05th November 2024

GBON National Contribution Plan of the Republic of Palau

Systematic Observations Financing Facility

Weather and climate data for resilience

GBON National Contribution Plan

Republic of Palau

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Module 1. National Target toward GBON Compliance

Table 1 GBON National Contribution Target

Type of station	WMO GBON Global Gap Analysis, June 2023				GBON National Contribution Target	
	Target	Reporting	Gap		To improve	New
			To improve	New		
	[# of stations]				[# of stations]	
Surface	3	0	3	0	3	0
Upper-air	1	1	0	0	0	0
Marine	*when applicable					

Figure 1 - Proposed surface GBON stations with 250km radius circles. Palau Exclusive Economic Zone (EEZ) shown in yellow

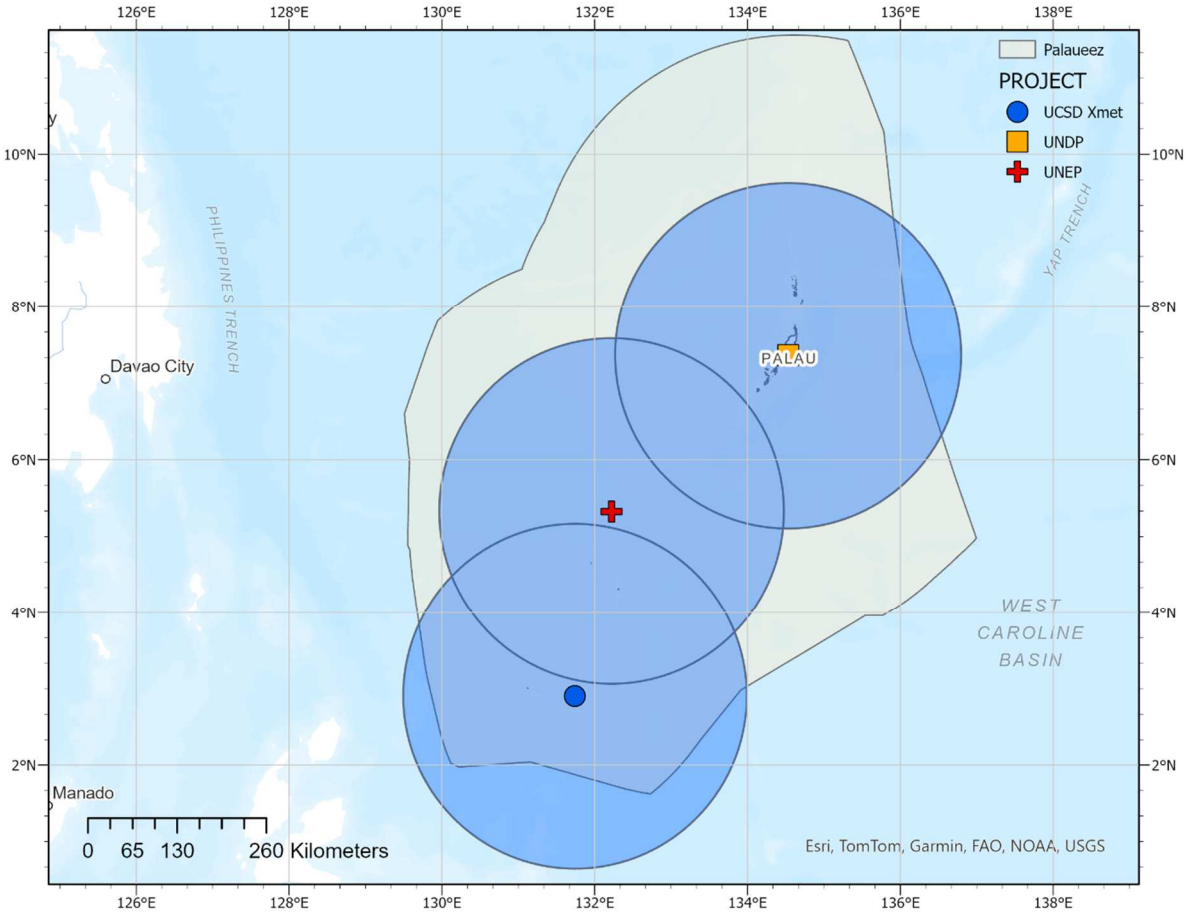
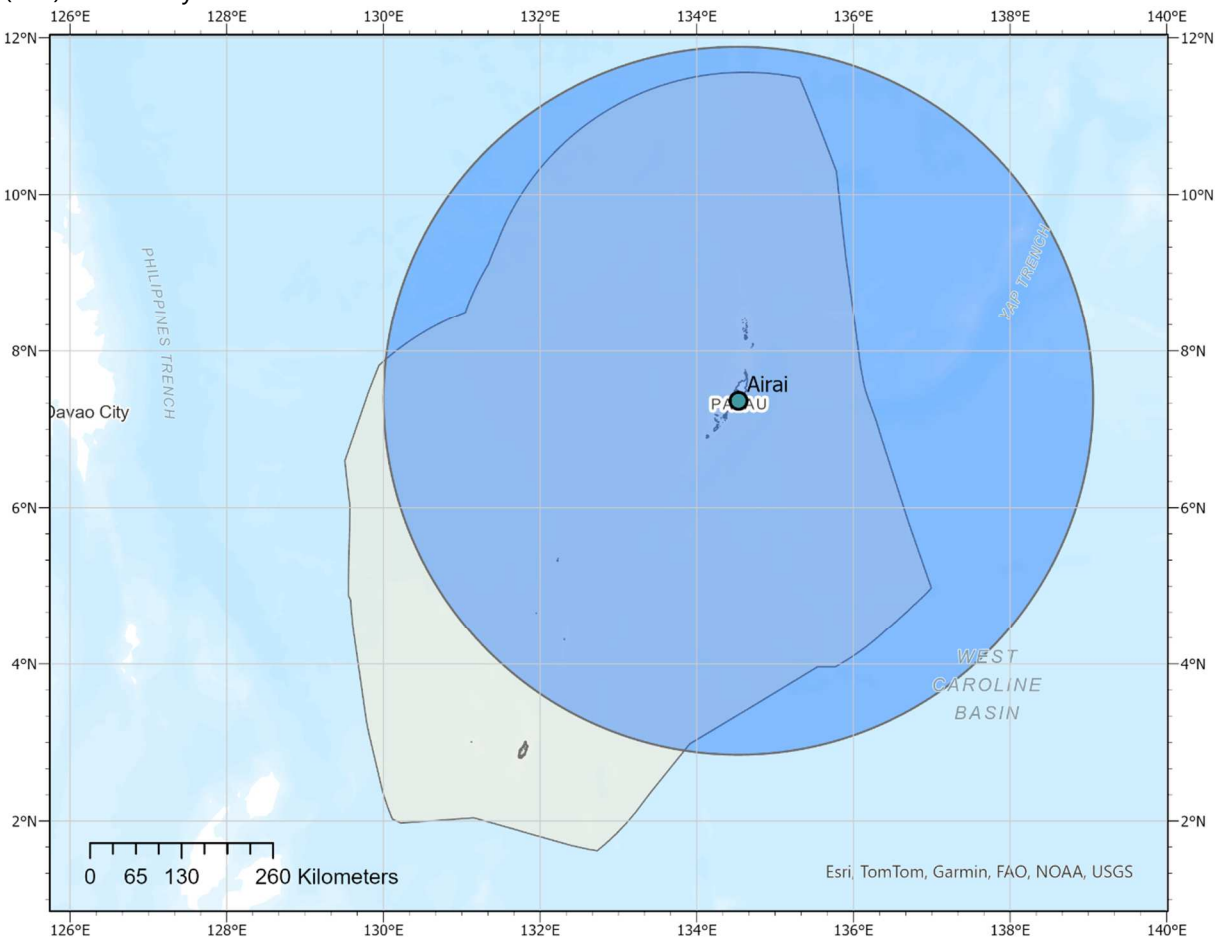


Figure 2 - Proposed upper air GBON station with 500km radius circle. Palau Exclusive Economic Zone (EEZ) shown in yellow.



Module 2. GBON Business Model and Institutional Development

2.1. Assessment of national governmental and private organizations of relevance for the operation and maintenance of GBON

The Republic of Palau and the United States of America (USA) signed the Compact of Free Association (COFA) in 1994. This treaty requires the USA to provide three services for Palau, a postal service, an air traffic service and meteorological service. National Oceanic and Atmospheric Administration (NOAA) National Weather Service (NWS) deliver weather services and associated programs throughout the Republic in line with COFA's Article VII (Weather Services and Associated Programs). According to Sections 5 to 13 of Article VII of COFA, the United States NOAA NWS provides weather services through a WSO created in Koror, Palau, and currently known as WSO Palau located in Airai, Palau. Subsequently, at the operational level, the National Weather Service Pacific Region Headquarters (NWSPRH) based in Honolulu, Hawaii Islands provides administration, financial, operational, management, and oversight assistance to WSO Palau via a contract between the U.S NOAA NWS and the Government of Palau.

WSO Palau collaborate closely with NOAA and the US NWS across all their operations and in particular with respect to observations. The existing upper air station in Palau is funded through NOAA including the costs associated with maintenance, spares and repairs. USNWS also provide technical and logistical support in relation to troubleshooting and securing supplies for the upper air network in Palau. Local technical staff in Palau are supported by USNWS staff based in Guam and Hawaii.

Recommendation 2(1): We recommended that the relationship between WSO and NWS is strengthened further to incorporate close cooperation on the implementation and operation of the observation network.

WSO Palau cooperates with the Federal Aviation Authority regarding the operation of both observation stations and provision of weather services at several airports around the nation. These sites are favourable for selection as GBON stations where this is possible, as there is high security and good communication availability. Airport sites also tend to be well exposed.

BOM are operating as a partner in the GCF investment in Palau and operate infrastructure and software which forms a key part of the capability of Palau to store and transmit data internationally. The Climate Data for the Environment (CliDE) database will be operated by BOM as well as communications systems and data processing. As part of the SOFF investment, provision for data sharing via WIS2.0 is recommended as this has not been implemented under the GCF program.

2.2. Assessment of potential GBON sub-regional collaboration

NOAA are a significant partner in the region and act as a coordinating entity between the WSOs RMI, FSM and Palau. There are regular Micronesia Managers Meetings chaired by NOAA 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. The two primary training courses currently being run 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 and Guam which provide training courses focused on meteorology and forecasting.

The Secretariat of the Pacific Regional Environment Programme (SPREP) is 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. The Headquarters is based in Apia, Samoa with other SPREP offices in Fiji, the Republic of the Marshalls Islands and Vanuatu. SPREPs 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 August 2011 to facilitate and coordinate the scientific and technical programme and activities of the regional meteorological services. The PMC provides policy relevant advice to the SPREP on the needs and priorities of its member countries and territories in relation to meteorology.

SPREP / PMC could serve as an important partner in the SOFF implementation phase, providing the opportunity to coordinate training 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. It is recommended that opportunities to align training opportunities across the region are explored through the investment phase, incorporating the findings and outputs from the SOFF Pacific Regional Event in April 2024.

Recommendation 2(2): We recommend that training opportunities for the investment phase across the region are explored in consultation with SPREP / PMC, incorporating the findings and outputs from the SOFF Pacific Regional Event in April 2024.

The ongoing United Nations Environment Programme (UNEP) Enhancing Climate Information and Knowledge Services for resilience in 5 island countries of the Pacific Ocean (CIS-Pac5) project is under way in 5 countries in the pacific (Cook Islands, Niue, Palau, Tuvalu and Republic of Marshall Islands). The project includes the deployment of a network of surface observations across the region including 8 AWSs in Palau. The project 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). This program in Palau, along with the proposals for other neighbouring SOFF beneficiary countries in the region (in particular the Federated States of Micronesia) has been considered as a principal part of the design of the GBON network in the region. This includes consideration for alignment of the network at national boundaries, alignment with respect to instrumentation and the full data process chain, and training opportunities. See annex 1 for further details.

There is scope for the establishment of a regional calibration and supply centre 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.

2.3. Assessment of a business model to operate and maintain the network

The majority of the current operating budget of the WSO is provided through the Compact of Free Association. The funding is passed from NWS to the WSO via the Palau Ministry of Finance.

Recommendation 2(3): We recommend the 3 GBON surface sites in Palau are fully publicly owned by the Palau government, with SOFF support to fund the sustainability costs of these sites. Operation of the networks will remain to be the responsibility of the WSO staff.

The UNEP led CIS-Pac5 programme includes the aim to strengthen the observation network of Palau and is installing four (4) Automated Weather Stations (AWSs) across the islands over the next 2 years. In addition, the United Nations Development Programme (UNDP) have recently installed four (4) AWSs across the islands - See Table 2 in section 3. The existing UNDP and proposed UNEP AWSs will all be owned by the government of Palau.

Palau requires 3 sites for GBON designation and SOFF will fund their sustainability. The remaining 5 sites will be owned by the government of Palau and there is an expectation that the sustainability of these will also be provided by SOFF. See annex 1 for further details.

Table 2 also identifies observation sites managed by the University of California (San Diego) (UCSD), operating X-met equipment.

Recommendation 2(4): We recommend the UCSD X-met on Tobi atoll is designated as a GBON site for Palau.

Recommendation 2(5): We recommend the development of an MOU between WSO Palau and the UCSD X-met programme to ensure sustainability of this GBON site.

2.4. Assessment of existing national strategies and projects related to observing networks

A strategic plan for WSO Palau was developed and drafted under the CREWS project in 2022. Given the significant change in the operational capabilities, responsibilities and need for future planning represented by the combined SOFF and GCF projects, WSO Palau have indicated that the strategic plan may not fully address the new requirements of the WSO and requires update and revision to reflect the changing nature of the WSO operations.

Recommendation 2(6): We recommend a revision of the strategic plan and development of an operational plan to reflect the changing nature of the WSO operations.

The United Nations Environment Program (UNEP) and the Green Climate Fund (GCF) are implementing the Enhanced Climate Information and Knowledge Services programme in 5 countries in the pacific (Cook Islands, Niue, Palau, Tuvalu and Republic of Marshall Islands) known as CIS-Pac5. The purpose of the Programme is to support increased resilience to climate variability and change in the five targeted countries. It is consistent with national and regional policies, and with international agreements and frameworks to which the Programme countries are parties. It draws on extensive detailed research undertaken by United Nations (UN) agencies, the World Meteorological Organization (WMO), the Australian Bureau of Meteorology (BoM) and the Australian Commonwealth Scientific and Industrial Research Organisation (CSIRO) into the current and projected future impacts of climate variability and change in the 14 independent Pacific island countries, including the five Programme countries. As part of this programme, the installation of 8 AWS across the Palau is under implementation, with the majority of the stations to be installed in 2024/2025.

Pacific Meteorological Council (PMC) adopted the Pacific Island Meteorological Strategy (PIMS) 2017-2026, developed and published by SPREP, that sets out the strategic context and direction for strengthening the National Meteorological and Hydrological Services (NMHSs) in the region to be able to deliver effectively their basic and core functions on weather and climate, and to ensure that NMHSs have the capacity to fulfill their responsibilities over the next decade. The strategy identifies four priority areas for action: 1. Improved weather services, in particular aviation, marine and public weather services 2. Improved end-to-end Multi Hazard Early Warning Systems (MHEWS) 3. Enhanced infrastructure (data and information services) for weather, climate and water 4. Improved climate services

2.5. Review of the national legislation of relevance for GBON

There is no national legislation related to the responsibility for measuring and providing weather observations or services in Palau.

Recommendation 2(7): We recommend there is consideration for the development of draft legislation to recognise the mandate of the WSO to be responsible for the provision and dissemination of meteorological observations (and other services, to be defined), on behalf of the nation.

NOAA funding is made available to WSO Palau via the finance ministry through a separate account to handle the transfer of funds form NOAA to support the WSO.

The CIS-Pac5 project is actively procuring and installing the observations hardware and it is anticipated that the same processes and procedures will be used for the training and development activities.

Module 3. GBON Infrastructure Development

3.1. Design the surface and upper-air observing network and observational practices

Surface Observations

WSO Palau currently operate a network of 4 AWSs in Palau, with a further 4 AWSs to be installed under the UNEP CIS-Pac project. In addition, there are a range of third-party observations taken in Palau.

A previous investment through United Nations Development Programme (UNDP) Palau Disaster Preparedness and Improved Infrastructure project included the installation of 4 AWSs in Palau between 2018 and 2022. The data collected by these stations are currently not shared via WIS or GTS.

The United National Environment Progamme (UNEP) are managing a Green Climate Fund (GCF) funded project programme in Palau, Enhancing Climate Information and Knowledge Services for resilience in 5 Pacific countries (UNEP CIS-Pac5). CIS-Pac5 is installing 4 AWS this year.

The Coral Reef Research Foundation (CRRF) established an autonomous weather station on Ngeanges Island in the central rock islands in 2007. The station is on a 40ft (12m) tower on top of a 100ft (30m) rock island, as there is no ideal site in the Rock Islands due to the topography.

The Scripps Institution of Oceanography (SIO), University of California San Diego (UCSD) has provided 5 “Xmet” autonomous weather stations. The Xmet data is not currently shared via WIS or GTS and is available online (http://www.palauweather.org/)

The GBON requirement for Palau is 3 surface observation sites. As described above, the range of existing and proposed surface observation sites in Palau exceed the Global Gap Analysis requirement of 3 stations. As such, a subset of 3 of these sites has been identified, distributed as widely across the EEZ as the geographic distribution of the island will allow. To the far south, the UCSD XMet site at Helen Atoll, further North the proposed CIS-Pac5 site on Sonsorol, and on the main island of Babeldaob the Airai site in close proximity to the WSO HQ and the airport. SOFF support will be requested for the ongoing operation, maintenance and sustainability of these three sites - See annex 1 for the options for the sustainability for the 6 remaining stations.

A full map of all observation sites is shown in Figure 3 and an extended map of the main island in Figure 4. The details of these sites are listed in Table 2. A map showing the selected GBON surface stations is shown in Figure 5.

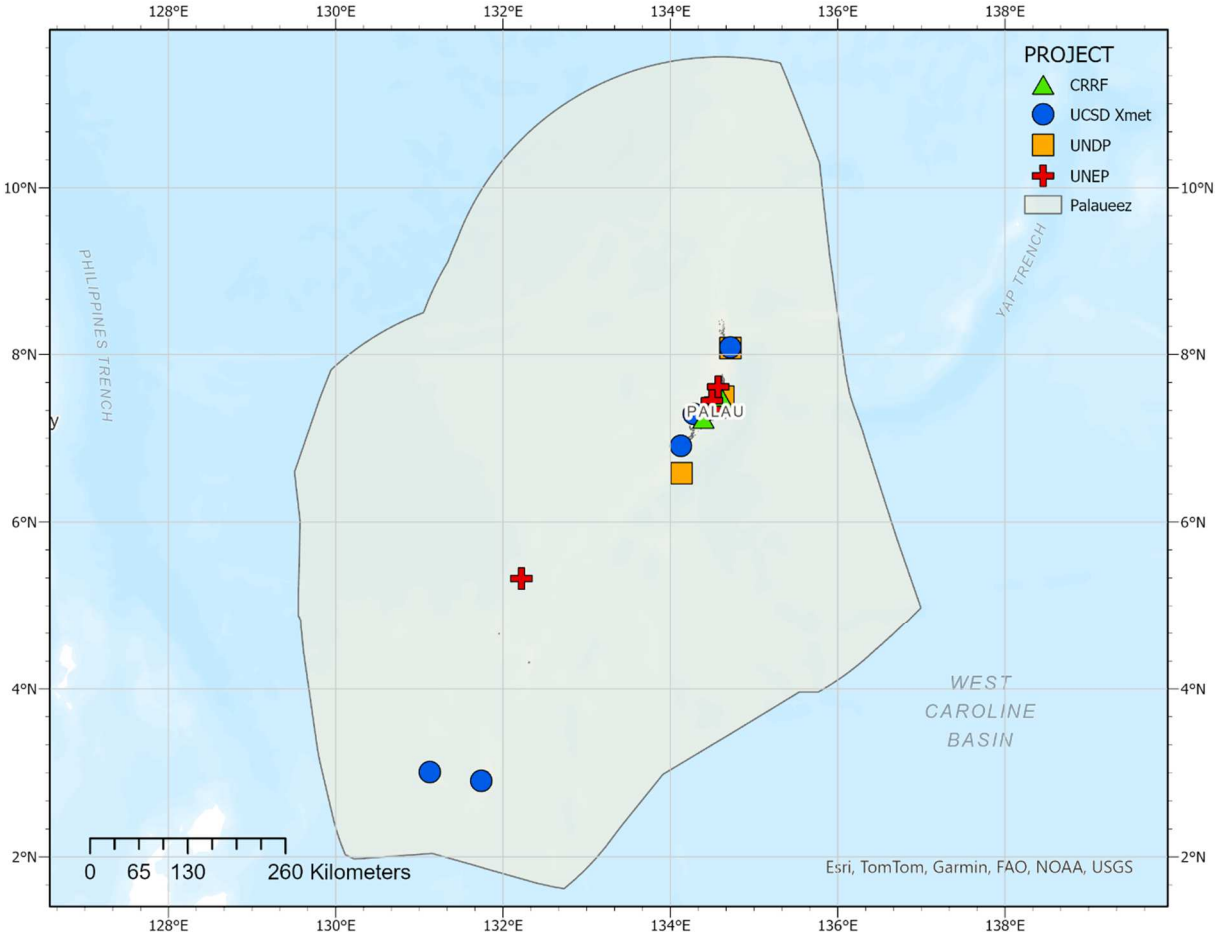


Figure 3 – Map of all surface observations in Palau. Palau EEZ shown in yellow.

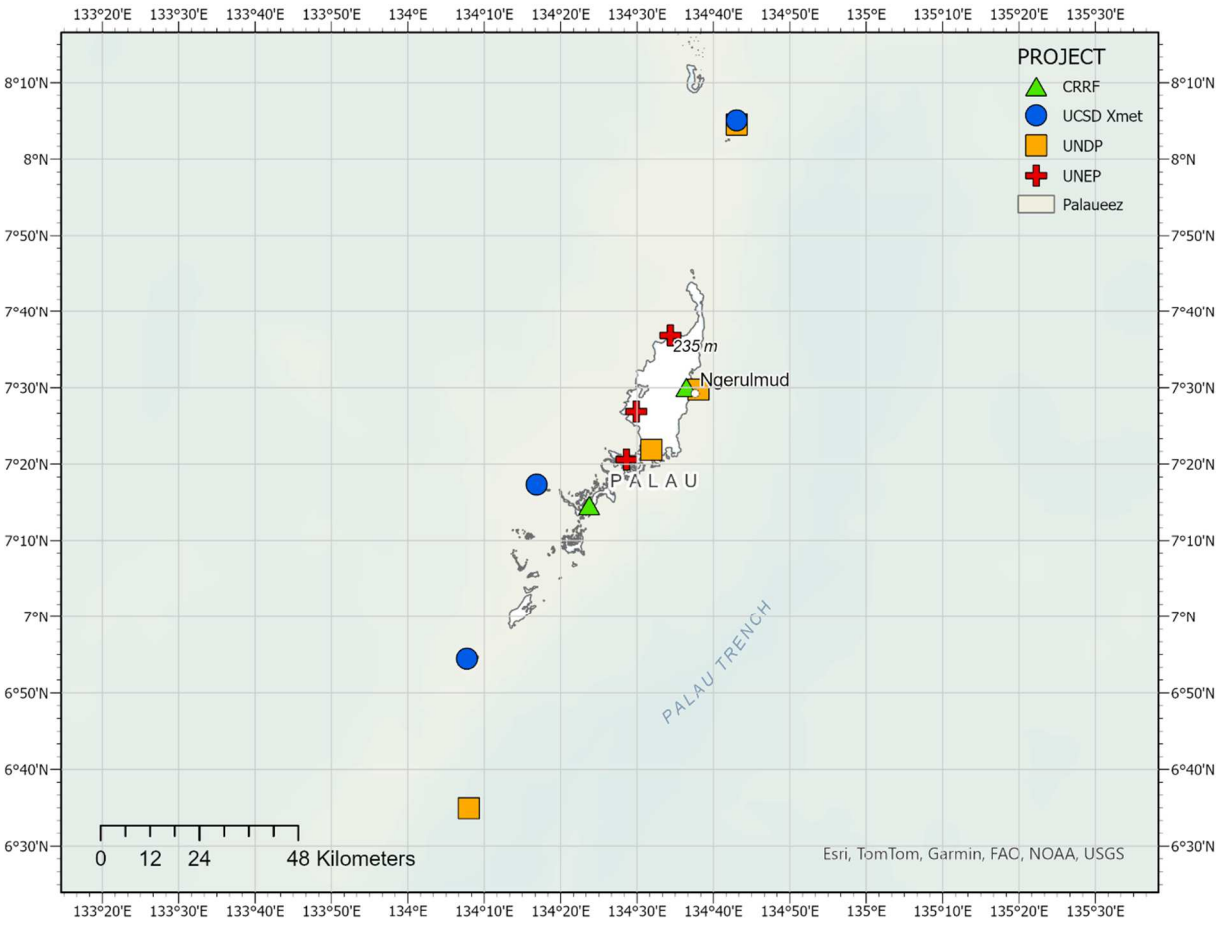


Figure 4 – Map of all surface observations in Palau showing the main island Babeldaob.

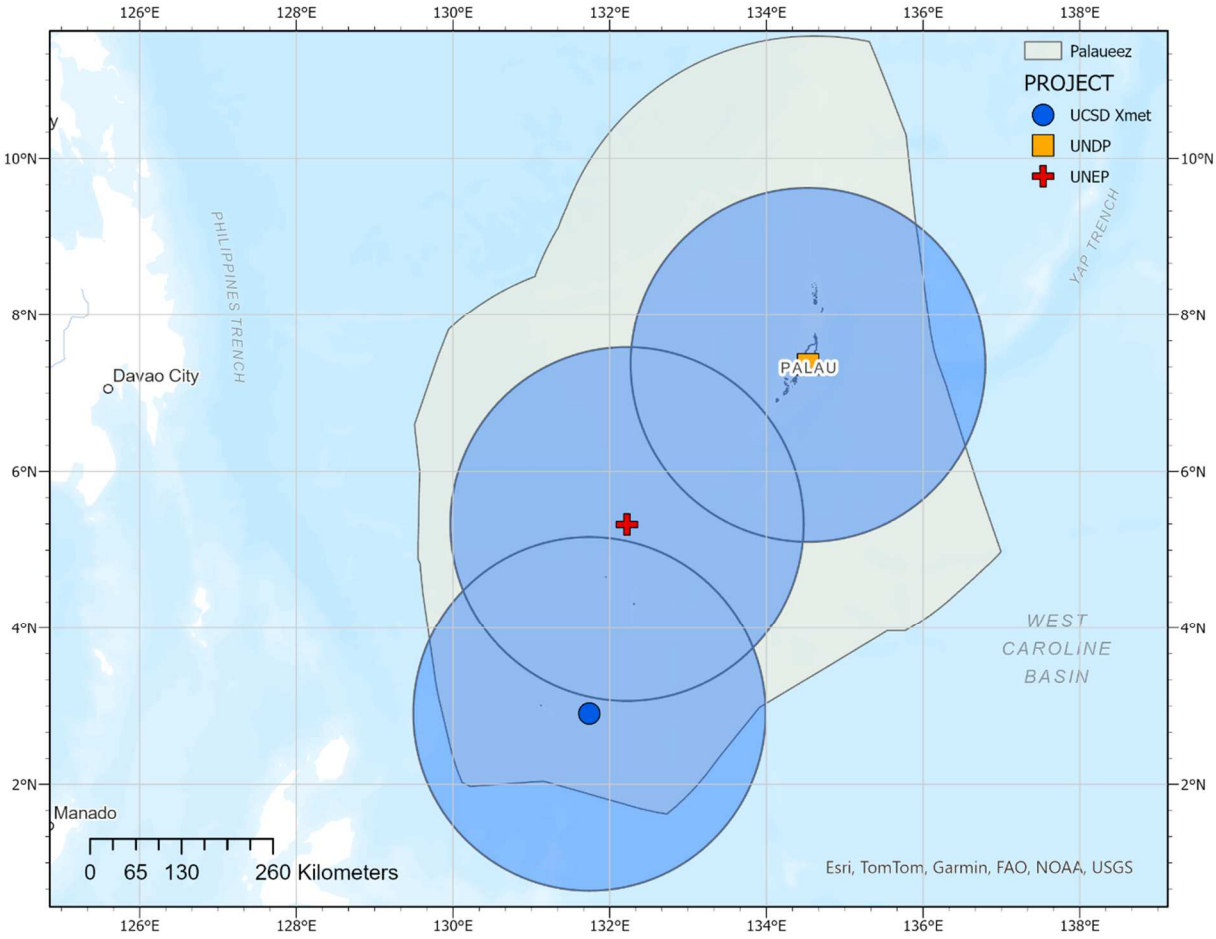


Figure 5 – Map of selected GBON surface observation site in Palau with 250km radius circles. Palau EEZ shown in yellow.

Table 2 - Details of GBON surface observation site locations

Station name	Station type (S/UA)	Owner (NMHS/third-party)	Funding source	GBON variable measured						Reporting cycle	GBON Compliance (Y/N)
				SLP	T	H	W	P	SD		
Airai	UA	NMHS	NOAA	X	X	X	X	X		2	N
Airai	S	NMHS	UNDP	X	X	X	X	X	NA	24	
Melekeok	S	NMHS	UNDP	X	X	X	X	X	NA	24	N
Kayangel	S	NMHS	UNDP	X	X	X	X	X	NA	24	N
Peleliu	S	NMHS	UNDP	X	X	X	X	X	NA	24	N
Helen Reef	S	UCSD Xmet	UCSD Xmet	X	X	X	X	X	NA	24	N
Tobi Island (Hatobohei)	S	UCSD Xmet	UCSD Xmet	X	X	X	X	X	NA	24	N
Angaur (Ngeaur Island)	S	UCSD Xmet	UCSD Xmet	X	X	X	X	X	NA	24	N
Ulong	S	UCSD Xmet	UCSD Xmet	X	X	X	X	X	NA	24	N

Kayangel	S	UCSD Xmet	UCSD Xmet	X	X	X	X	X	NA	24	N
Ngeruktabel	S	CRRF	CRRF	X	X	X	X	X	NA	24	N
Melekeok	S	CRRF	CRRF	X	X	X	X	X	NA	24	N

Recommendation 3(1): We recommend the selection of the following 3 stations for GBON designation in Palau:

- **Tobi atoll (UCSD XMet). See recommendation 2(5)**
- **Sonsorol (CIS-Pac5)**
- **Airai (UNEP).**

The AWS network to be installed under CIS-Pac5 has been developed in partnership with NIWA to contribute to improving the national and regional understanding of weather and climate and enable integration of station data within WMO's GBON network.

Each AWS measures all required parameters for GBON and provides data in near-real time including:

- Wind speed and direction measurements at 10 meters minimum.
- Air temperature and relative humidity measurements from a radiation screen, at approximately 1.2 meters above ground.
- Solar radiation.
- Rainfall intensity.
- Barometric pressure.
- Grass and ground temperatures (10,20,50,100). (Not required for GBON)
- Soil Moisture. (Not required for GBON)

The sensors selected to deliver these requirements are listed in Table 3. A summary of the general characteristics and requirements for each AWS and the associated monitoring system includes;

- AWS Data should be GBON compliant.
- Data should be logged locally at 10-minute intervals and available at least hourly.
- The telemetry should include communications diversity and where possible include satellite and cellular options. If one path isn't available, the data stream should automatically default to the other.
- All stations should be self-contained and include solar power supply.
- For some locations the measured data should be available for local real-time review.
- The telemetered data should be integrated with their National Weather Service Office CliDE database management system.

In addition, the AWS system should include capacity for inclusion of other sensors, should they be required.

Table 3 – Details of the AWS sensors to be installed under UNDP and CIS-Pac5 projects

Parameter	Manufacturer	Model	Range	Accuracy
Core GBON Parameters				
Wind speed	Vaisala	WMT703	0 to 75m/s	0 … 75 m/s (168 mph): ±0.1 m/s (0.2 mph) or 2 % of reading, whichever is greater
Wind direction	Vaisala	WMT703	0 to 360^0	Accuracy ±2°
Relative humidity	Vaisala	HMP155A	0 to 100%	Accuracy (including non-linearity, hysteresis, and repeatability) At +15 … +25 °C (+59 … +77 °F) ±1 %RH (0 … 90 %RH) ±1.7 %RH (90 … 100 %RH) At −20 … +40 °C (−4 … +104 °F) ±(1.0 + 0.008 × reading) %RH At −40 … −20 °C (−40 … −4 °F) ±(1.2 + 0.012 × reading) %RH At +40 … +60 °C (+104 … +140 °F) ±(1.2 + 0.012 × reading) %RH At −60 … −40 °C (−76 … −40 °F) ±(1.4 + 0.032 × reading) %RH
Air temperature	Intech	PT100	-30 to +180 ^{0}C	**Class AA** ± (0,1+0,0017 * t), ±0,1 °C (0 °C), ±0,27 °C (100 °C), defined on range -50…+250 °C (wire wound resistor), 0…+150 °C (thin film resistor)
Barometric pressure	Vaisala	PTB330	500 to 1100 hPa	Accuracy at +20 °C (+68 °F) *** ±0.10 hPa Class A
Rainfall	Hydrological Services	TB3	0.5mm / tip	0-250 mm per hour: +/-2 % 250-500 mm per hour: +/-3 %
Additional parameters not supported by SOFF				
Solar radiation	LiCor	LI200R	0-3000 W/m^{-2}	± 3% typical; ± 5% maximum.
Grass and earth temperature	Unidata	LM34	-30° to +100°C	Temperature Accuracy: ±0.2°C (Calibrated)
Soil moisture	Acclima	SM	0 to100%	Absolute VWC Accuracy: ±2% typical

These sensors and stations have been designed and selected to meet the technical specifications set out in TT-GBON approved technical specifications (TT-GBON approved material | World Meteorological Organization (wmo.int)) 6.1 – GBON Tender Specifications for AWS and 6.2 – Requirement document to be used as input to tender specifications for radiosonde-related procurements.

As the CIS-Pac5 AWS deployment has been designed around GBON compliance the procurement and installation of instruments will fully satisfy the GBON requirements for Palau. There is no additional activity required for the installation of AWS instruments (some further action is required to implement

reporting to WIS2.0, see section 3.2). It is recommended that a full review of the ongoing deployment of stations is undertaken in the investment phase in order to ensure that any technical difficulties or challenges related to logistics and maintenance can be overcome as early as possible and to ensure that the rollout of the project continues to align with the GBON network.

Outline maintenance plan for GBON surface stations

In line with international best practice, a four stage maintenance process is proposed for the GBON surface stations:

1. Remote monitoring

Remote monitoring will be conducted by the Palau WSO technical team. They will check the availability of data on the WIS2.0 box as well as on their central database via NEON or CLIDE. They will also regularly check data from neighbouring sites to spot anomalous data in real-time. Monthly statistical analysis will identify trends in the data over time that could indicate calibration drift, or complete sensor failure.

The Electronics and Facilities team will maintain a backlog of potential faults which will be communicated to regional maintenance staff. This will be updated once potential faults have been investigated and resolved. In this way any systematic faults across the network can be identified and addressed.

2. Routine site inspection & Maintenance

WSO Palau technical team will be responsible for conducting routine inspection & maintenance, as well as fault resolution site visits. It is expected that each site will be visited at least once every 6-months. During these visits, routine tasks such as grass cutting will be undertaken. The team will also conduct calibration checks during each visit and carry spares so that sensors and other hardware (e.g. solar panels, batteries and loggers) can be exchanged if they are found to be out of tolerance. Sensors will also be rotated during these visits so that they can be sent back to the regional calibration centre for more thorough calibration testing against known standards. A central maintenance log will be updated and any changes to meta-data recorded as part of each visit. However, for outstanding maintenance and repair faults that will not be resolved by the regional maintenance teams will be resolved by the central technical team.

3. Fault resolution

If a potential fault at a station has been identified, the technical team will direct regional maintenance staff to undertake a fault resolution visit. These visits will take priority over routine maintenance visits in order to maintain GBON compliance on data availability. It is expected that most faults will be resolved by the team swapping out a component at a site with a spare. It is expected that during a fault resolution visit, the regional team will also conduct routine site inspection and maintenance of the site (in line with point 2. above).

4. Calibration & supplier support

Faulty sensors, or sensors that require calibration, will be rotated out of sites and back to WSO Palau or the regional calibration centre for calibration. It is expected that some instruments will need to be either directly replaced or calibrated through an ongoing relationship with the AWS supplier (NIWA). An ongoing service agreement would enable this process. It would also provide 3rd line support to WSO Palau staff in maintaining the network and in dealing with more complex issues. It would also be

expected that this agreement would provide training throughout the SOFF investment and compliance phases, so that WSO Palau staff continually increase their capacity and skill.

Upper air observations

The existing Upper Air observation at Palau is supported by the USNWS and currently undertakes 2 radiosonde launches per day to GBON standard. This site does not require further intervention beyond integration into the data management process outlined in Section 3.2 to process store and transmit data internationally. A Map showing the location of the upper air site in Palau is shown in Figure 6

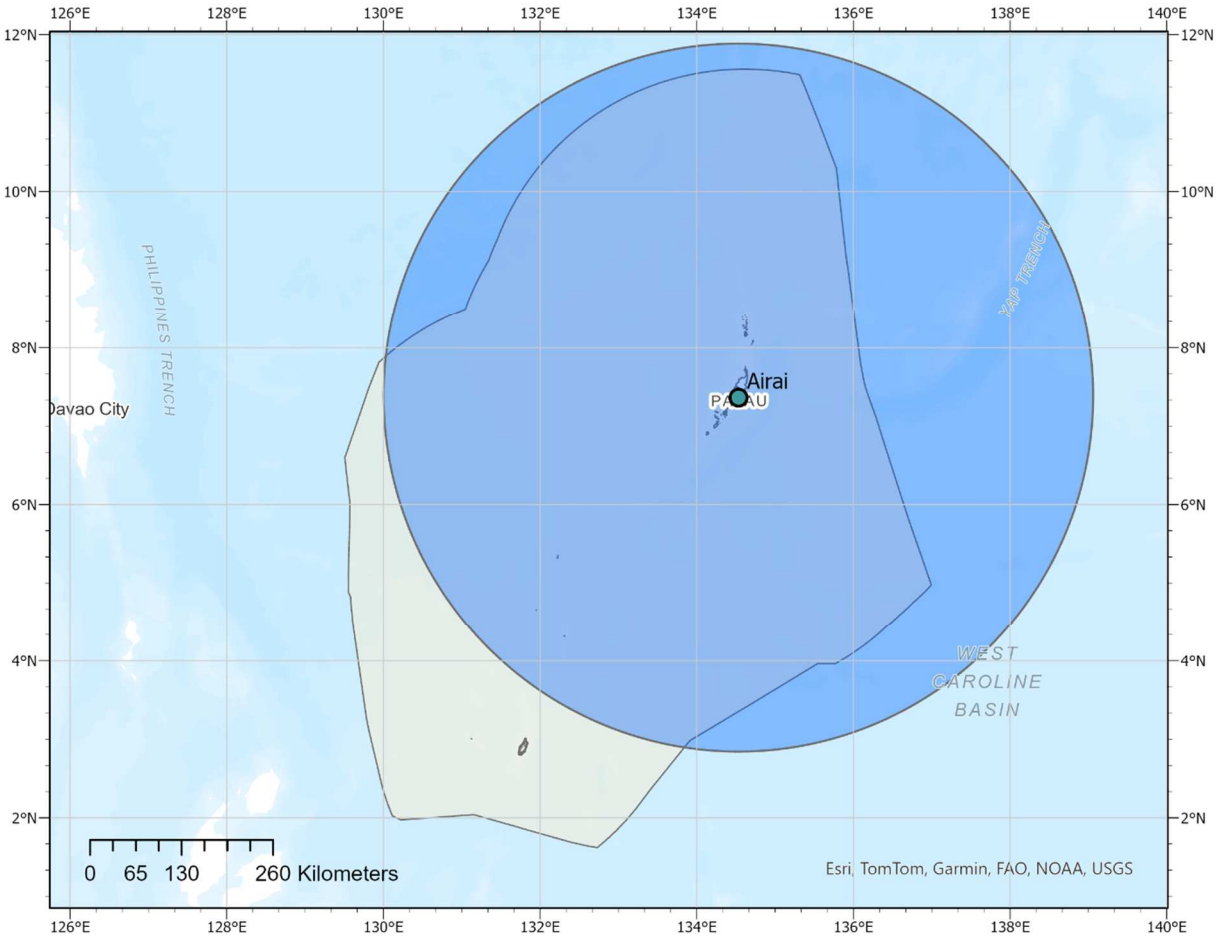


Figure 6 – GBON Upper Air site in Palau showing 500km radius circle. Palau EEZ shown in yellow.

Table 4 – Details of GBON upper air observation location

Station name	Station type (S/UA)	Lat	Lon
Airai / Palau WSO	UA	7.364N	134.531E

Sonsorol	S	2.904N	131.741E
Helen Reef	S	5.325N	132.220E

Annex 3.1f – Technical specifications for new instruments and observing systems

The specifications for instruments at the GBON surface observations sites are designed to align with TT-GBON approved material | World Meteorological Organization (wmo.int) for each observation instrument and observing system. The recommended instruments listed in Table 3 meet or exceed these specifications in all cases and should alternative instruments or systems be identified as part of the procurement process, these must meet the specifications referred to above.

3.2. Design of the ICT infrastructure and services / 3.3. Design the data management system

The design of the ICT infrastructure and data management system has been incorporated into the CIS-Pac5 project deployment and has been designed for GBON compliance. Some further action is required to implement WIS2.0 interoperability and it is recommended that this requirement is addressed and implemented as part of the CLIDE data management system currently employed.

An overview of the proposed solution is shown in Figure 7 and a detailed description of the ICT infrastructure, services and data management system follows.

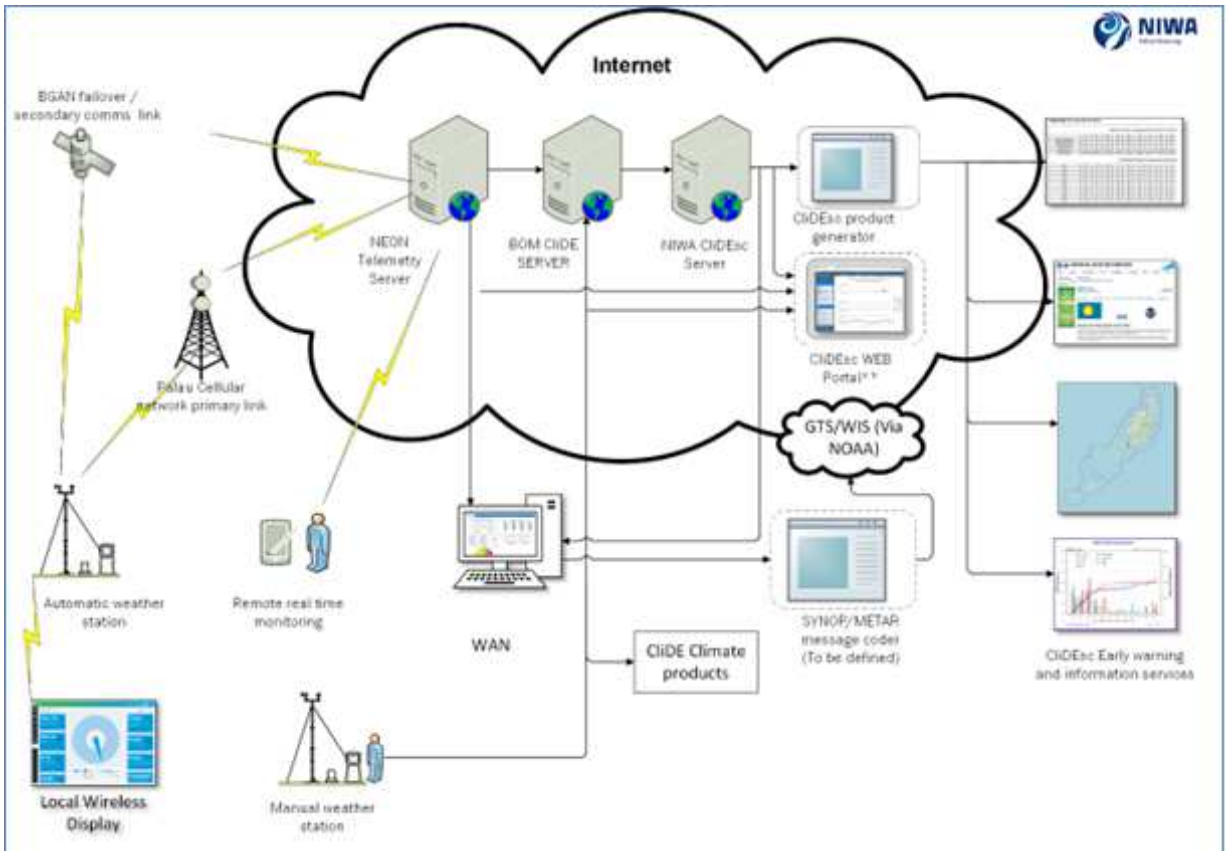


Figure 7 – Overview of ICT and data management system

Data from each station are being telemetered via dual communications. Where available IP (Internet Protocol) cellular modems (TCC) provide the primary mode of IP telemetry, with IP BGAN satellite serving as the failover back-up in the event of disruption to the primary telemetry mode.

Near-real time telemetered data, for use in operational monitoring and forecasting, can be accessed and viewed via the web-based NEON user interface. The NEON system allows the regular (10 minute) observations made on the IP based NRT data logger to be reviewed at various user defined intervals using a web-based system.

All data are stored in the NEON web server and the data are accessible using any web browser that has authorised access credentials and the NEON web interface/dashboard. Data in NEON are fully managed including full IT backup processes.

NEON will be deployed as a hosted system in which data is collected using NIWA central telemetry servers and a WEB hosted NEON system. Our recommendation is that WSO operate a NIWA-hosted network as it overcomes the difficulties of managing local IT systems.

NEON has a user security model that allows creation of user profiles, each with varying abilities to access data.

Profiles can be from simple “view only” access to station data through to full data management access. The system allows the appointment of a local NEON node manager, who will have the capability to enable users, and to create views of data for client organisations that are accessible by only those clients.

As well as data capture from remote stations, NEON provides basic data review and includes alarm handling and automated data reporting capabilities.

The NEON interface provides record of the most recently received data and a gateway to data to be display, or if the profile allows, to download data directly from the WEB interface. Data can be shown as a combination of sites and as an individual site.

The real-time data transmitted from each station are able to be viewed and monitored for TMS operations in the NEON web-based telemetry system, and have been automatically ingested into CliDE (Climate Database for the Environment) for archival and generation of data summaries.

WSO Palau uses the CliDE database management system developed by the Australian Bureau of Meteorology as its primary climate data archive.

All station metadata such as commissioning reports, and site and instrument details and photographs, have been developed electronically for archiving in the CliDE database file system. This serves as a permanent record for the installations and is a base reference for subsequent maintenance management and recording of subsequent site visits for instrument inspections, and calibration, and general maintenance. WSO PALAU staff are encouraged to build on these records to track and record all maintenance activities that support climate network operations.

To provide a local access to the near real-time on-site data, the NEON system has an optional Real-time MODBUS Display Module (RTMDMthat reports the logger scan rate (typ. 3 second) data for all (or some) sensors to a local display module.

The display option can include a local wireless link that can operate over several kilometres of a line-of-sight path. The remote display unit can be solar or mains powered.

If the station has nearby local WAN or LAN (wide area network) the display data can also be made available on any terminal on the WAN (Intranet only).

The local display stores and allows display of up to 1 week of data and can also automatically derive METAR/SYNOP reports based upon the automatically retrieved AWS data.

3.4. Environmental and sustainability considerations

Recommendation: 3(2): We recommend the following considerations are incorporated into installation and operational plans. Environmental and sustainability considerations should be incorporated into the procurement process as part of the specifications including the use of reusable instruments where possible and sustainable methods of observation. Surface instruments should be reusable where appropriate and consideration of the environmental and sustainability impacts of maintenance (including associated travel) should be made as part of the SOP for maintenance and calibration. Similarly, consideration of the use of biodegradable materials for upper air observations should be made where possible as well as the environmental impact of shipping methods and materials.

Module 4. GBON Human Capacity Development Modul

4.1. Assessment of human capacity gaps

Table 5 WSO Palau Staff Summary

Name	Job title	Gender	Education qualification (level)
Maria Ngemaes	Meteorologist-in-Charge	F	Degree, Business Management Degree, Meteorology
Kikuko Mochimaru	Staff Meteorologist	F	Degree, Meteorology
Maylene Joshua	Administrative Assistant/Weather Service Specialist	F	Certificate, Associate of Arts
Joyleen Tmatk-Temengil	Supervisory Weather Service Specialist	F	Certificate, Associate of Arts
Rick Dizon	Weather Service Specialist	M	Certificate, Associate of Arts
Livan Chin	Weather Service Specialist	M	Certificate, Associate of Science
Godwin Sisior	Weather Service Specialist	M	Certificate, Associate of Arts
Ngotel Browny	Weather Service Specialist	M	Certificate, Associate of Arts
Reuben Inawo	Weather Service Specialist	M	Certificate, Associate of Arts
Dexter Sadang	Electronics Program Specialist	M	Certificate, Associate of Science
O'Brien Ubedei	Electronics Program Specialist	M	Certificate, Associate of Science
Torual Ulechong	Electronics Program Specialist	M	Certificate, Associate of Science
Ralph Ubedei	Maintenance Coordinator (Facility Technician)	M	Certificate, Associate of Arts

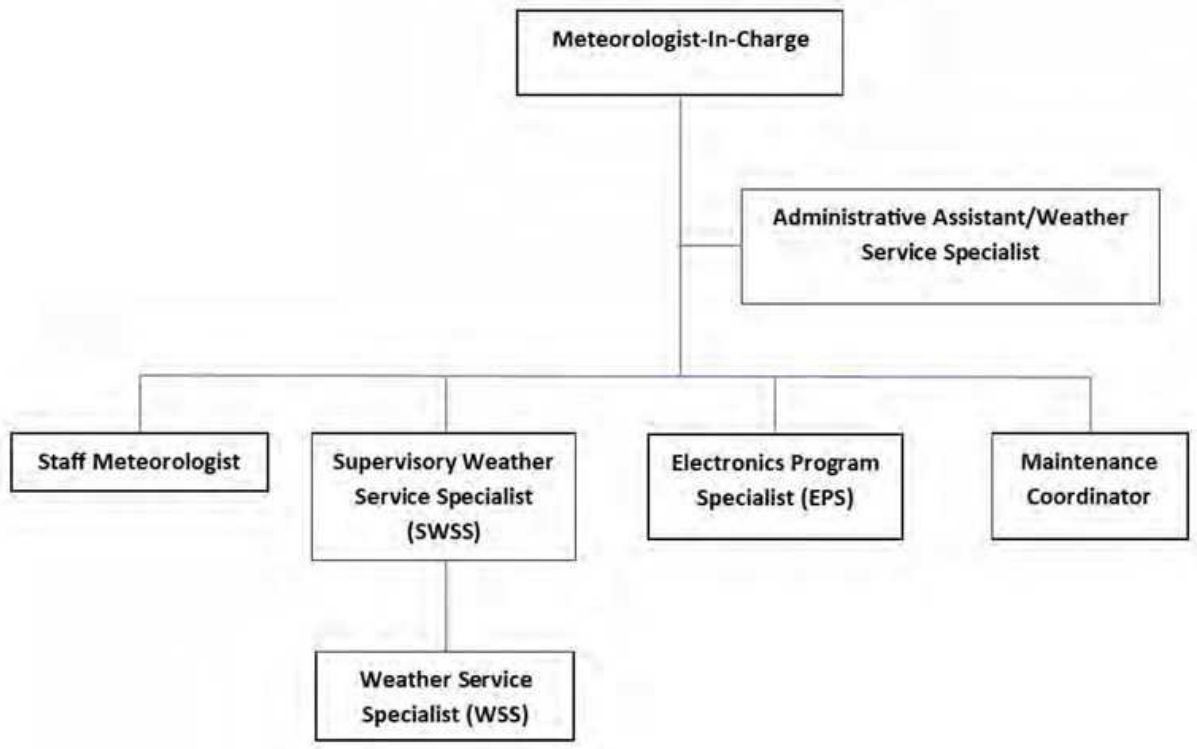


Figure 8 – WSO Palau Organisation Chart

As a prerequisite to taking on the role, Weather Service Specialist staff have completed the selected online training on meteorology and hydrology through the University Corporation for Atmospheric Research (UCAR) Comet Met Ed program. WSO Palau staff have undertaken a range of training courses through the Pacific International Training Desk covering: Tropical Meteorology topics, including: Thermodynamics; Satellite Interpretation; Surface and Upper-Air Analysis; General Circulation; Local Circulations; Tropical Weather Features; Numerical Weather Prediction; Forecast Philosophy; Forecast Verification; Marine Forecasts; Tsunamis; Severe Weather and Tropical Cyclones; Tropical Climate Variability; and Messaging and Weather Communications. A summary of staffing, education levels and gender balance are set out in Table 5 and Figure 8 shows the organisation chart.

To achieve GBON compliance and sustainability, there needs to be a review of the current job roles at the WSO. GBON compliance in Palau requires a member of staff to be dedicated to take full responsibility for the establishment and sustainability of the observations network, a role that currently doesn't exist at the WSO in Palau.

Recommendation 4(1) We recommend the establishment of a new Observations Network Manager role at the WSO Palau.

4.2. Design capacity development activities for technical staff

To ensure that the maintenance and operations of observing and network equipment is high quality and consistent **Recommendation 4(2): We recommend an ongoing programme of formal and informal training is undertaken across the technical staff at WSO Palau.** In addition, as the department grows and changes in line with the updated strategic plan it is essential that all new staff are similarly trained.

Recommendation 4(3): We recommend the initial procurement and deployment of observations equipment is supported by the supplier and partner as set out in the project plans for the UNEP CIS-Pac5 programme.
Recommendation 4(4): We recommend the new role of Observations Network Manager (ONM) takes responsibility for this activity. As the WSO develops, any new staff will be trained and be able to assume responsibility for the GBON stations, as required.

Technical staff across the organisation require formal training in the operation and maintenance of the instruments which could be sourced from the manufacturer or supplier of the instruments. This requirement will be consistent with other SOFF nations in the region and can be coordinated through SPREP and NIWA. Specific training on the maintenance and observation practices associated with the surface observations should be provisioned for existing technical staff and extended to new staff as necessary.

Recommendation 4(5): We recommend a repository of reusable training materials be developed, managed by the ONM and made available to ensure consistent training can be efficiently provided in the case of staff turnover. Similarly, training on the calibration of instruments should be provisioned for the technical staff and updated in the event of staff turnover.

Recommendation 4(6): We recommend this is coordinated as a regional training workshop activity including other SOFF beneficiary countries in the region who have deployed the same instrumentation.

Training on the operation, maintenance and calibration of instruments, as well as the use of the proposed ICT and data management infrastructure has been provided by NIWA through the CIS-Pac5 project. An outline of the training programme is shown in Table 6. It is recommended that this training should be continued and refreshed as necessary for staff at WSO Palau, and the process managed by the ONM.

Table 6 - Outline of technical training provided by NIWA through CIS-Pac5 project

Topics	Expectations/Outcomes
Travel	
1. **Programme Overview:** **a) Christchurch site induction, staff introductions, orientation, health & safety** **b) Programme overview/logistics, workbook, WMO Competency framework and course expectations** 2. **Technical workshop exercise – baseline knowledge assessment (with focus on PALAU context):** **a) Weather/climate/hydrology services in PALAU** **b) Instruments and measurements** **c) Data transfer, telemetry, and integration** **d) Data storage and quality management** **e) Products and client services**	Familiarization with site and programme logistics. Knowledge sharing on the state of services in Palau.

f) Sector/user engagement, decision support and risk management **g) Challenges, opportunities, potential pathways.** **3. Development of activity for review at completion of Technical Training in conjunction with trainees – e.g. Planning and drafting a routine inspection and maintenance plan including quality assurance - Participant to work independently under supervision.**	Demonstration of knowledge transferred via the development of a draft routine inspections and maintenance plan, which can be refined/incorporated into annual workplans upon return to PALAU.
4. **Workshop / calibration lab** **a) Troubleshooting** **b) Fault repair** **c) Validation/Verification/Calibration (Use equipment supplied PALAU)** 5. **Re-cap and refresh on Telemetry systems currently in use** **a) Modem configuration and testing** 6. **Re-cap and refresh on existing instruments used by PALAU, and new instruments.** 7. **CliDE** **CliDEsc server** **Extremes dashboard**	Basic and advanced learning of monitoring systems/network operations, maintenance, troubleshooting. Refurbishment (servicing, repair, calibration) of currently non-operational instruments. Basic and advanced learning of monitoring systems/network operations, maintenance, troubleshooting. Basic and advanced knowledge on CliDE and CliDEsc operations. CliDE training in Metadata Management. Station numbers (WIGOS identifiers)
8. **Field visit**	Siting and measurement considerations (WMO Siting classification) Key AWS maintenance tasks.
9. **Familiarisation with new equipment** **a) Station wiring** **b) Sensor testing and verification.** **c) Modem configuration and testing** **d) Fault diagnosis and resolution** 10. **Station hardware** **a) Mast configuration** **b) Boxing and concrete quantity calculation** **c) Re-termination of parafil guys** 11. **Metadata updating** **a) NEON** **b) CliDE**	Basic and advanced learning of monitoring systems/network operations, maintenance, troubleshooting.
12. **Course completion:** **a) Activity assessment, feedback, and reflection**	Assessment of skills learned course relevance/applicability, challenges, and opportunities.

b) Course feedback and reflection of outcomes/achievements relative to expectations **c) Certification.**	

Training on the operation and maintenance of the upper air observations must also be provisioned including routine operations of the radiosonde sites and the hydrogen generation equipment.

Recommendation 4(7): We recommend this training is provisioned for all staff with responsibility for upper air observations including those on site at the upper air station and a selection of technical staff from WSO HQ to ensure resilience and sustainability.

Recommendation 4(8): We recommend technical staff utilise existing online resources including WMO training materials in the WMO Education and Training Programme, in particular courses under the Instruments and Methods of Observation section and the available training and workshops on the implementation of WIS2.0.

4.3. Design capacity development activities for senior management

WSO Palau have a broad and diverse range of responsibilities, and as awareness of the climate crisis increases, demand for more services from the NMS is also increasing. This situation puts an increasing burden on WSO Palau, especially the Director and the leadership team, and puts their ability to sustain the GBON at risk. To manage this situation requires a range of interventions that will rapidly satisfy the needs in an effective and sustainable manner.

Recommendation 2(6) identifies the need to refresh the Strategic and Operational plans and will clearly highlight priority needs and provide relevant evidence to government and investors. Thereafter, it is recommended to provide development in two forms.

Recommendation 4(9): Firstly, we recommend off-the-shelf training packages, such as Management and Leadership training, Managing Successful Projects training, Financial Management, Gender, Equality and Social Inclusion (GESI) training and Human Resource Management training.

Recommendation 4(10): Secondly, through practical implementation of the NMS Strategy and Operational plans with a peer to deliver GBON compliance. This will include the development of standard operating procedures for quality assurance, maintenance, and sustainability, and their adoption into a Quality Management System (QMS).

In recognition of the existing significant workload of the NMS, it is recommended that a project unit is established. There may be a need to recruit a post for this unit to be responsible for the effective introduction of all SOFF funded outputs to the NMS.

4.4. Gender and CSOs considerations

WSO Palau recognises the importance of Gender, Equality and Social Inclusion (GESI) and the crucial role of WSO Palau to address the issues of GESI and support people and communities disproportionately impacted by extreme weather, seasonal events and climate change. Proactive support for women, girls and marginalised people who are more likely to be negatively affected by the impacts of a climate and weather-related extreme event is essential.

Recommendation 4(11): We recommend WSO Palau undertake Gender, Equality and Social Inclusion (GESI) training as part of a broader activity to ensure GESI is mainstreamed in WSO Palau working practices.

In addition, the following guidelines (from the WISER GESI Minimum Standards) should be followed and adhered to on all SOFF activities:

1. Is there a GESI context analysis to inform programming which identifies:
   i. Barriers and enablers to people of different gender, ages and ability, social economic constraints, or marginalised groups accessing project services.
   ii. The risks of project activities which might negatively impact GESI and how to mitigate such risks?
2. Can people of different gender, ages and ability, social economic constraints, or marginalised groups with differing abilities meaningfully participate in the design, implementation and Monitoring, Evaluation and cross-Learning (MEL) of the project, so they can build individual agency, change gender and group relations, transform systems and structures
3. How does the project contribute to gender equity, protection, and longer term empowerment of different genders, ages and ability, social economic constraints, or marginalised people?
4. Is there a plan for building the capacity of local partners on GESI using these Minimum Standards and GESI upskilling?
5. Does the MEL system enable analysis of GESI issues and does the project Logframe or results framework integrate qualitative and quantitative:
   i. Gender and social inclusion targets, that capture evidence of leadership, empowerment and meaningful participation in decision-making?
   ii. Sex, age, and differing ability disaggregated data and account for intracommunity diversity and complexity?

There was no formal gender assessment undertaken during the readiness phase, so it is recommended that a gender assessment of the institution is undertaken in the investment phase and include insights to their modernisation plans. During the Investment Phase, and any further modernisation, recruitment and training should follow these guidelines:

- Women should represent at least 50 % of all participants in SOFF-related and supported training
- Women should represent at least 50 % of all participants in SOFF consultations, planning workshops, etc.
- Women should represent at least 50 % of staff for operating and maintaining GBON stations
- Women should represent at least 50 % of decision-making and project management positions where applicable

It is also recognized that engagement with civil society is an important factor, to raise awareness of WSO Palau and the observation sites and how they play an important role in the value-chain that provides high-impact weather information, especially to women and girls. The proposed investment in GBON sites across Palau will require cooperation with CSOs in that area and a series of engagement events will be held to engage with this sector to mitigate against the risk of theft and vandalism and ensure that the value of the project is communicated.

Recommendation 4(12): We recommend a consultation event be held with CSOs, including those focused on women's empowerment.

Module 5. Risk Management Framework

5.1 Assess the risks of the observing network and propose mitigation measures

The primary risks to the observation network are set out in the risk register below.
Recommendation: 5(1): We recommend this risk register is owned and maintained by the Meteorologist-In-Charge (MIC) and updated on a quarterly basis.

Operational risks to the observations network						
Risk description	**Impact description**	**Impact level**	**Probability level**	**Priority level**	**Mitigation**	**Owner**
Severe weather (tropical cyclone / monsoon / storm surge)	Damage to equipment, loss of data	Major - extreme	Possible		Spare / backup equipment available in-situ SOP for disaster response	
High humidity / marine environment	Degradation corrosion of sensors / equipment	Major	Possible		Remote monitoring of data and QA/QC Regular preventive maintenance Stainless steel equipment where available Spare equipment on hand	
Theft / damage / vandalism	Loss / damage to equipment	Moderate	unlikely		Fences around sites Regular site inspections Outreach to local communities	
Power and comms.	Loss of power / comms leading to data outage	Major	Very likely		Redundant comms (satellite + cell network modem) Solar + battery power Local storage of data on datalogger	
Staffing	Staff leave / retire with limited succession planning – loss of institutional knowledge	Major	Very likely		Recruitment and succession planning Regular + thorough documentation of processes and procedures	
Staff retention	Staff leave after training	Major	Rare		Staff engagement, incentives, good compensation,	

					length of service award	

Module 6. Transition to SOFF investment phase

Recommendation 6(1): We recommend that, on approval of the Investment Phase Funding Request, a workshop including the WSO Palau, UNEP, NWS and Met Office is arranged to review the outputs of the readiness phase and discuss the transition to the investment phase.

Recommendation 6 (2): We recommend routine project board meetings undertaken in the readiness phase should continue under the coordination of UNEP and should include the peer advisor and other relevant partners as necessary.

Summary of GBON National Contribution Plan

Components	Recommended activities	Related outputs and technical details
Module 2. GBON business model and institutional development	**2(1):** The relationship between WSO and NWS is strengthened further to incorporate close cooperation on the implementation and operation of the observation network.	2.1
	2(2): training opportunities for the investment phase across the region are explored in consultation with SPREP / PMC, incorporating the findings and outputs from the SOFF Pacific Regional Event in April 2024.	2.2
	2(3): The 3 GBON surface sites in Palau are fully publicly owned by the Palau government, with SOFF support to fund the sustainability costs of these sites.	2.3
	2(4): One of the UCSD X-met on Helen or Tobi atoll is designated as a GBON site for Palau.	2.3
	2(5): The development of an MOU between WSO Palau and the UCSD X-met programme to ensure sustainability of this GBON site.	2.3
	2(6): A revision of the strategic plan and development of an operational plan to reflect the changing nature of the WSO operations.	2.4
	2(7): Consideration for the development of draft legislation to recognise the mandate of the WSO to be responsible for the provision and dissemination of meteorological observations (and other services, to be defined), on behalf of the nation.	2.5
	3(1): Selection of the following 3 stations for GBON designation in Palau, Tobi atoll (UCSD XMet), see	3.1

Module 3. GBON infrastructure development	recommendation 2(5), Sonsorol (CIS-Pac5) and Airai (UNDP).	
	3(2): environmental and sustainability considerations are incorporated into procurement, installation, and operational plans.	3.4
Module 4. GBON human capacity development	**4(1)** establishment of a new Observations Network Manager role at the WSO Palau.	4.1
	4(2): an ongoing programme of formal and informal training is undertaken across the technical staff at WSO Palau.	4.2
	4(3): the initial procurement and deployment of observations equipment is supported by the supplier and partner as set out in the project plans for the UNEP CIS-Pac5 programme.	4.2
	4(4): the new role of Observations Network Manager (ONM) takes responsibility for this (Recommendation 4(3)) activity.	4.2
	4(5): a repository of reusable training materials be developed, managed by the ONM and made available to ensure consistent training can be efficiently provided in the case of staff turnover	4.2
	4(6): a regional training workshop on the calibration of instruments, including other SOFF beneficiary countries in the region who have deployed the same instrumentation.	4.2
	4(7): upper air training is provisioned for all staff with responsibility for upper air observations including those on site at the upper air station and a selection of technical staff from WSO HQ to ensure resilience and sustainability.	4.2
	4(8): technical staff utilise existing online resources including WMO training materials in the WMO Education and Training Programme, in particular courses under the	4.2

	Instruments and Methods of Observation section and the available training and workshops on the implementation of WIS2.0.	
	4(9): off-the-shelf training packages, such as Management and Leadership training, Managing Successful Projects training, Financial Management, Gender, Equality and Social Inclusion (GESI) training and Human Resource Management training.	4.3
	4(10): practical implementation of the NMS Strategy and Operational plans with a peer to deliver GBON compliance.	4.3
	4(11): WSO Palau undertake Gender, Equality and Social Inclusion (GESI) training as part of a broader activity to ensure GESI is mainstreamed in WSO Palau working practices.	4.4
	4(12): a consultation event be held with CSOs, including those focused on women's empowerment.	4.4
Module 5. Risk Management	**5(1):** the risk register is owned and maintained by the Meteorologist-In-Charge (MIC) and updated on a quarterly basis.	5.1
Module 6. Transition to SOFF investment phase	**6(1):** on approval of the Investment Phase Funding Request, a workshop including the WSO Palau, UNEP, NWS and Met Office is arranged to review the outputs of the readiness phase and discuss the transition to the investment phase.	6
	6 (2): routine project board meetings undertaken in the readiness phase should continue under the coordination of UNEP and should include the peer advisor and other relevant partners as necessary.	6

Annex 1: Easy fix options:

As part of the SOFF readiness phase in Palau, it became apparent there was significant overlap and mutual dependencies between the CIS-Pac5 and SOFF initiatives. The CIS-Pac5 project includes the installation of 4 AWSs in Palau. In addition, UNEP inherited 4 AWSs installed under a UNDP project and are now the responsibility of the WSO Palau. The national gap analysis identified the need for 3 surface stations, and we have recommended (recommendation 3(1)) one from UNDP, one from CIS-Pac5 and one existing AWS run by UCSD. Consideration is required for the remaining 6 stations, 3 CIS-Pac5 and 3 UNDP. Through discussions with all the relevant stakeholders, the SOFF Secretariat advised us to set out the easy fix options separately to the main national contribution plan. This annex sets out the options for consideration by the SOFF Secretariat/SOFF Steering Committee for the sustainability of the remaining 6 stations.

Background:
The ongoing United Nations Environment Programme (UNEP) Enhancing Climate Information and Knowledge Services for resilience in 5 island countries of the Pacific Ocean (CIS-Pac5) project is under way in the Cook Islands, Niue, Palau, Tuvalu and Republic of Marshall Islands. The project includes the deployment of a network of surface observations across the region including 4 AWSs, plus adoption of the 4 UNDP sites in Palau. The project 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). This program in Palau, along with the proposals for other neighbouring SOFF beneficiary countries in the region (in particular the Federated States of Micronesia) has been considered as a principal part of the design of the GBON network in the region. This includes consideration for alignment of the network at national boundaries, alignment with respect to instrumentation and the full data process chain, and training opportunities.

The UNEP led CIS-Pac5 programme includes the aim to strengthen the observation network of Palau and is installing 4 Automatic Weather Stations (AWS) across the islands this year and adopting 4 UNDP funded installations from a previous project. Of these, 2 will be designated as GBON stations and will be sustained through SOFF compliance funding. The remaining 6 sites will be owned by the Palau government and there is an expectation that the sustainability of these will also be provided by SOFF.

A sustainability strategy for the CIS-Pac5 programme was developed as a part of the CIS-Pac5 funding request jointly with WMO and mentioned SOFF as one of its key components. At the time the CIS-Pac5 funding request was being drafted, 2021, there was consideration by WMO that GBON would require observations with 100km spacing – see Figure 9 and Figure 10 below. In addition, the installation of these sites by CIS-Pac5 and the adoption of the UNDP sites presents an opportunity to have a high-density, GBON compliant surface network, with all the benefits that provides, with only investment required for operations and maintenance. If funding for the operations and maintenance of the 6 additional stations is not secured, there is a high likelihood that WSO Palau will be unable to sustain them beyond the CIS-Pac5 project.

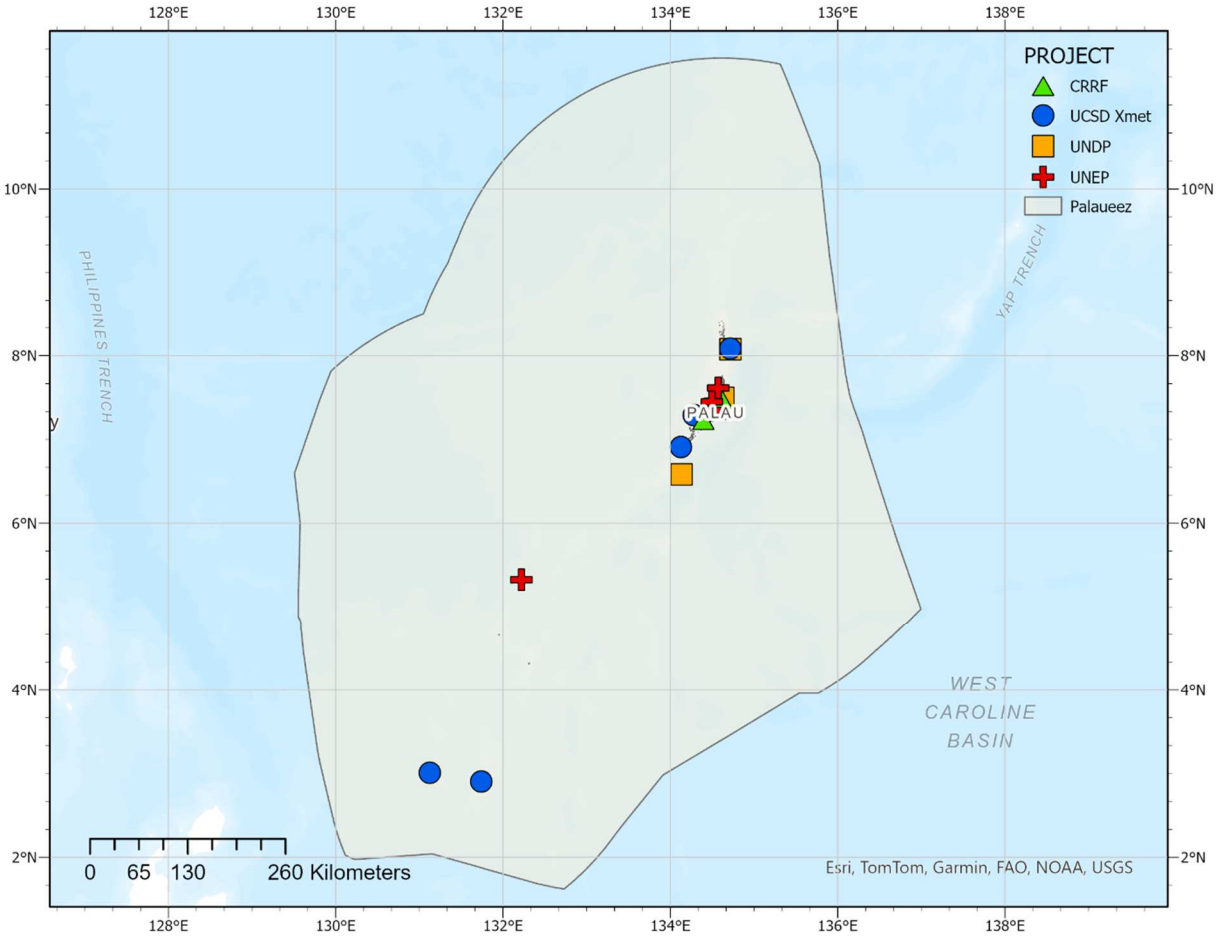


Figure 9 - Map of all surface observations in Palau.

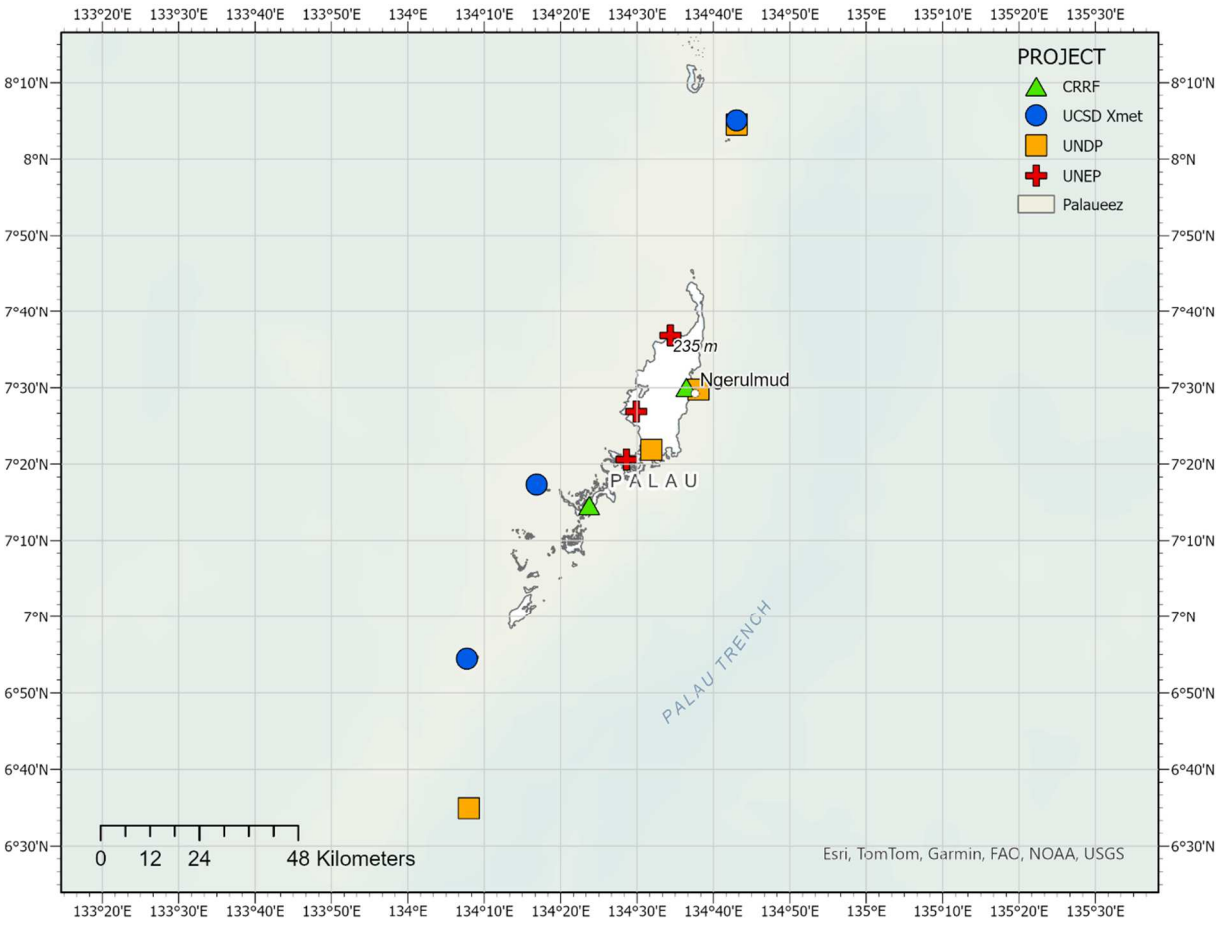


Figure 10 - Map of all surface observations on the main island, Babeldaob.

Easy fix options:

Option 1:

SOFF provides funding for the operations and maintenance of the additional 6 sites beyond the end of the CIS-Pac5 project.

This option provides an opportunity for SOFF investment to fully leverage the benefits of ongoing projects in Palau and in accordance with the principles set out in the SOFF framework. This option will deliver sustained operation of a high resolution, homogeneous network of GBON compliant observations in a data sparse region. This option will increase the level of investment required by SOFF. The expanded observation network represents a greater obligation on the WSO Palau operations to maintain all sites to GBON standards and will require close management.

Option 2:

UNEP/WSO Palau identifies an alternative entity to provide sustainability funding for the additional 6 stations.

This option will require another entity to fund the ongoing operations and maintenance of the 6 additional observation sites. This option will deliver operation of a high resolution, homogeneous network for the duration of the available funding. In the event the funding is limited, the quality of the observation could potentially degrade over time, resulting in a non-homogeneous (non GBON compliant) network.

Option 3:

Funding for operations and maintenance of the 6 stations beyond the CIS-Pac5 project is not available.

This option represents a circumstance in which the 6 additional stations will not be maintained and become non-operational. This option limits the scope of the observation network, making it easier for WSO Palau to maintain the 3 stations to GBON standards. This option will deny CIS-Pac5 (and UNDP) full benefit realization of a component of the project. This option would deny SOFF the full benefit of delivering an “easy fix.”

Report completion signatures

Peer Advisor signature 
Beneficiary Country signature 
WMO Technical Authority signature