COUNTRY HYDROMET DIAGNOSTICS

Informing policy and investment decisions for high-quality weather forecasts, early warning systems, and climate information in developing countries.

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Marshall Islands NMHS Peer Review Report

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SOFF Systematic Observations Financing Facility | Weather and climate data for resilience | Alliance for Hydromet Development

The findings, interpretations and conclusions expressed are those of the named authors alone and do not necessarily reflect those of the agencies involved.

Authorisation for release of this report has been received from the Peer Reviewing Agency and the Country NMHS.

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Glossary

AFIS	Aerodrome Flight Information Service
AWS	Automatic Weather Stations
BOM	Bureau of Meteorology
BUFR	Binary Universal Form for the Representation of meteorological data
CAP	Common Alerting Protocol
CIS-PAC5	Climate Information & knowledge Services for resilience in 5 island countries of the Pacific
CliDE	Climate Data for Environment
CPC	NOAA Climate Prediction Centre
COFA	Compact of Free Association
COSPPAC	Climate & Oceans Support Programme in the Pacific
CREWS	Climate Risk and Early Warning Systems
DoD	US Department of Defence
DRR	Disaster risk reduction
EARWatch	Early Action Rainfall Watch
ECMWF	European Centre for Medium-range Weather Forecasting
EDIS	Email Data Input System
EEZ	Exclusive Economic Zone
ENSO	El Nino Southern Oscillation
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FACT	Ministry of Fisheries, Agriculture, Commerce and Tourism
FSM	Federated States of Micronesia
GBON	Global Basic Observing Network
GCF	Green Climate Fund
GFS	Global Forecasting System model
GoRMI	Government of the Republic of the Marshall Islands
GOS	Global Observing System
GTS	Global Telecommunication System
IBEWS	Impact Based Early Warning System
ICT	Information & Communications Technology
JAMSTEC	Japan Agency for Marine-Eart Science & TEChnology
JMA	Japan Meteorological Agency
KMA	Korea Meteorological Administration
MAPSO	Micro Art Paperless Surface Observations
METAR	METeorological Aerodrome Report
MFAT	Australian Ministry of Foreign Affairs and Trade
MHEWS	Multi-Hazard Early Warning System
MWSCo	Majuro Water & Sewerage Company
NCEI	US National Centre for Environmental Information
NCOF	National Climate Outlook Forum
NDC	National Disasters Committee
NDMO	National Disaster Management Office
NERP	National Emergency Response Plan

NGO	Non Governmental Organisation
NIWA	National Institute of Water and Atmospheric Research
NOAA	National Oceanic and Atmospheric Administration
NSPWWCS	National Strategic Plan for Weather, Water and Climate Services
NWP	Numerical Weather Prediction
Oscar/Surface	Observing Systems Capability Analysis & Review tool
PACIOOS	Pacific Islands Ocean Observing System
PIRCA	Pacific Islands Regional Climate Assessment
PMC	Pacific Meteorological Council
PREP2	Pacific REsilience Project 2nd Phase
PRH	USNWS Pacific Regional HQ
PTWC	Pacific Tsunami Warning Centre
QC	Quality Control
QMS	Quality Management System
QPE	Quantitative Precipitation Estimate
QPF	Quantitative Precipitation Forecast
RBON	Regional Basic Observing System
RIC	Regional Instrument Centre
RMI	Republic of the Marshall Islands
RTS	Reagan Test Site
RSMC	Regional Specialised Meteorological Centre
SDP	Station Duty Manual
SIDS	Small Island Developing State
SOFF	Systematic Observations Financing Facility
SOP	Standard Operating Procedure
SPREP	Secretariat of the Pacific Regional Environment Programme
TASI	University of Hawaii Telecommunications and Social Informatics Programme
UA	Upper Air
UCAR	University Corporation for Atmospheric Research
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
USP TAFE	University of the South Pacific Technical And Further Education
USNWS	United States National Weather Service
WASH	WAter Sanitation and Hygeine cluster
WDQMS	WMO Data Quality Management System
WFO	Weather Forecast Office
WIGOS	WMO Integrated Global Observing System
WIS	WMO Information System
WMO	World Meteorological Organisation
WRF	Weather Research & Forecasting model
WRP	Weather Ready Pacific
WSO	Weather Service Office

Executive Summary

Ten critical hydrometeorological elements have been assessed by the peer advisor and beneficiary against maturity of service within the Republic of Marshall Islands (RMI) national context.

RMI currently has maturity scores ranging between 1 and 3 across the ten value chain elements – key gaps are identified and remedial recommendations offered. The Weather Service Office (WSO) in RMI is unusual in comparison to some other Small Island Developing States (SIDS) NMHSs, due to the support they receive from the US National Weather Service (USNWS) via the Compact of Free Association (COFA), providing a stable basis for foundation weather services. However, the main services are relatively limited in scope, especially in relation to the understanding and communication of the value of WSO products and services to users, and thus the WSO continues to require support to further develop service capability of benefit to RMI.

Key focus should include, in particular, consideration of:

- The governance context, data sharing and understanding the national value of products and services provided beyond COFA-funded WSO services
- Observing and service infrastructure across the FSM
- Climate & hydrological services

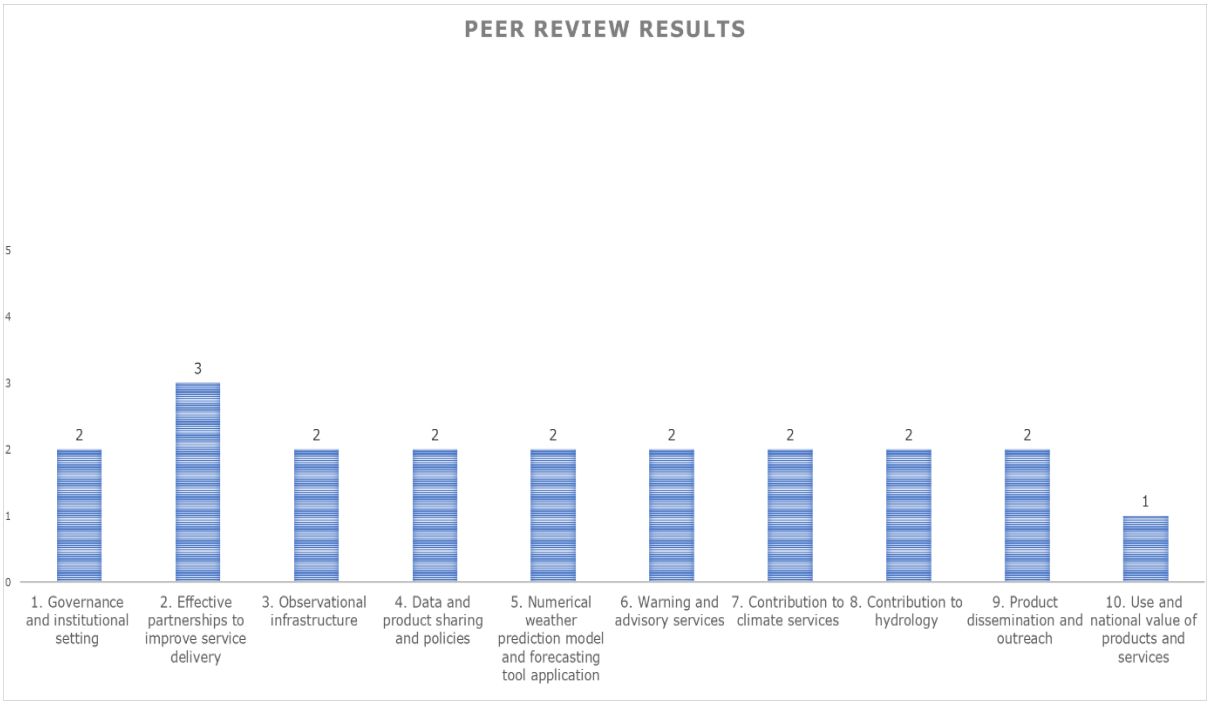


Fig 1: Summary of Maturity Level Assessment for the National Meteorological Service of the Republic of the Marshall Islands

Element	Maturity level score
1. Governance and institutional setting	2
2. Effective partnerships to improve service delivery	3
3. Observational infrastructure	2
4. Data and product sharing and policies	2
5. Numerical weather prediction model and forecasting tool application	2
6. Warning and advisory services	2
7. Contribution to climate services	2
8. Contribution to hydrology	2
9. Product dissemination and outreach	2
10. Use and national value of products and services	1

Table 1: Summary of Maturity Level Assessment for the National Meteorological Service of the Republic of the Marshall Islands

CHD methodology

This report has been prepared using CHD operational guidance in support of the WMO GBON SOFF initiative. An initial desktop review was performed based on information provided by WSO. An in-country visit and subsequent follow-up visit to WFO Guam were also undertaken alongside work to support SOFF delivery, with interviews held with WSO Majuro, USNWS Pacific Regional Headquarters (PRH) Honolulu and the RMI National Disaster Management Office (NDMO) at the Office of the Chief Secretary, who are responsible for coordinating dissemination of disaster warnings and disaster relief and coordination. This report presents the ten most critical hydrometeorological elements ad defined in by the Country Hydromet Diagnostics methodology, assessed against maturity of service with recommendations to remediate specific issues.

Gaps, Urgent Needs and Key Recommendations

Governance & Institutional Settings:

- WSO RMI should continue to work with the national government and project partners to sustainably strengthen resourcing and carefully consider logistics to access remote islands in order to meet national needs with respect to protection of life and property.
- The WSO should further seek to progress the legal status of the WSO within the national context.

Effective Partnerships to Improve Service Delivery:

- WSO RMI should continue to promote the benefits of their work to national government and further strengthen relationships with delivery partners.
- The WSO should seek further opportunities to engage in funded research as may aid the implementation of Impact Based Early Warning Systems (IBEWS) and the capacity development of WSO staff.

Observational Infrastructure:

- WSO RMI should fully engage with the SOFF programme to access funding for new automated surface observation stations and additional radiosonde observations to meet national GBON targets.
- The WSO should strengthen links with partner organisations where there are opportunities to access third party observation network data.
- The WSO should review its arrangements for National Focal Points and engagement with respect to WIGOS, Oscar and WDQMS, noting that RMI is not currently a formal WMO member.

Data & Product Sharing & Policies:

- WSO RMI should consider formalisation of a GBON-compliant data policy within national legislation in anticipation of SOFF investment.

Numerical Model & Forecasting Applications:

- WSO RMI should review skills and training in relation to interpretation of satellite and model outputs from global centres, enabling greater confidence in refining and adding local value to USNWS forecasts where appropriate.
- WSO should enhance feedback and communication with WFO Guam and wider USNWS to improve quality of local forecasts.

Early Warning and Advisory Services:

- WSO RMI should aim to initiate regular reviews of warning performance, both internally and based on third party feedback where possible; and work with others to move towards implementation of impact-based warnings.

Contribution to Climate Services:

- WSO RMI should undertake consultation/outreach with RMI government and key industry representatives to identify climate requirements, training and potential funding sources to support the development of climate services tailored to sector needs.

Contribution to Hydrology:

- WSO RMI should formalise data sharing agreements and SOPs between the WSO and MWSCo, EPA and wider WASH cluster stakeholders, recognising a potential leading role in hydrological matters for the WSO within RMI government.
- The WSO should gauge national hydrological requirements to better understand the need to undertake staff capacity building in hydrological services.

Product Dissemination & Outreach:

- WSO RMI should consider how they might implement further outreach and communication activities to reach remote or marginalised communities.

Use of National Products and Values:

- WSO RMI should consider implementing routine formal user feedback within NDC, also employing questionnaires to improve their products and services.
- The WSO should look to implement a more robust local QMS and associated capacity building/ training via projects such as SOFF (observations).

Chapter 1: General information

Introduction

Overview

The Marshall Islands is an island nation in the central North Pacific Ocean, about halfway between Hawaii and Australia. The country consists of 29 low-lying coral atolls and five individual islands spread across RMI's Exclusive Economic Zone (EEZ) of c.2,131,000 km2 of Pacific Ocean.

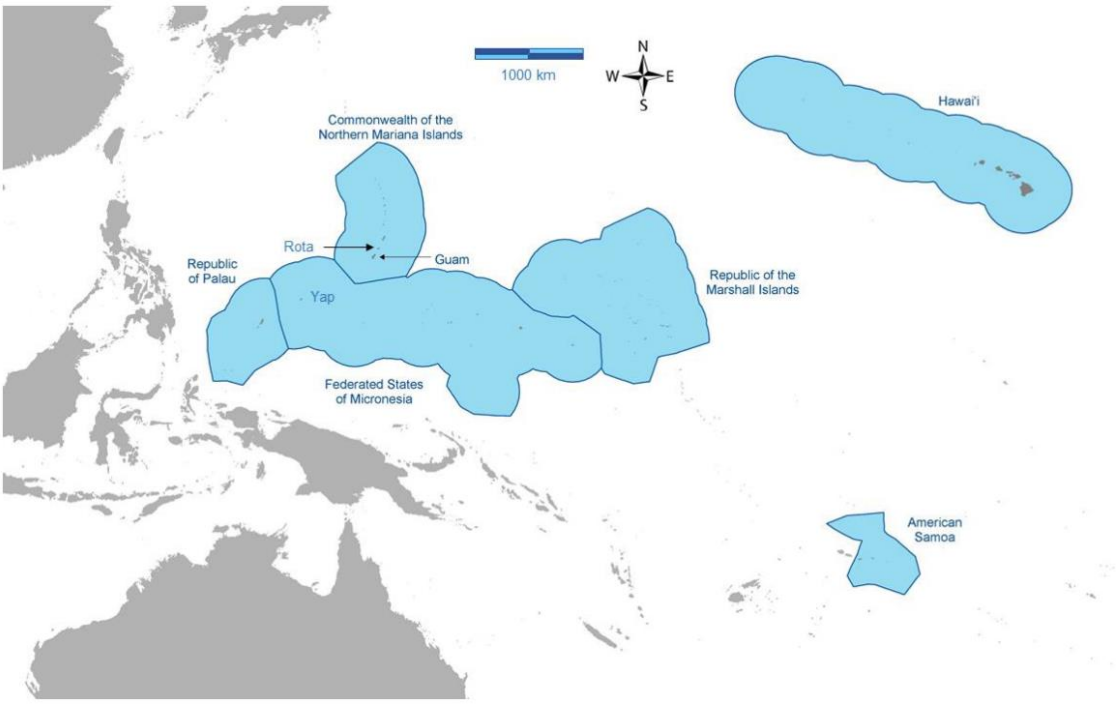


Figure 2. Map of the Exclusive Economic Zones of American-affiliated Pacific Islands. Reproduced by permission from Pacific RISA, US National Oceanic and Atmospheric Administration, **pacificrisa.org**.

The atolls consist of an irregular, oval-shaped coral reef surrounding a lagoon; the islands are coral caps set on the rims of submerged volcanoes rising from the ocean floor[1]. The atolls and islands form two groups: the Ratak (sunrise) and the Ralik (sunset). The two island chains lie approximately parallel to one another, running northwest to southeast, comprising only about 70 square miles (181 km^2) of land mass in total[2]. Each group includes 15-18 islands and atolls. The islands and islets of the Ratak chain tend to be more densely vegetated than those of the Ralik. Coconut and pandanus palms and breadfruit trees are the principal vegetation. Soils are generally sandy and low in fertility.

[1] https://www.britannica.com/place/Marshall-Islands
[2] https://en.wikipedia.org/wiki/Marshall_Islands

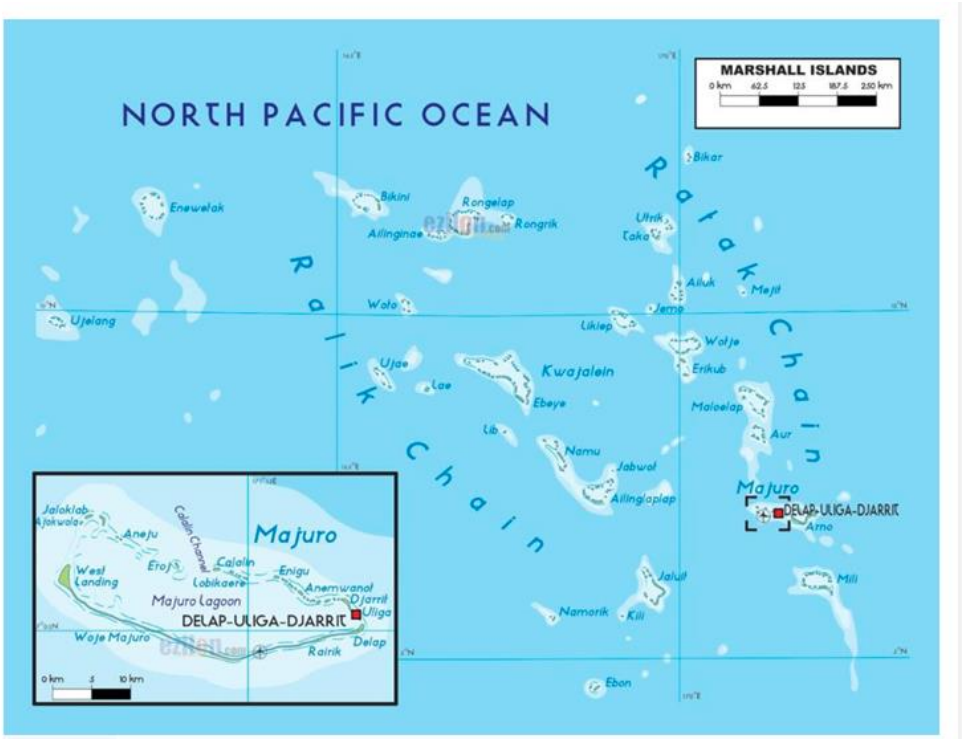


Figure 3: Map of Marshall Islands courtesy © 2024 Mapsland

24 of the atolls and islands are inhabited - none rise to more than 20 feet (six metres) above high tide. Majuro atoll holds the seat of government, but the largest atoll, dominated by a US military base, is Kwajalein with a land area of 6 square miles (16 km^2) - it surrounds a 655 square mile (1,700 km^2) lagoon. The remaining atolls are uninhabited due to poor living conditions, lack of rain, or nuclear contamination dating back to US atomic bomb tests during the second world war.

Figure 4: Runit Dome radioactive waste repository in Enewetak Atoll (ABC image)

Climate & Natural Hazards

The Marshall Islands have a tropical maritime climate, with high humidity and a mean annual temperature across the island group of c.28°C. Annual precipitation varies from 500-800 mm in the north to c.4,000mm in the southern atolls, largely from sharp convective showers. The climate has a relatively dry season from December to April, the height of the northeasterly trade-wind season, and a wet season from May to November; the wettest months are October and November. Many Pacific typhoons begin as tropical storms in the Marshall Islands region in the wet season and grow stronger as they move west toward the Mariana Islands and the Philippines.

However, the threat of drought is common throughout the island chains with population outstripping the supply of fresh water and several of the northern atolls are uninhabited owing to insufficient rainfall[3]. The climate varies considerably from year to year due to the El Niño-Southern Oscillation (ENSO). Conditions during La Niña years are generally wetter than normal. El Niño events tend to bring warmer than normal wet seasons and warmer, drier dry seasons. Following severe El Niño events, rainfall can be reduced by as much as 80%. Prolonged droughts are devastating to subsistence farmers and quickly cause water stress in urban centres. RMI declared a State of Disaster in 2013 and 2016 as a result of prolonged and unseasonal droughts, estimated to cost the nation about 4.9 million in US Dollars. Another particular challenge relates to climate change and the low-lying nature of RMI - king tides are becoming more frequent and intense due to sea level rise and prolonged periods of La Niña; salt water is also increasingly seeping into freshwater lenses, creating urgent challenges for the islands.

The National Meteorological Service of the Republic of the Marshall Islands

Operational meteorological services are provided in the Republic of the Marshall Islands (RMI) via the Weather Services Offices (WSO) in collaboration with the US National Oceanographic and Atmospheric Administration's (NOAA) National Weather Service (USNWS) under the Compact of Free Association (COFA)[4]. The WSO works closely with the regional Weather Forecast Office (WFO) Guam across all their operations and in particular with respect to provision of technical and logistical support for forecasting, warnings and observations. Funding and oversight assistance is provided under contract to WSO via the National Weather Service Pacific Region Headquarters (PRH) as part of COFA.

[3] Marshall Islands - Brittanica & discussion with WSO RMI
[4] The Compacts of Free Association

Chapter 2: Country Hydromet Diagnostics

Element 1: Governance and institutional setting

1.1 Existence of Act or Policy describing the NMHS legal mandate and its scope

The Republic of the Marshall Islands (RMI) and the United States of America (USA) signed the Compact of Free Association (COFA) on June 25, 1983. This treaty requires the US to provide three services for RMI: a postal service, an air traffic service and meteorological service. The US National Oceanic and Atmospheric Administration's (NOAA) National Weather Service (USNWS) delivers weather services and associated programs throughout RMI in line with COFA's Article VII (Weather Services and Associated Programs). According to Sections 5 to 13 of Article VII, USNWS provides weather services through a Weather Service Office (WSO) created in Majuro, Republic of Marshall Islands. Subsequently, at the operational level, the National Weather Service Pacific Region Headquarters (PRH) based in Honolulu provides administration, financial, operational, management, and oversight assistance to the WSO via a 5 year rolling contract between the NWS and the Government of the Republic of the Marshall Islands (GoRMI). The NWS Weather Forecasting Office (WFO) Guam provides operational forecast, warning and observational support services to the WSO.

Aviation services are not provided by the WSO - The US Federal Aviation Administration (FAA) provides this at airports around RMI under COFA, but the WSO cooperates with the FAA regarding backfill for manual METAR observations at the main Majuro International Airport if airport employees are unavailable, underpinned by an MoU; the WSO also trains airport observing staff. The upper air station in Kwajalein is funded and operated through the DoD.

Beyond COFA, the WSO reports to GoRMI but there is no national legislation specifically recognising the responsibility of the WSO for providing weather observations or services in RMI. Draft legislation is under development as part of Green Climate Fund (GCF) project funding, though the extent of the legislative mandate this will provide to the WSO is currently unclear as it continues to be negotiated with GoRMI (timescales for resolution unknown). There is no overarching Multi-Hazard Early Warning Services (MHEWS) Act in RMI but the WSO is recognized as the national alerting authority for hydrometeorological hazards.

1.2 Existence of Strategic, Operational and Risk Management plans and their reporting as part of oversight and management.

A strategic plan for WSO RMI was developed and drafted under a Climate Risk and Early Warning Systems (CREWS) project in 2022. This National Strategic Plan for Weather, Water, and Climate Services (NSPWWCS) for RMI serves to coordinate activities across the whole of government that build resilience across 2 key thematic areas, climate change and climate-related hazards/disasters. Strategic goals include:

- Strategic Goal 1: Ensure that the Government of RMI (GoRMI) has enabling legislation that formally places WSO RMI into the organizational structure of GoRMI.
- Strategic Goal 2: Enhance partnerships with stakeholders to improve service delivery, increase the effectiveness and proper use of meteorological, hydrological, ocean, and climate products and services, and ensure successful risk communication.
- Strategic Goal 3: Enhance the human capacity, performance management, and operational efficiency of WSO RMI.

- Strategic Goal 4: Enhance the meteorological, hydrological, ocean and climate observational networks across the RMI area of responsibility and ensure their continued operation.

The draft plan is currently under review by GoRMI and is expected to be approved in 2025 – the WSO are already working to it on this assumption. An Implementation Plan was drafted in Feb 2024, supported by United Nation Environment Programme (UNEP) through the GCF project "Enhancing Climate Information and Knowledge Services for Resilience in 5 Island Countries of the Pacific Ocean" (CISPac5). WSO RMI and CISPac5 will report monthly on progress implementing these plans. No formal national operational or risk management plans are in place, but Station Duty Manuals (SDMs) are provided through USNWS.

1.3 Government budget allocation consistently covers the needs of the NMHS in terms of its national, regional, and global responsibilities and based, among others, on cost-benefit analysis of the service. Evidence of sufficient staffing to cover core functions

The WSO's annual budget is entirely provided by USNWS – it is not possible to disclose this budget due to commercial contract confidentiality – see 1352.209-72 Restrictions against disclosure provided by USNWS. This annual budget is, however, confirmed to be sufficient for salaries and day to day operations. The existing upper air station on Majuro is funded through NWS including the costs associated with maintenance, spares and repairs. Local technical staff in RMI undertake UA operations but are logistically and technically supported by USNWS staff based in Guam and Hawaii. There is limited scope for ongoing capacity development under the current COFA budget - periodically capacity building project opportunities arise, but these come via GoRMI or locally-based international non-governmental organisations (NGOs).

Airport observing is funded separately by the FAA under COFA and the Kwajalein Upper Air station is funded by DoD under contract.

1.4 Proportion of staff (availability of in-house, seconded, contracted- out) with adequate training in relevant disciplines, including scientific, technical, and information and communication technologies (ICT). Institutional and policy arrangements in-country to support training needs of NMHS.

WSO RMI currently has 12 directly employed permanent staff members including: 1x Meteorologist-In-Charge (MIC); 1x Staff Meteorologist; 1x Supervisory Weather Service Specialist (SWSS); 5x Weather Service Specialist (WSS); 1x Supervisory Electronic Program Specialist (EPS); 1x Facilities Technician (vacant); 1x Tradesman (vacant); and a CISPac5-funded Climate/Finance Officer position. All these staff are male, though the WSO does contract some female observers in remote islands. WSO RMI does not currently have any concerns over large-scale staff retirements, with a succession plan in place for the only Meteorological Technician who is close to retirement.

WSO staff are well trained via staff competency frameworks determined by COFA/USNWS; certification of staff is via NOAA and the University of Hawaii. NOAA provide training opportunities in meteorology, forecasting and management through in-person training courses run out of either Hawaii or Guam offices. The two primary training courses currently being offered by NOAA are the Pacific Leadership Academy, which provides leadership and management training to senior staff at the WSOs, and the Pacific

International Training Desk in Honolulu which provide training courses focussed on meteorology and forecasting. As a prerequisite to taking on the role, Weather Service Specialist staff must have completed the selected online training on meteorology and hydrology through the University Corporation for Atmospheric Research (UCAR) Comet Met Ed program. Two members staff have also completed the University of the South Pacific Technical and Further Education (USP TAFE) Certificate IVs in Project Management Practice and Climate Change Resilience, sponsored by USAID. WSO RMI have also received training support for climate and ocean services via the Climate & Oceans Support Programme in the Pacific (COSSPAC), notably assisting the establishment of a National Climate Outlook Forum (NCOF).

Ongoing training and development for ICT applications is required in relation to the need to support direct GBON data dissemination to WIS 2.0. RMI surface observations are not currently GBON-compliant (not automated and submitting hourly to the GTS or WIS 2.0) and this is expected to be addressed within a funding proposal for SOFF support. In the longer term, the regional Weather Ready Pacific (WRP) programme and the Pacific Meteorological Council (PMC) may also be able to contribute to support ICT training of RMI staff, alongside more general training available for meteorology, hydrology and electronics. This would be expected to be achieved via accredited courses facilitated through a regional training facility in Fiji supplemented by on-line and twinning initiatives.

1.5 Experience and track record in implementing internationally funded hydromet projects as well as research and development projects in general.

WSO RMI has been engaged in projects with numerous partners including:

- The Climate Risk and Early Warning Systems (CREWS) initiative supported enhanced GoRMI coordination and the development of a MHEWS framework and a Strategic Plan for WSO RMI (see section 1.3) via the Strengthening Hydro-Meteorological and Early Warning Services in the Pacific (CREWS Pacific SIDS 2.0) project.
- Enhancing Climate Information and Knowledge Services for resilience in 5 island countries of the Pacific Ocean (CIS-Pac5) is an ongoing project which is being delivered by the United Nations Environment Programme (UNEP) in RMI and 4 other Pacific nations: Palau, Niue, Tuvalu and the Cook Islands. CIS-Pac5 aims to deliver on the Pacific SIDS need for accurate, timely and actionable information and early warnings on local weather, water, climate and ocean conditions and related risks to human and environmental health. The project includes the deployment of a network of 24 AWSs on inhabited islands across RMI, with the majority of the stations expected to be installed in 2025. These stations are being installed primarily in partnership with the National Institute of Water and Atmospheric Research (NIWA). This programme in RMI, along with the proposals for other neighbouring SOFF beneficiary countries in the region (in particular fellow COFA country Palau) has been considered as a principal part of the design of the GBON network in the region. This includes consideration for alignment with respect to instrumentation and the full data process chain, training opportunities and associated technical support throughout the duration of the project. The project will also support implementation of a Rainbird mobile software app provided by Korean Met Agency (KMA) to support early warning outputs.

- The WSO has also been party to other international research collaborations with a variety of partners including: published research with the Japan Agency for Marine-Earth Science and Technology (JAMSTEC); WRP, PMC and COSSPAC on training and capacity development initiatives; World Bank in support of the PREP2 project to provide HF radio and other communications equipment to support 2-way hazard messaging to outer islands; the Australian Ministry of Foreign Affairs and Trade (MFAT) who have funded LIDAR analysis of some islands (Majuro and Kwajalein so far) via COSSPAC climate science research activities.

Summary score and recommendations for Element 1

RMI is assessed as **Maturity Level 2** on the CHD scale – ***effort ongoing to formalize mandate, introduce improved governance, management processes and address resource challenges.***

RECOMMENDATIONS:

- WSO RMI should continue to work with national government and project partners to sustainably strengthen resourcing and carefully consider logistics to access remote islands in order to meet national needs with respect to protection of life and property.
- The WSO should further seek to progress the legal status of the WSO within the national context.

Element 2: Effective partnerships to improve service delivery

2.1. Effective partnerships for service delivery in place with other government institutions.

As outlined above, USNWS is the primary partner for service delivery internationally under the COFA agreement. However, the WSO is an active member of relevant multi-sector national response and consultative fora including the:

- National Disaster Committee (NDC) – enacts the National Emergency Response Plan (NERP) as emergencies dictate; routine meetings held quarterly, chaired by the National Disaster Management Office (NDMO);
- National Climate Outlook Forum (NCOF; building from Pacific Islands Climate Outlook Forum template) – annual meeting, led by WSO;
- Marshall Islands Mayors Association – annual meeting to build cooperative dialogue and understanding of island requirements and the role played by weather in disaster management;
- Water, Sanitation & Hygiene (WASH) Cluster - led by NDMO; and
- Food Security Cluster - led by the Ministry of Fisheries, Agriculture, Commerce and Tourism (FACT; with NDMO providing the secretariat).

Key government partners within this context include:

- Office of the President – owns the COFA relationship and guides integration of RMI NWS WSO Majuro in government; can support the WSO on legislation, funding, and coordination in government. Requires data & products produced by WSO for effective decision-making.
- NDMO and Chief Secretary's Office – coordinate the NERP under the Disaster Act. The WSO ensures NDMO and the NDC receive high priority weather and warnings, who disseminate onwards. NDMO works with National Climate Change Directorate and relies on WSO analysis and climate science to inform UNFCCC engagements, the National Adaptation Plan and Sea Level Rise Policy.
- FACT - requires data & products for effective decision-making and planning; the WSO provides advice on early warnings, agrometeorology and climatology. FACT uses information & data to improve sector productivity; the Marine Resources Authority receive climate outlook products.
- Ministry of Culture, Social Services and Outer Island Affairs - requires data & products produced by WSO for effective decision-making and early warning information - works on improving warnings and forecasts that reflect culture.
- Ministry of Health and Human Services - requires weather and climate data & products produced by WSO for effective decision-making and planning in support of monitoring and forecasting dengue, zika and other mosquito borne diseases.
- Ministry of Justice, Immigration and Labour - requires data & products produced by WSO for effective decision-making, particularly in relation to climate change impact on sea level rise and island inundation.
- Office for Environmental Planning and Policy Coordination - requires data & products from the WSO for decision making and informs Climate Change plans.
- Ministry of Transportation, Communication and Information Technology - requires WSO data & products and works on improving communication infrastructure for warnings and forecasts. The National Telecommunications Authority underpins two-way warning messages sent to all islands, using text, HF radio, internet, telephone. The WSO also cooperates with a range of transportation stakeholders for dissemination of weather and warning data, notably the FAA regarding support for meteorological observation.

- Ministry of Works, Infrastructure and Utilities - uses information & data to improve decision making; considers weather & climate in infrastructure planning, notably in relation to sea level rise and inundation. National Energy Office require climate data (notably wind) to plan and operate alternate energy supplies.
- WSO RMI also provides advice, warnings and climate data where required to private companies such as the Marshall Islands Utilities Corporation (to monitor reservoir levels and to minimise disaster service disruption) and NGOs including the RMI Red Cross and the Marshall Islands Conservation Society.

WSO RMI also maintains agreements with private individuals or organisations to ensure service delivery, notably for land and surf (wave heights and periods) observations contracted to observers in 6 outer islands. The US DoD also supplies surface, upper air and radar observations (via their contractor RTS Weather) from Kwajalein to the WSO, alongside access to FAA airfield METAR observational data.

2.2. Effective partnerships in place at the national and international level with the private sector, research centres and academia, including joint research and innovation projects.

WSO RMI maintains a number of collaborative partnerships at the national and international level. The relationship with NOAA/USNWS is key and the US is a significant partner in the region, acting as a coordinating entity between the WSOs in the Republic of the Marshall Islands (RMI), Palau and the Federated State of Micronesia (FSM) under the COFA agreement. There are regular Micronesia Managers Meetings chaired by USNWS which provide coordination of activities and priorities in the region and represent strong ongoing collaboration between the WSOs. NOAA provide training opportunities in meteorology, forecasting and management through in-person training courses run out of either Hawaii or Guam offices. WSO RMI is also party to a number of international collaborations and research projects through its association with USNWS, including: the Pacific Islands Ocean Observing System (PacIOOS; which supports inundation forecasts wave/ocean current monitoring); the University of Hawaii Telecommunications and Social Informatics Programme (TASI; in relation to meteorological and disaster communication research and training) and the Pacific Islands Regional Climate Assessment (PIRCA; research assessing change indicators, impacts, and adaptive capacity of the US-Affiliated Pacific Islands).

WSO RMI works closely with the Secretariat of the Pacific Regional Environment Programme (SPREP), the regional organisation established by the Governments and Administrations of the Pacific charged with protecting and managing the environment and natural resources of the Pacific. SPREP headquarters is based in Apia, Samoa with other SPREP offices in Fiji, RMI and Vanuatu. SPREP's mandate is to promote cooperation in the Pacific region and provide assistance in order to protect and improve its environment and to ensure sustainable development for present and future generations. The Pacific Meteorological Council (PMC) is a specialized subsidiary body of SPREP, established in 2011 to facilitate and coordinate the scientific and technical programme activities of the regional meteorological services. PMC meetings are held every 2 years and provide policy-relevant advice to the SPREP on the needs and priorities of its member countries and territories in relation to meteorology[5]. SPREP / PMC could serve as an important partner in the SOFF implementation phase, providing the opportunity to coordinate training

[5] https://www.pacificmet.net/pmc

programmes at a regional level, enabling efficiencies in the design and commissioning of the training programmes and enabling access to ongoing refresher training for SOFF countries in the region.

The WSO also has an indirect relationship with the World Meteorological Organization (WMO), where RMI is not a member, through the USNWS and SPREP/PMC and its Pacific Meteorological Desk Partnership.

2.3. Effective partnerships in place with international climate and development finance partners.

As noted in Section 1.5, WSO RMI has had success with partner projects in relation to climate and other investments, e.g. COSSPAC. Of particular currency is the ongoing Green Climate Fund (GCF) funded United Nations Environment Programme (UNEP) Enhancing Climate Information and knowledge Services for resilience in 5 island countries of the Pacific Ocean (CIS-PAC5) project. CIS-PAC5 is under way for RMI and neighbouring Pacific countries (Cook Islands, Niue, Tuvalu and Palau). The project includes the deployment of various observing infrastructures and has been developed with GBON compliance as a core part of the design of the instrumentation, in partnership with the National Institute of Water and Atmospheric Research (NIWA). The Australian Bureau of Meteorology (BoM) are also operating as a partner in this project, providing the Climate Data for the Environment (CliDE) database as well as communications systems and data processing.

This programme will seek GBON sustainability funding in RMI through SOFF going forwards, along with the proposals for other SOFF beneficiary countries in the region (notably Palau). This includes consideration for alignment with respect to instrumentation, training and the full data processing chain. As part of SOFF investment, international data sharing via WIS2.0 will be implemented where this has not been delivered by CIS-Pac5. There is also scope for the establishment of a regional calibration and supply centre in Fiji funded via the Weather Ready Pacific (WRP) initiative which could provide calibration services to all SOFF nations in the Pacific region. This would enable access to high quality calibration equipment and centralized expertise to all NMHSs in the region, where a distributed approach across the islands would be challenging to implement. This could be coordinated through regional organisations such as SPREP in recognition of the increasing need for calibration across the region.

2.4. New or enhanced products, services or dissemination techniques or new uses or applications of existing products and services that culminated from these relationships.

New product and service development is limited within the COFA framework, but WSO RMI has been involved in developing services via previously outlined projects and partnerships including the annual National Climate Outlook Forum (NCOF) and a regular drought statement. USNWS WFO Guam-provided forecasts and warnings are translated into local language by the WSO and disseminated to local emergency management; and some social media content has been developed based on consultation with national and international partners. The WSO aspires to introduce Impact-Based Early Warning Systems (IBEWS) and tailored forecasts and products for industry sectors by further partner collaboration. Development of downscaled weather models and tools to better capture sea level rise are sought via further involvement in national and regional projects.

Summary score, recommendations, and comments for Element 2

RMI is assessed as **Maturity Level 3** on the CHD scale – ***Moderately effective partnerships but generally regarded as the weaker partner in such relationships, having little say in relevant financing initiatives***

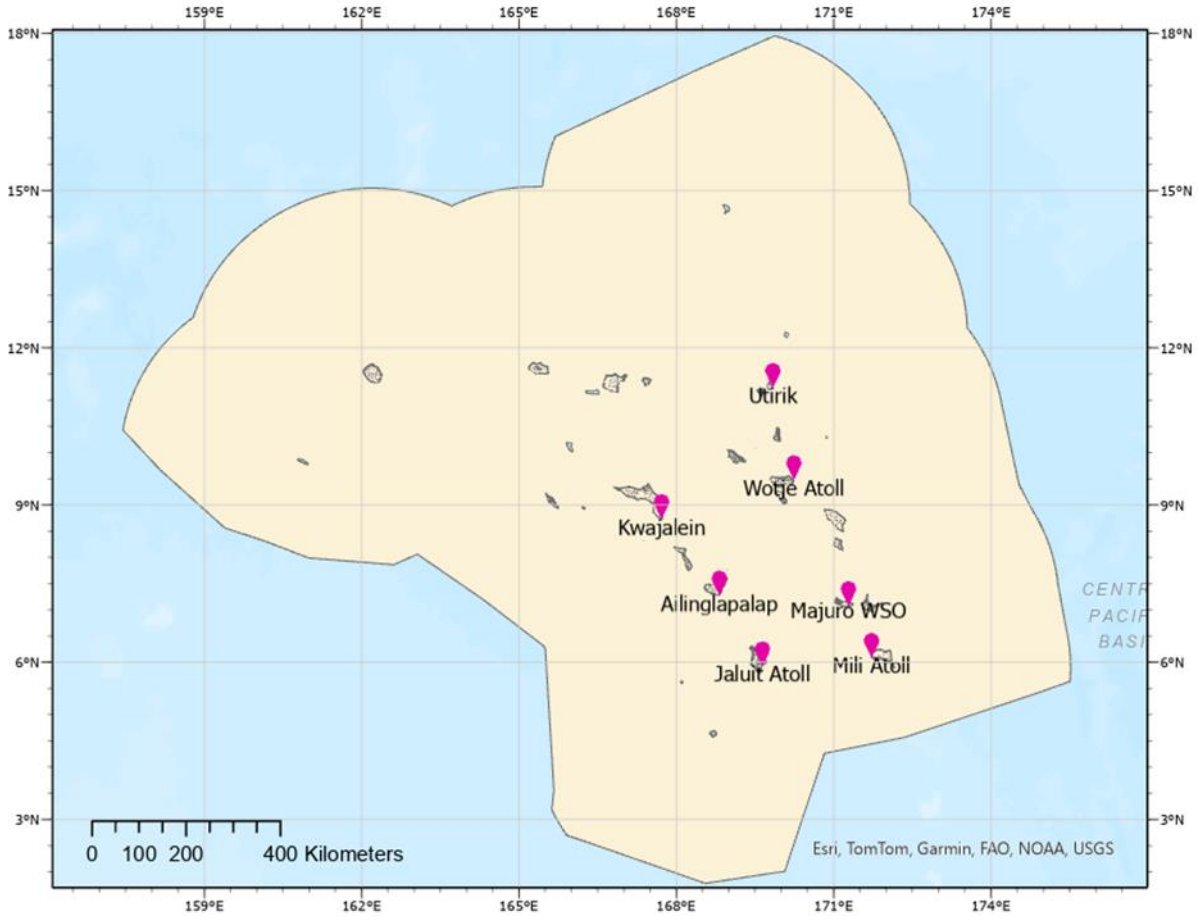
RECOMMENDATIONS:

- WSO RMI should continue to promote the benefits of their work to national government and further strengthen relationships with delivery partners
- The WSO should seek further opportunities to engage in funded research (e.g. WRP, WISER Asia-Pacific) as may aid the implementation of Impact Based Early Warning Systems (IBEWS) and the capacity development of WSO staff.

Element 3: Observational infrastructure

3.1. Average horizontal resolution in km of both synoptic surface and upper-air observations, including compliance with the Global Basic Observing Network (GBON) regulations.

WSO RMI currently operate a network of 7 manual surface observation stations, mainly in the eastern islands, reporting via email at 6 hourly intervals located at or near airfields on 7 of the islands and atolls across RMI; 2 UA stations at Majuro and Kwajalein are also operated (see Figures 5 below). With a land area of about 181 km2 spread over many islands, resolution over land mass is currently c.26km2 per station, but RMI's large Exclusive Economic Zone (EEZ) lends itself to an average horizontal resolution over sea of a surface station for every c.304, 429 km2; and 1,065,500 km2 for every upper air station. RMI stations are not currently GBON compliant, both in terms of spatial and temporal criteria. 9 stations producing 24 hourly automated observations per day and 3 UA stations producing twice daily radiosonde ascents shared to WIS 2.0 (with appropriate spacing of stations across the EEZ) would be required to achieve GBON compliance.



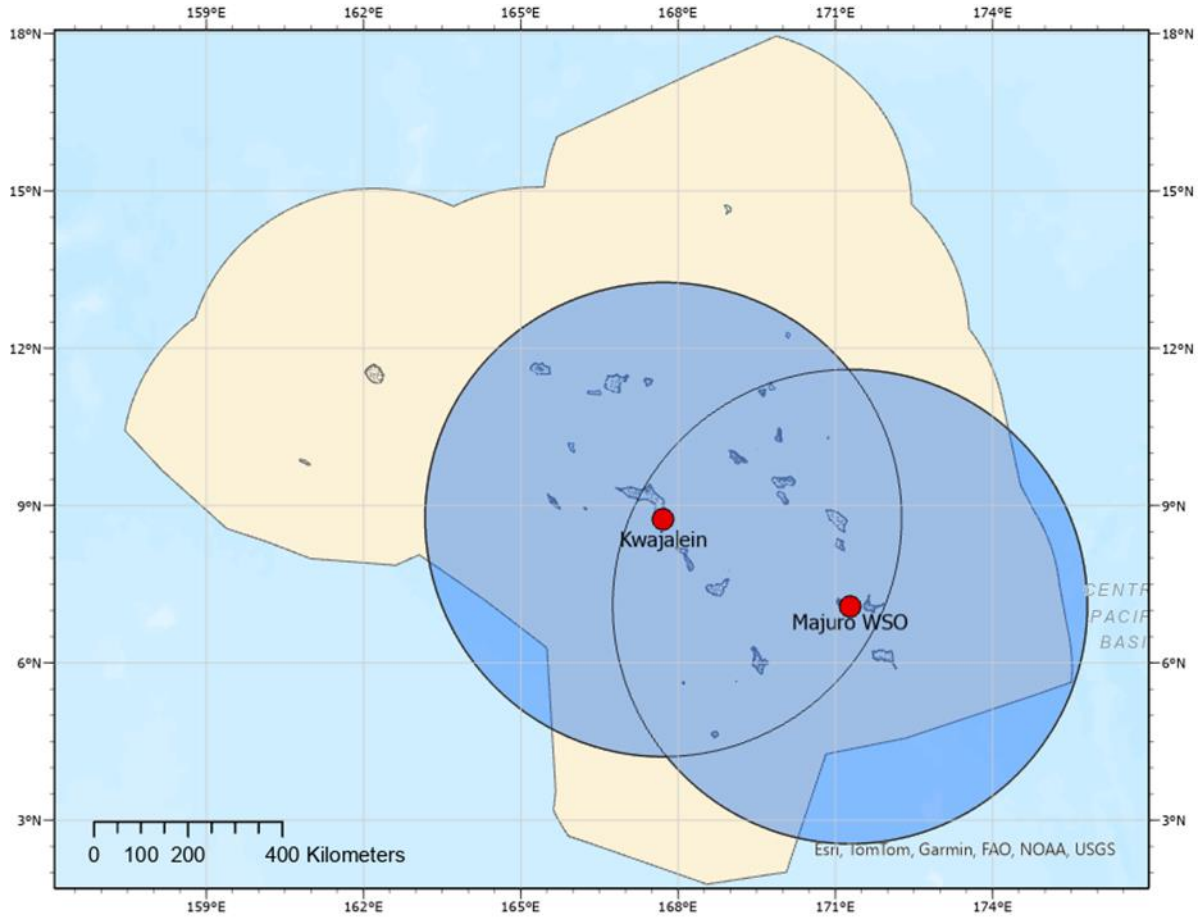


Figure 5 - Map of existing (a) manual surface and (b) upper air observations stations in RMI. Republic of Marshall Islands Exclusive Economic Zone (EEZ) area shown in yellow.

3.2. Additional observations used for nowcasting and specialized purposes.

The upper air station at Kwajalein is not operated by the WSO but by RTS Weather on behalf of the US DoD. At present the site undertakes around two launches per week, dependent on DoD operational requirements. RTS also operate a weather radar, whose output is openly available to the WSO via the internet. Additionally, tide gauge wave observations are available for Majuro via PacIOOS, but the majority of the EEZ has limited marine observing capability. Additional manual surface synoptic and wave state observations are periodically reported in from volunteers on remote islands across RMI.

3.3. Standard Operating Practices in place for the deployment, maintenance, calibrations and quality assurance of the observational network.

Station Duty Manuals (SDMs) and checklists for WSO services and equipment are provided through USNWS at the operational level and these are in the process of being collaboratively updated. A NIWA manual is in place for expected CIS-Pac5 AWSs, but SOPs for the ongoing operation of the planned GBON AWS network are to be further developed under SOFF (to include connection to WIS 2.0) and owned by the proposed observation network officer position.

There is no national WIGOS governance mechanism in place and National Focal Points for WIGOS, Oscar/Surface and WDQMS are via the USNWS. Local technical staff in RMI are supported by USNWS staff based in Guam and Hawaii in terms of basic maintenance, but the WSO is unable to perform regular calibration locally – calibrated equipment is provided by USNWS from mainland facilities, e.g. the US Pressure Standards Laboratory. For proposed SOFF investment, there is potential for a future calibration arrangement to be put in place with a Regional Instrument Centre (RIC) and discussions have been undertaken for a Fiji-based SPREP facility to potentially serve Pacific nations.

3.4 Implementation of sustainable newer approaches to observations.

The majority of surface observations in RMI are manual and the only internationally exchanged observations are the 6 hourly observations disseminated from the main WSO Majuro and Kwajalein locations via the USNWS EDIS (Email Data Input System). The observation network of 24 AWSs being implemented under CIS-PAC5 requires connection to WIS 2.0 and sustainable ongoing maintenance/communications/data management for GBON compliance, for which SOFF is seen as a long-term funding partner. In terms of early warnings, RMI would also benefit from additional maintenance support for marine observations within its EEZ, should this become available via SOFF.

3.5. Percentage of the surface observations that depend on automatic techniques.

From a total of 7 WSO-operated surface observations 0% are automated. All surface observations routinely shared internationally in real time are manual 6 hourly SYNOPs (via EDIS) and METARS (via AFIS) from eg Majuro International Airport. AFIS observers are trained and certified by the WSO. Upper Air observations are manually released (0% automated).

Summary score, recommendations, and comments for Element 3

RMI is assessed as **Maturity Level 2** on the CHD scale - ***Basic network, large gaps, mostly manual observations with severe challenges and data quality issues***.

RECOMMENDATIONS:

- WSO RMI should fully engage with the SOFF programme to access funding for new automated surface observations and additional radiosonde observations to meet national GBON targets
- The WSO should strengthen links with partner organisations where there are opportunities to access third party observations network data.
- The WSO should review its arrangements for National Focal Points and engagement with respect to WIGOS, Oscar and WDQMS, noting that RMI is not currently a formal WMO member.

Element 4: Data and product sharing and policies

4.1. Percentage of GBON compliance – for how many prescribed surface and upper-air stations are observations exchanged internationally. Usage of regional WIGOS centres.

The main surface and UA GBON stations currently shared to GTS via EDIS are Majuro & Kwajalein. WDQMS shows that the Majuro UA station operated by WSO (and funded by USNWS) is broadly compliant (>95%), but the Kwajalein UA station (funded by DoD) only launches radiosondes once a day and is thus not compliant; manual surface stations only report every 6 hours routinely and are also not compliant. RBON Surface stations are additionally nominated on OSCAR for the other 5 currently operational manual stations (Ailinglapap, Jaluit, Mili, Utirik and Wotje), plus Ebon and Maleolap; General Observation Stations (GOS) are additionally nominated for Roi-Namur, Ujae, Ujelang, Ailinglapap and Enewatak.

RMI as a whole is currently not GBON-compliant spatially based on operational stations: the 7 surface stations represent only 78% of the spatial RMI EEZ compliance target of 9 stations; and of the existing 2 main stations (22%) routinely reporting to the GTS via EDIS, 6 hourly observations only allow for a maximum of 17% temporal compliance. For UA, compliance is currently a maximum of 50% overall (67% spatial compliance with 2/3 stations but with Kwajalein only meeting c.50% of its GBON target). WSO RMI is currently not migrated to WIS 2.0 and is not transferring data using WIS 2.0 protocols; as above, the WSO continues to use the USNWS EDIS.

4.2. A formal policy and practice for the free and open sharing of observational data.

RMI does not have a stated formal data sharing policy for free and unrestricted sharing of synoptic/BUFR observational data internationally, but METARs are available via the FAA and the WSO aligns with NOAA data sharing policies (Section 6 Integrity of Scientific Activities), ensuring free flow of all forms of scientific information in accordance with WMO Unified Data Policy. As such, observational data produced by WSO RMI (surface and upper air) is reported to the GTS via the USNWS and is openly discoverable/usable.

There are no national or international agreements or interagency protocols for data exchange (noting RMI is not currently a WMO member), but available data is shared with Weather Forecast Office (WFO) Guam wherever possible. The WSO has limited capability in place for quality controlling, archiving and sharing observational data locally. Quality control is undertaken by a meteorologist at WSO level via a NWS system called MAPSO (Micro Art Paperless Surface Observations) and has a monthly output. QC of data from NOAA-supported sites is also undertaken at Pacific Region Headquarters (PRH) regional level and at NOAA's National Centre for Environmental Information (NCEI). This QC only applies to data from WSO RMI's 7 manual observing sites.

4.3. Main data and products received from external sources in a national, regional and global context, such as model and satellite data.

WSO RMI receives a range of satellite data including imaging, scatterometer data and other satellite-borne radar products from NOAA websites and the Japanese Meteorological Agency (JMA). WSO staff can also access the Kwajalein weather radar directly online. Forecasts are received via internet/email from Guam WFO; other NOAA websites with

wave images and NWP output (eg - GFS, ECMWF, WRF; see Section 5.1) are also used by the WSO. Not all WSO staff have been trained on remote sensed data and interpretation for priority hazards.

Summary score, recommendations, and comments for Element 4

RMI is assessed as **Maturity Level 2** on the CHD scale - ***A limited amount of GBON compliant data is shared internationally. The existing data sharing policies or practices or the existing infrastructure severely hamper two-way data sharing.***

RECOMMENDATIONS:

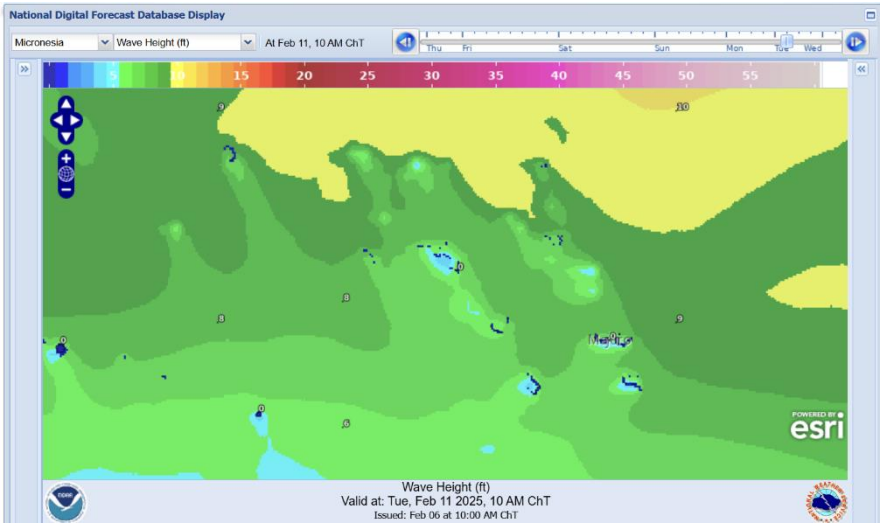
- WSO RMI should consider formalisation of a GBON-compliant data policy within national legislation in anticipation of SOFF investment.

Element 5: Numerical model and forecasting tool application

5.1. Model and remote sensed products form the primary source for products across the different forecasting timescales.

Forecast model products are provided by WFO Guam and other NOAA websites. WSOs primarily focus on tailoring and translating direct products and guidance from WFO Guam to the specific needs of local people to increase reach and accessibility – the WFO and wider USNWS base their forecasts and guidance on a suite of global models.

WSOs directly receive Global Forecast System (GFS; 22km resolution every 6 hours), Weather Research & Forecasting (WRF; 3 hourly at 1, 3 and 9km resolution over the islands) and ECMWF (9km resolution every 12 hours) model data and JMA satellite imaging (eg - scatterometer, HIMAWARI datasets). As such, modelling and other products received by the WSO are deemed sufficient for general forecasting purposes. WSO specialist staff are trained in basic interpretation and use of model and observational products and have access to World Meteorological Centre/Regional Centre hazard products and guidance but further capacity building in this area would be beneficial to boost meteorologist confidence.

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PMZ181-061900-
Majuro Coastal Waters-
200 PM ChST Thu Feb 6 2025

...SMALL CRAFT ADVISORY IN EFFECT THROUGH EARLY SATURDAY MORNING...

.TONIGHT...East wind 15 to 25 kt with frequent gusts to 30 kt. Wind
waves 4 to 6 ft. East swell 7 to 9 ft and northeast 3 ft.
.FRIDAY AND FRIDAY NIGHT...Northeast wind 15 to 20 kt with frequent
gusts to 25 kt. Wind waves 3 to 5 ft. East swell 6 to 9 ft and
northeast 3 ft.
.SATURDAY AND SATURDAY NIGHT...East wind 15 to 20 kt. Wind waves 3
to 5 ft. East swell 5 to 7 ft and northeast 3 ft. Scattered showers
and isolated thunderstorms.
.SUNDAY THROUGH TUESDAY...Northeast wind 10 to 20 kt. Wind waves 2
to 4 ft. Northeast to east swell 4 to 6 ft and north 3 ft. Chance of
showers and slight chance of thunderstorms.
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Figure 6 – Examples of wave height model and Small Craft Advisory products provided to WSO RMI by WFO Guam

ROUTINE PRODUCTS ISSUED BY WSO MAJURO					
PRODUCT	**SOURCE**	**FREQUENCY**	**DURATION**	**UPDATES**	**PRODUCT DISTRIBUTION**
Local Adaptive Forecast Area Forecast Discussion (AFD)	WFO Guam	Every 24 hours	5 Days	As Needed	To GoRMI HOD, embassies, hotels, tour companies, and the public.
Marshall Islands Climate Bulletin	WSO, published records (normals and means), PEAC, OCOF, WFO Guam, ACCESS-S, CliDE, PICASO, SCOPIC.	Monthly	1 month (with 3-month seasonal outlooks)	N/A	National Disaster Management Office and local partner organizations.

Figure 7 – Routine products issued by WSO RMI (excl. observations)

5.2. a) Models run internally (and sustainably), b) Data assimilation and verification performed, c) appropriateness of horizontal and vertical resolution.

WSO RMI does not have any internal modelling capability and relies on USNWS and other partnerships to deliver model-based products, forecasts and warnings. The WSO does not have an integrated system for analysis, weather forecasting and visualisation.

5.3. Probabilistic forecasts produced and, if so, based on ensemble predictions.

No probabilistic forecasts are produced locally. Some probabilistic products are received by the WSO from WFO Guam (based on GFS, ECMWF, BoM) but short-term forecasts produced locally are generally based on deterministic output. Seasonal products are produced by the WSO and use probabilistic outputs from the monthly National Climate Outlook Forum (NCOF), resulting from the COSSPAC project. WSO RMI would benefit from general NWP and probabilistic forecasting sensitisation training.

Summary score, recommendations, and comments for Element 5

RMI is assessed as **Maturity Level 2** on the CHD scale - ***Basic use of external model output and remote sensed products in the form of maps and figures, covering only a limited forecast time range.***

RECOMMENDATIONS:

- WSO RMI should review skills and training in relation to interpretation of satellite and model outputs from global centres, enabling greater confidence in refining and adding local value to USNWS forecasts where appropriate.
- WSO should enhance feedback and communication with WFO Guam and wider USNWS to improve quality of local forecasts.

Element 6: Warning and advisory services

6.1. Warning and alert service cover 24/7.

NDMO is the lead authority in RMI for early warnings to the public and disaster response, informing other NDC agencies and the public; the NERP defines the roles and responsibilities. WSO RMI does not itself issue warnings locally but alerts NDMO to USNWS WFO Guam warnings 24/7; WSO RMI specialists also tailor and translate into local language. Warnings handled by WSO RMI are as follows:

NON-ROUTINE PRODUCTS ISSUED BY WSO MAJURO					
PRODUCT	**SOURCE**	**FREQUENCY**	**DURATION**	**UPDATES**	**PRODUCT DISTRIBUTION**
Tsunami Bulletins: 1. Information 2. Watch 3. Warning 4. Cancelled	PTWC, WFO Guam, WSO tsunami warning tools and SOPs.	As Needed	Warnings: 3 hours; Watches: 6 hours	As Needed	RMI NDMO (or AM broadcast/mass text if the threat is 3 hours away)
Tropical Cyclone: 1. Advisory 2. Watch 3. Warning 4. Clear	JTWC, WFO Guam	Based on the latest updates from WFO Guam.	Warnings: 24 hours Watches: 48 hours Based on latest updates from WFO Guam & RMI NDMO	Based on latest updates from WFO Guam & RMI NDMO	RMI NDMO
Marine Hazards: 1. Advisory 2. Cancelled	Coastal Hazard Message PGUM, PacIOOS Inundation Model, Coastal Flooding	Based on the latest updates from WFO Guam.	Based on latest updates from WFO Guam	As Needed	RMI NDMO
Drought	Drought SWS, PEAC, ACCESS-S, SCOPIC, PICASO	Daily, Wkly, monthly or seasonally	Daily, Weekly, monthly or seasonally	As needed	RMI NDMO

Figure 8 – Non-routine (warning) products issued by WSO RMI

Tropical cyclone, drought and storm surge warnings are created by WFO Guam based on specific forecast points (against criteria defined in the WSO SDM); Tsunami warnings originate from the Pacific Tsunami Warning Centre (PTWC) – Section 6.2. The WSO highlights warnings and special weather statements to NDMO and the NDC and advises on their local reformulation and dissemination.

6.2. Hydrometeorological hazards for which forecasting and warning capacity is available and whether feedback and lessons learned are included to improve warnings.

WSO RMI is responsible for highlighting and reformulating a range of warnings to NDMO and maintains a 24/7 watch for incoming WFO Guam and wider US government guidance, initiating local dissemination of warning messages where required. WFO Guam issues special weather statements, advisories and warnings for RMI including:

- Tsunami Information Statement and Tsunami Threat Messages – received directly by fax by both WSO RMI and WFO Guam from the Pacific Tsunami Warning Centre (PTWC). Given the short response time for tsunami warning, WFO Guam calls WSO RMI directly to ensure receipt of official tsunami warnings products and prompt

WSO dissemination within RMI. WSO RMI primarily inform NDMO to initiate national response.

- Typhoon warnings and guidance – warnings and products are received by WSO RMI from WFO Guam and the US Navy Joint Typhoon Warning Centre. The WSO also receives products from the Regional Specialised Meteorological Centre (RSMC) Tokyo at the Japan Meteorological Agency (JMA), but WSO protocol is to follow US NOAA advice as primary.
- Coastal Flood Statements and Special Weather Statements – these are for general meteorological/drought/high surf/coastal flood events, excluding tsunamis. There is no specific statement issued for pluvial flood events - WFO Guam will generate freeform Special Weather Statements that may discuss potential for heavy rains and landslides, etc, but there is no NOAA federal entity that specifically issues pluvial flood statements at this time for RMI.

The WSO archives warnings and undertakes some event analysis/lessons learned, but does not formally evaluate MHEWS performance. NDMO have local staff in the remote islands who report back to the WSO and Guam during high impact weather situations and occasional feedback about the forecasts is provided to NWS Guam, with the forecast amended as necessary. The National Climate Outlook Forum (NCOF) will gather feedback from all sectors and is used to design products.

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654
WWPQ81 PGUM 160814
SPSPQ1

Special Weather Statement
National Weather Service Tiyan GU
614 PM ChST Sat Dec 16 2023

MHZ002-171015-
Majuro-
614 PM ChST Sat Dec 16 2023

...INVEST 92W WILL BRING OCCASIONAL NEAR GALE GUSTS TO THE MARSHALL
ISLANDS SUNDAY AND SUNDAY NIGHT...

The Joint Typhoon Warning Center's Invest 92W is centered near
4N172E, or 150 miles south of Majuro. 92W is still loosely organized
per analysis of satellite and other available tools. The invest is
currently rated LOW, meaning tropical cyclone develop is not expected
in the next 24 hours. Model guidance moves 92W north-northeast over
the next 24 hours with some models hinting at some strengthening as
the system approaches Majuro from the south. Expect periods of heavy
rainfall and gusts to 30 knots, with occasional gusts up to 35 knots
possible, Sunday and Sunday night. Models vary on the solution,
though the consensus is for 92W to strengthen south of Majuro, then
weaken and either move off to the east or dissipate.

Residents should monitor local weather forecasts and conditions
closely over the next 24 to 48 hours as 92W remains in the vicinity.
Stay up to date with information from your Weather Service office in
Majuro, and for information from the local emergency management
office. The latest Majuro forecast can be found at
weather.gov/gum/PublicForecasts.
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Figure 9: Example of a Tropical Cyclone Special Weather Statement issued for RMI

6.3. Common alerting procedures in place based on impact-based services and scenarios taking hazard, exposure and vulnerability information into account and with registered alerting authorities.

Common Alerting Procedures (CAP) are in place only for ocean services (i.e. – tsunamis). RMI supports advice given to users on actions to be taken, e.g. – for tropical cyclone and drought warnings; and what mariners should do in the event of high seas warnings.

Summary score, recommendations, and comments for Element 6

RMI is assessed as **Maturity Level 2** on the CHD scale - ***Basic warning service is in place and operational but with limited public reach and lacking integration with other relevant institutions and services.***

RECOMMENDATIONS:

- WSO RMI should aim to initiate regular reviews of warning performance, both internally and based on third party feedback where possible; and work with others to move towards implementation of impact-based warnings.

Element 7: Contribution to Climate Services

7.1. Where relevant, contribution to climate services according to the established capacity for the provision of climate services.

COFA only sponsors a defined scope of funded services and thus climate services are relatively limited outside of the NCOF. The US National Centre for Environmental Information (NCEI) and BoM's CLIDE system archive all data, and daily observations are retained by NWS dating back to c.1950s. The WSO has a relatively basic level of foundation systems (e.g. data management, monitoring, production & delivery of climate information or services), user interfaces and decision support products and services in relation to climate services.

Weekly, monthly, and seasonal Climate Bulletins are produced as part of the NCOF, first initiated with national stakeholders in 2024 via COSSPAC support. Outputs are based on a range of guidance from the NOAA Climate Prediction Centre (CPC) and the Early Action Rainfall Watch (EARWatch; BoM) – see example images below. NCOF users require training to increase the understanding and potential opportunities from the WSO RMI NCOF process. Under the CISPAC5 project, there has been sector-based outreach to understand user needs for climate services, but further consultation would benefit the development of effective climate services tailored to RMI's needs.

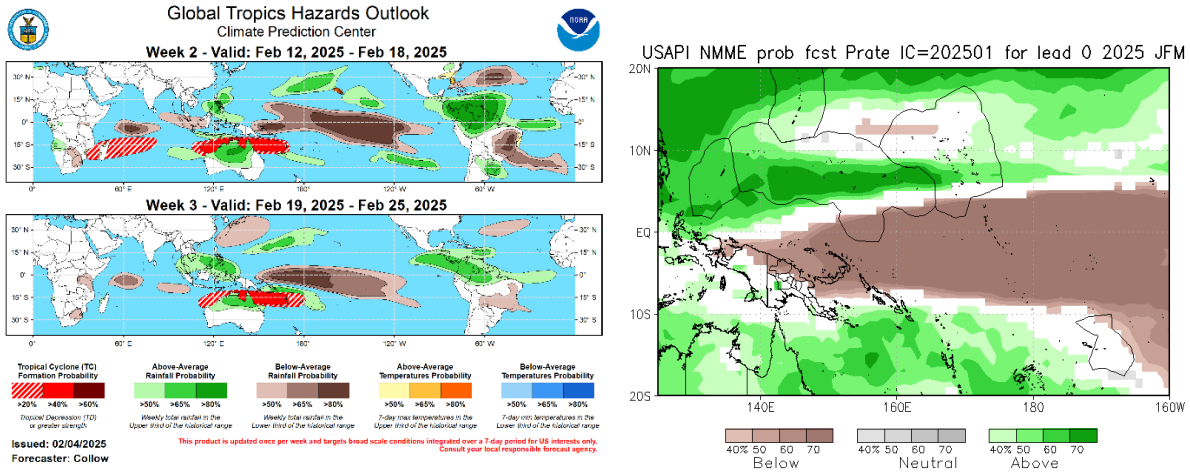


Figure 10: Examples of NOAA CPC weekly and seasonal prediction outputs

Summary score, recommendations, and comments for Element 7

RMI is assessed as **Maturity Level 2** on the CHD scale - ***Basic Capacity for Climate Services Provision.***

RECOMMENDATIONS:

- WSO RMI should undertake consultation/outreach with RMI government and key industry representatives to identify climate requirements, training and potential funding sources to support the development of climate services tailored to sector needs.

Element 8: Contribution to hydrology

8.1. Where relevant, standard products such as quantitative precipitation estimation and forecasts are produced on a routine basis according to the requirements of the hydrological community.

WSO RMI delivers only limited operational hydrology outputs to the Environmental Protection Authority (EPA) and other RMI stakeholders. Quantitative Precipitation Estimation (QPE) is not available; experimental Quantitative Precipitation Forecast (QPF) output is available from WFO Guam, but is not currently operationally supported. Early Action Rainfall Watch (EARWatch) outputs for heavy rain events are also available via websites/email from BoM.

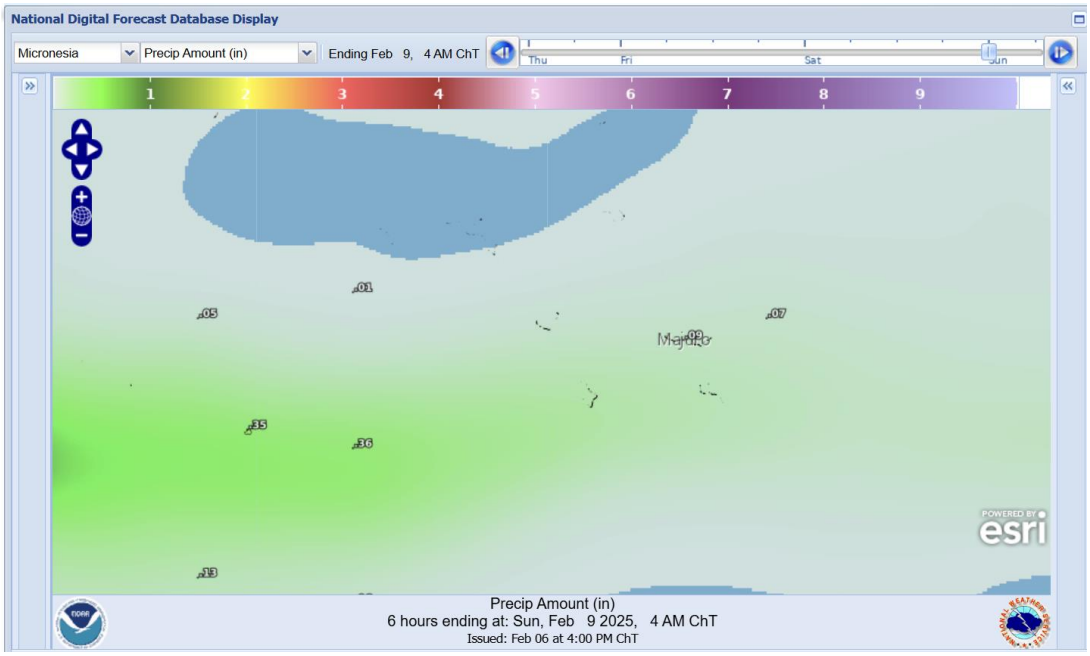


Figure 11: Example of experimental gridded QPF and significant wave height data for RMI

8.2. SOPs in place to formalize the relation between Met Service and Hydrology Agency, showing evidence that the whole value chain is addressed.

There is no single formal hydrology agency in RMI but the EPA is responsible for hydrological services and water resources; the WASH Cluster and the NDC are the national platforms coordinating Disaster Risk Reduction (DRR) in relation to hydrological matters. In practice, WSO RMI provides rainfall data to the the Majuro Water & Sewerage Company (MWSCo). There is potential for enhanced understanding of the hydrological value chain, notably with the NDC and MWSCo who maintain reservoirs.

8.3. Data sharing agreements (between local and national agencies, and across international borders as required) on hydrological data in place or under development.

The EPA, MWSCo and RMI WSO are members of the NDMO WASH cluster and collaborate on water projects, exchanging rainfall information. There are no formal data sharing agreements currently in place in-country, but WSO RMI shares data as required.

8.4 Joint projects/initiatives with hydrological community designed to build hydrometeorological cooperation.

COSSPAC coordinates joint projects with the hydrological community in the wider region, but there are no specific initiatives currently being undertaken within the WASH cluster or wider hydrometeorological community.

Summary score, recommendations, and comments for Element 8

RMI is assessed as **Maturity Level 2** on the CHD scale - ***Meteorological input in hydrology and water resource management happens on an ad hoc basis and or during times of disaster***

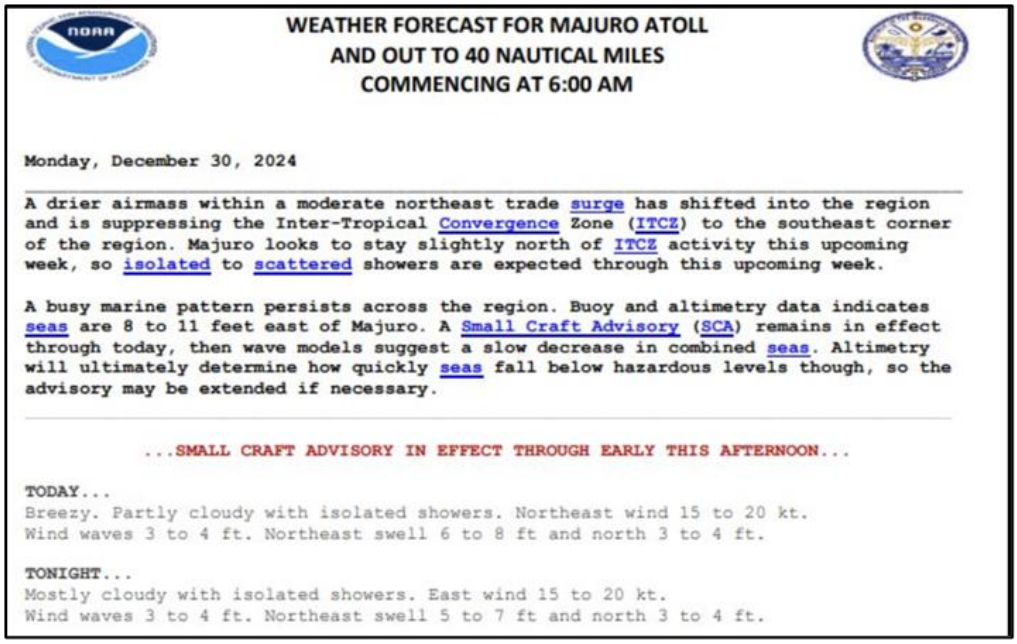
RECOMMENDATIONS:

- WSO RMI should formalise data sharing agreements and SOPS between the WSO and MWSCo, EPA and wider WASH cluster stakeholders, recognising a potential leading role in hydrological matters for the WSO within RMI government.
- The WSO should gauge national hydrological requirements to better understand the need undertake staff capacity building in hydrological services.

Element 9: Product dissemination and outreach

9.1. Channels used for user-centred communication and ability to support those channels (for example, does the NMHS operate its own television, video or audio production facilities? Does it effectively use cutting-edge techniques?).

Public forecasts are sent out by RMI WSO via the National Broadcasting station, with warnings sent out via the National Disaster Management Office (NDMO) for publication on their website and via national media – the WSO is not permitted to send warning out directly. Bulletins are produced by the WSO and disseminated to emergency managers and public across RMI. RMI also employs social media and WhatsApp groups to ensure its message reaches users on time and in full.



WEATHER FORECAST FOR MAJURO ATOLL
AND OUT TO 40 NAUTICAL MILES
COMMENCING AT 6:00 AM

Monday, December 30, 2024

A drier airmass within a moderate northeast trade surge has shifted into the region and is suppressing the Inter-Tropical Convergence Zone (ITCZ) to the southeast corner of the region. Majuro looks to stay slightly north of ITCZ activity this upcoming week, so isolated to scattered showers are expected through this upcoming week.

A busy marine pattern persists across the region. Buoy and altimetry data indicates seas are 8 to 11 feet east of Majuro. A Small Craft Advisory (SCA) remains in effect through today, then wave models suggest a slow decrease in combined seas. Altimetry will ultimately determine how quickly seas fall below hazardous levels though, so the advisory may be extended if necessary.

...SMALL CRAFT ADVISORY IN EFFECT THROUGH EARLY THIS AFTERNOON...

TODAY...
Breezy. Partly cloudy with isolated showers. Northeast wind 15 to 20 kt.
Wind waves 3 to 4 ft. Northeast swell 6 to 8 ft and north 3 to 4 ft.

TONIGHT...
Mostly cloudy with isolated showers. East wind 15 to 20 kt.
Wind waves 3 to 4 ft. Northeast swell 5 to 7 ft and north 3 to 4 ft.

Figure 12: Example of weather forecast output for Majuro Atoll

9.2. Education and awareness initiatives in place.

Some outreach is undertaken by RMI WSO including e.g. school visits and support to community events on relevant topics. The WSO has good working relationships with the RMI NDMO and collaborate with them on joint outreach activities.

9.3. Special measures in place to reach marginalized communities and indigenous people.

RMI WSO re-drafts WFO Guam BAU products to make them more easily accessible for the public, as well as translation into local languages for users across the remote islands of RMI. Warnings are also translated and sent to NDMO for distribution.

Summary score, recommendations, and comments for Element 9

RMI is assessed as **Maturity Level 2** on the CHD scale - ***Traditional communication channels and a basic dedicated website is used to disseminate forecasts and basic information.***

RECOMMENDATIONS:

- WSO RMI should consider how they might implement further outreach and communication activities to reach remote or marginalised communities.

Element 10: Use and national value of products and services

10.1. Formalized platform to engage with users in order to co-design improved services.

WSO RMI is a member of the quarterly NDC (as the key DRR platform) and other national fora (eg the Mayors' Association), and thus has the opportunity to consult on the design of products and services tailored to national needs in collaboration across government and with other stakeholders. The NSPWWCS was developed through a coordinated process of outreach under several planning efforts, e.g. the National Strategic Plan (2020) and Disaster Management Arrangements (2019), with extensive consultations specifically about weather and climate risks and the services of WSO RMI. A Post Disaster Needs Assessment was also conducted after the severe drought in 2015/16 including some assessment of socioeconomic impacts.

WSO RMI uses annual NCOF events, which it convenes, to gather user feedback from sectors on weather and seasonal timescales and relays information to WFO Guam and USNWS to help influence product design. The WSO believe there may be scope to work with others more to develop climate products, but this is less likely with weather products where outputs are currently tied to NOAA/USNWS warnings and data.

10.2. Independent user satisfaction surveys are conducted, and the results used to inform service improvement.

WSO RMI has no formalised satisfaction surveys for routine public feedback, but occasional informal feedback is acquired from users, eg via phone calls, social media or other channels. The WSO does not routinely review this feedback to improve services (informal review only), but WFO Guam routinely reviews and reports on the accuracy and delivery of their underlying US-sponsored services.

10.3. Quality management processes that satisfy key user needs and support continuous improvement.

An overview of the QC process for observations is described in Section 4.2 – currently this has a limited role in continuous improvement locally. The WSO operates QMS for weather observations and service delivery and undertakes climate data management/QC via the MAPSO (Micro Art Paperless Surface Observations) application. Further development of a more robust local QMS system for warnings and observations would be beneficial, potentially via SOFF, and RMI aim to do this within 1-2 years. There is limited QMS reporting for marine services (externally audited by IMO previously); RMI aspires to meet FAA requirements for QMS of air navigation services but this would require US Federal Aviation Authority (FAA) endorsement.

Summary score, recommendations, and comments for Element 10

RMI is assessed as **Maturity Level 1** on the CHD scale - ***Service development lacks any routine stakeholder feedback practice.***

RECOMMENDATIONS:

- WSO RMI should consider implementing routine formal user feedback within NDC, also employing questionnaires to improve the products and services
- The WSO should look to implement a more robust local QMS and associated capacity building/ training via projects such as SOFF (observations)

Annex 1 Consultations (including experts and stakeholder consultations)

Meetings were held with the Meteorologist-in-Charge of WSO RMI, Reginald White; the National Disaster Management Office (NDMO); and with the support of Eric Lau and Brandon Bukunt of USNWS PRH.

Annex 2 Urgent needs reported

The most urgent needs for WSO RMI, is to develop the following service areas beyond the current scope of COFA USNWS-funded services:

- The governance context, data sharing and understanding the national value of products and services provided by the WSO
- Enhancing WSO RMI's role in the provision and reach of warnings originating from USNWS capability
- Observing and service infrastructure across RMI
- Climate & hydrological services

Annex 3 Information supplied through WMO

The peer adviser acknowledges the guidance provided by SOFF in documents and templates throughout the Readiness phase, notably the CHD EW4All Datasheet for RMI, which established a useful baseline prior to subsequent discussions with stakeholders on mission.

Annex 4 List of materials used

The peer adviser utilised the following materials:

- Interview data, in person contributions and personal communication provided during the drafting of this report.
- Various WSO RMI materials including: Compacts of Free Association (COFA) for RMI; the National Strategic Plan for Weather, Water, and Climate Services (NSPWWCS); and the Pacific Islands Meteorology Strategy (PIMS).
- Web pages of WSO RMI (https://www.weather.gov/gum/WSOMajuro).
- Online material provided as links in this document.