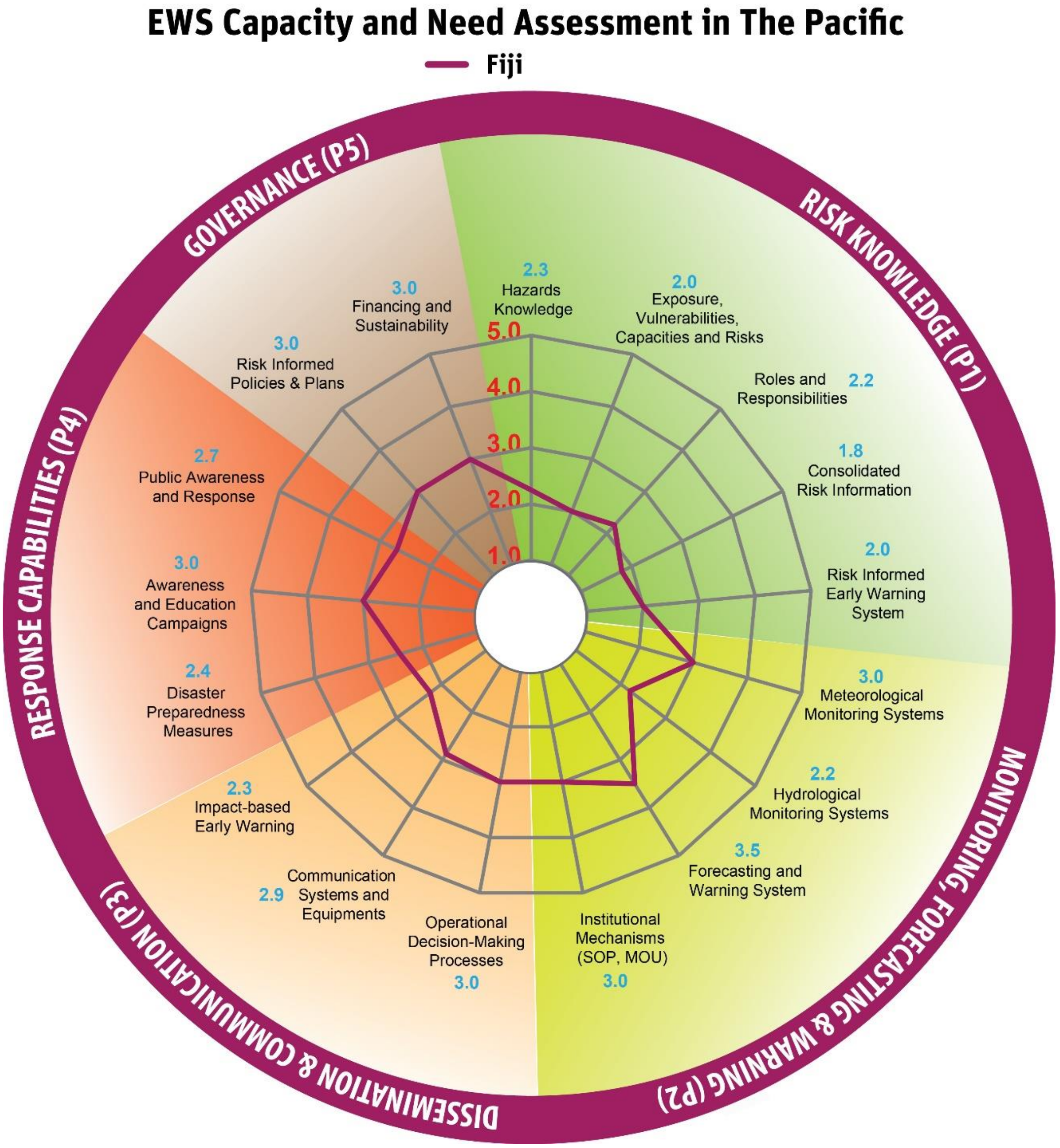
1-No progress; 2-Minimal progress; 3-Moderate progress; 4-Major progress; 5-Completed

6.3.6 Summary

Overview of the MHEWS:

The spider web diagram presented in **Figure 27** summarises the present status of the MHEWS in Fiji. They have shown a fairly moderate level of development under the pillar "Detection, monitoring, analysis and forecasting of the hazards and possible consequences". However, they need to make improvements under Disaster Risk Knowledge which includes the need for carrying out risk assessments for multiple possible disaster events.

Figure (27): tatus of MHEWS in Fiji

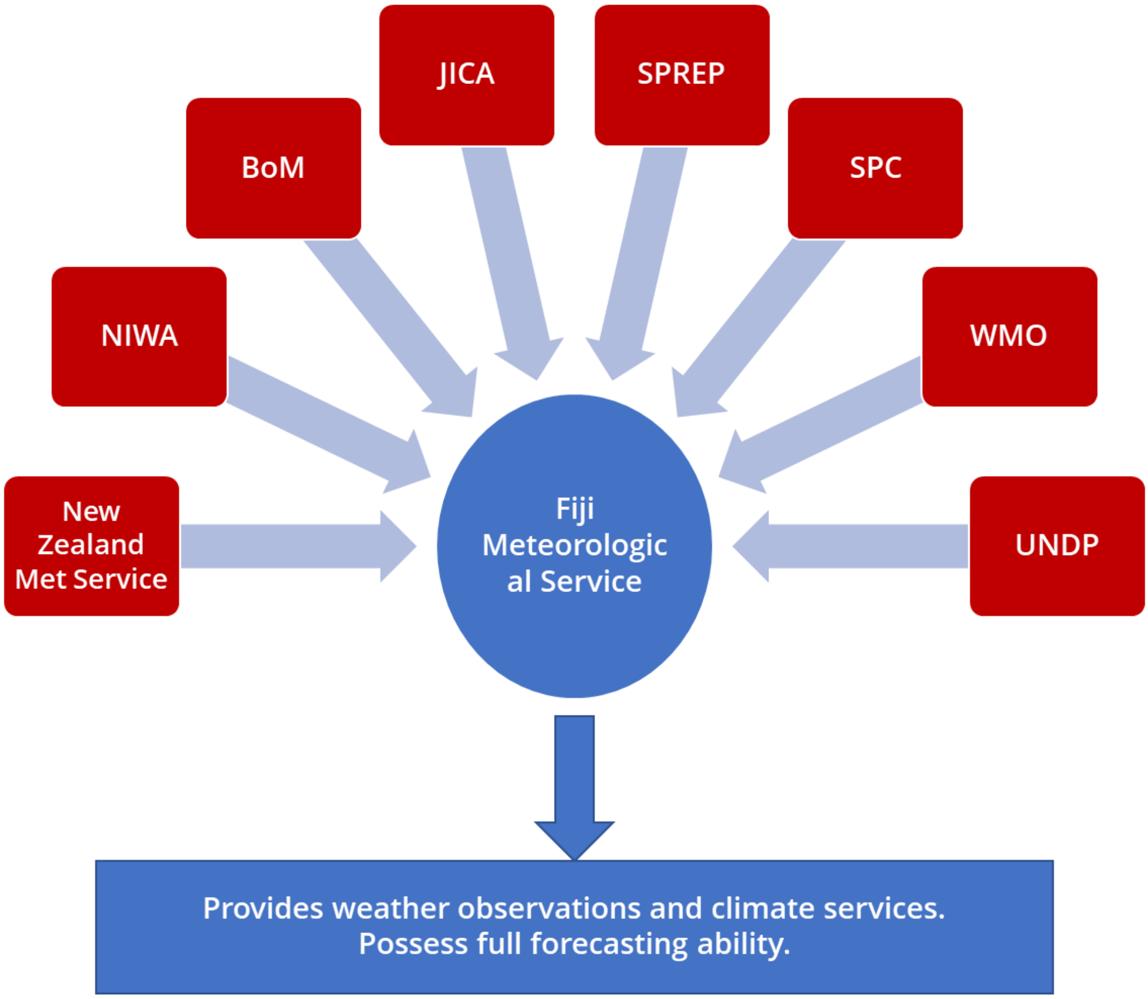


Source: ADPC assessment

Development partners

The development partners associated with FMS in assisting to build their MHEWS is mapped in the **Figure (28)**.

Figure (28): Development partners of FMS



Source: NMHS consultation

Best Practices

- Fiji Meteorological Service is implementing the Flash Flood Guidance System (FFGS). Fiji FFGS is funded by the Climate Risk Early Warning System (CREWS) Initiative and Environment and Climate Change Canada (ECCC), and implemented by the World Meteorological Organization (WMO) and the Hydrological Research Center (HRC). It uses the best science of meteorology and hydrology to further improve the quality and lead-time for early warning of flash flooding. The Fiji FFGS will supplement existing systems for monitoring and early warning for floods in the Fiji Islands. The Fiji FFGS will provide guidance to the Fiji Meteorological Service's weather experts to generate and issue operational flash flood forecasts and warnings with improved lead-time and sites' specific.

6.3.7 Needs and recommendations

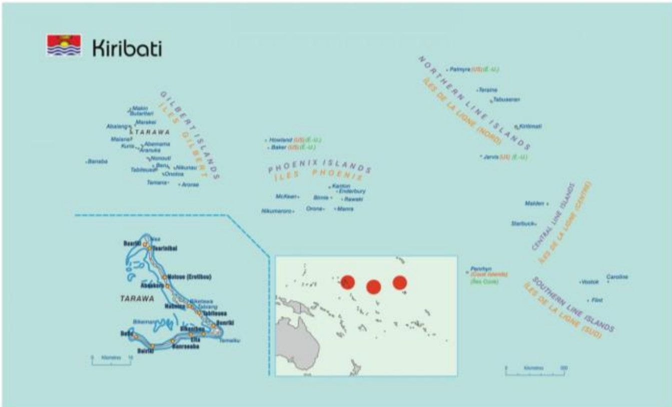
Table (7): Need and recommendations	
Pillar	**Needs and recommendations**
Disaster risk knowledge	• Improvements are needed in developing hazard maps, archiving historical hazard information and in identification of hotspots at national as well as local level. • It is essential to improve the progress made in carrying out disaster risk assessments including information on hazard, vulnerabilities, exposure and capacities. • There is a need of a central standardized repository to store all event/disaster and risk information. • It is essential to improve the progress made in incorporating risk information into the forecasting and early warning messages.
Detection, monitoring, analysis and forecasting of the hazards and possible consequences	• FMS do not have a downscaled weather model. They use global weather models for carrying out weather forecasting. A downscaled weather model would permit FMS to improve on forecasting tasks and produce 7-days weather forecasts. • There is a lack of weather observation instruments mainly ocean observing equipment currently at FMS. • Weather observation instruments and its systems are being installed by different manufactures. As a result, there are incompatibility issues between systems. It is essential to support the ongoing efforts of FMS in setting up a common data management system platform which works with different systems. • Maintenance of instruments and systems is a challenge for the FMS as it involves a greater monetary cost. Hence, an increase in budget allocation is needed. • FMS would like to improve the training division with resource persons in the field of weather forecasting, as it would capacitate them to provide in-house training within the organisation. Currently they rely on WMO for weather forecasting training.

Table (7): Need and recommendations	
Pillar	**Needs and recommendations**
	• FMS has plans to automate the production of weather products in future. Hence, support is needed to achieve success in the proposed task. • Need to improve the progress in setting up hydrological monitoring systems.
Warning, dissemination and communication	• Need to improve the progress made in setting up feedback mechanisms to verify that warnings have been received and to correct potential failures in dissemination and communication. • There is a need to establish better backup systems in the event of failure. • Communication and dissemination systems need to be improved to cater the different needs of specific population groups ((urban and rural populations, women and men, older people and youth, people with disabilities, etc.). • More efforts are needed in developing agreements to utilize private sector resources where appropriate (e.g., television, amateur radios, social media) to disseminate warnings. • Need further progress in developing clear warning messages that are consistent, gender-sensitive, specific for disabled groups, and include risk and impact information.
Preparedness and response capabilities	• Need to utilize multi-hazard risk assessments to develop and update disaster preparedness including response plans. • Need more progress in preparing strategies and their implementation to maintain preparedness for longer return period and cascading hazard events. • Need improvements in establishing protocols for emergency and health services that need to be ready to respond to events promptly.

Table (7): Need and recommendations	
Pillar	**Needs and recommendations**
	• It is essential to undertake regular exercises to test and optimize the effectiveness of the early warning dissemination processes, preparedness and response. • Need to ensure that early warning simulations, drills and exercises are conducted with first responders and community regularly.
Governance	• A meteorology act for FMS is essential to have clear identified roles and responsibilities for the met office.

6.4 Kiribati

Kiribati is a low-lying atoll nation in the central Pacific Ocean, has a population of just over 113,400 people. The 33 atolls that make up Kiribati, occupy a vast area in the Pacific. Kiribati straddles the equator and stretches nearly 4,000 km from east to west, and more than 2,000 km from north to south. Most of the islands are less than 2 km wide, and no higher than 6 m above sea level. **Table (8)** represents the country profile of Kiribati.

<table>
<tr><th colspan="2">Table (8): Country profile: Kiribati</th></tr>
<tr><td>Capital: Tawara</td><td rowspan="9">Geographical location

Source: Pacific Community[37]</td></tr>
<tr><td>Location: 1°28'N 173°2'E</td></tr>
<tr><td>Geographical area: 811 km²</td></tr>
<tr><td>Population: 113,400</td></tr>
<tr><td>Max height above Sea Level:
81 m</td></tr>
<tr><td>RSMC: Nadi</td></tr>
<tr><td>NMHS: Kiribati Meteorological Service
WMO member: March 2003[38]</td></tr>
<tr><td>Climate Risk Index Score: 125[39]
Climate Risk Index Rank: 135</td></tr>
<tr><td>INFORM Risk Index: 3.6[40]
INFORM Risk Class: Medium
INFORM Risk Rank: 99</td></tr>
</table>

6.4.1 Overview of susceptibility to hazards:

Kiribati faces a moderate degree of risk to natural disasters. Most of the population lives a subsistence lifestyle as Kiribati has few natural resources and is one of the least developed Pacific Island countries. Even minor emergencies can overwhelm national capacity and significantly affect communities and the economy. **Table (9)** represents susceptibility to natural hazards in Kiribati.

[37] https://www.spc.int/our-members/Kiribati
[38] WMO: https://public.wmo.int/en/about-us/members
[39] CRI (2020): https://www.germanwatch.org/en/17307
[40] INFORM (2020): https://drmkc.jrc.ec.europa.eu/inform-index/

Table (9): Susceptibility to natural hazards in Kiribati		
Natural hazards	**Hazard type**	**Susceptibility**
Coastal flood	Hydro-Meteorological	High
Tsunami	Geological	High
Extreme Heat	Hydro-Meteorological	Medium
Cyclone	Hydro-Meteorological	Low
River flood	Hydro-Meteorological	Very Low
Urban flood	Hydro-Meteorological	Very Low
Earthquake	Geological	Very Low
Wildfire	Other	Very Low
Landslide	Geological	No Data
Volcano	Geological	No Data
Drought and Water Scarcity	Hydro-Meteorological	No Data
Source: GFDRR | ThinkHazard[41]		

Kiribati is also located in an area of high seismic activity and undersea earthquakes can generate destructive tsunamis. Due to the low level of some of the islands, Kiribati is highly vulnerable to the effects of tidal surges and sea level rises. To date, no major rapid onset natural disaster has occurred, however climate-change related events are of increasing concern. From last few years below average rainfall has led to an ongoing drought across the country, with the southern island most severely affected. Kiribati's traditional dry season, or Aumaiaki, occurs between April and September, with the rainy season, or Aumeang, from October to March. However, due to changes in climate, the country has been experiencing extreme drought-like conditions even during the traditional rainy season.

The country's NDMO, operates under the "Office of the President" and is responsible for the overall coordination of disaster risk management activities in the country. The government has been taking a proactive leadership role to strengthen its capacity to respond to and mitigate the impacts of natural disasters and climate change. The government continue to work with regional and international actors in mitigating the impact of drought in Kiribati. The United Nations maintains a joint presence office in Kiribati with UNICEF, UNDP, and UNFPA.

[41] https://thinkhazard.org/en/report/135-kiribati

6.4.2 National Meteorological and Hydrological Service (NMHS)

Kiribati Meteorological Service (KMS)

Kiribati Meteorological Service (KMS) mission is to deliver accurate and timely weather, climate, and ocean information in order to safeguard people lives and properties of Kiribati. The Kiribati Meteorological Service provides regional and national drought monitoring, seasonal climate outlooks, meteorological observations, marine weather bulletins, tide predictions, satellite imagery and national forecasts. Some of the services are provided by Fiji Meteorological Service (FMS) such as the Aviation and marine. The subject of hydrology is under the Ministry of Infrastructure and Sustainable Energy.

Organisation structure

KMS functions under Kiribati Government's Office of The President and has six offices. The headquarters is located on Betio Island in South Tarawa with a full surface and upper air station and a small forecasting office with a Himawari LRIT receiving station. There is an observing office at the main international airport in South Tarawa and an office at Christmas Island. Three SYNOP (Surface Synoptic Observations) stations are located on the outer islands (Love et al., 2018). KMS receives majority of its financial resources through different Project Partners.

6.4.3 Key programs

Majority of the initiatives currently underway are done through projects. These are supported by Project Partners as well as by the Government of Kiribati. Some of the ongoing Project Works are:

- COSPPac (Climate outlooks, Tide calendars),
- CREWS/ WMO (Climate risk early warning system),
- WMO/SPREP (Upper air sounding),
- RESPAC (Reopening of closed stations),
- NZAID/SPC (Installation of rain gauges at 9 outer islands).

Three Automatic Weather Stations (AWSs) have been installed in three islands under Least Developed Countries Fund (LDCF) project. There is a committee called Kiribati National Expert Group which overlooks all issues related to climate change. KMS fall under the field of Meteorology and climate service of the committee. Projects related to climate change and weather are under the umbrella of this expert group committee. This committee selects the key areas for further development in the country.

6.4.4 Training and capacity building:

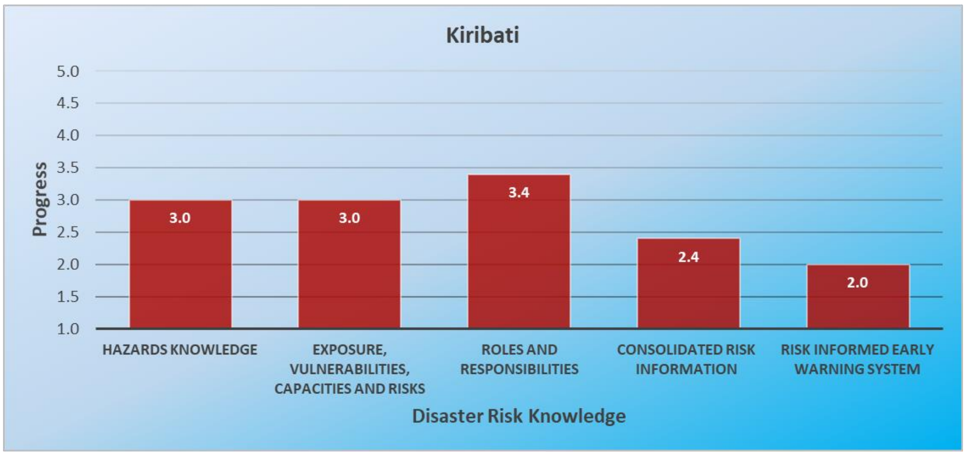
KMS staff undergo basic meteorological in-house trainings as well as regional trainings. A very small number have undergone advanced meteorological trainings such as those provided by BOM, PAGASA, New Zealand Met Service etc. In-house training is provided for observers according to a training plan. This is done in collaboration with FMS. KMS seeks support from other external partners to undertake training of their staff. Weather forecast training is carried out in the "Pacific International Training Desk in Honalulu" which is run by the United States national weather service. Practical trainings on handling of weather monitoring equipment are also provided at the same place.

6.4.5 Present status of the MHEWS

Pillar 1: Disaster Risk Knowledge:

KMS has shown a moderate level of progress in identifying key hazards and in assessing exposure, vulnerabilities and risks. The progress shown in identifying roles and responsibilities of stakeholders is at moderate to major level. It is the most developed theme with in the pillar of "Disaster Risk Knowledge". A minimal progress is shown with respect to the development of themes "Consolidated Risk Information" and "Risk Informed Early Warning System". **Figure (29)** summarises the progress of different themes which fall under the 1st Pillar: Disaster Risk Knowledge.

Figure (29): Level of progress: Disaster Risk Knowledge



1-No progress; 2-Minimal progress; 3-Moderate progress; 4-Major progress; 5-Completed

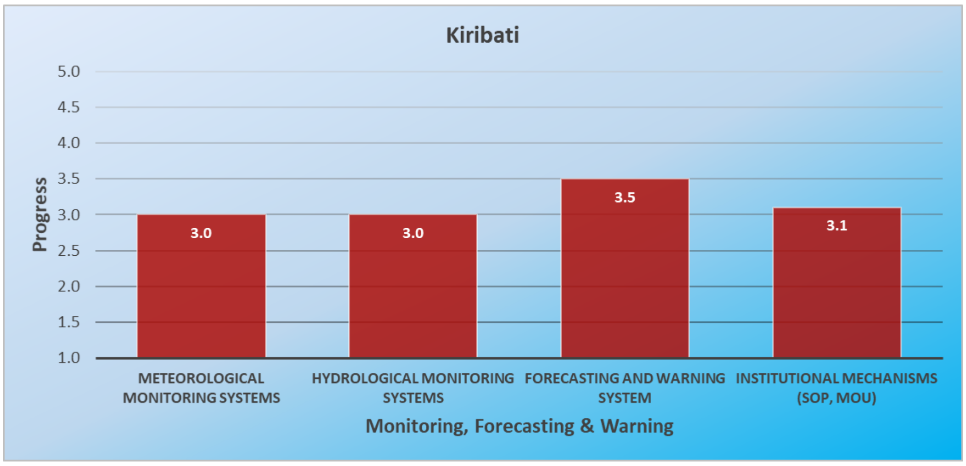
Pillar 2: Detection, Monitoring, Analysis and Forecasting of the Hazards and Possible Consequences:

KMS provides basic meteorology services, weather observations and public weather forecasts. It is responsible for issuing Tsunami warnings based on the information from Pacific Tsunami Warning Center (PTWC). The warnings are localized to suit the local context after studying the weather/climate products sent by PTWC. Forecasting staff work on shifts to cover 24/7-time coverage.

The meteorology office has three manual weather stations in the outer islands. Two AWSs are located in Tarawa and Christmas Islands. KMS has staff who are trained for the maintenance of equipment of AWSs. The upper air information program at KMS is supported by the donor partner - UK met office. Soundings are carried out once a day. In addition, KMS possess tide gauges as ocean observing equipment. They do not have any buoys in possession.

All the themes in the pillar have shown moderate and above moderate levels of progress. The most developed theme is "Forecasting and Warning System" followed by "Institutional Mechanisms". **Figure (30)** summarises the progress of different themes which fall under the 2nd Pillar: "Detection, Monitoring and Forecasting".

Figure (30): Level of progress: Detection, Monitoring and Forecasting



1-No progress; 2-Minimal progress; 3-Moderate progress; 4-Major progress; 5-Completed

Pillar 3: Warning, Dissemination and Communication:

The main mediums of dissemination of climate/weather information and warnings are through "Radio Kiribati", website[42], and through social media (Facebook page[43]). Satellite messaging systems are also used (Chatty Beetle Units) in practice. Radio is the fastest medium of communication.

KMS is working towards incorporating impact-based messages in its warnings and products. These have been incorporated into drought warnings and extreme tides. Messages regarding strong winds, precipitation, and other meteorological phenomena are yet to implement this.

The NDMO is under the "Office of the President" and KMS work closely with NDMO in issuing warnings and activities related to climate change and weather-related projects. KMS directs early warning messages to the NDMO. If the message is very urgent then KMS directly issues them to general public via radio & emails. In case of less urgent situations such as drought, KMS issues warnings to NDMO and then to media (Radio). Other messages are delivered to media in hard copies as well. NDMO then delivers the warning messages to island disaster councils. The "Island Councils" take actions to notify the village leaders.

Weather/ climate information are delivered to the media twice a day through email and social media/website. Social media is quite popular. KMS receives feedback from the public/communities through social media.

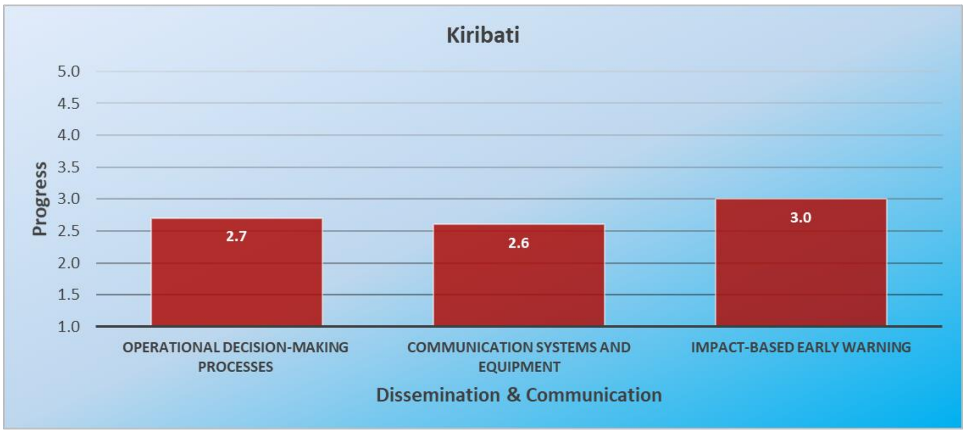
Internet coverage and mobile phone coverage in the outer islands are improving at the present time. No. of mobile phone users are increasing in the country. KMS is expecting that with the current progress of internet and mobile phones technology, they would be able to deliver warning messages through SMS.

[42] http://www.met.gov.ki/en/
[43] https://www.facebook.com/kiribatimetservice/

Climate outlook forums are issued every month providing information on rainfall (whether there will be more/less rainfall) and drought. The theme "Impact-based early warning" shows moderate level of progress being the most developed with in the Pillar. The other two themes show a progress at a minimum to moderate level.

Figure (31) summarises the progress of different themes which fall under the 3rd Pillar: Warning, dissemination and communication.

Figure (31): Level of progress: Warning, Dissemination and Communication



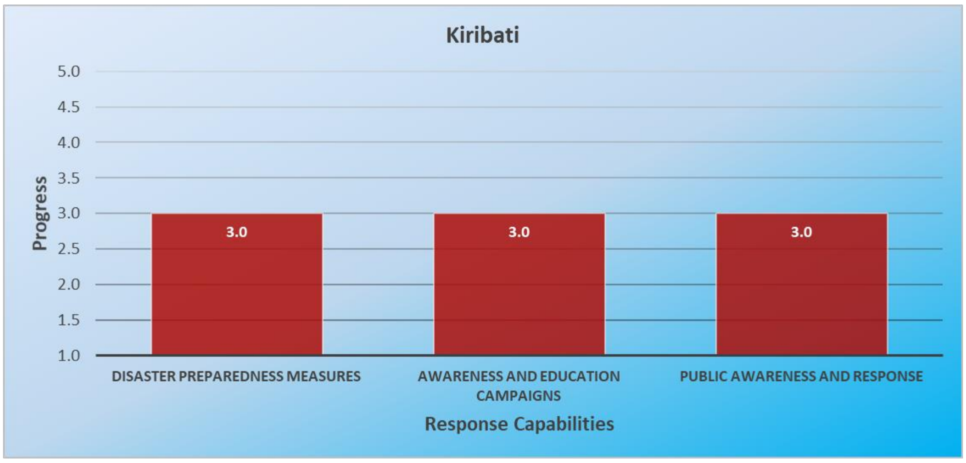
1-No progress; 2-Minimal progress; 3-Moderate progress; 4-Major progress; 5-Completed

Pillar 4: Preparedness and Response Capabilities:

KMS conducts educational awareness programs promoting & explaining the services offered by meteorology office, how the community can access such services. These interventions improve the awareness of the community on climate related issues. KMS has developed brochures and templates for distribution among the community. All the three themes in the pillar "Preparedness and response capabilities" have shown a moderate level of progress in their development.

Figure (32) summarises the progress of different themes which fall under the 4th Pillar: Preparedness and response capabilities.

Figure (32): Level of progress: Preparedness and Response Capabilities

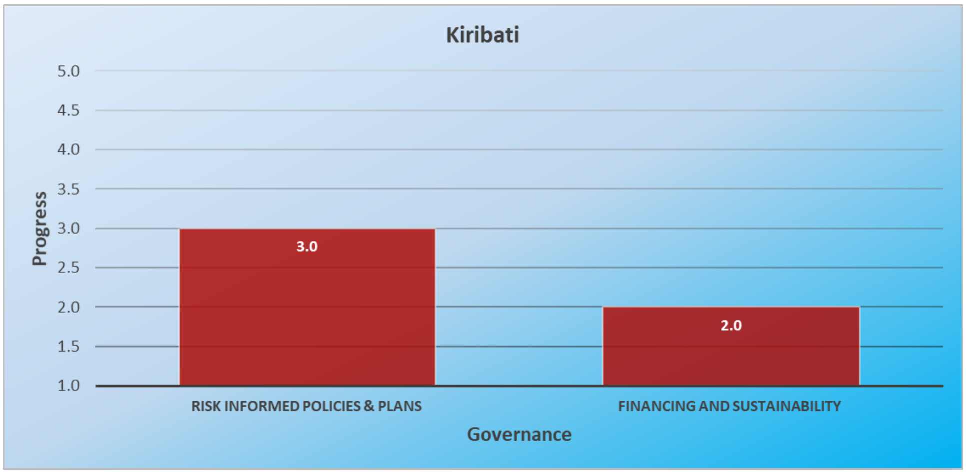


1-No progress; 2-Minimal progress; 3-Moderate progress; 4-Major progress; 5-Completed

Pillar 5: Governance:

Pacific Met Desk at SPREP assists KMS in drafting a meteorology act for Kiribati which will define the roles and responsibilities of the met office. Under Governance, the theme "Risk Informed Policies & Plans" has shown a moderate level of progress. More action is needed to improve on the theme "Financing and Sustainability". It is highlighted in the survey that the sustainability of projects can be achieved by having realistic objectives and by addressing the main needs of the country. **Figure (33)** summarises the progress of different themes which fall under the 5th Pillar: Governance.

Figure (33): Level of progress: Governance



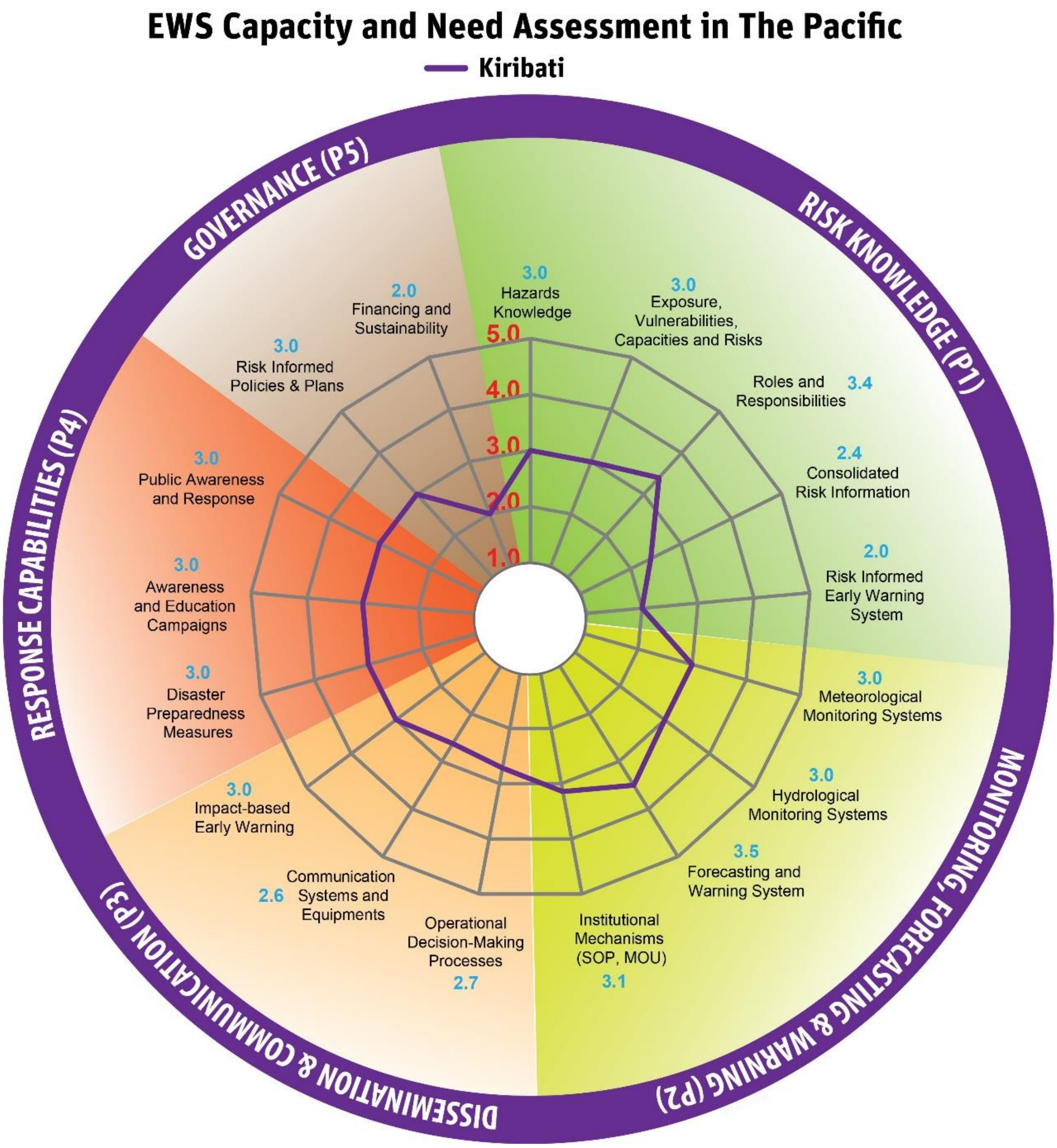
1-No progress; 2-Minimal progress; 3-Moderate progress; 4-Major progress; 5-Completed

6.4.6 Summary:

Overview of the MHEWS:

The spider web diagram presented in **Figure (34)** summarises the present status of the MHEWS in Kiribati which has shown a fairly moderate level of development. More attention is required in further development of the themes “Financing & Sustainability” and “Risk informed early warning systems”.

Figure (34): Status of MHEWS in Kiribati

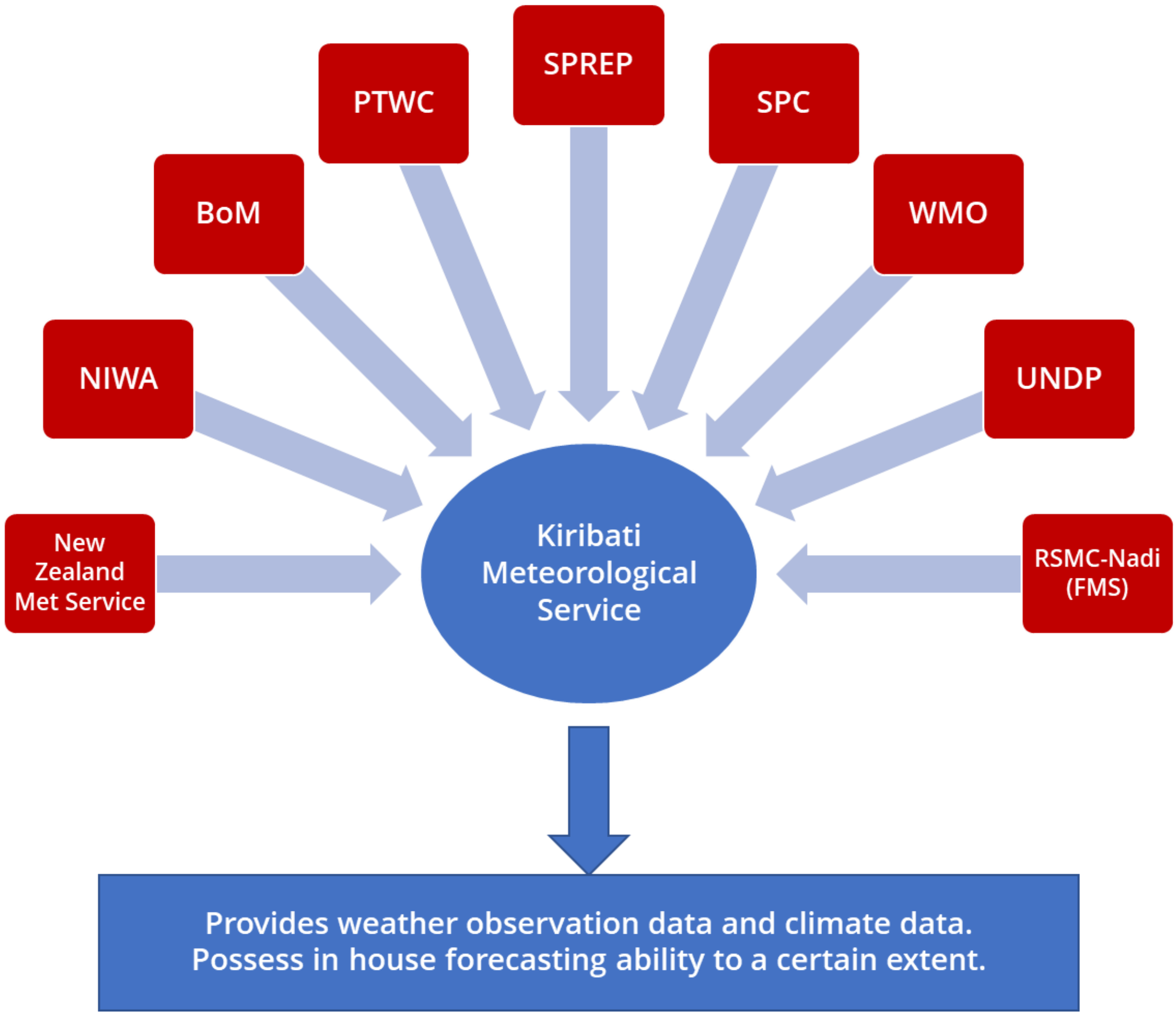


Source: ADPC assessment

Development partners:

The development partners associated with KMS in assisting to build their MHEWS is mapped in the **Figure (35).**

Figure (35): Development partners of KMS



Source: NMHS consultation

Best Practices:

- Carrying out community outreach programs promoting & explaining the services offered by KMS among the general public. These interventions improve the community awareness on climate related issues.

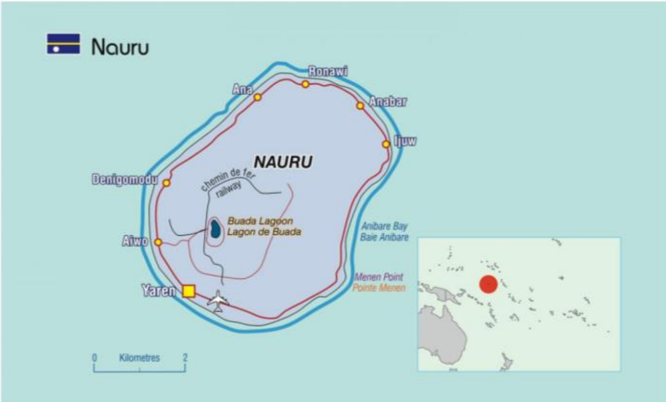
6.4.7 Needs and recommendations:

Table (10): Need and recommendations	
Pillar	**Needs and recommendations**
Disaster risk knowledge	• More efforts need to be taken in incorporating risk information when making forecasts and issuing early warning messages. • More attention should be drawn in incorporating cross-cutting issues such as gender, age, disability and governance when issuing early warnings.
Detection, monitoring, analysis and forecasting of the hazards and possible consequences	• There is a need to improve the data coverage in weather observations. • Need to build staff capacity in the fields of aviation and marine weather forecasting. • AWSs data is not directly integrated into CliDE System. Data is entered manually. Hence, it is needed to have a mechanism where AWSs data are automatically fed into the CliDE System. • It is essential to increase the no. of weather stations in the outer islands. • KMS would like to have Buoys for obtaining Ocean Data. (Eg; information on wave heights).
Warning, dissemination and communication	• Improvements are needed in developing agreements to utilize private sector resources where appropriate (e.g., television, amateur radios, social media) to disseminate warnings. • More attention is needed in creating mechanisms to update the information that are in place and are resilient to the event. • Need to have more communication and dissemination systems tailored to the different needs of specific groups (urban and rural populations, women and men, older people and youth, people with disabilities, etc.). • Need more efforts in the assessment of communication strategies to ensure messages are reaching the population, particularly people in vulnerable conditions.

Table (10): Need and recommendations	
Pillar	**Needs and recommendations**
Governance	• KMS highlights the need of restructuring its services in order to move from basic meteorology to the more advanced. • It is essential to draft a meteorology act for KMS defining its roles and responsibilities. • An increase in budget allocations for KMS would improve its functions as well as its services.

6.5 Nauru

The Republic of Nauru is one of the world's smallest republic, covering just 21 km² of land and with a population of 10,840 people (Table 11). The country belongs to the subregion Micronesia which lies to the north of the equator in the Pacific Ocean. Table (11) represents country profile of Nauru.

<table>
<tr><th colspan="2">Table (11): Country profile: Nauru</th></tr>
<tr><td>Capital: Yaren</td><td rowspan="9">Geographical location


Source: Pacific Community[44]</td></tr>
<tr><td>Location: 0°31'S 166°55'E</td></tr>
<tr><td>Geographical area: 21 km²</td></tr>
<tr><td>Population: 10,840</td></tr>
<tr><td>Max height above sea level:
71 m</td></tr>
<tr><td>RSMC: Nadi</td></tr>
<tr><td>NMHS: Nauru Meteorological Service
WMO member: March 2019[45]</td></tr>
<tr><td>Climate Risk Index Score: NA
Climate Risk Index Rank: NA</td></tr>
<tr><td>INFORM Risk Index: 3.3[46]
INFORM Risk Class: Low
INFORM Risk Rank: 107</td></tr>
</table>

6.5.1 Overview of susceptibility to hazards

Nauru is considered a minimal risk to natural disasters; however, it is also considered to have a low capacity to respond to disasters because of its small population and isolation. Nauru is most vulnerable to drought due to its proximity to the equator. During the wet season, from November to April, fierce winds, sea swells and tropical cyclones sometimes occur. No major rapid onset natural disasters have occurred in Nauru. However, climate-change related disasters are of increasing concern. Due to the low level of the island, Nauru is vulnerable to the effects of tidal surges and sea level rises.

[44] https://www.spc.int/our-members/Nauru
[45] WMO: https://public.wmo.int/en/about-us/members
[46] INFORM (2020): https://drmkc.jrc.ec.europa.eu/inform-index/

Nauru has a national disaster risk management plan that supports the government disaster risk management policy intended to assist the process of effectively managing hazards and risk in Nauru. **Table (12)** represents susceptibility to natural hazards in Nauru.

Table (12): Susceptibility to natural hazards in Nauru

Natural hazards	Hazard type	Susceptibility
Coastal flood	Hydro-Meteorological	High
Tsunami	Geological	Medium
Extreme Heat	Hydro-Meteorological	Medium
Urban flood	Hydro-Meteorological	Low
Cyclone	Hydro-Meteorological	Very Low
River flood	Hydro-Meteorological	Very Low
Earthquake	Geological	Very Low
Wildfire	Other	Very Low
Landslide	Geological	No Data
Volcano	Geological	No Data
Drought and Water Scarcity	Hydro-Meteorological	No Data

Source: GFDRR | ThinkHazard[47]

6.5.2 National Meteorological and Hydrological Service (NMHS)

Nauru Meteorological Service

Nauru Meteorological Service was established in May 2015 under the Ministry of National Emergency Services. The country joined the WMO as its 193rd member on the 16th of May 2019 (SPREP, 2019b).

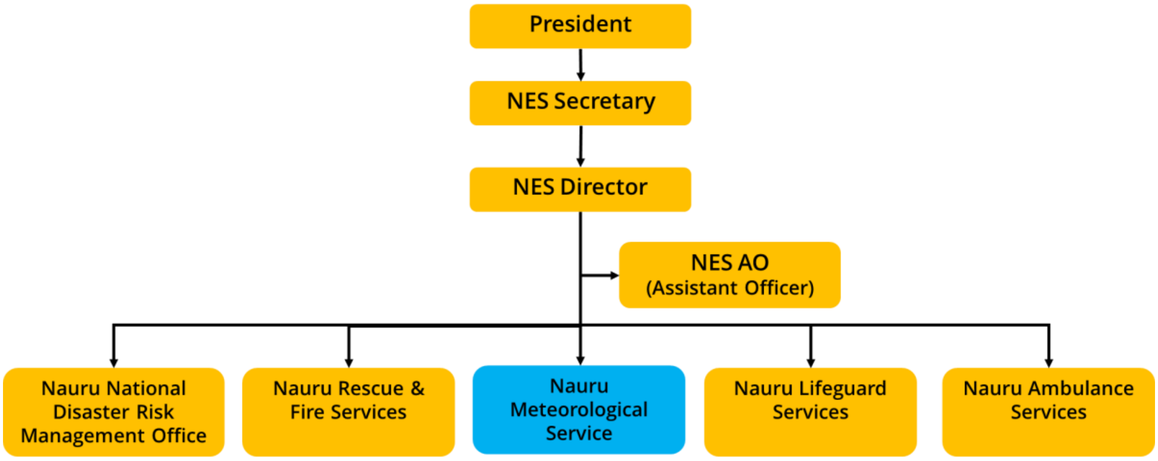
The mandate of Nauru Meteorological Service is to oversee the weather for Nauru and provide weather updates to the government of Nauru, Nauru media, and for different sectors such as aviation, marine, fisheries and agriculture.

[47] https://thinkhazard.org/en/report/173-nauru

Organisation structure

Nauru Meteorological Service functions under the Ministry of National Emergency Services (NES) and comes under the purview of National Disaster Risk Management Act 2016. **Figure (36)** indicates its position within the NES structure. The NES comes directly under the President.

Figure (36): Representation of Nauru Meteorological Service in the NES structure



Source: Harris 2019

With respect to the financial resources, Nauru Meteorological Service receives financial support from the government to cover up the salaries of the staff and other minor operations. In addition, regional organisations such as UNDP, SPREP, JICA and SPC provides financial assistance to Nauru NMHS for carrying out various activities.

Nauru Meteorology Service consists of 9 no. weather observers, 2 no. weather forecasters and 1 no. hydrologist. The two weather forecasters have attended training programs conducted by the Pacific Desk International Training Desk in Hawaii. Further, they have gained knowledge on the information received from "Himawari (Satellite)" via training programs conducted in Fiji. The hydrologist monitors the information received from tide gauges and is also engaged in undertaking maintenance activities of the tide gauges. They also carry out weather observations related to aviation.

6.5.3 Key programs:

Nauru has few projects related to early warning systems and climate services. Apart from CREWS project, Nauru Meteorology Service is implementing projects of UNDP and JICA. JICA is supporting Nauru Meteorology Service for capacity buildings and trainings.

6.5.4 Training and capacity building

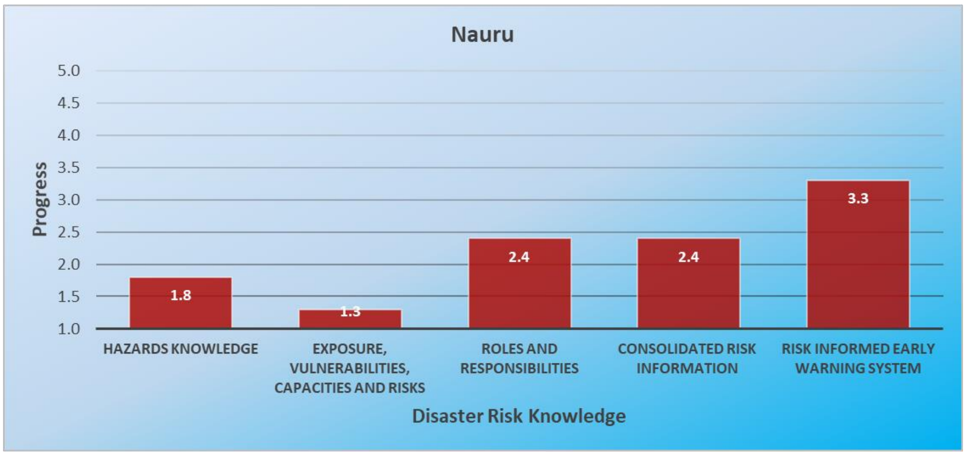
Nauru Meteorology Service provides inhouse training on basic meteorology aspects. Nauru Meteorology Service will require international and regional support to build capacities of its technical human resources.

6.5.5 Present status of the MHEWS

A. Disaster Risk Knowledge:

The survey reveals that the most developed theme within the pillar is "Risk informed Early Warning System" which shows a moderate level of progress in its development. The progress made in identifying roles and responsibilities and in consolidating risk information is minimum. A greater attention is needed in developing themes "Hazard Knowledge" and "Exposure, Vulnerabilities, Capacities & Risks. **Figure (37)** summarises the progress of different themes which fall under the 1st Pillar: "Disaster Risk Knowledge".

Figure (37): Level of progress: Disaster Risk Knowledge



1-No progress; 2-Minimal progress; 3-Moderate progress; 4-Major progress; 5-Completed

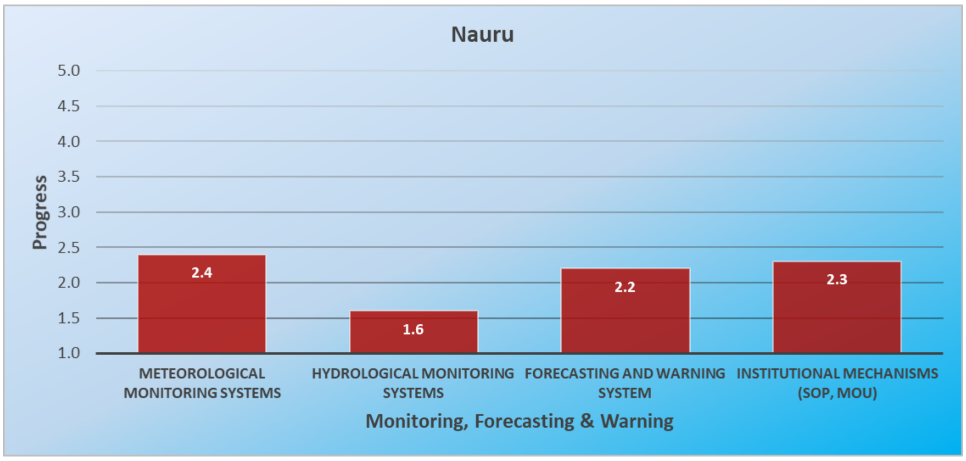
B. Detection, Monitoring, Analysis and Forecasting of the Hazards and Possible Consequences:

Nauru met service issues weather forecasts once per day (24-hour forecast). The marine forecasts include sea surface temperature, wind speed and tide movement. The data is collected from the Tide station which is installed with support from the COSPPac[48] project. For weather forecasting, they use weather models such as Windy, GFS and European models. Met-connect model is used in the time of severe weather. The met office possesses a manual weather station from which they gather weather data.

At present, they generate monthly climate outlooks and disseminate to the public in a user-friendly format which is easily understandable by the end users. They are based on the information received from NIWA. The survey indicated that the major themes under this pillar have shown a minimum level of progress except for the theme "Hydrological monitoring systems". A very minimal progress has been shown in its development and more efforts are needed for its improvement. **Figure (38)** summarisesummarises the progress of different themes which fall under the 2nd Pillar: Detection, Monitoring and Forecasting.

[48] https://www.pacificmet.net/project/climate-and-ocean-support-program-pacific-cosppac

Figure (38): Level of progress: Detection, Monitoring & Forecasting



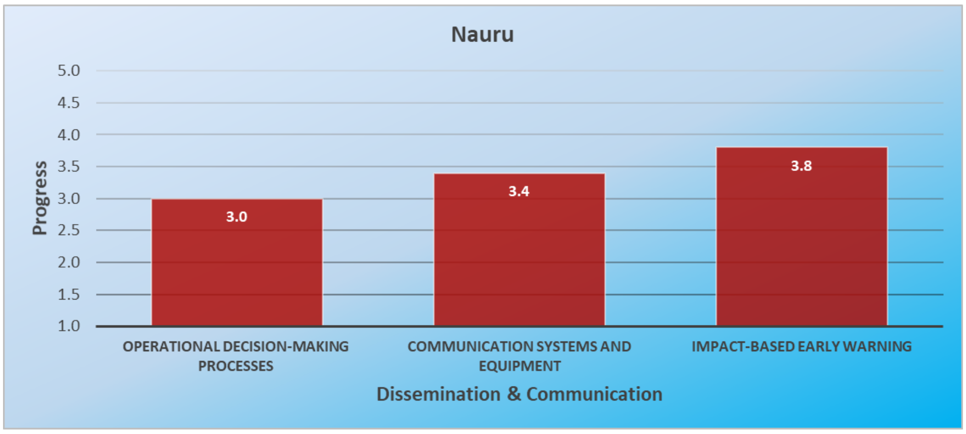
1-No progress; 2-Minimal progress; 3-Moderate progress; 4-Major progress; 5-Completed

C. Warning, Dissemination and Communication:

Nauru Meteorology Service sends weather information and weather updates through email to all the stakeholders including the disaster management office. In emergency situations, information is sent via text messages or short message service.

They do not possess a radio facility. They are trying to set up a website for Nauru Meteorological Service with the support through CREWS project and the SPREP. Information related to tsunami warnings are received from PTWC. Information on cyclone warnings are received from RSMC Nadi and SPC. The major themes under "Warning, Dissemination & Communication" have shown a moderate to major level of development **Figure (39).**

Figure (39): Level of progress: Warning, Dissemination and Communication

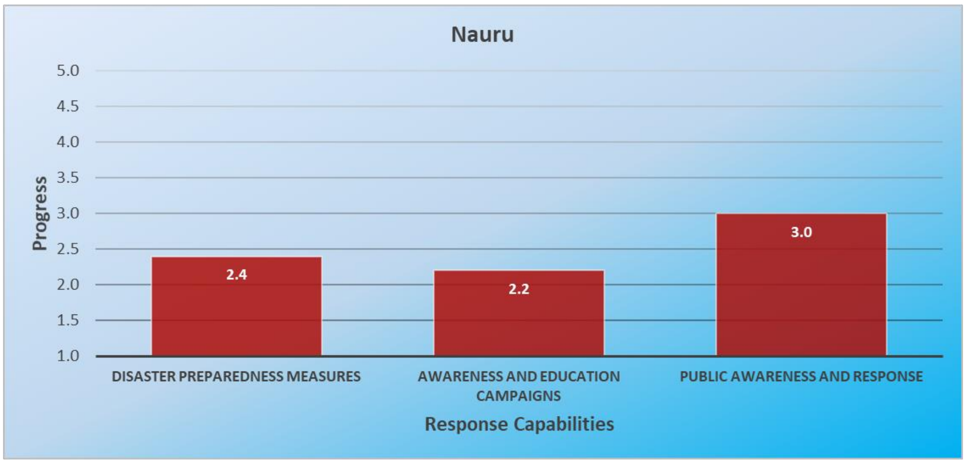


1-No progress; 2-Minimal progress; 3-Moderate progress; 4-Major progress; 5-Completed

D. Preparedness and Response Capabilities:

Nauru Meteorology Service conducts regular public awareness programs by working together with schools, island councils, NDMO and media.
The progress in developing preparedness measures and in conducting awareness and education campaigns are at a minimal level. However, the theme "Public Awareness and Response" has shown a moderate level of progress in its development. **Figure (40)** summarises the progress of different themes which fall under the 4th Pillar: Preparedness and response capabilities.

Figure (40): Level of progress: Preparedness & Response Capabilities



1-No progress; 2-Minimal progress; 3-Moderate progress; 4-Major progress; 5-Completed

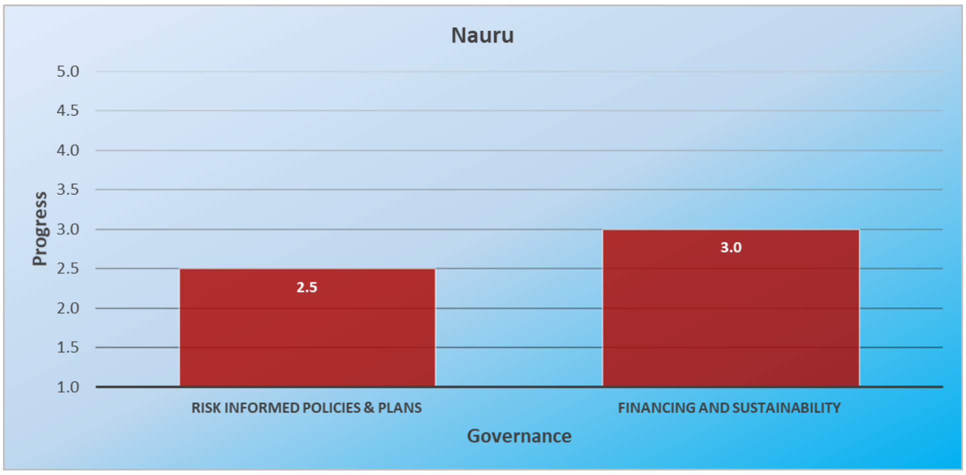
E. Governance:

Nauru Meteorological Service does not have a meteorological act defining its roles and responsibilities. At present, they are working with the legislation team at the Justice Department to come up with a draft act.

Nauru Meteorological Service receives limited financial support from the government that covers up the salaries of the staff and other minor operations. In addition, regional organisations such as UNDP, SPREP, JICA and SPC provide financial assistance to Nauru Met Service via different projects.

Development of the theme "Risk Informed Policies & Plans" has shown a minimum to moderate progress level. The next theme "Financing and Sustainability" has shown moderate progress in its development **Figure (41)**.

Figure (41): Level of progress: Governance



1-No progress; 2-Minimal progress; 3-Moderate progress; 4-Major progress; 5-Completed

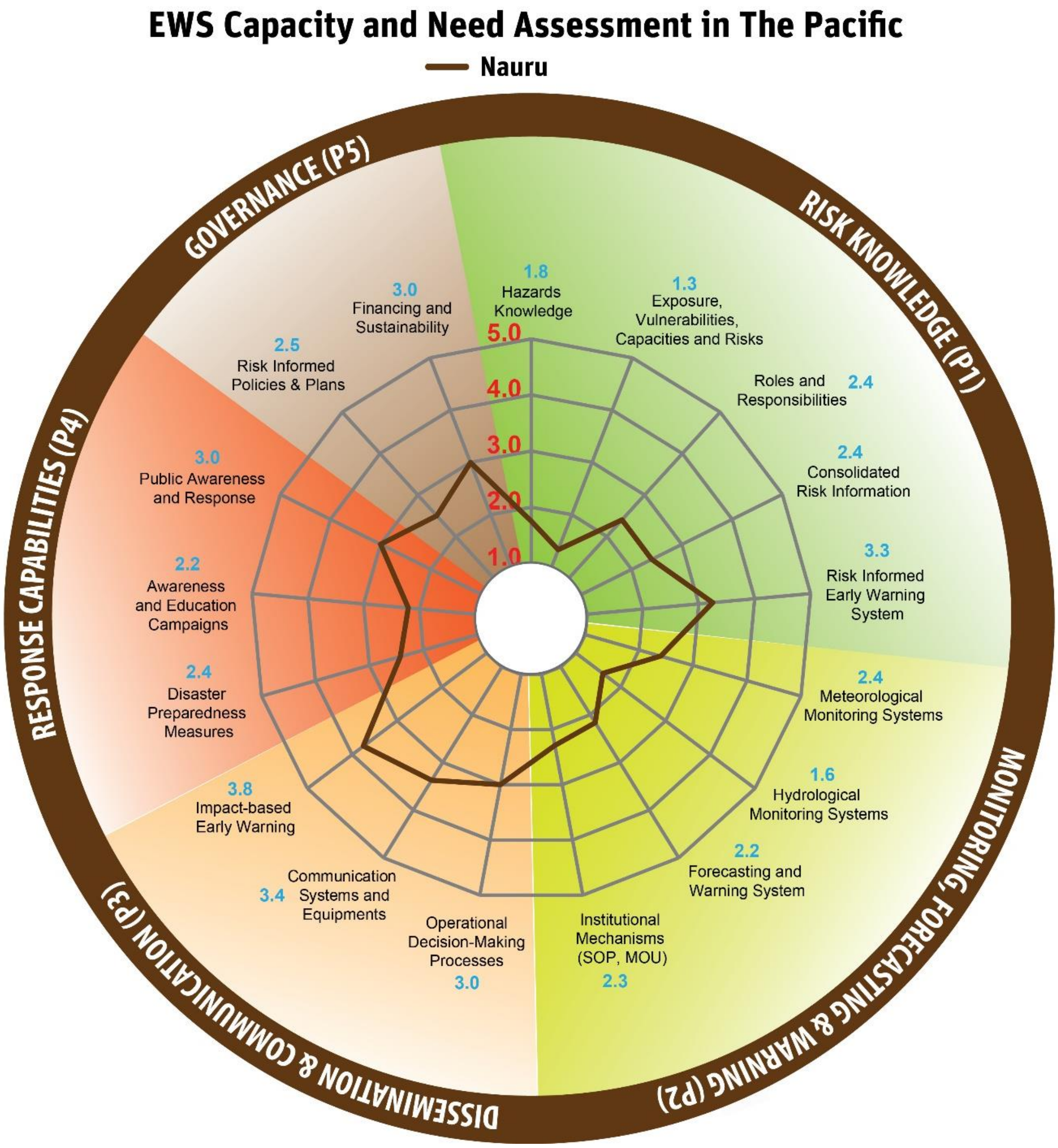
6.5.6 Summary

Overview of the MHEWS:

The spider web diagram presented in **Figure (42)** summarises the present status of the MHEWS in Nauru. The most developed pillar is "Warning, dissemination and communication".

The development of other pillars are at a minimal to moderate level of progress. More attention is required in developing the themes "Exposure, vulnerabilities & capacities" and "Hydrological monitoring systems".

Figure (42): Status of MHEWS in Nauru

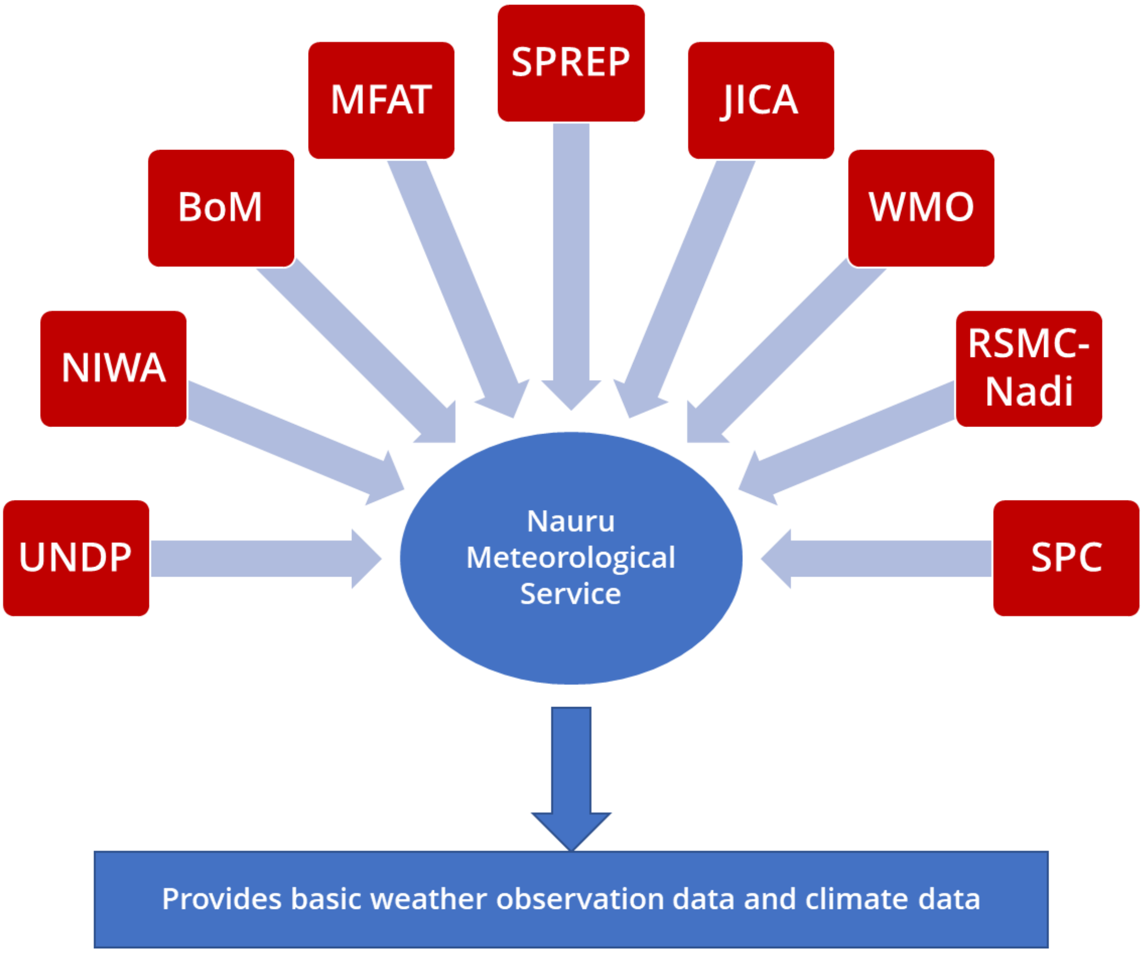


Source: ADPC assessment

Development partners:

The development partners associated with Nauru Meteorology Service in assisting to build their MHEWS is mapped in the **Figure (43)**.

Figure (43): Development partners of Nauru Meteorology Service



Source: NMHS consultation

6.5.7 Needs and recommendations:

Table (13): Needs and recommendations

Pillar	Needs & recommendations
Disaster risk knowledge	More efforts are needed in identifying key hazards, developing hazard maps and archiving historical hazard information. It is essential to conduct comprehensive disaster risk assessments which include information on exposure, vulnerabilities and capacity. The staff lack knowledge and tools in conducting such assessments, hence capacity building is needed. Need active participation of scientific and technical experts in carrying out hazard, vulnerability and risk assessments.
Detection, monitoring, analysis and forecasting of the hazards and possible consequences	It is essential to build the capacity of the existing staff at Nauru Meteorology Office so that they can be competent. There is a need of more weather observing equipment such as the AWSs. Implementation of Automatic Weather Stations would greatly improve the climate services. AWSs will give the met office the opportunity to gather more data and maintain them on the CLiDE system. The met office will also gain the ability to share these data with other agencies and get assistance from them to generate information such as monthly climate outlooks for Nauru. The met office lacks computers. However, one staff is available at the office who is a professional from IT field (With master’s degree). The person is capable of handling activities related to AWS with necessary assistance if they are installed. Need more efforts in setting up hydrological monitoring systems which will include flood monitoring and modelling capabilities. More capacity building in the field of Hydrology is also required. It is essential to establish agreements and interagency protocols within country for data exchange of monitoring systems and baseline data necessary to produce data products. Need to establish bilateral/multilateral agreements with neighbouring island countries to permit cross-border exchange of warnings and observation data for concerns such as tropical cyclones and technical capacity building.

Table (13): Needs and recommendations	
Pillar	**Needs & recommendations**
Warning, dissemination and communication	Need to improve the progress in developing feedback mechanisms to verify that warnings have been received and to correct potential failures in dissemination and communication. Need more efforts in establishing Standard Operating Procedures (SOPs) for early warning information dissemination, function, and decision making. More attention is needed in setting up backup systems in the event of failure.
Preparedness and response capabilities	Need to achieve more progress in developing public awareness and education campaigns (on hazards, vulnerabilities, exposure, and how to reduce disaster impacts) which are tailored to the specific needs of target groups (e.g., women, children, older people, and people with disabilities). More progress is needed in preparing strategies and implementing them to maintain preparedness for longer return period and cascading hazard events. It is essential to improve the progress in undertaking regular exercises to test and optimize the effectiveness of the early warning dissemination processes, preparedness and response.
Governance	Limited funding is available for the construction of a meteorology dedicated office. Hence, additional avenues must be explored to obtain necessary funding. An increase in budget allocations are also needed for providing advance training to the staff via programs conducted in Philippines and in India. It is essential to draft a meteorology act defining the roles and responsibilities of the Meteorological Service.

6.6 Niue

Niue is one of the largest raised coral atolls in the world. It has a jagged and steep coastline, buffering it from all but the worst sea storms. Situated in Polynesia, it is located approximately 480 km east of Tonga and 660 km southeast of Samoa. It has no mountains or rivers, little arable land and limited natural fresh water supplies. **Table (14)** represents country profile of Niue.

Table (14): Country profile: Niue	
Capital: Alofi	**Geographical location**  Source: Pacific Community[49]
Location: 19°03'S 169°52'W	
Geographical area: 259 km²	
Population: 1,520	
Max height above sea level: 68 m	
RSMC: Nadi	
NMHS: Niue Meteorological Service WMO member: May 1996[50]	
Climate Risk Index Score: NA Climate Risk Index Rank: NA	
INFORM Risk Index: NA INFORM Risk Class: NA INFORM Risk Rank: NA	

6.6.1 Overview of susceptibility to hazards:

Niue faces a lower degree of natural disaster risk than most Pacific Islands countries due to its geography. However, Niue’s resilience to natural disasters is very low due to its lack of fresh water supplies and remoteness.

Cyclones are the most frequently occurring disaster. The worst cyclone on record, Cyclone Heta, struck Niue in January 2004 killing two people, severely injuring many, and leaving others homeless. It damaged a significant part of the country, including the capital Alofi. **Table (15)** represents susceptibility to natural hazards in Niue.

[49] https://www.spc.int/our-members/Niue
[50] WMO: https://public.wmo.int/en/about-us/members

Table (15): Susceptibility to natural hazards in Niue		
Natural hazards	**Hazard type**	**Susceptibility**
Cyclone	Hydro-Meteorological	High
Tsunami	Geological	High
Coastal flood	Hydro-Meteorological	Medium
Earthquake	Geological	Very Low
Wildfire	Other	Very Low
Extreme Heat	Hydro-Meteorological	Medium
River flood	Hydro-Meteorological	No Data
Urban flood	Hydro-Meteorological	No Data
Landslide	Geological	No Data
Volcano	Geological	No Data
Drought and Water Scarcity	Hydro-Meteorological	No Data
Source: GFDRR | ThinkHazard[51]		

In February 2018, tropical cyclone Gita before making landfall in the Kingdom of Tonga passed by Niue on 11 February 2018. Niue was also affected but impacts in the island national was very minor. The country has a national disaster plan that outlines arrangements for an all hazards approach to Niue's hazard and vulnerabilities.

6.6.2 National Meteorological and Hydrological Service:

Niue Meteorological Service:

Niue Meteorological Service provides timely weather and climate services to all the stakeholders. It is the key department that issues disaster related early warnings (cyclones, drought) to the general public. Hydrological services and water resource management falls under the Department of Infrastructure.

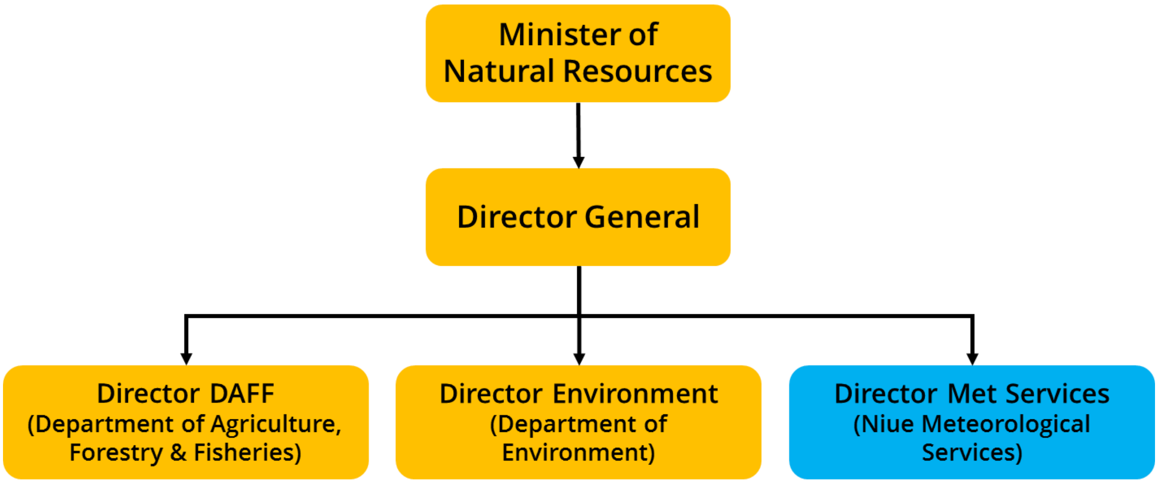
Organisation Structure:

The country has a stand-alone Meteorology Act (Niue Meteorological Services Act 2013) which defines its roles and responsibilities. Niue Meteorological Service functions under the

[51] https://thinkhazard.org/en/report/183-niue-n-z

Ministry of Natural Resources. **Figure (44)** indicates the position of Department of Met Services within the ministry structure (http://niuemnr.com/).

Figure (44): Organogram of Ministry of Natural Resource and representation of Niue Meteorological Service



Source: http://niuemnr.com/

The government of Niue provides financial support to the meteorological service mainly covering administration and operational expenditure. In addition, the agency receives funding from external agencies via different projects. Hence, the funding mechanism consists of a partnership between government and projects. There are 10 staff working in the met service. One climate officer and the rest are meteorology officers.

6.6.3 Key programs

Niue is involved in the implementation of the project called Climate and Oceans Support Program in the Pacific (COSPPac[52] - Phase 2) which is funded by the Government of Australia. Niue Meteorological Service benefits from various climate and weather products (e.g.: Rainfall Outlooks) developed by the project.

The project Climate Risk and Early Warning Systems (CREWS[53]) has helped to improve knowledge in terms of climate services and issuing early warnings to the communities and stakeholders. Further, Ridge to Reef project supports Niue Meteorological Service in terms of collecting and monitoring climate traditional knowledge which is also a component under COSPPac project. SPREP and Pacific Met desk are the key partners of Niue Meteorological Service.

6.6.4 Training and capacity building

At present with the COVID-19 pandemic they attend virtual trainings conducted under SPREP. Niue met service also conducts inhouse training programmes where senior staff trains the new

[52] https://www.pacificmet.net/project/climate-and-ocean-support-program-pacific-cosppac
[53] https://public.wmo.int/en/climate-risk-and-early-warning-systems-crews

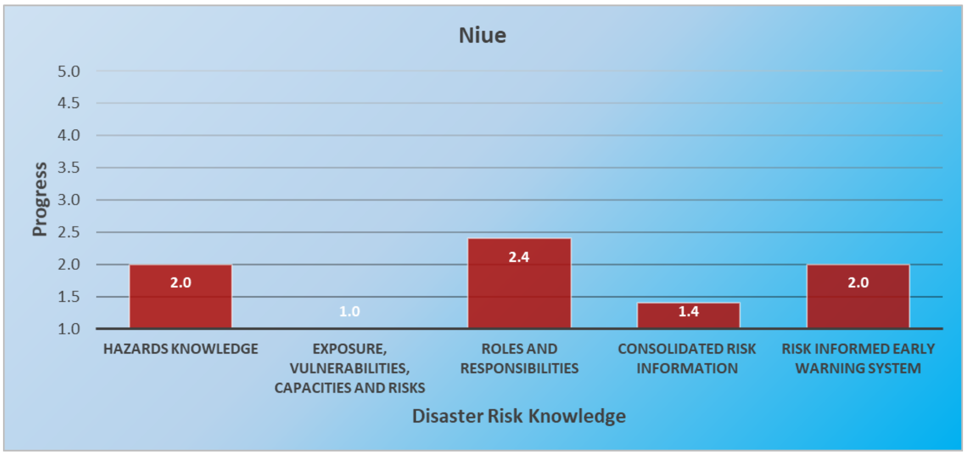
recruits. Their staff also attend regional training programs as well in order to keep up to date with the knowledge and support different activities of the met office. Two staff have completed training in the University of South Pacific where the main focus was on basic climate knowledge, climate change, climate resilience and designing & writing project proposals.

6.6.5 Present status of the MHEWS

Pillar 1: Disaster Risk Knowledge:

Niue Disaster Management Office is tasked with the study of hazards assessment. Niue Meteorological Service supports the Disaster Management Office in carrying out hazard assessments in the country. The met office maintains a record of impacts caused by the last recent cyclones. The progress made in identifying key hazards, roles & responsibilities of stakeholders and incorporating risk information into the early warning system have shown a minimal level. Lot of efforts need to be put in for the development of the themes "Exposure, Vulnerabilities & Risks" and "Consolidated Risk Information". **Figure (45)** summarises the progress of different themes which fall under the 1st Pillar: Disaster Risk Knowledge.

Figure (45): Level of progress: Disaster Risk Knowledge

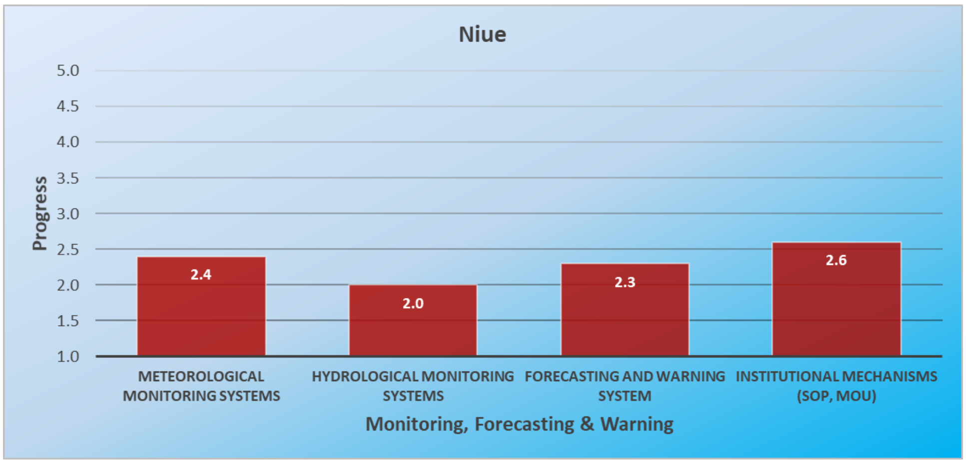


1-No progress; 2-Minimal progress; 3-Moderate progress; 4-Major progress; 5-Completed

Pillar 2: Detection, Monitoring, Analysis and Forecasting of the Hazards and Possible Consequences:

Niue Meteorological Service receives 24-hour weather forecasts from Fiji. They build on that information to produce three-day weather forecasts for Niue. The met office issues marine forecasts too. The met office has one AWS installed at the Hanan Airport, Alofi. A rainfall monitoring station is installed to the eastern side of the Island. The survey indicates a minimal to moderate progress in setting up institutional mechanisms. The other three themes have shown a minimum level of development **Figure (46)**.

Figure (46): Level of progress: Detection, Monitoring & Forecasting



1-No progress; 2-Minimal progress; 3-Moderate progress; 4-Major progress; 5-Completed

Pillar 3: Warning, Dissemination and Communication:

The warnings issued by the Niue Meteorology Service is transmitted to the Niue Disaster Council through email for under taking necessary actions during emergency situations. At the time of disaster, the level of alerts which explain the public what actions to undertake is issued by the Niue Disaster Council.

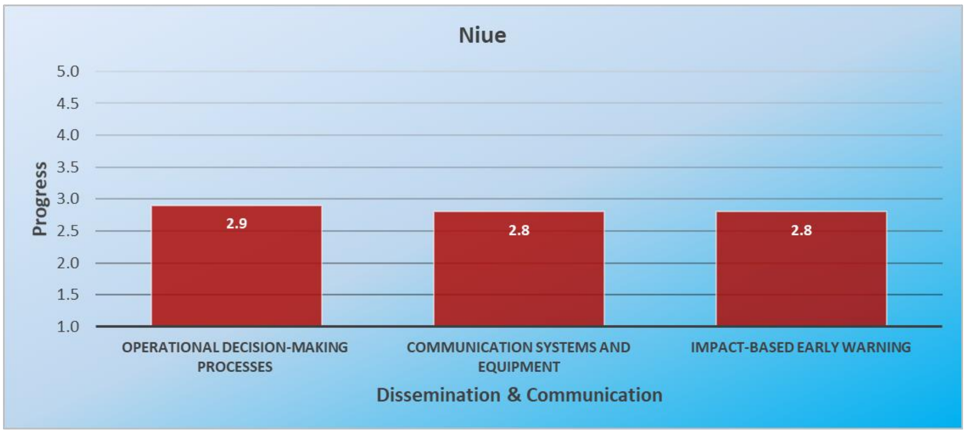
The met office disseminates weather /climate information to the public using media such as the government radio and the Facebook page[54]. The website of Niue Meteorology Service is under development at the moment within the main website of Ministry of Natural Resources. The office also delivers messages to the public via community groups (Niue Girls and Boys Brigade). Information is delivered faster through Facebook (Social Media). Feedbacks on the information provided by the met office are collected from the community groups.

The general public in Niue is now becoming more familiar with the scientific terms used in early warning messages. However, improvement is needed in making the people understand how early warning messages apply to everyday living. There are difficulties in translating the English scientific terms into the local language. When traditional knowledge aspects are incorporated in the messages, public tend to get more awareness/ understanding of the terms. Having both scientific and traditional knowledge is very useful.

The three major themes related to the pillar have shown a development close to the moderate level as indicated in **Figure (47)**.

[54] https://www.facebook.com/niuemetoffice.staff

Figure (47): Level of progress: Warning, Dissemination and Communication



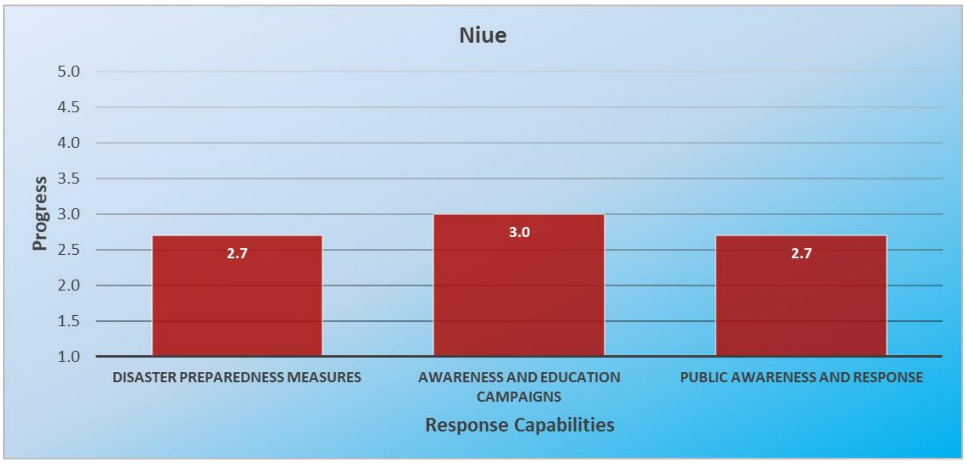
1-No progress; 2-Minimal progress; 3-Moderate progress; 4-Major progress; 5-Completed

Pillar 4: Preparedness and Response Capabilities:

Niue Meteorological Service conducts education and awareness programs with the assistance of NDMO, community groups (Eg: Niue Girls and Boys brigade, different women's groups) to raise the awareness of the general public in relation to weather/ climate matters.

The met office develops Climate Outlooks on a monthly basis. They include weather and climate summaries and other relevant news items from the met service. They are distributed in printed format and via social media & email. The survey indicates that the themes related to the pillar "Response Capabilities" show a development progress close to moderate level **Figure (48)**.

Figure 48: Level of progress: Preparedness & Response Capabilities



1-No progress; 2-Minimal progress; 3-Moderate progress; 4-Major progress; 5-Completed

Pillar 5: Governance

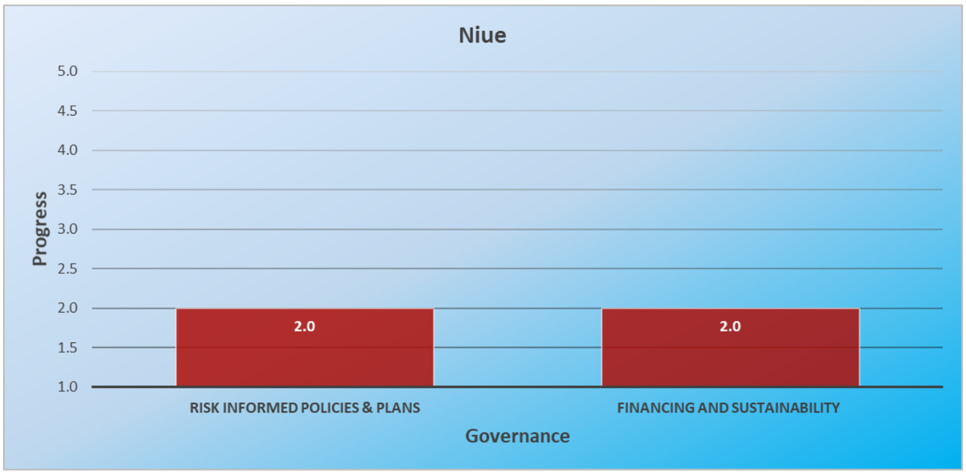
Niue Meteorological Service has a stand-alone meteorology act (Niue Meteorological Services Act 2013) which defines its roles and responsibilities.

It is highlighted in the survey that, it is a challenge for Niue Meteorological Service to maintain and sustain weather observation equipment for a longer time unless the projects have an agreement to provide advisory support. The met office has such agreement with NIWA and New Zealand Met Service in relation to maintenance of some of their equipment. The met office also looks at the possibility to use new projects to support equipment maintenance and further support other ongoing activities.

With respect to the sustaining of the knowledge, the community groups used the new knowledge by applying them in their communities together with traditional knowledge and with the participation of rest of the members.

The two themes under Governance, “Risk Informed Policies & Plans” and “Financing and Sustainability” have shown minimal progress in development (**Figure 49**).

Figure 49: Level of progress: Governance



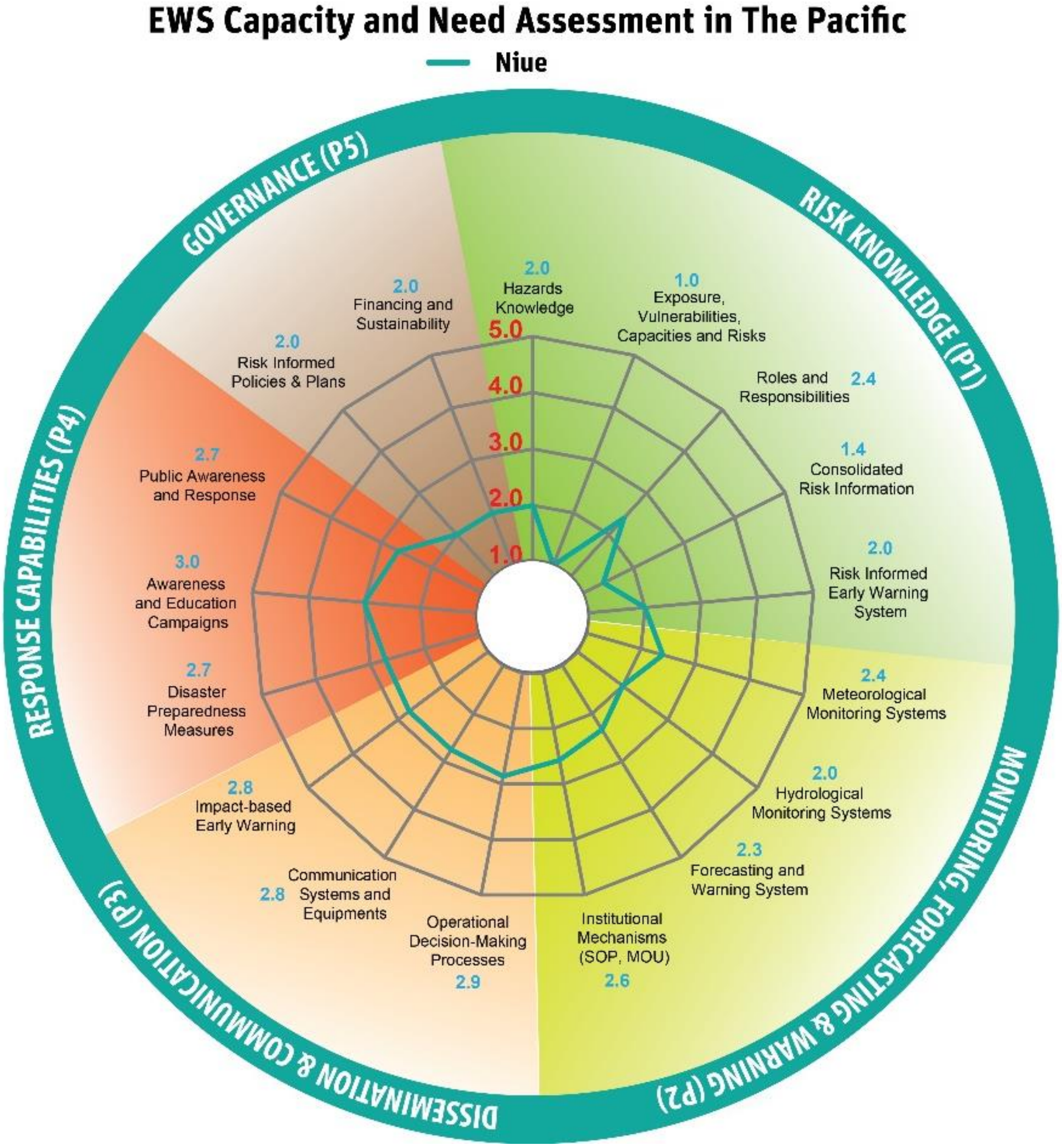
1-No progress; 2-Minimal progress; 3-Moderate progress; 4-Major progress; 5-Completed

6.6.6 Summary

Overview of the MHEWS

The spider web diagram presented in **Figure 50** summarises the present status of the MHEWS in Niue. Disaster Risk Knowledge Pillar needs lot of improvement as it appears to be the least developed among the five pillars. The rest shows development levels which varies from minimal to moderate degree.

Figure 50: Status of MHEWS in Niue

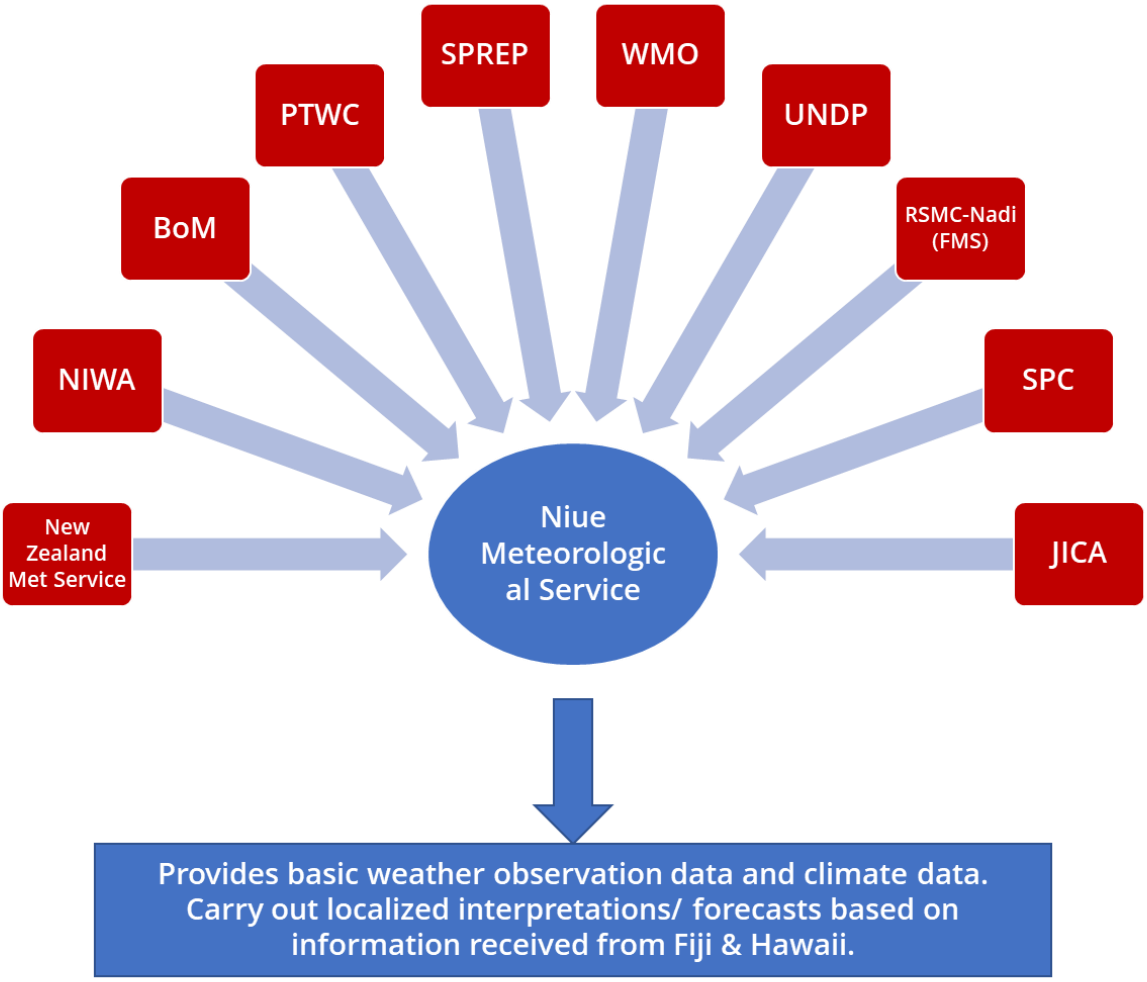


Source: ADPC assessment

Development partners:

The development partners associated with Niue Meteorology Service in assisting to build their MHEWS is mapped in the **Figure 51**.

Figure 51: Development partners of Niue Meteorological Service



Source: NMHS consultation

Best practices

- Niue Meteorological Service works with communities especially at the bottom layer with main actors in the smaller groups. This helps to deliver relevant information and messages (disasters & climate change) effectively to the most vulnerable community groups.

- The met office incorporates Climate Traditional Knowledge in Niue when issuing climate information to the general public.

- They have a compilation of climate traditional knowledge collected from the surveys conducted under the COSPPac project. The compilation is in the draft report format and would be published in the near future.

6.6.7 Needs and recommendations

Table (16): Needs and recommendations	
Pillar	**Needs and recommendations**
• **Disaster risk knowledge**	• Need to carry out comprehensive hazard/risk assessments at the national level which includes information on exposure, vulnerabilities and capacities.
• **Detection, monitoring, analysis and forecasting of the hazards and possible consequences**	• Capacity building of staff and more equipment is needed to interpret and derive weather forecasts. • Need technology support. Some of their equipment are running obsolete and need to be upgraded. • Need improved computer infrastructure to carry out advanced forecasting tasks using advanced computer software. • AWSs data is not directly integrated into CliDE System. Data is entered manually. Hence, it is needed to have a mechanism where AWSs data are automatically fed into the CliDE System.
• **Warning, dissemination and communication**	• The community expects the messages be disseminated in local language. However, translations of some words in English is difficult, because such words do not exist in the local language. Hence, support is needed in developing clear warning messages. • Need improvements in the internet connection in order to access social media platforms (Facebook) for dissemination of climate & weather information via the same. • Niue Meteorology Service would like to make improvements to the climate data management system so that the office would be able to disseminate the information to the public very effectively.
• **Preparedness and response capabilities**	• There is a need to conduct public awareness and education campaigns with more resources/knowledge products catered for

Table (16): Needs and recommendations	
Pillar	**Needs and recommendations**
	specific population groups (Eg: young children, elderly people).
• **Governance**	• Limited operational budget is available for maintenance of the equipment that are being installed under various projects. Hence, a review of the budget allocation is essential. • There is a need for a Climate Data Analyst to analyse climate parameters and work with stakeholders. The met office also needs an extra climate officer to perform data entry of climate data.

6.7 Tokelau

Tokelau means 'North Wind' and consists of three atolls (Fakaofo, Nukunonu, and Atafu) located approximately 720 km north-west of Samoa. It has a combined land area of 12 km² and is no more than 2 m above sea level. Tokelau is a Polynesian territory of New Zealand and has a population of only 1,400 people. Air transportation is not available in the country. The transport to Tokelau is by sea from Samoa. Administrative and legislative powers of the Administrator of Tokelau are formally delegated to the three Taupulega (Village Council of Elders) of Tokelau as the highest authority. Authority for national issues is re-delegated to the General Fono (National Assembly) to deal with issues beyond those properly undertaken by each village alone. National-level administration is primarily done by the national public service, most of which is based in Apia (https://www.tokelau.org.nz/). **Table (17)** represents country profile of Tokelau.

<table>
<tr><th colspan="2">Table 17: Country profile: Tokelau</th></tr>
<tr><td>Capital: Nukunonu</td><td rowspan="9">Geographical location


Source: Pacific Community[55]</td></tr>
<tr><td>Location: 8°-10° S 171°-173° W</td></tr>
<tr><td>Geographical area: 12 km²</td></tr>
<tr><td>Population: 1,400</td></tr>
<tr><td>Max height above sea level: 5 m</td></tr>
<tr><td>RSMC: Nadi</td></tr>
<tr><td>NMHS: Tokelau Meteorological Service
WMO member: -</td></tr>
<tr><td>Climate Risk Index Score: NA
Climate Risk Index Rank: NA</td></tr>
<tr><td>INFORM Risk Index: NA
INFORM Risk Class: NA
INFORM Risk Rank: NA</td></tr>
</table>

6.7.1 Overview of susceptibility to hazards

Tokelau is most vulnerable to tropical cyclones which are becoming more severe and frequent due to climate change. The islands climate is hot with an average temperature of 28ºC. Severe tropical storms and cyclones are closely linked to El Niño Southern Oscillation (ENSO) conditions with previous damaging events occurring in 1987,1990, 1991 and 2005 causing extensive damage to households and general infrastructure, due to the low-lying nature. The most recent disaster event was Tropical Cyclone Percy that hit Tokelau in February 2005

[55] https://www.spc.int/our-members/Tokelau

causing damage to vegetation and infrastructure. Three cyclones in the late 1980s and early 1990s also caused extensive damage. **Table (18)** represents susceptibility to natural hazards in Tokelau.

Table 18: Susceptibility to natural hazards in Tokelau

Natural hazards	Hazard type	Susceptibility
Cyclone	Hydro-Meteorological	High
Coastal flood	Hydro-Meteorological	Medium
Tsunami	Geological	Medium
Extreme Heat	Hydro-Meteorological	Medium
Earthquake	Geological	Very Low
Wildfire	Other	Very Low
River flood	Hydro-Meteorological	No Data
Urban flood	Hydro-Meteorological	No Data
Landslide	Geological	No Data
Volcano	Geological	No Data
Drought and Water Scarcity	Hydro-Meteorological	No Data

Source: GFDRR | ThinkHazard[56]

Changing weather patterns and high sea level rises are expected to impact Tokelau's long-term survival. Its resilience to natural disasters is considered low due to its remoteness, inaccessibility by air or sea port, and lack of fresh water supply.

At the end of December 2017, the Tokelau Meteorological Office was re-established with a fully functional office. The re-establishment of a fully functional Meteorological Office will further enhance and improve early warning system for the island nation. Tokelau has a national strategy for enhancing the Resilience of Tokelau to Climate Change and related natural hazards 2017 – 2030. Tokelau has also developed its National Disaster Risk Reduction Plan.

6.7.2 National Meteorological and Hydrological Service (NMHS)

Tokelau Meteorological Service is designated with the task of providing meteorology services to the nation including climate services and early warnings of disasters.

[56] https://thinkhazard.org/en/report/244-tokelau-n-z

Organisation structure:

National meteorology and hydrology services comes under the Department of Economic Development, Natural Resources and Environment (EDNRE). All the functions pertaining to Meteorological Services are handled by the Environment Division of the department. At present, the Meteorology Office consists of three meteorology officers. Department of EDNRE is also responsible for the management of water resources in Tokelau. The same staff of the meteorology service is engaged in monitoring the safeness of drinking water. The main partners who assist Tokelau in developing its meteorological services are the UNDP, Ministry of Foreign Affairs and Trade (MFAT) New Zealand and BOM. Tokelau receives financial aid from the partners through the implementation of different Projects (Eg: CREWS project by WMO, RESPAC project by UNDP/ Russian Federation). MFAT New Zealand was the major partner behind the water security projects conducted in Tokelau.

6.7.3 Key programs

A feasibility study is ongoing for setting up a national radio for Tokelau with technical/ financial assistance from WMO CREWS Project. The primary objective of this study is to identify equipment, resources, institutional arrangements, other needed items and their related costs to set up and sustain a national radio service for Tokelau. A national radio for Tokelau would provide a very effective mechanism in communicating early warnings to the general public prior to disasters mainly due to cyclones. Further, the installation process of two AWSs in Tokelau are carried out under the RESPAC Project.

6.7.4 Training and capacity building

Tokelau Meteorology office relies on external donors to conduct training and build the technical capacities of their staff. At present, the three met officers have received training only on retrieval of data from rain gauges. The Met Office considers the Tokelauan students who undertake tertiary education at the University of the South Pacific in the field of Environment would be good prospects for its meteorology service in the country in future.

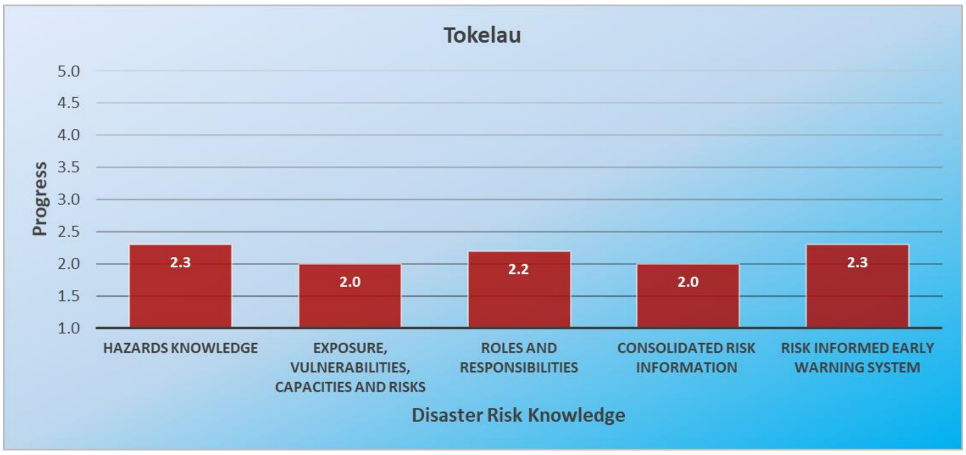
6.7.5 Present status of the MHEWS

Pillar 1: Disaster Risk Knowledge

Tokelau has carried out studies on cyclone related coastal hazards, tsunami hazard and its associated risks with the assistance of international development partners (NIWA, UNDP, MFAT). The compiled reports are available at the website of Government of Tokelau under Climate Change[57]. The questionnaire survey results indicated that Tokelau has made a minimal to moderate progress in identifying key hazards, and roles & responsibilities of the stakeholders. The level of progress in accessing risks and consolidating risk information is minimum. However, the survey indicated that the country has made attempts in establishing risk informed early warning systems with minimum to moderate level of progress. **Figure 52** summarises the progress of different themes which fall under the 1st Pillar: Disaster Risk Knowledge.

[57] https://www.tokelau.org.nz/Climate.html

Figure 52: Level of progress: Disaster Risk Knowledge

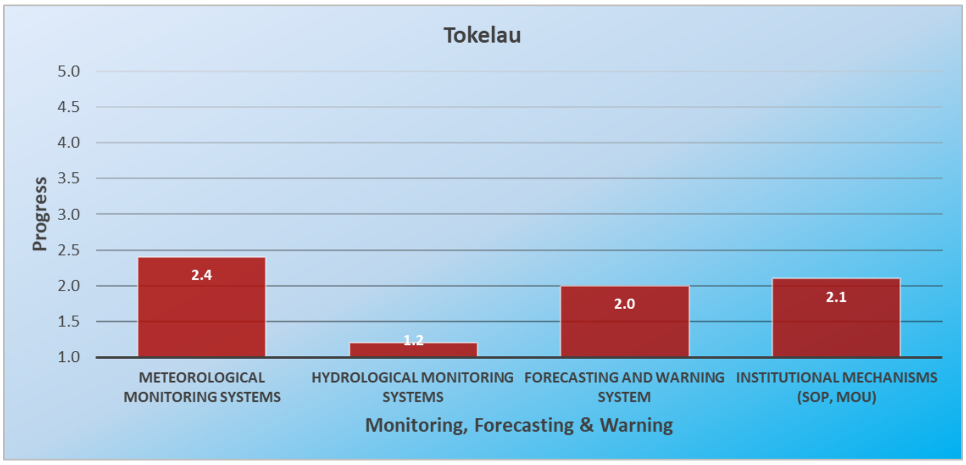


1-No progress; 2-Minimal progress; 3-Moderate progress; 4-Major progress; 5-Completed

Pillar 2: Detection, Monitoring, Analysis and Forecasting of The Hazards and Possible Consequences

Weather forecasts for Tokelau are derived from information and regional weather bulletins received from FMS. Tokelau Meteorology Service also receives assistance from Samoan Meteorological Service in issuing weather forecasts. Further, Tokelau Foreign Affairs also receives climate and weather information from New Zealand Meteorology Service and NIWA. The progress with respect to the availability of meteorological monitoring systems is at minimal to moderate level. Establishing forecasting & warning systems and institutional mechanisms have shown a minimal progress. The survey results indicated that the work related to setting up of hydrological monitoring systems are still at the primary level. **Figure 53** summarises the progress of different themes which fall under the 2nd Pillar: Detection, Monitoring and Forecasting.

Figure 53: Level of progress: Detection, Monitoring & Forecasting



[1-No progress; 2-Minimal progress; 3-Moderate progress; 4-Major progress; 5-Completed]

Pillar 3: Warning, Dissemination and Communication

Public weather forecasts for Tokelau received from FMS are translated by one officer in the meteorology office into local language and are then disseminated via email to other departments.

Tokelau meteorology service communicates information on weather forecasts to village mayors (Office of the Taupulega) in emergency situations and issues appropriates warning messages to them. The village mayor is responsible for the operation of the village and for taking appropriate actions to prepare for disaster events. Further, the village mayors receive information on pending disasters from the Tokelau Apia Liaison Office (Tokelau National Disaster Risk Reduction Plan, 2011).

Weather forecasts and warnings are communicated to the general community in the present time primarily by emails. Everybody who are competent in English language (government workers, village workers, church workers) are recipients of those emails.

Some villages of Tokelau possess satellite phones for communication, in case if the telephone system breaks down (as a backup measure). It is also noted that the operation of such satellite phones is expensive.

The messages are communicated to the general public in Tokelauan language during the no cyclone season (From March to October). However, in the time of the cyclone season, the warning messages are issued in English language as the translation into local language is a time-consuming task. The messages are also communicated via the Facebook page[58] of Tokelau Meteorology Service.

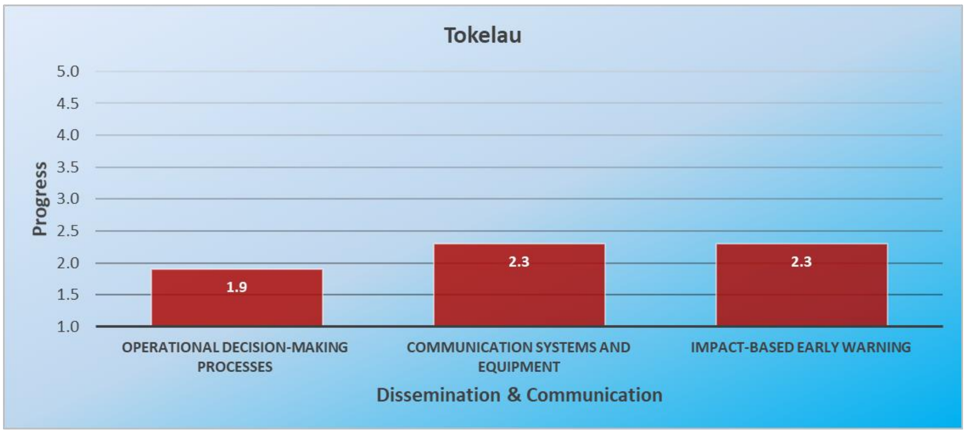
Tokelau has shown a progress close to minimum level with respect to setting up operational decision-making processes. It is also noted that substantial improvements need to be incorporated when carrying out coordination, planning and review meetings between the warning issuers and the media. Further, there is a need to setup feedback mechanisms to verify that warnings have been received and understood by the general public and relevant stakeholders.

The progress made in establishing communication systems and its operations are at minimum to moderate level. Attention is required in updating the communication equipment to utilize new technologies and in assessing of communication strategies to ensure messages are reaching the population, particularly people in vulnerable conditions. The communication of effective impact based early warnings has also shown a minimum to moderate progress level.

Figure 54 summarises the progress of different themes which fall under the 3rd Pillar: Warning, dissemination and communication.

[58] https://www.facebook.com/TokelauMetService

Figure 54: Level of progress: Warning, Dissemination & Communication



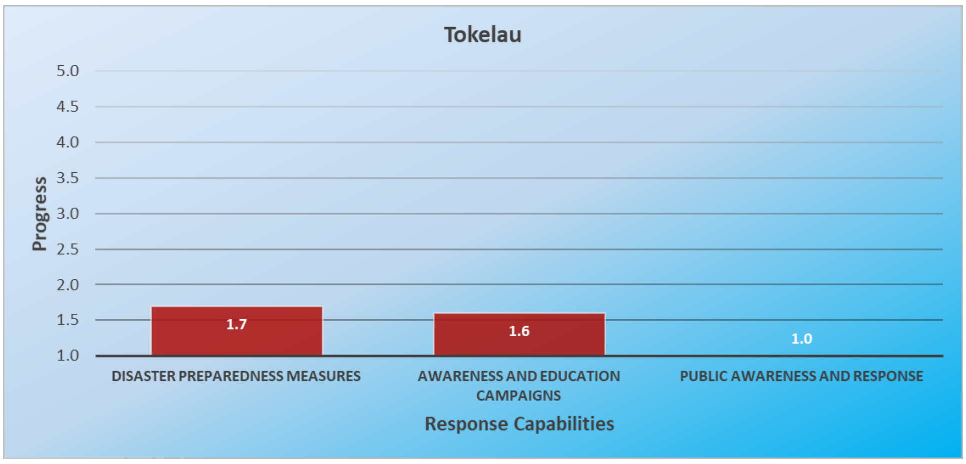
1-No progress; 2-Minimal progress; 3-Moderate progress; 4-Major progress; 5-Completed

Pillar 4: Preparedness and Response Capabilities

The three major themes under the pillar "Preparedness and Response Capabilities" have shown very minimum progress in its development. Aspects related to "Public Awareness and Response" appears to be not yet addressed. These include analysis of previous emergency and disaster events, setting up of public awareness strategies and conducting of early warning simulations, drills & exercises. The progress made under the two themes, availability of disaster preparedness measures and implementation of awareness & education campaigns is also found at a very minimum level.

Figure 55 summarises the progress of different themes which fall under the 4th Pillar: Preparedness and response capabilities.

Figure 55: Level of progress: Preparedness & Response Capabilities



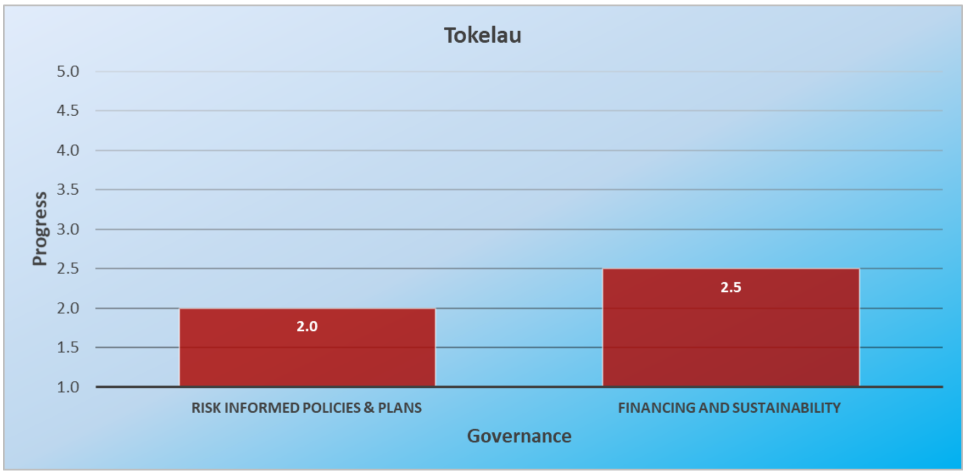
[1-No progress; 2-Minimal progress; 3-Moderate progress; 4-Major progress; 5-Completed]

Pillar 5: Governance

Tokelau has a national water policy. However, a meteorology act is unavailable for Tokelau describing the roles and responsibilities of the national meteorological service.

In the present time, the themes under "Governance" have shown minimum to moderate level of progress. It is noted that there is a need to mainstream EWS and risk information into the national level policy, strategies, and development plans further. During the survey it is also highlighted with adequate remuneration rates/ better rewards, Tokelau meteorology service would be able to retain its staff and sustain them for a longer time serving for Tokelau. **Figure 56** summarises the progress of different themes which fall under the 5th Pillar: Governance.

Figure 56: Level of progress: Governance



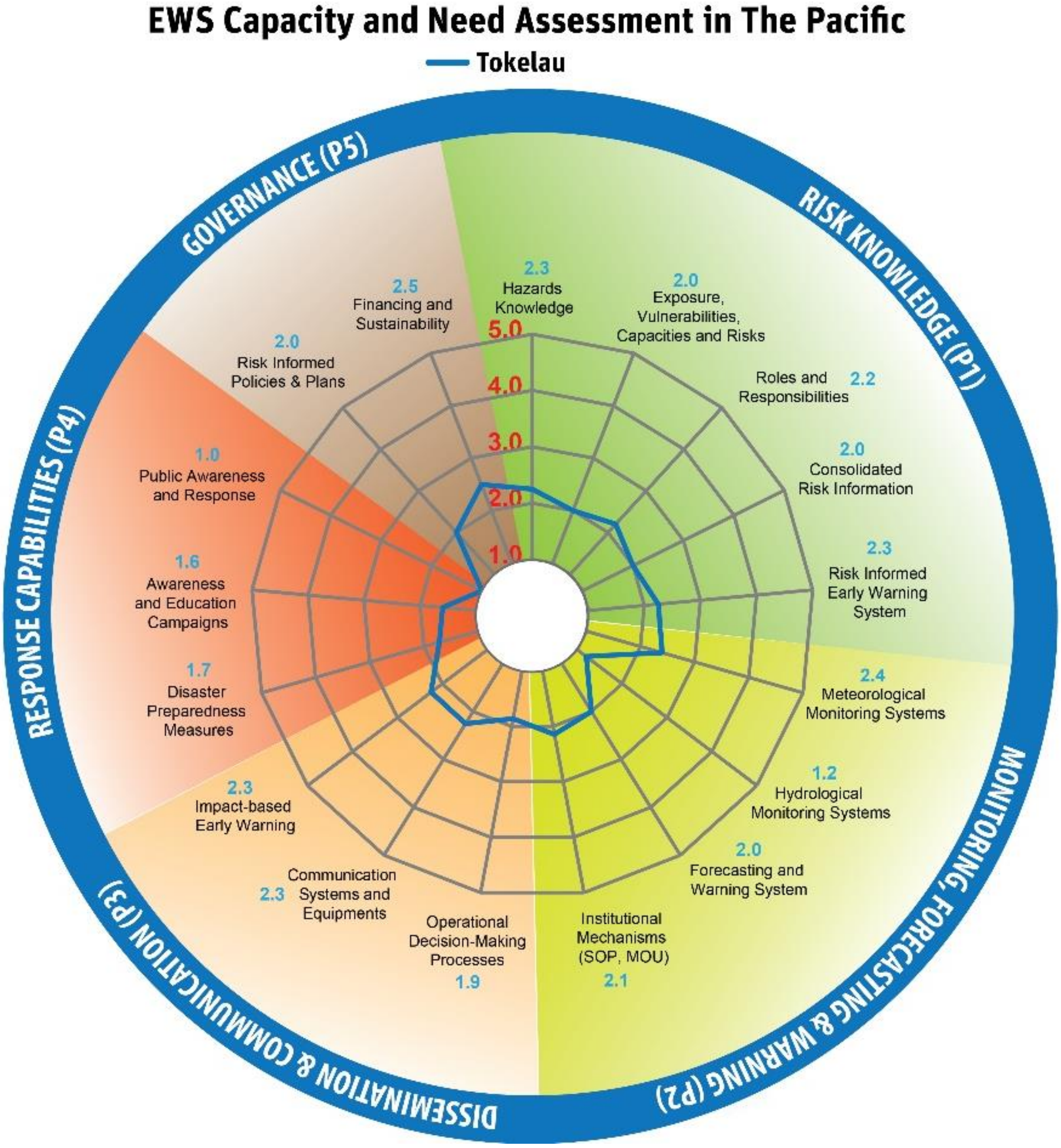
1-No progress; 2-Minimal progress; 3-Moderate progress; 4-Major progress; 5-Completed

6.7.6 Summary

Overview of the MHEWS:

The spider web diagram presented in **Figure 57** summarises the present status of the MHEWS in Tokelau. Based on the survey results, it is noted that all the pillars of MHEWS are in the first stages of development. More attention is needed in developing hydrological monitoring systems and with respect to public awareness and response.

Figure 57: Status of MHEWS in Tokelau

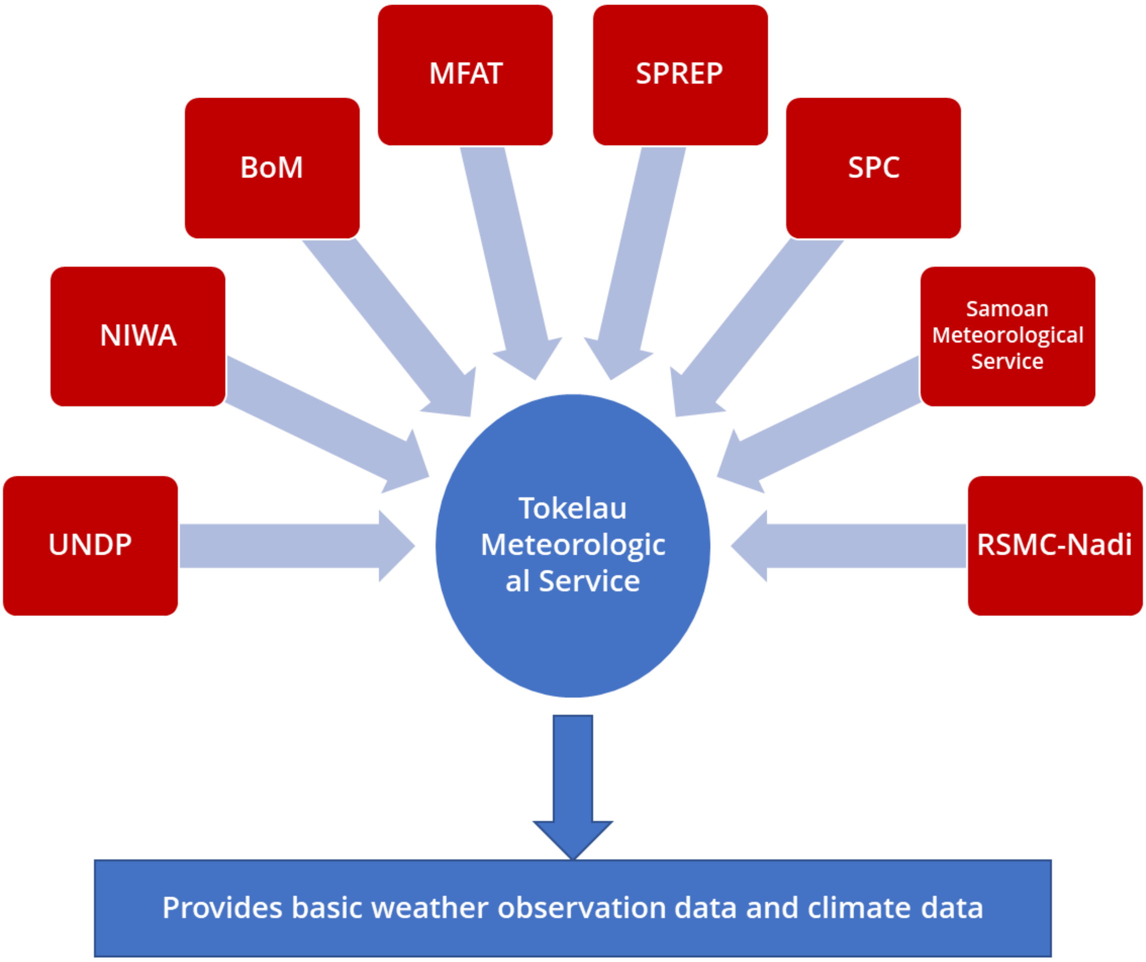


Source: ADPC assessment

Development partners of Tokelau Meteorology Service:

The development partners associated with Tokelau Meteorology Service in assisting to build their MHEWS is mapped in the **Figure 58**.

Figure 58: Development partners of Tokelau Meteorological Service



Source: NMHS consultation

Best Practices:

Some of the best practices related to climate services in Tokelau are:

- Tokelau seeks technical/ financial assistance from external/ international organisations to develop the meteorological operations/ services of Tokelau.
- The meteorology office retrieves data from the three manual weather stations at the beginning of each month and stores them in their laptops. Currently, the met office is looking ahead for a proper weather data storage system such as the CliDE, so that the collected data can be stored safely and be used for various climate & weather applications.
- Meteorology officers share climate & weather data with FMS and RSMC Nadi for interpreting weather patterns in the Pacific. Such data and information from Tokelau is used for preparation of weather maps and for other related technical tasks.

- The met office plans to retain manual weather stations to function in parallel with AWSs. The manual stations would come in handy if any technical errors occur in AWSs disrupting the monitoring of weather.

- The Department of EDNRE publishes an e-newsletter which contains information about Environment, Meteorology and Weather with the aim to raise the awareness and knowledge of the general public on the respective thematic fields.

6.7.7 Needs and recommendations:

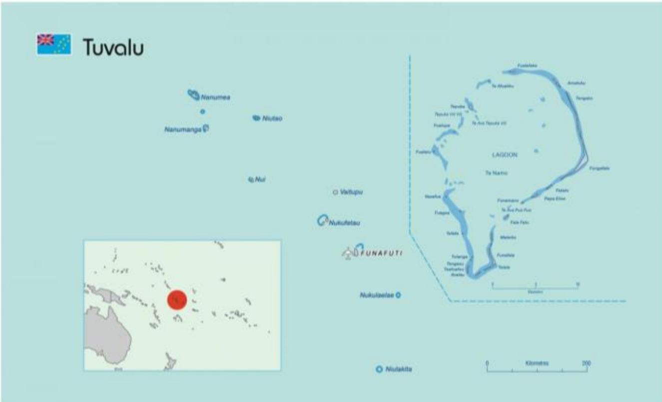
Table 19: Needs and recommendations	
Pillar	**Needs and recommendations**
Disaster risk knowledge	• Need more involvement of scientific and technical experts in conducting hazard, vulnerability and risk assessments. • There is a need of a data management system for processing and storing weather related data. Such data will help in climate modelling and will be useful for different sectors such as tourism, civil aviation etc.
Detection, monitoring, analysis and forecasting of the hazards and possible consequences	• Need capacity development in all aspects of meteorology starting from databases operation & maintenance and retrieving data from AWSs. • The three met officers need education qualifications in order to better perform their duties. At present, the three met officers have received training only on retrieval of data from rain gauges. With more advanced training, the met officers would be able to generate localized weather forecasts for Tokelau using the information received from FMS. • Development of hydrological monitoring systems is essential including fluvial/pluvial/coastal flood detection, modelling and hydrological data management. • There is a need to standardize processes and roles & responsibilities of all organisations generating and issuing warnings. It is also needed to mandate them by legislation or another authoritative instrument (Eg: MoU, SOP).
Warning, dissemination and communication	• There is a need for a national radio as it will be much more effective in covering the nation in delivering early warning messages and weather/climate information rather than emails and telephone messages.

Table 19: Needs and recommendations	
Pillar	**Needs and recommendations**
	• There is a lack of technical knowledge in operating radio services, hence it is essential to carry out capacity building on the said area. • It would be much better to issue emergency warning messages in Tokelauan language as it would provide a better understanding to the general public. • Regular coordination between the warning issuers and the media needs to be improved. • There is a need to set up feedback mechanisms and communication strategies to ensure that warnings are been received by the people at risk. • Upgrading of equipment with the latest technology and setting up of a mechanism for their regular maintenance is essential in order to ensure a smooth operation.
Preparedness and response capabilities	• Preparation of strategies and their implementation is vital to maintain preparedness for longer return period and cascading hazard events. • Need to establish protocols to activate/mobilize last mile operators (e.g. local police, firefighters, volunteers, health services) who disseminate warnings to the public and decide public measures, including issuing orders for evacuation or sheltering place. • Undertake regular exercises to test and optimize the effectiveness of the early warning dissemination processes, preparedness and response to warnings. • There is a need to set up public education campaigns to raise the awareness on possible hydro-meteorological hazards among the public with specially tailored programs to specific needs of target groups (Eg: women, children, older people, and people with disabilities). • There is a need to conduct an analysis on the nature of responses made to historical emergency/ disaster events and incorporate lessons learnt into

Table 19: Needs and recommendations	
Pillar	**Needs and recommendations**
	preparedness/ response plans and into capacity building strategies. • Early warning simulations, drills and exercises are essential to be conducted regularly in order to raise the awareness of the people to respond to an emergency appropriately.
Governance	• NDMOsare based in Apia, Samoa and EDNRE doesn't appear to have a good communication mechanism with them. Hence, adequate communication is needed to ensure essential information is conveyed between the two entities. • Tokelau Meteorology Office prefers getting information directly from RSMC-Nadi in Fiji to Tokelau rather than waiting to get them through Apia as it would provide them with more time as well as avoid unnecessary delays in undertaking necessary actions and preparations. • It is essential to draft a Meteorology Act defining the roles and responsibilities of Tokelau Meteorology Service. • An increase in the government budget allocation for the Department of EDNRE is needed in order to cater the increase in capacity and increase in technicalities of the meteorology office.

6.8 Tuvalu

Tuvalu is one of the smallest countries in the world and consists of a densely populated, scattered group of nine coral atolls. The UN has classified Tuvalu as a Least Developed Country, due to its small size, almost total lack of exploitable resources, and vulnerability to environmental shocks. UN maintains a joint presence office in Tuvalu with UNDP, UNICEF and UNFPA working together on programmes with UNDP taking the lead. **Table 20** represents country profile of Tuvalu.

<table>
<tr><th colspan="2">Table 20: Country profile: Tuvalu</th></tr>
<tr><td>Capital: Funafuti</td><td rowspan="8">Geographical location


Source: Pacific Community[59]</td></tr>
<tr><td>Location: 8°31'S 179°13'E</td></tr>
<tr><td>Geographical area: 26 km²</td></tr>
<tr><td>Population: 10,200</td></tr>
<tr><td>Max height above sea level:
5 m</td></tr>
<tr><td>RSMC: Nadi</td></tr>
<tr><td>NMHS: Tuvalu Meteorological Service
WMO member: September 2012[60]</td></tr>
<tr><td>Climate Risk Index Score: 125[61]
Climate Risk Index Rank: 135</td></tr>
<tr><td>INFORM Risk Index: 3.1[62]
INFORM Risk Class: Low
INFORM Risk Rank: 112</td><td></td></tr>
</table>

6.8.1 Overview of susceptibility to hazards:

Tuvalu faces a moderate degree of natural disaster risk. However even minor emergencies can overwhelm national capacity. Humanitarian impacts from climate-change related disasters are of increasing concern. Rising sea levels due to climate change are a significant threat to the country's islands with its highest point only 4-5 metres above sea level. In year 1997, three tropical cyclones hit Tuvalu; Gavin and Hina in March, and Keli in June. A national emergency in September 2011 was declared due to severe drought. Tropical Cyclone Pam impacted Tuvalu in March 2015. Table 21 represents susceptibility to natural hazards in Tuvalu.

59 https://www.spc.int/our-members/Tuvalu
60 WMO: https://public.wmo.int/en/about-us/members
61 CRI (2020): https://www.germanwatch.org/en/17307
62 INFORM (2020): https://drmkc.jrc.ec.europa.eu/inform-index/

Table 21: Susceptibility to natural hazards in Tuvalu		
Natural hazards	**Hazard type**	**Susceptibility**
Cyclone	Hydro-Meteorological	High
Coastal flood	Hydro-Meteorological	High
Tsunami	Geological	Medium
Extreme Heat	Hydro-Meteorological	Medium
Earthquake	Geological	Very Low
Wildfire	Other	Very Low
River flood	Hydro-Meteorological	No Data
Urban flood	Hydro-Meteorological	No Data
Landslide	Geological	No Data
Volcano	Geological	No Data
Drought and Water Scarcity	Hydro-Meteorological	No Data
Source: GFDRR | ThinkHazard[63]		

6.8.2. National Meteorological and Hydrological Service (NMHS):

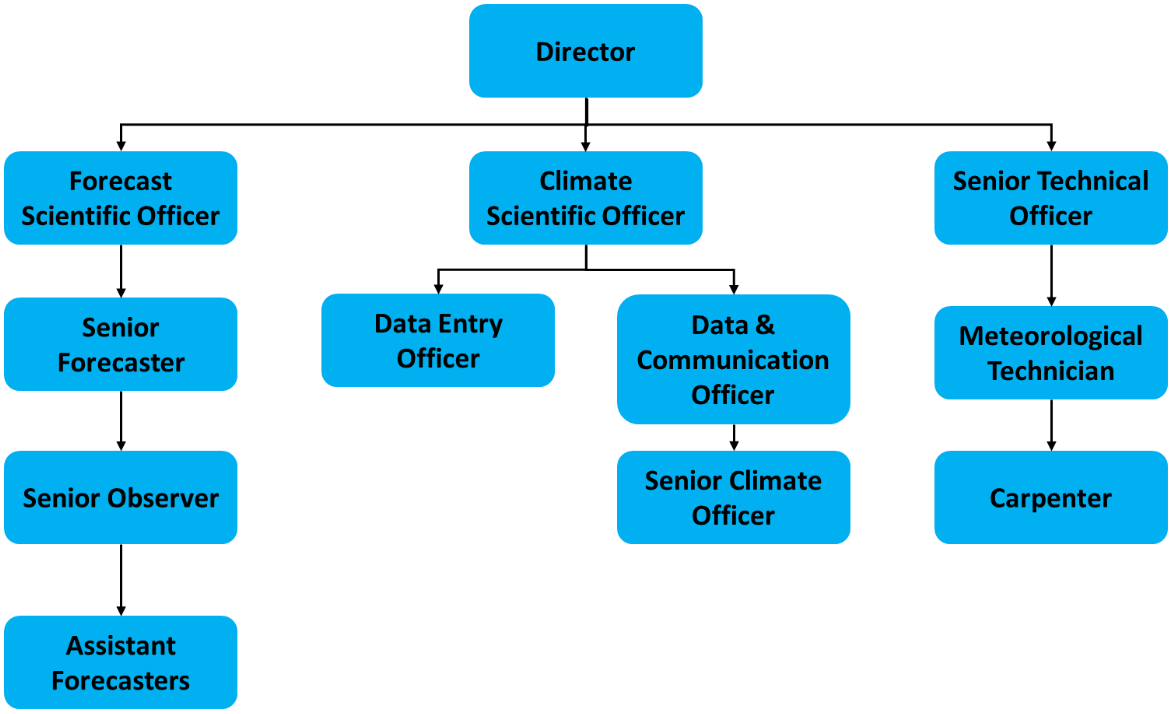
The main role of Tuvalu Meteorological Service is to take and record meteorological observation and provide weather forecast and climate outlook for government sectors and the general public living in the islands of Tuvalu. Delivering information on ocean behavior is also a responsibility of Tuvalu meteorology service. Hydrology field does not come under the mandate of Tuvalu Meteorological Service. The Tuvalu Public Works Department (Water and Plumbing Division) looks after hydrological matters.

Organisation structure:

Tuvalu Meteorological Service functions under the Ministry of Communications and Transport. The main observational office is located on the island of Funafuti. Three other offices are located on the outer islands of Nanumea, Nui and Niulakita. There are three subdivisions within the meteorological service. They are Forecast, Climate and Technical. There are 21 staff in total. Among them, two have master degree and postgraduate qualifications, three with bachelors and two with certificate level qualifications. **Figure 59** presents the organigram of Tuvalu meteorology service.

[63] https://thinkhazard.org/en/report/252-tuvalu

Figure 59: Organigram of Tuvalu Meteorology Service



Source: Tuvalu Meteorological Service

Tuvalu meteorological service receives limited funding from the government. In addition, it receives funding through major projects such as NAPA (National Adaptation Programmes of Action). The NAPA is one of the major projects that has contributed to achieve the goals of the Meteorology Service (Eg: Installation of Early Warning Systems – Chatty Beetles in outer islands).

Figure 61: Chatty Beetle at Tuvalu meteorological service

Chatty Beetle is a portable Iridium satellite terminal that permits text-based alerts and messaging in remote locations, where communication options are limited.

Source: Facebook[64]

[64] https://www.facebook.com/Tuvalu-Meteorological-Service-109004227200666/?ref=page_internal

6.8.3 Key programs:

Tuvalu NAPA project has helped Tuvalu meteorological service to achieve most of the goals. Eg: Installation of early warning system (Chatty Beetles System) in the outer islands. NAPA is supported by SPC and UNDP. Further, a program is conducted for offshore wave forecasting under CREWS WMO project. Offshore wave forecasting model provide forecasts on swells, storm surges, high tides, low tides.

6.8.4 Training and capacity building:

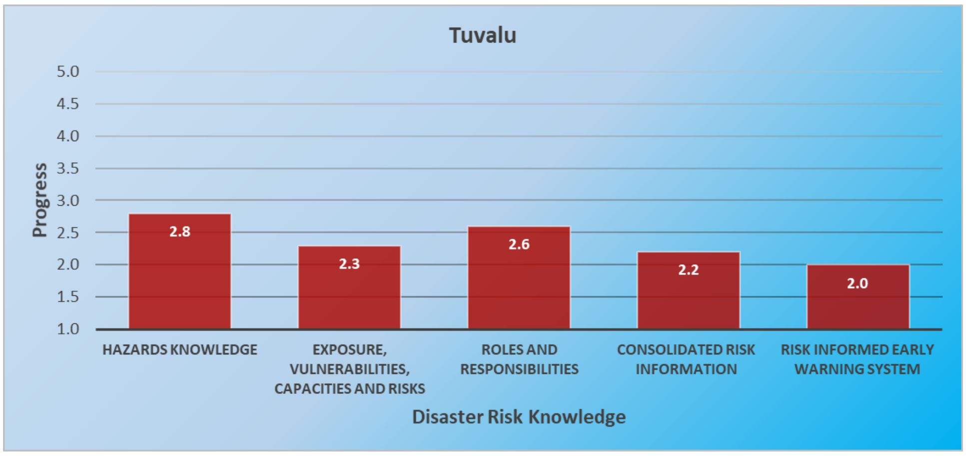
Most of the training programs for staff of Tuvalu meteorological service are done overseas such as in the FMS, Pacific Training Desk in Hawaii and other types of training in the Pacific funded by the WMO. The staff need more training to enhance their capacity skills and knowledge to perform the duties and services of the met office.

6.8.5 Present status of the MHEWS

Pillar 1: Disaster Risk Knowledge:

There has been a progress close to moderate level in identifying key hazards and roles and responsibilities of stakeholders. The progress achieved in assessing risks and in consolidating risk information is at minimum to moderate level. The least developed theme is “Risk informed Early Warning System” with the minimal progress level. **Figure 62** summarises the progress of different themes which fall under the 1st Pillar: Disaster Risk Knowledge.

Figure 62: Level of progress: Disaster Risk Knowledge



1-No progress; 2-Minimal progress; 3-Moderate progress; 4-Major progress; 5-Completed

Pillar 2: Detection, Monitoring, Analysis and Forecasting of the Hazards and Possible Consequences:

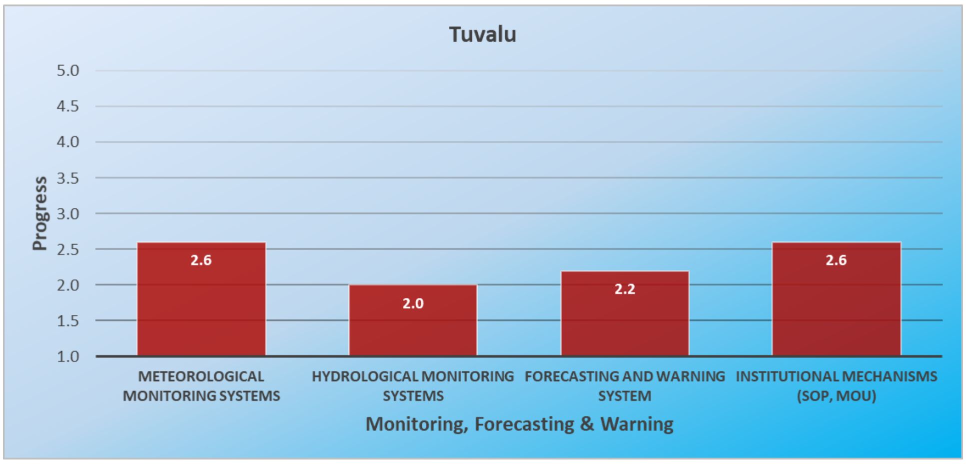
Tuvalu Meteorological Service depends on PTWC in Hawaii and RSMC Nadi in Fiji for the issuance of disaster warning messages. Tsunami warnings are based on the information received from PTWC based in Hawaii. Cyclone warning information are received from RSMC

Nadi. The water section of the Public Works Department looks after hydrological matters and the meterological service has a close collaboration with them. (Eg: sharing of data).

Tuvalu Meteorological Service issues daily weather forecasts which include morning and evening forecasts. They have a weather bulletin that goes to the public every day. Weather forecasting models such as MetConnect, Stream line Analysis, WinMap, ARL models are used by Tuvalu meteorological service.

The progress shown in setting up meteorological monitoring systems and having institutional mechanisms can be considered as minimum to moderate level. Setting up of forecasting and warning systems has shown a progress little more above the minimum level. However more attention is required for further development on the theme hydrological monitoring systems. **Figure 63** summarises the progress of different themes which fall under the 2nd Pillar: Detection, Monitoring and Forecasting.

Figure 63: Level of progress: Detection, Monitoring & Forecasting



1-No progress; 2-Minimal progress; 3-Moderate progress; 4-Major progress; 5-Completed

Pillar 3: Warning, Dissemination and Communication:

There are SOPs used in issuing warnings (Eg: Issuance of Tsunami Warning). Tuvalu meteorological service has all staff emails of all the government stakeholders, all the island councils and communities and are included in the email list when issuing warnings. The warning information received from PTWC and RSMC Nadi are put into standard template made by Tuvalu meteorological service in order to compile the warning messages for dissemination. The warnings are issued to the general public after getting the approval from the secretary to the government. Cyclone warnings are issued directly to the general public through the Tuvalu meteorological service. When an emergency situation arises in a non-working day, the director of Tuvalu meteorological service is the one who authorizes before issuing the alerts to the general public. The final decision to disseminate the warning to the media and other stakeholders is taken from Tuvalu Met Service.

The main communication method to disseminate information to the general public is through radio Tuvalu. The radio is the most effective way to reach out all the communities in Tuvalu

covering the scattered islands. Most of the elderly people have radios at home and used to listen to its programs.
The information dissemination via social media is effective only in the capital city – Funafuti as there is a reliable internet connection in place and people have the ability to afford the use of internet. Especially, the people in the outer islands have limited access or do not have access to social media. Some of the outer islands/ communities do not have reliable internet connections and have difficulties in meeting the cost of the connections as they appear to be expensive. Most of the people in the outer islands do not have phones or laptops as they are expensive and unable to afford.

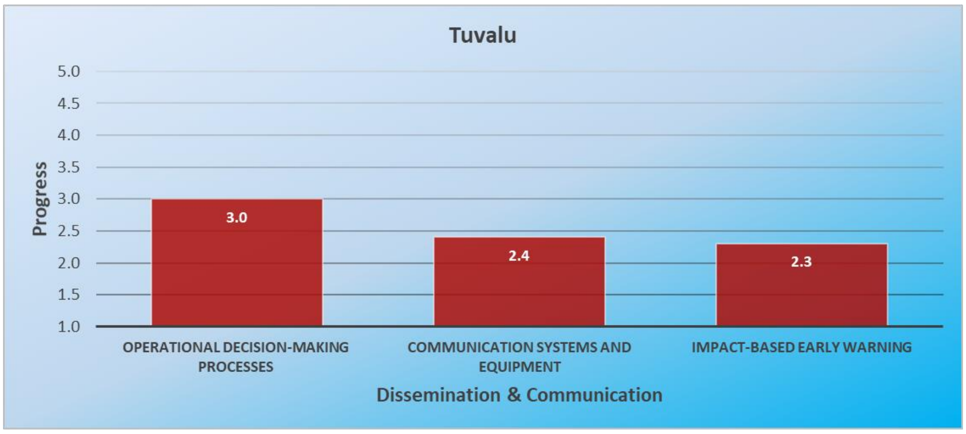
Tuvalu meteorological service has chatty beetles which is the most robust and effective means to deliver messages during emergency when other means of communication is not working. Further, the news bulletins and emergency warning messages are updated on the online platforms (Facebook[65] & Website[66]) of Tuvalu met office. The warning messages issued by the Tuvalu meteorological service are not impact based.

There are community-based organisations consisting of volunteers in the islands. They are smaller communities within the islands, and they help in dissemination of weather and climate information.

Tuvalu meteorological service cooperates directly with the Tuvalu NDMO in case of emergency situations. During strong warnings, the meteorological service carries out briefings every 3 hours in the met office gathering closest stakeholders (Eg: Red Cross, NDMO, Media,) for them to get an idea on the level of preparedness.

There has been a moderate progress with respect to operational decision-making process. The themes "Communication Systems and Impact-based Early Warning have shown a minimum to moderate level of development. **Figure 64** summarises the progress of different themes which fall under the 3rd Pillar: Warning, dissemination and communication.

Figure 64: Level of progress: Warning, Dissemination & Communication



1-No progress; 2-Minimal progress; 3-Moderate progress; 4-Major progress; 5-Completed

[65] https://www.facebook.com/Tuvalu-Meteorological-Service-109004227200666
[66] https://www.tuvmet.tv/index.php/

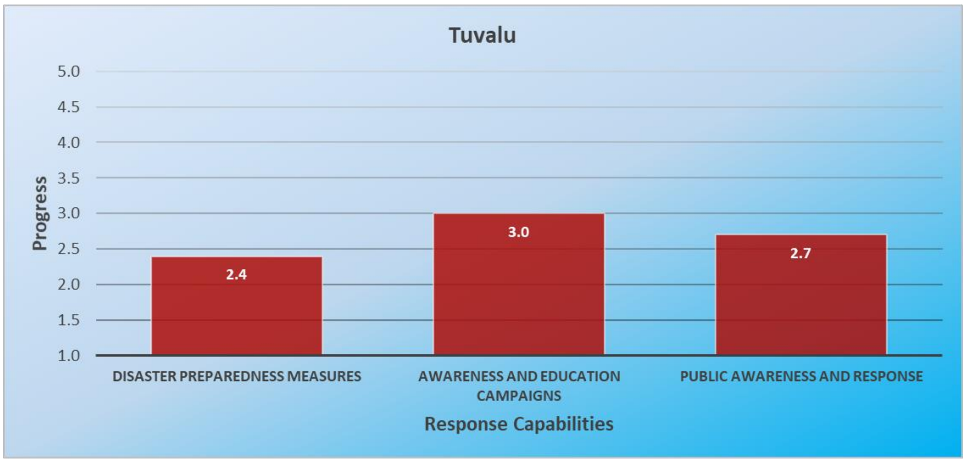
Pillar 4: Preparedness and Response Capabilities:

Tuvalu meteorological service conducts house to house awareness program letting people know about the information depending on the season (tropical season/ dry season). This program helps people to take a better understanding of climate related information where radio transmissions alone cannot do. The program includes face to face interview explaining the people (in picture form/ graph form) about the weather, clarifying details about warning messages. These kinds of interventions help especially the older people.

In addition, the met office also take actions to put up display boards by the road sides displaying information related to weather & climate and early warning messages in Tuvalu capital city in order to improve the awareness of the general public (Eg: Informing the public that La nina season is approaching and what measures to take).

The survey results showed that there has been a moderate level of progress in conducting awareness and education campaigns. The theme "Public Awareness and Response" has shown a level of progress close to moderate level. The least developed theme within the pillar "Disaster Preparedness Measures" shows a minimum to moderate level of progress. **Figure 65** summarises the progress of different themes which fall under the 4th Pillar: Preparedness and response capabilities.

Figure 65: Level of progress: Preparedness & Response Capabilities



1-No progress; 2-Minimal progress; 3-Moderate progress; 4-Major progress; 5-Completed

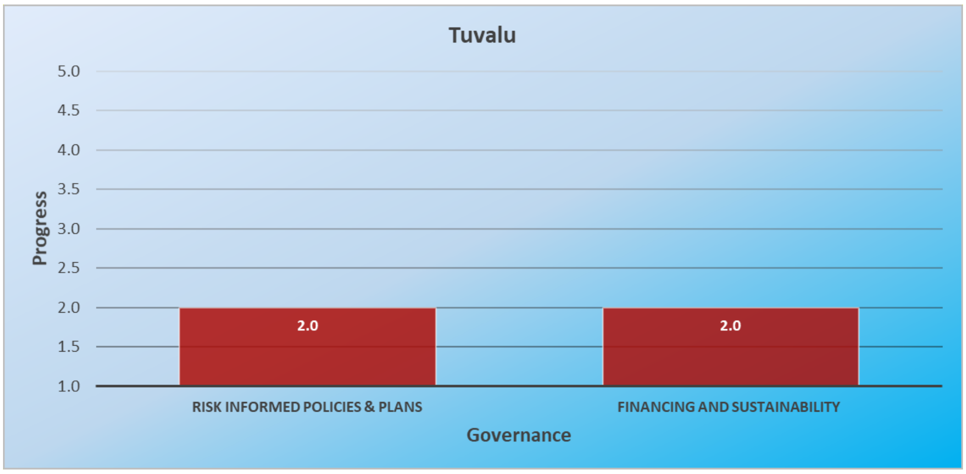
Pillar 5: Governance:

The two themes under Governance, "Risk Informed Policies & Plans" and "Financing and Sustainability" have shown minimal progress **(Figure 66)**.

Tuvalu meteorological service is not equipped with a meteorology act defining its specific roles and responsibilities. Staff retention is one of the problems faced by the met office. Some of the experienced staff have moved out of Tuvalu meteorological service leaving gaps in its capacity.

Tuvalu meteorological service receives limited funding from the national budget to carry out its operations. Other financial resources come through by way of Projects from external agencies.

Figure 66: Level of progress: Governance



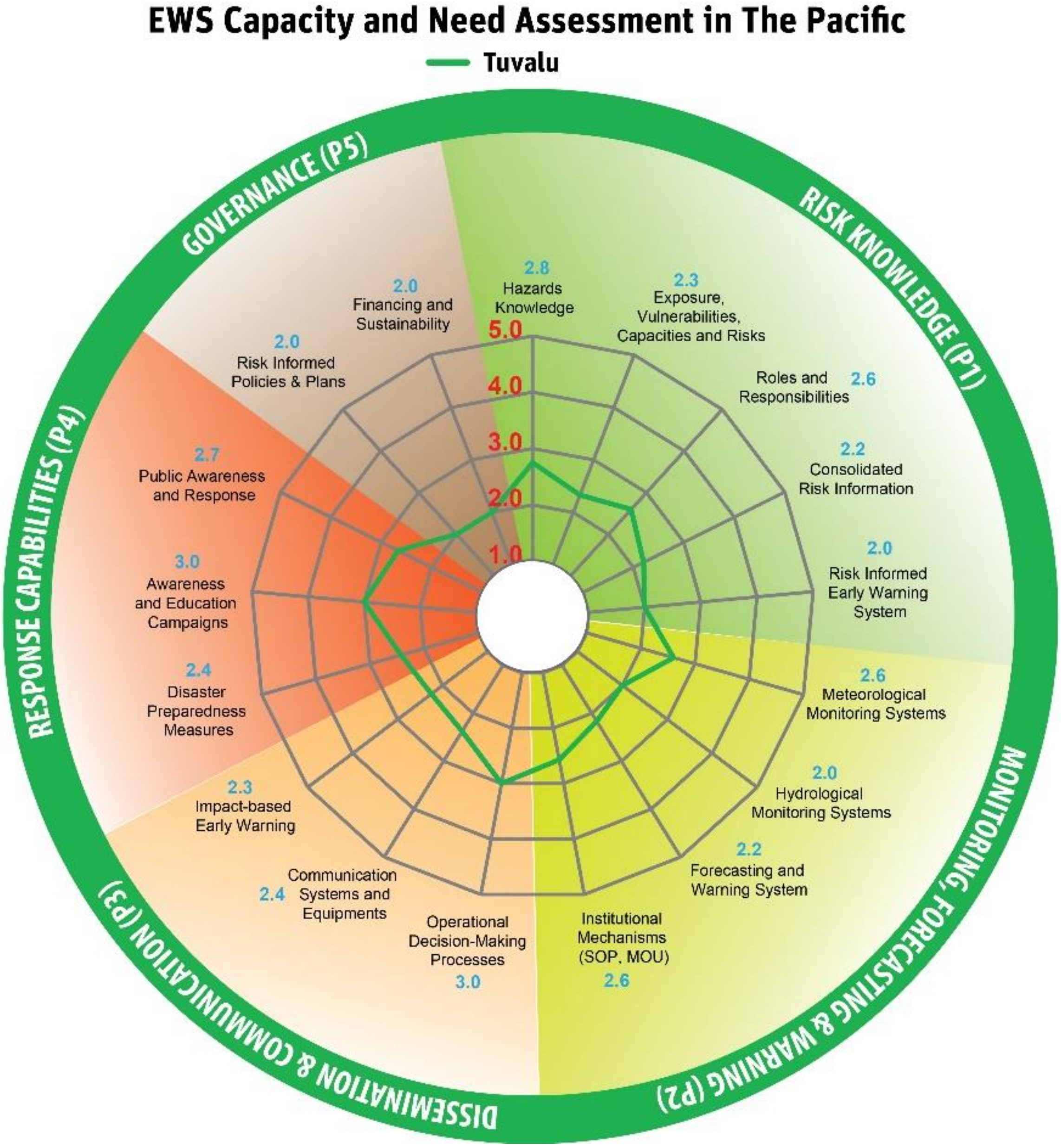
1-No progress; 2-Minimal progress; 3-Moderate progress; 4-Major progress; 5-Completed

6.8.6 Summary

Overview of the MHEWS:

The spider web diagram presented in **Figure 67** summarises the present status of the MHEWS in Tuvalu which has shown a minimum to moderate level of development. More attention is required in further development of the themes "Risk informed Policies & Plans, Financing & Sustainability, Risk Informed Early Warning Systems and Hydrological Monitoring Systems".

Figure 67: Status of MHEWS in Tuvalu

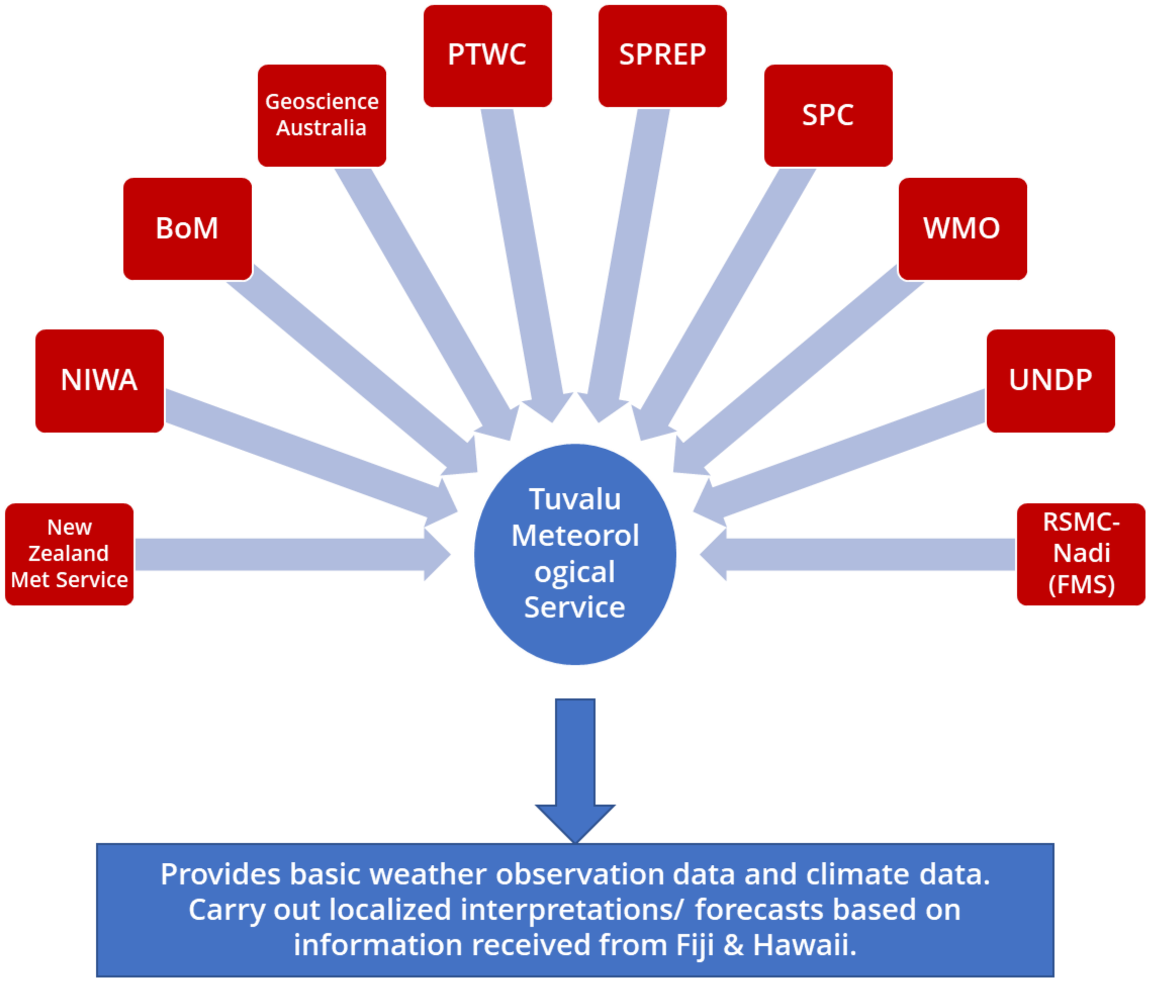


Source: ADPC assessment

Development partners of TMS:

The development partners associated with TMS in assisting to build their MHEWS is mapped in the **Figure 68**.

Figure 68: Development partners of Tokelau Meteorological Service



Source: NMHS consultation

Best practices:

- House to house awareness program letting people have a better understanding of climate related information. These kinds of interventions help to raise awareness among people who are older and with different needs.
- Setting up display boards/ sign boards displaying information related to weather & climate and early warning messages by the roadside in the capital city.
- Use of Chatty Beetles to disseminate early warning messages. Chatty beetles are very useful in emergencies when power interruptions take place. They work on both electricity and battery.
- Offshore wave forecasting in order to issue early warning on storm surge.

6.8.7 Needs and recommendations:

Table 22: Needs and recommendations

Pillar	Needs and recommendations
Disaster risk knowledge	• There is a need to carry out comprehensive disaster risk assessments. This should include hazard, vulnerability and exposure information. Such assessments would enable issuance of impact-based early warnings.
Detection, monitoring, analysis and forecasting of the hazards and possible consequences	• Assistant weather forecasters need more advanced training. They currently have basic knowledge (Eg: how to read cloud cover, determine wind direction, etc.). Better trained Assistant Forecaster would improve the forecasting service of Tuvalu meteorological service. • There is a need to upgrade weather observation tools with the latest technology and to improve the internet connectivity of the Met Office. • The met office does not have more advanced weather models and instruments. More knowledge and expertise personnel are needed in the field of meteorology to interpret and work on forecast and warning systems.
Warning, dissemination and communication	• Outer islands of Tuvalu have only 1 Chatty Beetle per island which is installed either at the island council office or the island hall. When a message is received by a Chatty Beetle an alarm is activated. It is not loud enough, when people are at home, during night time & during emergency. Hence, it is suggested that it would be better to have a siren fitted onto Chatty Beetle so that it will be loud enough to be heard by the people living nearby island councils (where chatty beetles are located) as and when messages are received. This issue has been discussed at National Climate Outlook Forum (NCOF). • There are difficulties when translating messages from English to Tuvaluan since all English technical terms has not got words in Tuvaluan language. As a result, local people find some terms hard to understand (Eg: Low pressure area in English). • Staff at Tuvalu meteorological service is now trying to create a more comprehensive glossary with English

Table 22: Needs and recommendations	
Pillar	**Needs and recommendations**
	terms and the corresponding Tuvaluan terms which will enable people to have a better understanding on the messages delivered by Tuvalu meteorological service. This ongoing study should be supported.
Preparedness and response capabilities	• The allocated budget for carrying out public awareness activities is limited. Hence, different avenues should be explored to increase the budget allocation.
Governance	• An increase in financial budget and human personnel in the office will definitely improve services provided by the Tuvalu Meteorological Service. • Internet connectivity is also a major challenge for the department as connectivity most of the time is inconsistent. There is only one IT officer at present time on a temporary basis, hence there is a need for more IT staffs that can work on IT matters and also monitor the internet connectivity in the office.

The United Nations maintains a joint presence office in Tuvalu with UNDP, UNICEF and UNFPA working together on programmes with UNDP taking the lead.

7. Recommendations

The MHEWS assessment provided a valuable insight about existing EWS in Fiji, Cook Islands, Kiribati, Nauru, Niue, Tokelau and Tuvalu. However, some key recommendations should be highlighted and acknowledged.

There is a limited number of surface observations instruments in Fiji, Cook Islands, Kiribati, Nauru, Niue, Tokelau and Tuvalu, especially at smaller island level, which resulted in limited detection capacity of surface events (high winds, heavy rain, etc.). There is a need for installations of modern surface observations instruments in project countries and also to integrate it with the overall systems that are available at regional level.

A long-term observation strategy needs to be developed to improve the monitoring network to provide reliable observations in real-time and also people's awareness and knowledge related to weather forecasts, warning role. The quality of forecasts, warnings also need to be enhanced and more precise. Awareness programme should aim at strengthening the level of preparedness. The programmes should be contextualized and scenario-based.

There is requirement of trained human resources and trainings of existing staff on regular intervals at all level from national to local level. Capacity building at local level on EWS (technical and management) is crucial for system development and implementation. The township committee and city authority should earmark funds for training so as to assist the process of strengthening the emergency operation centre (EOC), communities at risk, media, emergency responders and key stakeholders.

Simple and easy to use visualization tools should be made available by technical and disaster management agencies to the citizens. This will ensure participation and effective decision-making. Also need for a simplified technical language in forecast and warning.

Warning products should clearly indicate threats to the population/stakeholders. Efforts have to be made by the technical and disaster management agencies to tailor the warning that allows not only understanding the potential event but also determining the potent impact. The warning at the city level should highlight societal impacts and not be broad-based. Stakeholders should be able to distinguish between low impact and high impact events. At the city level, there has to be minimum ambiguity in information when shared with the general public. Communities at risk should be able to perceive risk and react appropriately.

Development of EWS (monitoring, impact forecasting, warning formulation) has to be hazard specific. EWS development should take into consideration predominant hazards and more frequent/less frequent events (but with a potential for severe damage).

Warning mechanism should keep focus on communities at risk. A generic city-level warning may not be appropriate, given the diversity of the geo-climatic conditions in both the countries. In addition, customized local level warnings need to be provided to hotspot locations.

There is a need to create discussion platform for deliberation and discussion between technical agencies (NMHS and NDMO), other key departments at national and sub-national level. In addition, there is a need to create an appropriate framework with due legal process to ensure that roles and responsibilities of the agencies are defined and executed. There is a requirement of functional EWS with clear SOPs that determine response. Standardization of departmental plans and terminology ensures effective response actions. SOPs have to be evaluated and modified through conduct of drills. Township and city level agencies should develop hazard analysis, vulnerability assessment and risk assessment (on GIS platform). Climate variability and climate change should be an integral part of the risk assessment.

To strengthen disaster preparedness and emergency response, it is important to ensure that emergency response actions are guided through scientific and observed data. The local level EOC should establish and harmonize flow of information from all agencies and determine potential impact locations within the city.

Recommendation 1: 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 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 many project countries (such as Fiji, Cook Islands, Kiribati) 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 all project countries, 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.

Recommendation 2: Partnerships for data sharing

A system that focuses on impacts requires significantly more information than is routinely available to meteorologists. Partnerships among agencies (NMHS, NDMO) 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.

Recommendation 3: All hazards approach

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.

Recommendation 4: Capacity building and 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. There is a need identified to establish Regional Training Centre (RTC) for training and capacity building in the Pacific.

Recommendation 5: Coordination capacity

As highlighted earlier, the NMHS need to strengthen its technical competence on forecasting and early warning for extreme weather events, flash floods, floods, storms and drought. Other ministries and line departments also need to coordinate well with NMHS to inform last mile. Currently there is an apparent limitation in the coordination between NMHS with its stakeholders in a timely and effective manner. There is therefore a critical need to strengthen this coordinating capacity.

Recommendation 6: Adequate networks

To be able to fill the gaps and meet the requirements of good weather service to EWS, the following actions should be taken:

- Upgrade or modernize stations/instruments together with data communication network (domestic links);
- automation of rain gauge stations with denser network and improve precision in rainfall monitoring;
- automation of synoptic stations (automatic weather station, AWS) and convert manual (analogue) instruments to digital;
- Establish stations for upper air sounding facilities, with training of professional staff
- Improve the quality of observations, equipment maintenance, automatic quality control and data management;
- Enhance severe weather monitoring and forecasting capability, especially for typhoons when they originate in the Pacific.

Recommendation 7: Robust communication system

Communication with remote islands is critical in the Pacific 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 NMHS and NDMO. A proper all-weather communication system should be established to link field stations to a central hub at the NDMO level. In addition, data processing, display and archival systems are to be installed at the NMHS Weather Forecasting Office to keep real time track of the weather situation in the country and share this information with all relevant stakeholders.

- Upgrade communication from field monitoring stations to the NMHS and NDMO headquarters.
- Establish appropriate tools (hardware & software) for climatology applications with recruitment and training of professional staff.
- Establish visualization display system.
- Facilitate exchange of real time rainfall data observation during the passage of typhoons.
- Integrated decision and information system to forecast severe meteorological and environmental events.

Ensure the following:

- Warning messages reach all at risk;
- Ensuring redundancy of warning systems;
- Use of information and communication technologies for the communication and dissemination of warnings;
- Recognition of a single authoritative voice for issuing warnings;
- Use of standard terminology nationwide and across national boundaries;
- Clarity and packaging of the warnings;
- Clarity of the roles played by various stakeholders;
- Political will to communicate warnings;
- Education and awareness raising to all stakeholders, at all levels and using all structures to ensure understanding of warnings;
- Integration of traditional knowledge in risk assessments and warning messages;
- Collaboration between warning providers and the media;
- Appropriate coordination among relevant actors.

Recommendation 8: Enhance flood monitoring and forecasting and modeling capabilities to enable short, medium- and long-term forecasting

In parallel with the improvements in meteorological observation capacities, the existing hydrometric network for flood monitoring and forecasting needs enhancement to provide an effective flood EW mechanism as well as the repair/upgrade and rehabilitation of existing hydrological/stream gauging stations with expansion to cover un-gauged sub-basins should be made.

Recommendation 9: Establish lightening and wind gust detection and response capabilities

Although lightning is not recorded as a major disaster in project countries, however it is observed that the number of casualties due to lightning has been increasing over the past years. At present, project countries have no lightning detector so there is also a need to put up about few lightning stations, but these can be integrated in the network of AWSs. Similarly, wind gust is also an unpredictable hazard which causes death and property damages in project countries.

- Set up technical advisory committees for lightning and wind gust response;
- Facilitate meetings to raise awareness to national and local stakeholders;
- Develop national and island council level response plans.

Recommendation 10: Improve response capacity of communities to multi-hazard early warning

The purpose of investing a substantial amount of developing an EWS would be lost unless the communities are knowledgeable in what the early warning messages are and how to respond to them. This will need response plan development at all levels beginning from household and requires an extensive social marketing campaign.

Recommendation 11: Develop organisational and inter-organisational Standard Operating Procedures (SOPs)

SOPs are formal written guidelines or instructions for incident response. They have both operational and technical components and enable emergency responders to act in a coordinated fashion across disciplines in the event of an emergency. Clear and effective SOPs are essential in the development and deployment of any solution in project countries.

Recommendation 12: Enhance 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. Although each of the 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. MOU for aviation meteorology between Fiji Meteorological Service and all 6 NMHSs can be signed in order to ensure safe air operations in all-weather situations. The objective of aviation meteorology is to contribute towards the safety, economy, regularity and efficiency of air navigation.

Recommendation 13: Community preparedness and response

Community preparedness and response needs to be strengthened to include natural hazard risk considerations. Technical advice from NMHS and NDMO on these can strengthen the approaches used by agencies working with communities. These 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 advise being provided by NDMO. 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 hazard, exposure, vulnerability and risk assessments need to done for a range of hazards across all the project countries. These activities can strengthen community capacity to prepare for and respond to natural hazard impacts and also identify suitable evacuation centres. An evaluation of the structural integrity and capacity of identified evacuation centres will need to be undertaken and recommendations for improvement provided to government.

Recommendation 14: 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 project countries. 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.

Recommendation 15: Indigenous, traditional and local knowledge

Pacific Island communities have a long history of coping with extreme events and climate variability by reading the signs in their natural environment. Indigenous, traditional and local knowledge passed on through generations would assist where technology could not assist. Ancient early warning systems used by ancestors to predict an incoming natural disaster have been an integral part of saving lives long before the introduction of technology. By combining their indigenous, traditional and local knowledge with modern day technology, a valuable forecast product can be produced for improved decision making, risk management and disaster prevention. A detailed study can be commissioned to capture hazard specific and island wise indigenous, traditional and local knowledge. Indigenous, traditional and local knowledge also can be used by NMHS to raise awareness and build capacities of island communities.

Recommendation 16: Common alert protocol

The Common Alerting Protocol (CAP) is a simple but general format for exchanging all-hazard emergency alerts and public warnings over all kinds of networks. With adequate alerting, people are better able to act to reduce damage and loss of life from natural and human-caused hazardous events. The key is to get timely and appropriate alerts to people who need them. A detailed study can be commissioned to understand the existing alert protocols in project countries and to develop Common Alerting Protocol for all hazards.

8. Final remarks

MHEWS assessment report provides insights to issues that need to be addressed for an operational EWS in Fiji, Cook Islands, Kiribati, Nauru, Niue, Tokelau and Tuvalu.

The results of EWS assessment provide an understanding on current technical capacities, issues and future needs to improve existing EWSs, as well as for design and implementation of upcoming EWSs in the seven countries.

It was envisaged that these countries need to tailor solutions for public safety, and EWS should be designed and developed considering various extreme events and hazard scenarios. It is important to keep these systems people-centric and subsequently build risk knowledge among the stakeholders for success of an EWS. Early warning system assessment matrix developed for this assessment can be used as a tool for further review in the seven countries. A robust EWS audit mechanism can also be rolled in the future to measure system efficiency.

Based on the EWS assessment conducted in Fiji, Cook Islands, Kiribati, Nauru, Niue, Tokelau and Tuvalu in the Pacific Region, the study summarised that the countries have EWSs in place at national level and NMHSs are equipped with the latest technology and instruments. However, the systems do have few bottlenecks and barriers that needs to be addressed at sub-national and city/township/local level. It is important at this stage to note that existing EWS in the seven countries at sub-national and local level needs upgradation and enhancement to meet the larger objective of reducing fatalities and protecting infrastructure/assets from future events. It was recognized during assessment that an operational EWS has the potential of minimizing loss and contributing to sustainable development and building resilience. While technology is available for establishing the robust communication system for early warning system, it is the institutional foundation and the networking arrangements which have to be deep rooted for meeting the desired objectives of the system. All the key elements of the system have to be functional and it is important to review them annually by targeting for different scenarios and measuring performance.

The assessment identifies that the critical bottlenecks and barriers exists when it comes to coordination, resource availability, dissemination and communications of early warning information from national to local level which also forms the last mile connectivity of an effective EWS. These bottlenecks and barriers are been well highlighted from the EWS assessment results.

The assessment further summarised that more awareness generation and capacity building programmes need to be organized both at sub-national and local levels that should include testing of existing guidelines, SOPs, conduct drills and simulations for specific hazards and introduction of more innovative approach for community awareness. These should then result in strengthening the existing systems by making it more effective, robust and reliable. Steps at the national level should also include periodic review of EWS and their feasibility to update and upgrade.

Adequate allocation of resources (budget and human) is an important area to achieve for further strengthening of the systems as well as improving the linkages in communication networks from national to local levels to make it more reliable and effective so that timely information reaches the vulnerable sections at a much faster pace. It is also been expected that countries involve more experts in getting their technical advice and build their institutional capacities towards achieving the skills and knowledge of understanding and using EWSs effectively so that it reaches the right kind of people at the right time.

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Annex I: Key Contact Details:

Country	NMHS Focal Point
Cook Islands	**Mr Bates Manea** Operational Observer Cook Islands Meteorological Service Email: bates.manea@cookislands.gov.ck
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Kiribati	**Mr Thomas Zackious** Chief Forecaster Kiribati Meteorological Service Email: thomaszackious@gmail.com; cfo@met.gov.ki
Nauru	**Mr Roy Harris** Secretary, National Emergency Service Ministry, Nauru Government Email: royharris111@gmail.com **Mr Graymea Ika** Officer-In-Charged Nauru Meteorological and Hydrological Service Email: graymeaika1510@gmail.com
Niue	**Ms Rossy Mitiepo** Director, Niue Meteorological Service Email: rossy.mitiepo@mail.gov.nu

Country	NMHS Focal Point
Tokelau	**Mr Mika Perez** Director Department of Economic Development, Natural Resources and Environment Tokelau Government Email: mika.perez@tokelau.org.nz **Ms Mile Fonua** Manager of Environment Division Department of Economic Development, Natural Resources and Environment (EDNRE) Email: moliotoa@gmail.com
Tuvalu	**Mr Alamoana Tofuola** Senior Weather Forecaster Tuvalu Meteorological Service Email: alamoanat@gmail.com

Annex II: Multi Hazard Early Warning System Assessment Matrix (Online Questionnaire Form):

Multi Hazard Early Warning System Assessment						
Pillar I: Disaster Risk Knowledge						
	A. Are key hazards and related threats identified?	**1 (None/Very Low)**	**2 (Low)**	**3 (Medium)**	**4 (High)**	**5 (Very High)**
	A1. What type of natural hazards (Hydro-met and Geological) occurred in your region/city?					
	A2. Are there any hotspots identified in your region/city?					
	A3. How historical information archived (collected, collated and stored) in your region/city?					
	A4. Is there any natural hazard assessment conducted and mapping done in your region/city?					
	B. Are exposure, vulnerabilities, capacities and risks assessed?	**1 (None/Very Low)**	**2 (Low)**	**3 (Medium)**	**4 (High)**	**5 (Very High)**
	B1. What are the key elements at risk and critical infrastructure (exposure) in your region/city?					
	B2. Is there any vulnerability assessment conducted in your region/city?					
	B3. Is there any risk assessment conducted in your region/city?					
	C. Are roles and responsibilities of stakeholders identified?	**1 (None/Very Low)**	**2 (Low)**	**3 (Medium)**	**4 (High)**	**5 (Very High)**
	C1. Who is responsible to conduct hazard, vulnerability and risk assessment in your region/city?					
	C2. Who is responsible to disseminate risk information to different stakeholders in your region/city?					
	C3. Are you aware about any legislations, policy, plans for risk assessment in your region/city?					
	D. Is risk information consolidated?	**1 (None/Very Low)**	**2 (Low)**	**3 (Medium)**	**4 (High)**	**5 (Very High)**
	D1. How and which form the risk assessment and knowledge is stored in your region/city?					
	D2. Is there any plan to update the risk assessment with new data sets in your region/city?					

Multi Hazard Early Warning System Assessment						
	D3. How cross-cutting issues such as gender, disability and governance used in risk assessment?					
	D4. How risk information used in key sectors such as urban planning, infrastructural development in your region/city?					
E	**E. Is risk information properly incorporated into the early warning system?**	**1 (None/Very Low)**	**2 (Low)**	**3 (Medium)**	**4 (High)**	**5 (Very High)**
	E1. Is risk assessment and knowledge is incorporated in early warning system and evacuations planning?					
	E2. Are safe shelters identified based on risk assessment and knowledge?					
	E3. Are key sectors (urban planning) are using this information in their day-to-day activities or policy & plans in your region/city?					
	E4. Is there any cross-cutting issues such as gender, disability and governance incorporated in early warning system					
Pillar-II: Detection, Monitoring, Analysis and Forecasting of the Hazards and Possible Consequences						
	A1. Are there any meteorological monitoring systems in place?	**1 (None/Very Low)**	**2 (Low)**	**3 (Medium)**	**4 (High)**	**5 (Very High)**
	A1.1. Do you have any regional/national level **detection/monitoring** system for cyclones, heavy rainfall, droughts, etc. (Inc. Satellite, NWP, etc.)?					
	A1.2. What kind of weather **observation** network is available in the national level and the city?					
	A1.3. What kind of **data archiving** system is available?					
	A2. Are there any hydrological monitoring systems in place?	**1 (None/Very Low)**	**2 (Low)**	**3 (Medium)**	**4 (High)**	**5 (Very High)**
	A2.1. Are there riverine/urban flood **detection/monitoring** systems available?					
	A2.2. Are measurement parameters **data available** in real time/near-real time and how is the **quality**?					
	A2.3. Are the riverine/urban flood modelling well **calibrated and validated**?					
	B1. Are there meteorological/climatological forecasting and warning services in place?	**1 (None/Very Low)**	**2 (Low)**	**3 (Medium)**	**4 (High)**	**5 (Very High)**

Multi Hazard Early Warning System Assessment						
	B1.1. What kind of specific **forecasts and warnings** produced in nationally and for targeting the city?					
	B1.2. What kind of techniques (weather) used for information generation?					
	B1.2. What kind of techniques (climate) used for information generation?					
	B2. Are there hydrological forecasting and warning services in place?	**1 (None/Very Low)**	**2 (Low)**	**3 (Medium)**	**4 (High)**	**5 (Very High)**
	B2.1. Are there riverine/urban flood **forecasting** available?					
	B2.2. Are there riverine/urban flood **warning** services available?					
	B2.3. What are the **improvements** further required?					
	C1. Are there institutional mechanisms (meteorological and hydrological) in place?	**1 (None/Very Low)**	**2 (Low)**	**3 (Medium)**	**4 (High)**	**5 (Very High)**
	C1.1. Do you have your own **SOPs** for forecast and warning generation?					
	C1.2. Any (meteorological/hydrological) **Act** currently in place?					
	C1.3. Do you have any **MOU** signed with national, regional agencies/city development authorities and **cross-border** information sharing?					
Pillar-III: Warning Dissemination and Communications						
	A. Are organisational and decision-making processes in place and operational?	**1 (None/Very Low)**	**2 (Low)**	**3 (Medium)**	**4 (High)**	**5 (Very High)**
	A1. What are the **Organisational/Institutional arrangements** for dissemination and communications; what roles they play in EW dissemination and communications?					
	A2. Are there any **Standard Operating Procedures (SOPs)** for early warning information dissemination, function, and decision making established?					
	B. Are communication systems and equipment in place and operational?	**1 (None/Very Low)**	**2 (Low)**	**3 (Medium)**	**4 (High)**	**5 (Very High)**
	B1. What are the regular **channels/modes** used in existing EW dissemination system?					
	B2. What are the **equipment's** in practice for EW dissemination (E.g. radio, tv, website, MHEWC, VHF radio, megaphone)					

<table>
<tr><th colspan="7">Multi Hazard Early Warning System Assessment</th></tr>
<tr><td></td><td>B3. Is there any Emergency Operations Center (EOC) in place at target city/regional level?</td><td colspan="5"></td></tr>
<tr><td></td><td>C. Are impact-based early warnings communicated effectively to prompt action by target groups?</td><td>1 (None/Very Low)</td><td>2 (Low)</td><td>3 (Medium)</td><td>4 (High)</td><td>5 (Very High)</td></tr>
<tr><td></td><td>C1. Do the EW information reach from source to end user (end to end) promptly? What is the time lag for reaching the EW information to last-mile urban habitats?</td><td colspan="5"></td></tr>
<tr><td></td><td>C2. What is the process of validation and feedback on warning</td><td colspan="5"></td></tr>
<tr><td></td><td>C3. What is the process of interpretation of warning and risk information at various levels (eg authorities, local gov., citizens etc)?</td><td colspan="5"></td></tr>
<tr><td></td><td>C4. Does/how EW information triggers Evacuations at urban areas, what are the process and issues;</td><td colspan="5"></td></tr>
<tr><td></td><td>C5. Do the Social Inclusion issues in the warning information (PWDs) considered effectively?</td><td colspan="5"></td></tr>
<tr><th colspan="7">Pillar-IV: Preparedness and Response Capabilities</th></tr>
<tr><td></td><td>A. Are disaster preparedness measures, including response plans, developed and operational?</td><td>1 (None/Very Low)</td><td>2 (Low)</td><td>3 (Medium)</td><td>4 (High)</td><td>5 (Very High)</td></tr>
<tr><td></td><td>A1. Is there any disaster management plan existing for the target area? At what level and how functional is that?</td><td colspan="5"></td></tr>
<tr><td></td><td>A2. Is there any integration of EW and multi-hazard risk information in the disaster management plan?</td><td colspan="5"></td></tr>
<tr><td></td><td>B. Are public awareness and education campaigns conducted?</td><td>1 (None/Very Low)</td><td>2 (Low)</td><td>3 (Medium)</td><td>4 (High)</td><td>5 (Very High)</td></tr>
<tr><td></td><td>B1. Are there any public awareness campaigns or educational programs for the target communities existing?</td><td colspan="5"></td></tr>
<tr><td></td><td>B2. Is there adequate training on EW provided to the authorities and practitioners in the target urban areas?</td><td colspan="5"></td></tr>
<tr><td></td><td>C. Is public awareness and response tested and evaluated?</td><td>1 (None/Very Low)</td><td>2 (Low)</td><td>3 (Medium)</td><td>4 (High)</td><td>5 (Very High)</td></tr>
<tr><td></td><td>C1. Are there any EW simulations and drills carried out to test EW and evacuations in the target urban area? How often such EW simulations-drills are conducted?</td><td colspan="5"></td></tr>
</table>

Multi Hazard Early Warning System Assessment						
	C2. What is the status of **integration of EW and risk information into the Urban CBDRM** process?					
Pillar-5: Governance of EWS						
	A. Are there EWS and Risk information are mainstreamed into the national level policy, strategies and development plans and global commitments?	**1 (None/Very Low)**	**2 (Low)**	**3 (Medium)**	**4 (High)**	**5 (Very High)**
	A1. Has EWS and Risk information been integrated to specific national level policies, strategies and development plans?					
	B. Are there EWS related financing and sustainability included and provisioned into the national budget and financing?	**1 (None/Very Low)**	**2 (Low)**	**3 (Medium)**	**4 (High)**	**5 (Very High)**
	B1. What is the financing for EWS in the country?					
	C. On what level the 'Operation and Maintenance of the EWSs are provisioned and incorporated?	**1 (None/Very Low)**	**2 (Low)**	**3 (Medium)**	**4 (High)**	**5 (Very High)**
	C1. What are the operation and maintenance measures taken on a regular basis?					
	D. What level the 'Public Private Partnerships' are adopted for EWSs?	**1 (None/Very Low)**	**2 (Low)**	**3 (Medium)**	**4 (High)**	**5 (Very High)**
	D1. What type of PPPs are existing?					

Annex III: Letter for Assessing MHEWS Capacities, Gaps and Needs

WEATHER CLIMATE WATER
TEMPS CLIMAT EAU

WMO OMM

World Meteorological Organization
Organisation météorologique mondiale
Organización Meteorológica Mundial
Всемирная метеорологическая организация
المنظمة العالمية للأرصاد الجوية
世界气象组织

Secrétariat
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Tél.: +41 (0) 22 730 81 11
Fax: +41 (0) 22 730 81 81
wmo@wmo.int – public.wmo.int

Ref.: 203477/2020-1.3 MS/TSC

Our ref.: 19477/2020/MS-RAP

22 October 2020

Subject: Assessing capacities, gaps and needs of national (multi-hazard) early warning systems in selected Pacific Island States – Introducing the Asian Disaster Preparedness Center (ADPC) as Implementing Partner of WMO

Action required: Nominate a Focal Point from within your National Meteorological and Hydrological Service (NMHS) to help facilitate online and in-country (face-to-face) consultations by 29 October 2020

Dear Sir/Madam,

As you are aware, the World Meteorological Organization (WMO) is implementing the Project *Strengthening Hydro-Meteorological and Early Warning Services in the Pacific*, known as the CREWS Pacific SIDS Project. Respective funds have been granted by the Climate Risk and Early Warning Systems (CREWS) Financial Intermediary Fund and Environment and Climate Change Canada (ECCC) as part of its contribution to CREWS.

Under this Project, an assessment of the current capacities, gaps and needs for producing, delivering and acting on early warnings of different natural hazards is foreseen in six Pacific Island States and one Territory – Cook Islands, Fiji, Kiribati, Nauru, Niue, Tuvalu, and Tokelau – to inform further on-going and planned capacity development activities in the region under various projects and programmes. The National Meteorological and Hydrological Services (NMHSs) of WMO Members and their global and regional WMO support mechanisms play a key role in Disaster Risk Reduction (DRR) along the value chain multi-hazard early warning systems (MHEWSs). Regular evaluations of organizations' and countries' respective capacities to support DRR, including multi-hazard early warnings, are an essential prerequisite to maintain and improve these capacities and showcase the socioeconomic benefits of investing in them.

I am pleased to inform you that WMO has partnered with the Asian Disaster Preparedness Center (ADPC) to conduct this assessment over the coming months. It will include a desk study of ongoing/recently completed MHEWS and DRR programmes and projects (including assessments) at national and regional levels, stakeholder workshops, and the preparation of a regional status report and country-specific technical briefs. While the in-country activities such as Key Informant Interviews, Focus Group Discussions and Shared Learning Dialogues would normally be face-to-face consultations, given the travel restrictions due to the COVID-19 pandemic, ADPC, WMO and other international colleagues will only be able to facilitate and/or participate in these events remotely (preferably via Microsoft Teams).

To: Permanent Representatives of Members with WMO (limited distribution)

cc: Hydrological Advisers
Directors of National Disaster Management Offices (NDMOs); Directors of National Hydrological Services (NHSs); SPC; SPREP; UNDP Pacific Office, Fiji; UNDP MCO, Samoa; FAO Subregional Office for the Pacific Islands, Samoa; UNESCO Office for the Pacific States, Samoa; UNDRR Pacific Subregional Office, Fiji

Ref.: 20347/2020-1.3 HS/TSC

To allow the WMO Secretariat and ADPC colleagues to plan and organize these activities, especially in these circumstances, may I request you to nominate a Focal Point from your Service/Country for this activity no later than 29 October 2020. Kindly send his/her contact details to Ms Erica Allis, (Senior Programme Manager, Email: eallis@wmo.int) with a copy to Ms Lina Sjaavik (Project Manager CREWS Pacific SIDS, Email: lsjaavik@wmo.int) and Ms Tessa Tafua, (Associate Project Support Officer, Email: ttafua@wmo.int). The following ADPC experts will then reach out to your nominated focal point: Dr Senaka Basnayake (Director Climate Resilience Department, Email: senaka_basnayake@adpc.net) and Mr Lalit Kumar Dashora (Senior Early Warning Systems Specialist, Email: lalit.dashora@adpc.net).

I appreciate your continued support for the activities under the CREWS Pacific SIDS project.

Yours faithfully,

Dr Elena Manaenkova
for the Secretary-General

Annex IV: Meetings with Regional Organisations

Details of Online Consultation Meeting: As of 31/12/2020

Sr. No.	Name	Organisation	Date
1	Mr. Herve Damlamian	Ocean and Coast Team, SPC, Fiji	07th October 2020
2	Mr. Moritz Wandres	Ocean and Coast Team, SPC, Fiji	07th October 2020
3	Mr. Zulfikar Begg	Ocean and Coast Team, SPC, Fiji	07th October 2020
4	Uatea Salesa	Water Resources Team, SPC, Fiji	07th October 2020
5	Mr. Peter Sinclair	Water Resources Team, SPC, Fiji	07th October 2020
6	Eileen Turare	Disaster Reduction Team, SPC, Fiji	07th October 2020
7	Ms. Litea Biukoto	Disaster Reduction Team, SPC, Fiji	07th October 2020
8	Ms. Yvette Kerslake	UNDP Samoa	13th October 2020
9	Mr. Noud Leenders	UNDP Fiji	14th October 2020
10	Mr. Navin Bhan	UNDP Fiji	14th October 2020
11	Mr. Andy McElroy	UNDRR, Pacific Sub-regional	15th October 2020
12	Dr. Alasdair Hainsworth	Weather Ready Pacific Program Scoping Team	03rd November 2020
13	Dr. Andrew Ash	Weather Ready Pacific Program Scoping Team	03rd November 2020
14	Ms. Fiasili Lam	FAO, Fiji	19th November 2020
15	Ms Malia Talakai	FAO, Fiji	19th November 2020
16	Ms. Dora Fanene	FAO, Fiji	19th November 2020

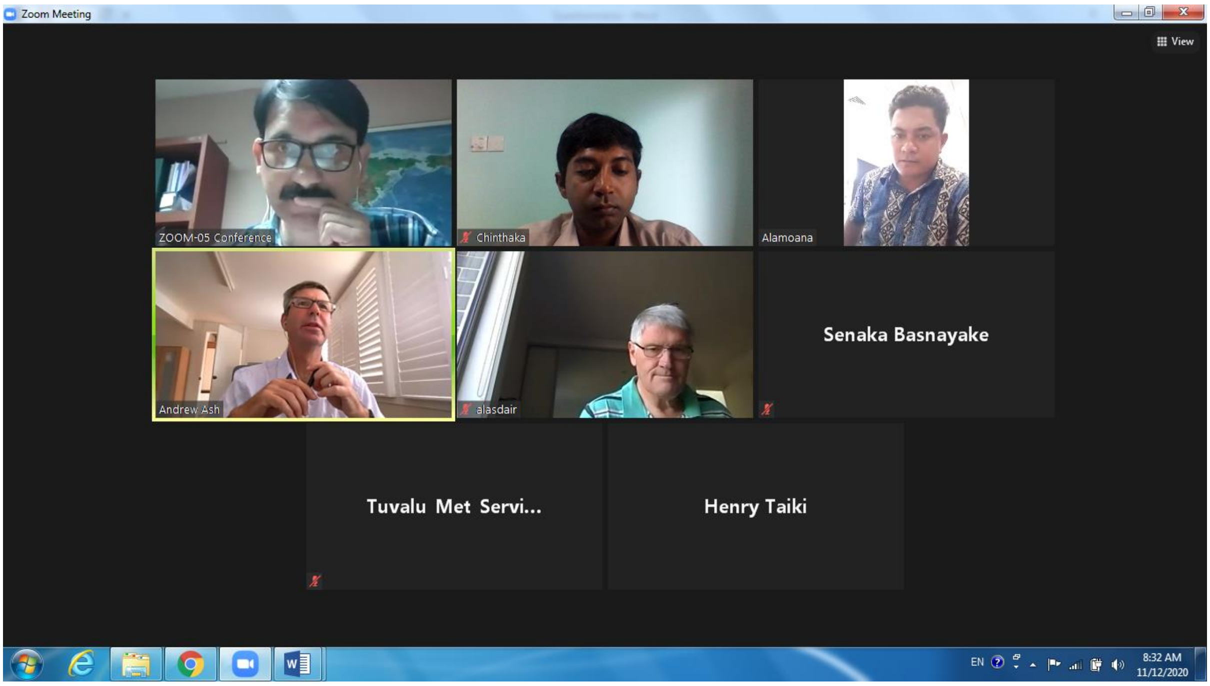
Annex V: Meetings with NMHS

Details of Online Consultation Meeting: As of 31/12/2020

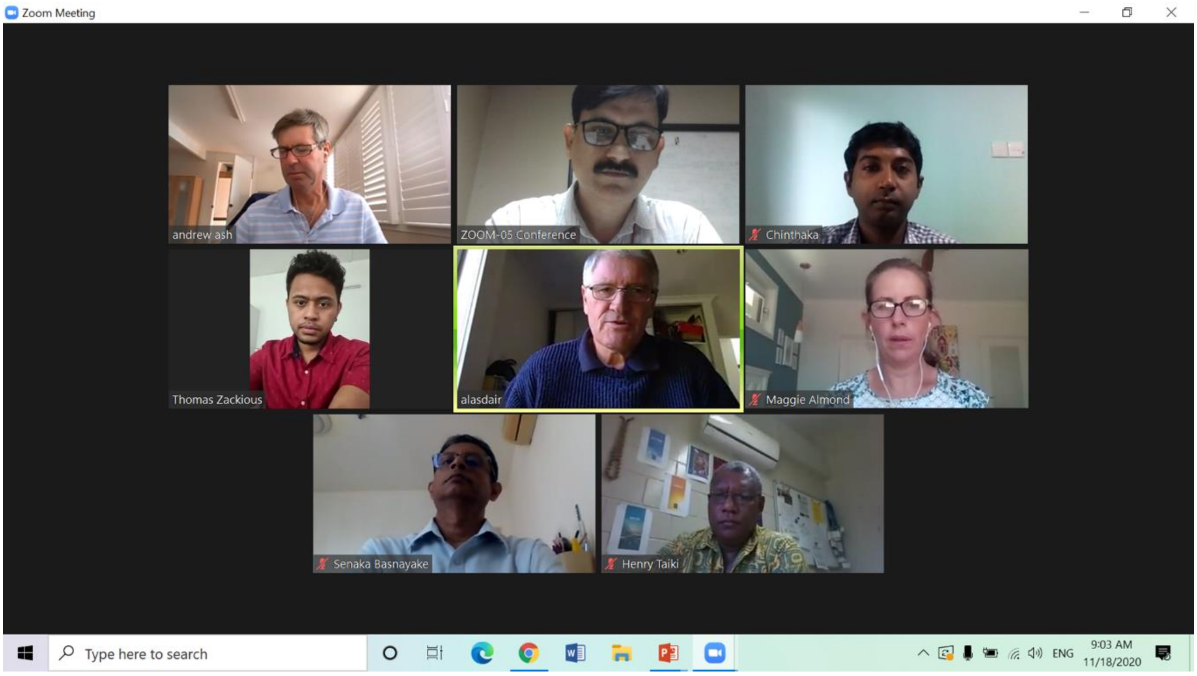
Sr. No.	Country	NMHS Focal Point	Date
1	Tokelau	Mr. Mika Perez Director Department of Economic Development, Natural Resources and Environment Tokelau Government mika.perez@tokelau.org.nz Ms Mile Fonua Manager of Environment Division Department of Economic Development, Natural Resources and Environment (EDNRE) Email: moliotoa@gmail.com	09th November 2020
2	Tuvalu	Mr Alamoana Tofuola Senior Weather Forecaster Meteorological Service Email: alamoanat@gmail.com	12th November 2020
3	Kiribati	Mr. Thomas Zackious Chief Forecaster Meteorological Service Email: thomaszackious@gmail.com , cfo@met.gov.ki	18th November 2020
4	Cook Islands	Mr Bates Manea Operational Observer Meteorological Service Email: bates.manea@cookislands.gov.ck	18th November 2020 (Cook Island) 19th November 2020 (Bangkok)
5	Fiji	Mr Stephen Meke Principal Scientific Officer – Weather Forecasting Meteorological Service Email: Stephen.meke@met.gov.fj	23rd November 2020
6	Niue	Ms Rossy Mitiepo Director, Meteorological Service Email: rossy.mitiepo@mail.gov.nu	24th November 2020 25th November 2020
7	Nauru	Mr. Roy Harris Secretary, National Emergency Service Ministry, Nauru Government Email: royharris111@gmail.com Name: Mr Graymea Ika Officer-In-Charged Meteorological and Hydrological Service Email: graymeaika1510@gmail.com	30th November 2020

Annex VI: Snaps of Consultation with NMHS:

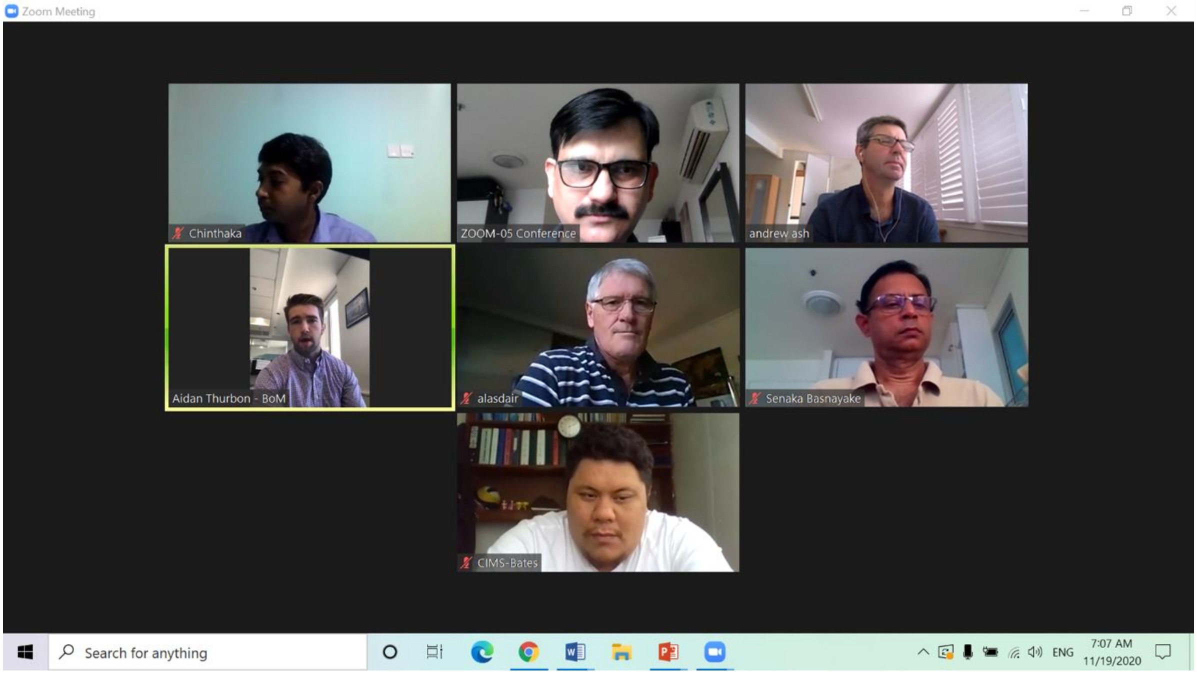
1. Consultation with Mr Alamoana Tofuola, Senior Weather Forecaster, Tuvalu Meteorological Service:



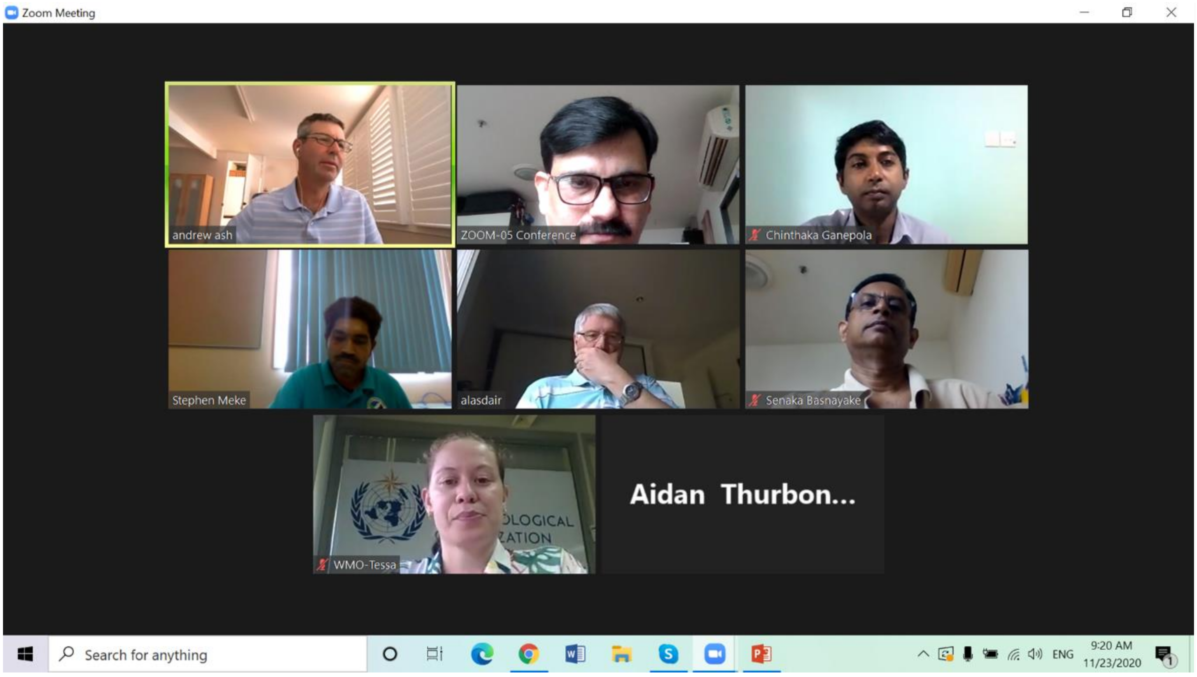
2. Consultation with Mr. Thomas Zackious, Chief Forecaster, Kiribati Meteorological Service:



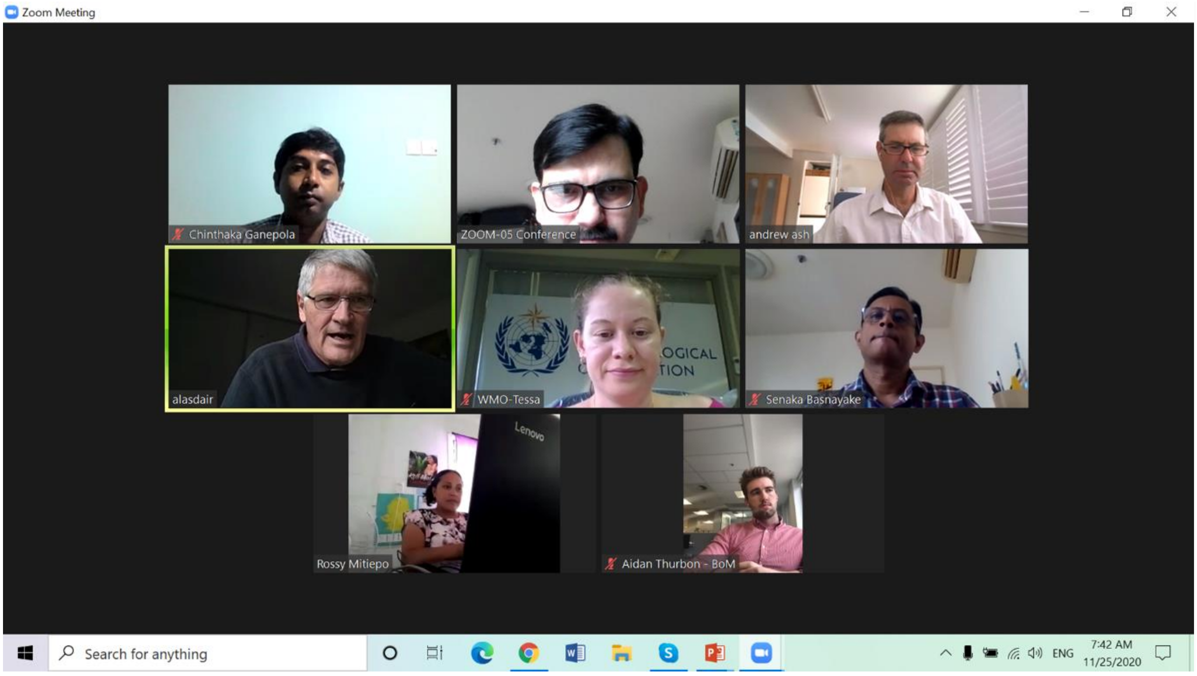
3. Consultation with Mr Bates Manea, Operational Observer, Cook Islands Meteorological Service:



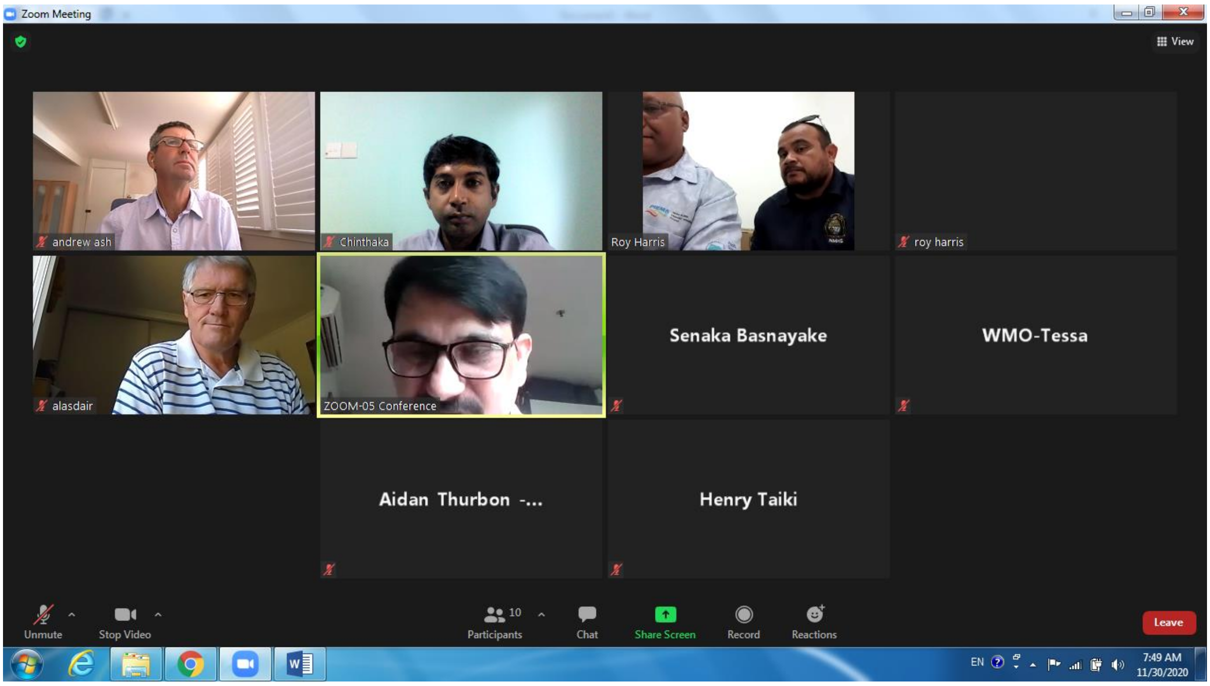
4. Consultation with Mr. Mr Stephen Meke, Principal Scientific Officer – Weather Forecasting, Fiji Meteorological Service:



5. Consultation with Ms. Rossy Mitiepo, Director, Niue Meteorological Service:



6. Consultation with Mr. Roy Harris, Secretary, National Emergency Service Ministry and Mr Graymea Ika, Officer-In-Charged, Nauru Meteorological Service:



Annex VII: Minutes of Meeting of 04th PSC Meeting

WMO CREWS Pacific SIDS 04th Project Steering Committee

Pacific EWS Assessment Project: Executive Summary

Date: 06th August 2020 | **Time**: 1130 Hrs. to 1300 Hrs.

1. Participants:

~ Asian Disaster Preparedness Center (ADPC):

Dr. Senaka Basnayake, Director, Climate Resilience Department, ADPC

Lalit Kumar Dashora, Senior Technical Specialist (EWS), ADPC

2. Key Points:

ADPC team participated in WMO CREWS 04th Project Steering Committee (PSC) meeting on 05th and 06th August 2020.

At the beginning, Dr. Senaka Basnayake, Director, Climate Resilience Department, ADPC presented about organisations and its presence and projects (completed, on-going and planned) in Asia and the Pacific region. He informed that ADPC is now an Intergovernmental Organisation (IGO). He also informed about various activities under SERVIR programme in South East Asia including drought and flood monitoring tools.

Later, Lalit Dashora presented about project and its activities completed till July 2020 and planned for remaining months in this year. Currently, ADPC is assessing the Capacities, Gaps, and Needs of National Meteorological and Hydrological Services (NMHSs) and their National (multi hazard) Early Warning Systems ((MH)EWS) including Regional and Global Support Mechanisms in Pacific Small Island Developing States (SIDS) especially for Cook Islands, Fiji, Kiribati, Nauru, Niue, Tokelau, and Tuvalu. He informed that IA (Implementation Agreement) was signed between WMO and ADPC on 31st March 2020.

He explained overall objective of this project which is “to assess the (MH)EWS of the selected countries in the Pacific (especially from the perspective of the NMHSs) and document the respective capacities, gaps, and needs at regional, national and sub-national (local/community) levels, including existing assessments and recently completed, on-going, and planned capacity and technical cooperation interventions.”

He presented key components of this project which are 1.) Desk study of ongoing/ recently completed MHEWS and DRR programmes and projects at regional and national levels; 2) Identification, analysis, and documentation of MHEWS capacities, gaps, and needs at regional, national, and sub-national/ local levels; 03) Preparation of regional report and country-specific technical briefs.

He presented overall methodology of project and informed that multi hazard early warning system capacities, gaps and needs will be assessed using early warning system assessment matrix, which was developed based on four pillars for early warning system suggested by World Meteorological Organization (WMO), including i.) disaster risk knowledge, ii.) detection, monitoring and forecasting of the hazards and possible consequences, iii.) warning dissemination and communication and iv.) preparedness and response capability and few cross-cutting issues such as governance and gender etc. He informed that matrix was developed by ADPC and tested in many countries in South East Asia under various projects including Myanmar, Cambodia, Vietnam, Nepal and Sri Lanka.

He informed that ADPC will assess capacities and needs of national level agencies through Key Informant Interviews (KII), Focus Group Discussions (FGD) and Shared Learning Dialogues (SLD) using structured set of questionnaires. He added that assessment will be carried out with NMHS, NDMO and other regional organisations such as RSMC Nadi, SPC, PIF and PMC on current status of multi-hazard early warning system.

Later, he updated about progress under each component of the project. He informed that ADPC prepared and submitted Inception Report (under Component 1), which is under review with WMO. He also informed that 2-3 rounds of progress meetings held with WMO team. ADPC also prepared and submitted list of projects in project countries (under Component 1).

He informed that as next step (under Component 2), ADPC will request WMO to provide letter of introduction and also key contact details from NMHS in project countries. ADPC will establish communication with NMHS and Key regional organisations after necessary communication from WMO. ADPC will initiate online consultations with each NMHS in Cook Islands, Fiji, Kiribati, Nauru, Niue, Tokelau, and Tuvalu as per their convenience and availability.

He also informed that ADPC prepared Business Continuity Plan (BCP) for this project with various scenarios and short term and long-term measures. Due to COVID-19, if situation remain same or aggravate, Activity 2 (identification, analysis, and documentation of MHEWS capacities, gaps, and needs at regional, national, and sub-national/ local levels) will be conducted through video conferencing. Required data/information will be requested and collected using File Transfer Protocol (FTP) or Dropbox. There is a possibility of extension till March 2021.

adpc

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