Experiences with donor funded climate monitoring in the Pacific

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ABSTRACT

Oceania has long been recognised as a data sparse region with significant logistical constraints on the development and maintenance of environmental monitoring networks.

Evidence of changing climate patterns and sea level rise have led to an increase in donor resourcing of programmes focussed on both Disaster Risk Reduction and Climate Change mitigation.

Along with groups from other donor countries, NIWA has provided technical and operational support to local PIC National Meteorological and Hydrological Services (NMHS) to install Automatic Weather and Hydrometric Stations (AWS), telemetry and data management capability, and to increase capacity to deliver near real-time, customised climate services from within their national organisational structures and policy settings.

Small Island Developing States (SIDS) typically have to contend with multiple donor and implementing agencies, concurrent projects that have overlapping objectives and outcomes, and programmes that implement diverse, often highly proprietary, technical solutions. This paper shares some of our experience in working on-the-ground in this challenging environment.

1 INTRODUCTION

In recent years, several technological developments have enabled simpler and more reliable collection and archiving of climate and other environmental data across the SW Pacific. *Challenges and strategies for climate monitoring in the Pacific [Harper, 2016]*

Despite these developments, many Pacific Island Countries and Territories (PICT) continue to face a number of challenges to the successful provision of climate information and services. These challenges include cultural, political, social, financial and infrastructure issues, as well as considerable geographic isolation between and within the islands of most countries.

Populations and GDP are relatively low, imposing constraints on Government resources and funding allocation for initiatives to build resilience against environmental hazards. Therefore, PICTs are often reliant on international aid and investment projects to support development initiatives, and to maintain the new infrastructure and services resulting from these projects.

Across the Pacific there are multiple donor programmes and implementing agencies providing capacity building for PICTS. Some examples include: ADB, COSPPac, FINPAC, GCF, GEF, GIZ, JICA, RESPAC, RIMES, SPREP, UNDP, UNESCO, WMO CREWS, and the World Bank.

Many projects within these programmes are built on Disaster Risk Reduction and Climate Change mitigation and the need for easily accessible climate services. However, the observations component is often a relatively small component within the wider project.

Experiences have been varied and depend on multiple factors such as the scope and size of the project, experience of the implementing personnel, or capacity of the NMHS to undertake the scope of the work. Many of the opportunities and challenges raised during the TECO-2016 discussion session on the “Benefits and Challenges of Transitioning to Automated Observations”, have been encountered during these projects.

Early dialogue amongst key stakeholders is critical to ensure the best outcomes possible are achieved. This includes attempting to address as many of the 14 Pacific Key Outcomes identified by the Pacific Island Meteorological Strategy (PIMS) as possible. Typically, projects are able meet or contribute to 12 of these:

- PKO 1: Aviation weather services are improved
- PKO 2: Marine weather services are improved
- PKO:3 Public weather services are improved
- PKO 4: Multi-Hazard Early Warning Systems (MHEWS) for tropical cyclones, storm surges, waves and tsunami in the PICTs’ region are implemented and improved
- PKO 5: Improved early warning system for floods (EWS-Floods)
- PKO 6: Climate information and prediction services, including drought prediction are improved
- PKO 7: Improved quality of observations and coverage of networks
- PKO 8: Historical data are preserved
- PKO 10: National Meteorological Service is more capable and effective
- PKO 11: Education, training and capacity development activities in the field of meteorology and climatology are coordinated and improved
- PKO 12: Donor funding is coordinated efficiently and effectively
- PKO 13: Enhanced strategic partnerships and collaboration with UN, regional and national organisations and agencies.

These early conversations can quickly evolve from a relatively simple installation of a climate station, to the more complex implications of these installation, which include archiving of data from multiple network sources into a single database, technical training, the provision of coded observations, and delivery of a variety of climate services.

While usually outside the scope of these type of projects, code generators to provide coded messages have also been developed to allow NMHSs to send data on global networks although implementing WIGOS remains a challenge for most NMHS in the region.

Other issues to consider include:

- Management of concurrent projects with overlapping outcome objectives
- Coping with diverse and often highly proprietary technical solutions
- Finite project lifespan - Projects are typically programmed for three to five years
- Access to relevant training for technical staff
- Access to ongoing support beyond the end of the project

Sustainability continues to be one of the biggest issues and often the NMHSs are left with residual operational costs that add pressure on already limited budgets and resources. Even sourcing basic materials such as paint and cleaning products to maintain the equipment can become a challenge.

Having staff with sufficient technical skills is an ongoing challenge but one that is changing. Many NMHS have low staff numbers and many of the technical staff are former observers with little electrical or ICT training, yet they are expected to maintain increasingly complex AWS and systems. Conversely, many NMHS also have good ICT capability but with little meteorological training. The larger NMHS are now developing balanced teams of technical staff with experience in both meteorology and ICT. The challenge is to build this capacity across all NMHS.

To assist in getting the best possible outcomes for an NHMS, one initiative has been the development of a Climate and Hydrological Network and Operations training Workbook, as a practical guide to assist staff who are managing climate and hydrological networks.

Where possible technical staff from the relevant NMHS have been hosted by NIWA for periods of two to four weeks. During this training period, technical staff are involved in a range of practical activities covering the configuration, testing, calibration and assembly of instruments, devices and software required in an AWS, prior to shipping and site installation. Installation requirements, trouble shooting, maintenance and metadata are also covered. This is reinforced further by in-country training during the final installation and commissioning phase.

2 EVOLUTION OF A TRAINING WORKBOOK

NIWA's Pacific Workbook is designed to expand technical knowledge and improve competencies in the context of day-to-day responsibilities and operational tasks, to strengthen both individual and institutional capability to deliver sustainable and improving information services.

The Workbook is specifically aimed at strengthening Climate Services and Early Warning Systems (CLEWS) which encompass improved understanding of past climates and underlying risk, real time monitoring of present weather and climate, and operational advice and services on future climate risk and opportunity on all time scales, from hours and days, to seasons and decades ahead.

The typical components of such a Pacific Island system are illustrated in Figure 1 below.

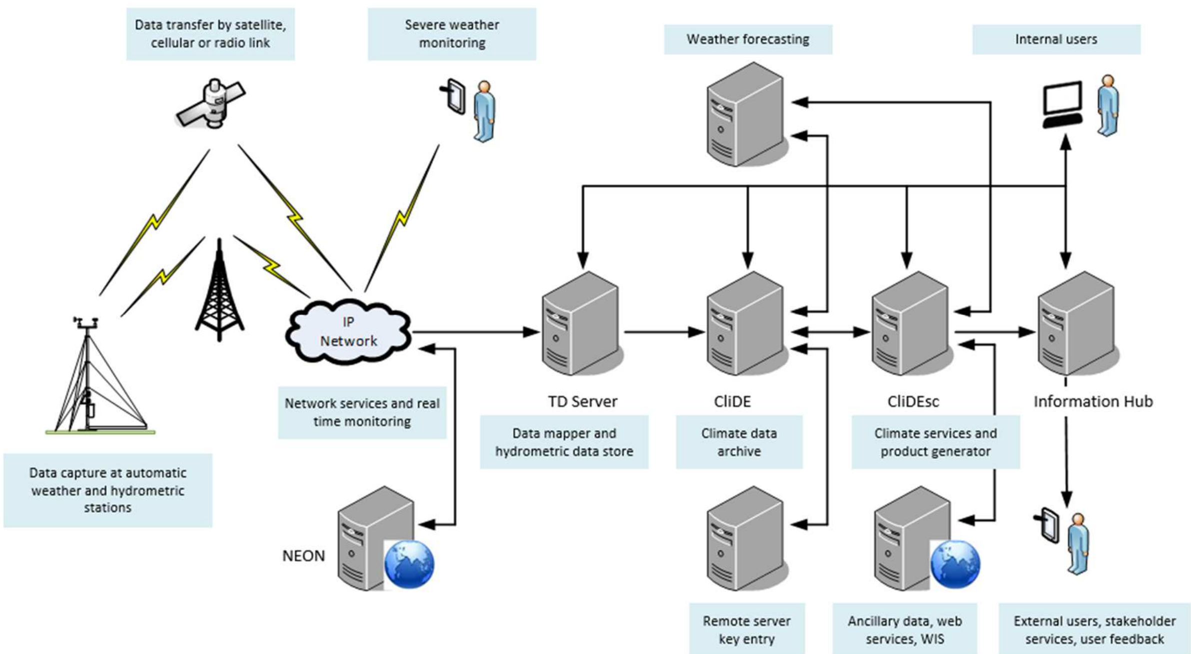

Figure 1: Generalized schema of Pacific Island climate monitoring, data management and operational services. Note that some data are also observed at manual recording sites and key entered to CliDE.

Successful management of these infrastructure and information services requires the engagement of operational personnel with a broad range of technical skills. Theoretical knowledge to operate infrastructure and information systems must be complemented by 'hands-on' operational competencies that are specific to national systems, infrastructure and procedures.

The Workbook includes six modules that incorporate a sequence of objectives, tasks and check lists, from the planning and development of a robust climate network and high quality observational recordings, through to the delivery of information to aid decision making and mitigation of climate risk.

The modules are:

1. Climate services – strategic and technical overview
2. Instruments and measurements
3. Data transfer, telemetry and integration
4. Data storage and quality management
5. Climate monitoring, reporting and client services
6. Sector engagement, decision support and risk management

To bring together relevant guidance and reference material in a simple and concise manner, each set of tasks is referenced, by in most cases clickable references (hyperlinks), to relevant World Meteorological Organisation (WMO) technical guides or manuals, including the WMO knowledge sharing portal, to ensure alignment with WMO recommended methods and competencies, and as a resource to provide supplementary training material where it is needed.

Manuals and operational guides specific to regional strategic documents and any national network infrastructure and systems – including automatic weather stations, data management and product generators are also referenced and linked.

2.1 Module 1: Climate services – strategic and technical overview

Module 1 is expected to be a 'scene-setting' workshop. This encompasses the strategic objectives and scope for building climate services and improving climate resilience. Important components include becoming familiar with the operational elements of a robust and effective climate information and early warning system (CLEWS).

Objectives of this module

- Understand and implement the strategic objectives for developing climate information and early warning services.
- Understand the technical scope and operations of climate information systems – from observations to decision-making.
- Introduce and outline the technical training programme for operational competencies.

Recommended participants

All technical and operations staff who are operating any part of the climate information and services system.

Topics addressed

PART 1: BACKGROUND

1. National objectives and framework for climate services.
2. Technical infrastructure and operations for climate services.
3. How to use this Workbook: Building operational skills and support: Introduction to the workbook for operational competencies; certification for operational competencies.

PART 2: GETTING STARTED

4. Implementing the system – planning and design, community engagement, user needs.
5. Maintenance and sustainability: staffing; budgets, operational costs; revenue.
6. Health and safety.
7. International collaboration and alignment; Pacific Meteorological Strategy; Global Framework for Climate Services.

Each topic has a table listing the required competency and relevant references. With the following example from Topic 7 International collaboration and alignment; Pacific Meteorological Strategy; Global Framework for Climate Services of the workbook for Vanuatu.

OBJECTIVE: Collate and discuss the strategic objectives supported by this project.

Strategic alignment		**Ref.**	**Date completed**
List and discuss key objectives of the NAPA supported by this project		1	
List and discuss Pacific Key Outcomes supported by this project		2	
List and discuss outcomes of the GFCS supported by this project		3	
List and discuss recommendations of the VFCS supported by this project		4	
REFERENCES	1. Vanuatu National Adaption Programme of Action 2. Pacific Islands Meteorological Strategy, 2012-2021 3. Global Framework for Climate Services 4. Vanuatu Framework for Climate Services		

Figure 2: Example table Module 1, Topic 7 International collaboration and alignment; Pacific Meteorological Strategy; Global Framework for Climate Services.

2.2 Module 2: Instruments and measurements

Module 2 covers basic aspects of network design but focuses mainly on instruments and measurements, and building and maintaining climate stations.

Objectives of the module

- Understand key principles of climate network design and purpose.

- Improve skills and knowledge to select, install and calibrate instruments, including suitability for the observing environment and measuring the required variables.
- Plan and implement a programme for sustainability – trouble shooting, instrument rotation and maintenance, documentation and metadata.

Recommended participants
Climate services technical officers, instrument technicians

Topics addressed

1. Climate network design objectives
2. Site location and exposure criteria
3. Selecting instruments
4. Installing a station
5. Station commissioning and documentation
6. Storing and preserving station records
7. Station inspections and routine maintenance
8. Trouble shooting and fault diagnosis

The following example is from Topic 2 Site location and exposure criteria.

OBJECTIVE: The principles of network design and climate monitoring are understood, and considered prior to new stations being established or network changes being made.

Selection of station location		Completed
Station location complements and strengthens network design and purpose	Network design considers and incorporates measurements that take into account: urban areas; different climate zones; different land-use; range of altitudes; spatially representativeness.	
	As far as possible, any network changes and additions assist the continuity and homogeneity of the climate record.	
	A period of overlap (preferably two years) between new and old observing systems and instruments has been undertaken to assist continuity and homogeneity of records.	
Select suitable locations for stations	Priority has been given to data-sparse regions and poorly observed parameters, for example places exposed to change and/or extreme conditions, or where improved time resolution is needed.	
	The collected data will adequately representative the local environment and climate, including both air and ground (e.g. soil temperature, soil moisture) conditions.	
	Local effects are fully considered ('exposure').	
	Ground surface is suitable for construction.	
	Siting classification tool has been applied (is site 'fit for purpose'?)	
Consider issues related to long-term site suitability and access	Exposure will not change (e.g. due to growth of trees, new buildings) or there will be minimum change.	
	Site access will be available for servicing – may need to establish protocols to give advance notice of access.	
REFERENCES	WMO-No 8 Guide to Meteorological Instruments and Methods of Observation WMO 100 Guide to Climatological Practices WMO 1185 Guidelines on Climate Observation Networks and Systems	

Figure 3: Example table Module 2, Topic 2 Site location and exposure criteria.

2.3 Module 3: Data transfer, telemetry and integration

Module 3 is typically carried out in parallel with Module 2 and focuses on telemetry systems, data transfer and ingest of data. The aim of this module is to ensure understanding and implementation of the full scope of data integration, including real time data ingest and display, quality assurance procedures on ingest to the data archive, management of multiple data sources and outputs including the GTS/WIS, and data transmission to an Integrated Weather Forecasting System.

Objectives of this module

- Understand, operate and maintain data logging, transfer by telemetry, and processes for data ingest into the climate data archive.
- Ensure data transfer and integration to all operational services as required.

Recommended participants

IT staff, instrument technicians, weather and hydrological monitoring and forecasting operational staff.

Topics addressed

1. Options for telemetry systems – cellular and satellite
2. At the AWS site – the sensor-logger interface
3. NEON (telemetry) configuration: Data logging and transmission
4. NEON (telemetry) operations: Data viewing and applications
5. Data integration with national climate and weather services
6. Data integration with Global systems – GTS/WIS

2.4 Module 4: Data storage and quality management

Module 4 focuses on managing the data in the CliDE (BOM - Climate data for the Environment) database management system (www.bom.gov.au/climate/pacific/about-clide.shtml), with a particular focus on quality assurance. Topics include station numbering and registration, data parameters and tables, ingest procedures, quality assurance and management, data rescue, data reporting and the storage and upkeep of metadata and station maintenance records. CliDE provides capacity for NMHS to store meteorological observations in a robust climate database management system (CDMS) via a user-friendly interface. It was produced by the Australian Bureau of Meteorology (BoM) and has been installed at the NMHS in 18 PICTs.

Time Dependent Data (TIDEDA) is a database developed to store and analyse time series data. It is particularly suitable for hydrological timeseries data. It was produced by NIWA and used in many countries including most PICTs.

Objectives of this module

- Improve proficiency in monitoring and maintaining all data entry and ingest services to meet NMHS standards and requirements.
- Ensure all operational data are up to date and quality assured.
- Maximise the capability and services of the CliDE data management system.

Recommended participants

Staff involved in key entry, automatic data ingest, data quality assurance and climate reporting; database administrators.

Topics addressed

1. CliDE administration

2. Station set up and registration, including metadata
3. Data tables and types
4. Data entry processes; automatic data ingest; monitoring data services.
5. Data quality assurance and data modification
6. Data reports and quality plots; identifying data quality issues.

The following example is from Topic 2.

OBJECTIVE: Data entry staff are familiar with station setup, prior to entry of data.

Set up stations in CliDE		**Completed**
Set up station metadata	Check station information correct and up to date	
	Set up new station for data entry	
	Complete station metadata check list (refer to CliDE station setup)	
	Complete instrument metadata check list and consistent with administration standards	
	Upload station information files and photographs	
Manage manual entry of data records	Key entry daily data	
	Key entry sub daily data	
	Conduct post-entry data checks	
Upload spreadsheet data to CliDE	Set up csv files in native CliDE ingest format	
	Submit and upload spreadsheet data	
	Check upload complete and correct	
Manage automatic data ingest (see also Section 4.5)	Set up DataToCliDE for an automatic station	
	Edit data channel thresholds as needed	
	Switch data channels on/off as needed	
Data rescue: Identify and collate station paper records, and upload data from historic records	Identify stations missing from the electronic data archive	
	Locate and organise/collate paper records	
	Check quality and reliability of paper records metadata	
	Key enter data from historic paper records	
REFERENCES	CliDE User Guide DataToCliDE WMO 100 Guide to Climatological Practices WMO 1185 Guidelines on Climate Observation Networks and Systems WMO 1186 Guidelines on Climate Metadata and Homogenisation	

Figure 4: Example table Module 4, Topic 2 Station set up and registration, including metadata.

2.5 Module 5: Climate monitoring, reporting and client services

Modules 5 aims to improve climate staff capability to monitor and report the climate using CliDE and CliDEsc data analysis and reporting tools. The module will include using the CliDE/CliDEsc platform to illustrate climate variability and extreme events, and to develop and generate routine climate reports. Staff will develop improved tools and services to help respond to stakeholder and public requests for climate products and advice.

Objectives of this module

- Monitor the climate in real time and recognise climate variations and extreme events.
- Develop and generate routine climate reports for public distribution.
- Respond to key clients to develop and routinely generate customise services.

Recommended participants
Climate services staff.

Topics addressed
1. CliDE data downloads and reports
2. Design and generate products and services with CliDEsc
3. Regular climate reports and advisories – monthly, seasonal, ENSO
4. Public data services and requests – data tables, data visualisation (time series and maps).
5. Advanced data analysis and products.

2.6 Module 6: Sector engagement, decision support and risk management

Module 6 encourages climate services staff to actively engage with sectors of government and business, civil societies and communities to determine climate vulnerabilities and needs for information. Staff working with these sectors will help develop the information content, format and communication needs to support vulnerability assessment and decision-making to strengthen climate resilience. Staff will work on the design of climate products and services, which is likely to include the development and installation of new CliDEsc product generators.

Objectives of this module
- Work with sectors of government, business, civil societies and communities to determine climate vulnerabilities and needs for information.
- Develop the scope and range of national climate services.
- Develop and apply advanced interpretation and application of climate data.

Recommended participants
Climate science and services staff.

Topics addressed
1. Engaging with end uses and identifying climate vulnerabilities and information needs
2. Data interpretation and reporting for decision making and risk management
3. Designing and implementing improved public bulletins, climate products and services
4. Improved data analysis and interpretation.
5. Developing sector partnerships and joint responsibilities

3 SUMMARY

There are excellent opportunities within these programmes including:
- Greater source of observations in a standardised and uniform manner
- Improvements in quality (provided maintenance and calibration schedules are maintained)
- Preservation of historical records
- Improved climate information and prediction services
- Education, training and capacity development activities in the field of meteorology and climatology are coordinated and improved
- Enhanced strategic partnerships and collaboration with UN, regional and national organisations and agencies.

- Improved effectiveness of NMHS

There are also challenges including:

- Financial resourcing for the sustaining the observations.
- Capacity. Does the NMHS have the technical staff mix right between meteorological and ICT staff?
- Maintenance of instruments, hardware and site. Is there a regular maintenance schedule for all components of the system?
- Calibration. Does the NMHS have the capacity (size, staff, skills, space) for expensive calibration facilities? How can they cooperate regionally?
- New developments mean NMHS are continually having to cope with developing and changing technology
- Parallel observations. Can the climatology be preserved for important sites?

Many of these opportunities and challenges were also raised during the discussion on Benefits and Challenges of Transitioning to Automated Observations at TECO-2016 and are not unique to Oceania.

The Workbook continues to evolve as work continues with implementing partners and NMHSs with the ultimate aim to give NMHSs the tools and to deal with multiple projects and build sustainable observation networks and climate services.

Targeted technical training is vital for capacity development.