Vanuatu Coastal Adaptation Project (V-CAP)

AWS Installation - Report on project completion

Prepared for Vanuatu Meteorology and Geo-Hazards Division

August 2017

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NIWA CLIENT REPORT No: 2017xxxWN
Supply, delivery and installation of Automatic Weather Stations in 6 locations in Vanuatu. Vanuatu Ministry of Climate Change Supply Contract G01/03
Report date: August 2017
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1 Introduction

The Ministry of Climate Change, Government of Vanuatu, contracted NIWA (The National Institute of Water & Atmospheric Research Ltd) for the 'Supply, delivery and installation of Automatic Weather Stations in 6 different locations in Vanuatu' (SC G02).

This work supports the *Adaptation to Climate Change in the Coastal Zone in Vanuatu* (V-CAP) project, funded by the Global Environment Facility, implemented by UNDP and the Vanuatu Ministry of Climate Change.

The work aligns with the **Vanuatu Framework for Climate Services** developed in 2016[1].

The overall goal of the project was to enable the Government of Vanuatu to develop improved climate information and early warning services for the people of Vanuatu, particularly in vulnerable coastal areas of the country.

Specific deliverables of the NIWA Contract for Services focussed on assisting the Vanuatu Meteorology and Geo-hazards Department (VMGD) to enhance near real-time management of climate and hydrometric data, and improve the functionality of the Vanuatu Climate Early Warning System (CLEWS). Core activities included building complete, end-to-end CLEWS functionality:

- automatic weather stations,
- telemetry for real time data transfer,
- data management and quality assurance,
- climate monitoring tools, and
- sector-customised reporting services.

1.1 Previous reports

A series of reports, user guides, and technical documents, listed in the References of this report, have been provided separately as part of the implementation of this project. These documents include:

1. Contract Proposal – a proposal document outlining much of the preparatory technical scope of the project and an outline of equipment specifications
2. VCAP Project Progress Report 1 – this document reported on the outcome of the project planning meeting between VMGD and NIWA during 29 November to 2 December, 2016. The report contained agreed work plans and timelines, and confirmed technical specifications and the scope and timing of training for VMGD technicians.
3. VCAP Project Progress Report 2 – this document reported on the progress of the project implementation through to March 2017, including equipment preparation and training in New Zealand, hardware and software systems purchasing and installations at VMGD, and planning for the remote field installations in Vanuatu, including full kitting reports.
4. Workbook for the Climate Information and Services Design Workshop, Port Vila, May 2 2017 – this Workbook was prepared to facilitate planning for information needs with the

[1] Vanuatu Framework for Climate Services. Prepared for Government of Vanuatu. Edit: Andrew Tait. SPREP 2016

VCAP-prescribed sectors, including Agriculture, Health, Hydrology, Energy, Marine, and Tourism.

5. VCAP Sector Workshop Report – this document reported the information requirements defined by the participants at the Information Services Design Workshop held on May 2, and at follow-up interviews with Sector officials.

6. AWS Installation Report, Mission 1 – a report on the remote AWS installations at Aneityum, Whitegrass and Lamap in May and June, 2017.

7. AWS Installation Report, Mission 2 – a report on AWS installations at Longana and Norsup, July 2017.

8. Automatic weather stations operations manual – this is the core technical reference for the installation, operations, and maintenance of the AWS network, including the telemetry system. The manual includes sensor descriptions and specifications.

9. Synop and METAR coding guide for managing automatic message coding from the AWS, manual QA, and message preparation for the WIS/GIS.

10. CliDEsc User Guide – this is the main printed reference for the CliDEsc product catalogue, and documentation for CliDEsc administration, with similar content to the application user guidance pages.

11. Vanuatu Climate Networks and Operational Services: Workbook for Operational Competencies – this is a reference training guide compiled by NIWA for climate and hydrology early warning system field technicians. The Workbook lists WMO references for technical procedures and competencies, and provides a step by step, task-based, modular training reference. The Workbook is in on-going development.

12. DataToCliDE – a document describing the software (called DataToCliDE) which maps the incoming AWS data to the CliDE database. The software enables station registration in the application, and control over data channels and range checks.

The present document is the **Final Implementation Report** summarising the implementation of the VCAP Contract for Services.

Finally, a draft Maintenance Plan has been provided under separate cover at the request of VMGD, and is under consideration. NIWA will be happy to consider options to support VMGD's climate network maintenance programme.

1.2 Project Implementation timeline

The AWS training, technical training, data integration and implementation of climate services required under the NIWA VCAP Contract for Services were implemented from November 2016 through to September 2017.

A log of key activities during the implementation period is compiled in Appendix B of this report.

A summary timeline of project delivery milestones is shown in the table below.

Date	Milestone
July 2016	Presentation of Proposal to Vanuatu Ministry of Climate Change
October 2016	Contract signed; assembly of equipment commenced
28 November to 2 December 2016	Pre-installation workshop, Port Vila
23 January to 17 February, 2017	Instrument and telemetry training for two VMGD field staff in Christchurch
20-24 March, 2017	Installation of telemetry and CliDEsc product generator servers at VMGD, CliDEsc1
1-5 May 2017	Sector services and information design workshop, VMGD
15 May to 10 June, 2017	AWS installations Aneityum, Whitegrass, Lamap
30 June to 15 July, 2017	AWS installations, Norsup, Longana
31 July to 11 August 2017	CliDEsc upgrade and training, CliDEsc2
12-16 August 2017	Installation of Sola AWS by VMGD team Initialisation of SYNOP and METAR automated messages coding
18-22 August 2017	Final CliDEsc2 and product suite upgrade and training for VCAP

2 Configuration of the Climate Early Warning System (CLEWS)

A generalised schema for the Climate Early Warning System is shown in the figure below. Successful implementation of the system requires robust and uninterrupted data flow from the AWS (left of figure) through the telemetry system to storage on the CliDE server, and data processing to produce decision support tools and information to be disseminated from the Information Hub.

The figure below illustrates in general form the flow of data through the connected processes of capture and final dissemination as products and services. VMGD staff have access to all nodes in the data process and are responsible for successful operation and maintenance of the system.

Data flow into the **CliDE data archive** through both automatically telemetered and manual data ingest processes. The **CliDEsc product generator** draws data from CliDE and from other web services and creates customised products for a range of user interests and requirements.

At Administrator level, the addition of new customised products and services is encouraged, to meet growing user needs for climate reporting and early warning services. The CLEWS system is now fully operational, while ongoing development will continue as resources permit.

While the CLEWS in Vanuatu is configured to the particular needs of VMGD, similar systems have been deployed in other Pacific Island nations and elsewhere, optimising the opportunity for shared learning and transportable tools for data analysis and information services.

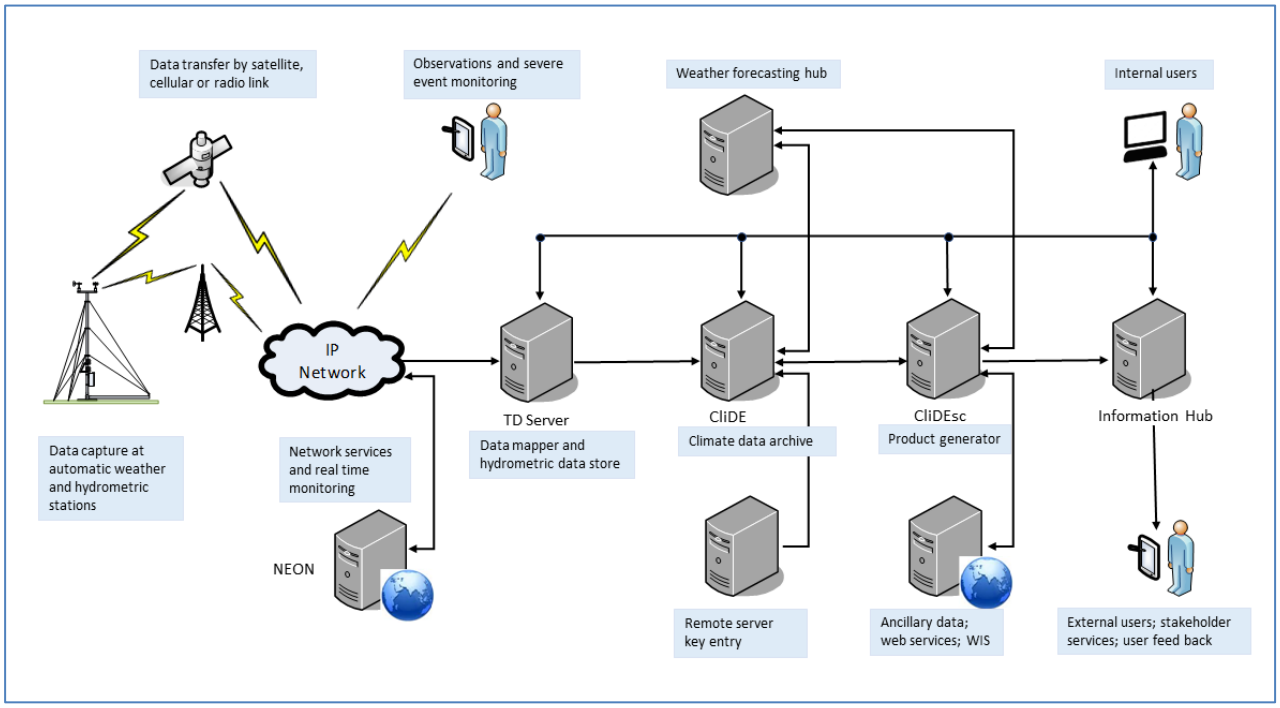


Figure 2-1: CLEWS generalised schema illustrating the flow of data from capture (left) to the dissemination of information services (right).

2.1 System connectivity

The illustration below shows data pathways in more detail.

The remote Windows Desktop is planned as a future collaborative development with the Water Resources Department, in order to facilitate the management of water security and natural hazards such as drought.

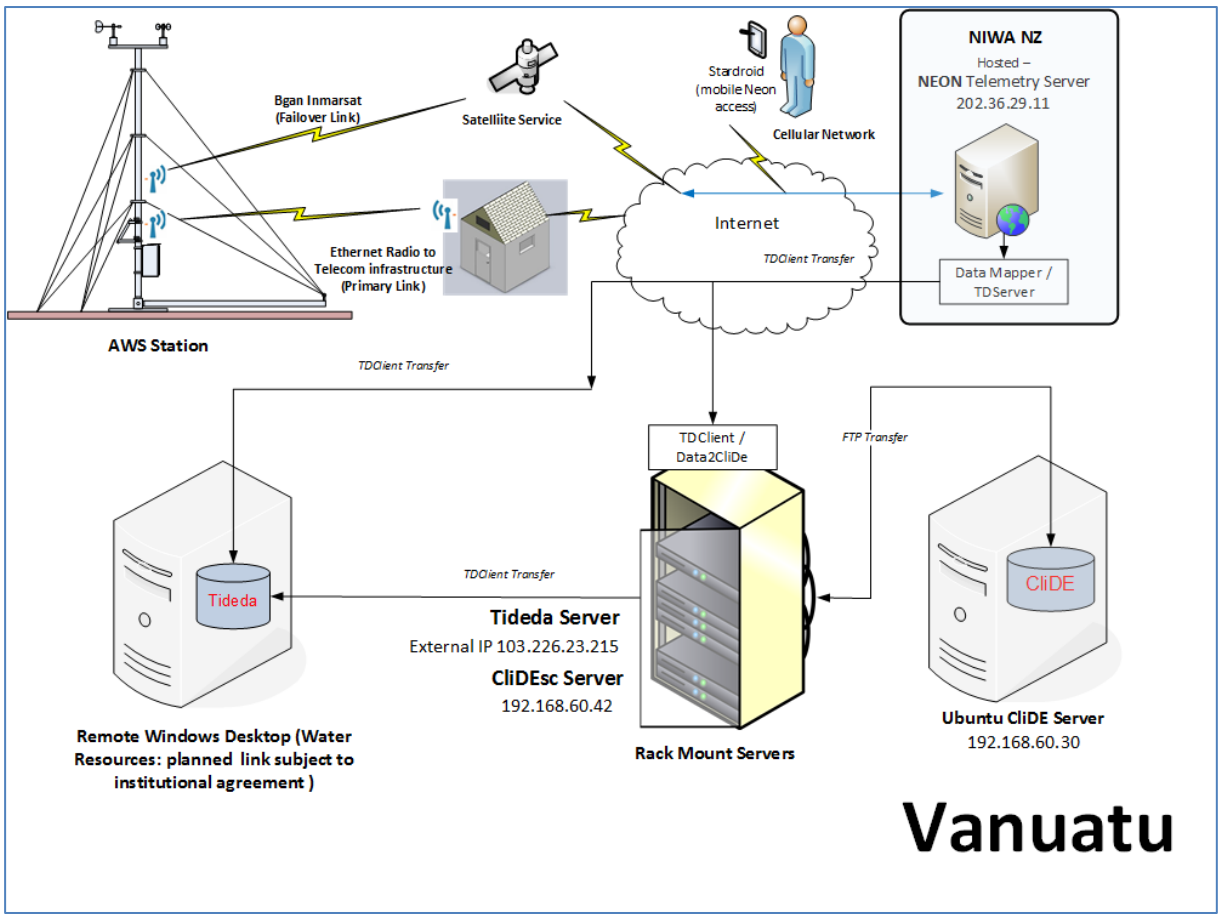


Figure 2-2: Schematic view of CLEWS system hardware data connectivity. The NEON telemetry system provides back-up data transfer in the absence or failure of the primary telecom link, as well as a near real-time data dashboard, and this service is currently provided from New Zealand. A stand-alone telemetry node in Vanuatu is an option for future development.

3 Completion of field installations

Automatic Weather Station (AWS) hardware was assembled in Christchurch, New Zealand during December, 2016 and January 2017. Two staff from VMGD assisted with instrument assembly, calibration, and station construction, as part of a comprehensive technical training programme (see Activities Log Frame, Appendix B, and VCAP progress reports, References 2 and 3).

Following training and instrument assembly, the equipment was packed in a container and assigned to Port Vila, departing from Christchurch 22 February and arrived in Port Vila on 19 March, 2017.

The NIWA implementation team arrived in Port Vila on 21 March and worked with VMGD staff for two weeks on preparations for the AWS installations, and training (see activities listed in Appendix B).

Installation at the six sites will be conducted during three field missions – (i) 10 May to 15 June, (ii) 30 June to 15 July, and (iii) 12 to 16 August. The first two missions were supported by NIWA technicians, while the installation during the third mission was completed by VMGD staff.

Full reports of Missions 1 and 2 are provided in VCAP Installation Reports 1 and 2 (References 2 and 3).

Site documentation was completed for each AWS location by NIWA and VMGD staff, ready for uploading to the CliDE station registration, file repository and metadata pages. Example station documentation is included in the AWS Operations Manual (Reference 8), and includes the following:

1. Site description including key text descriptions and site plans
2. Photographs showing 360 degree views to record site aspect and exposure, and all equipment installations
3. Siting classification based on WMO guidelines
4. Annual inspection protocols
5. Wiring diagrams

An example photograph showing Whitegrass AWS is shown below (Figure 4-2).

The new AWS were assigned unique WMO numbers to enable the observations to be encoded in Synop and METAR reports and provided to the WIS. See the Synop and METAR Automatic Coding Document (Reference 9) for further details.)

4 AWS site locations

The six automatic weather stations installed under VCAP are the named sites in the map below. In most cases the stations are located in order to provide continuity (or overlap) in data observations at pre-existing manually operated sites.

The adjacent map shows, in addition, the existing manual (synoptic) sites. The CliDEsc software, in a process called Station Chaining (see CliDEsc User Guide, Reference 10) allows users to link the new AWS to the existing manual sites to provide a continual (integrated by not homogenised) data record using data from the adjacent locations respectively.

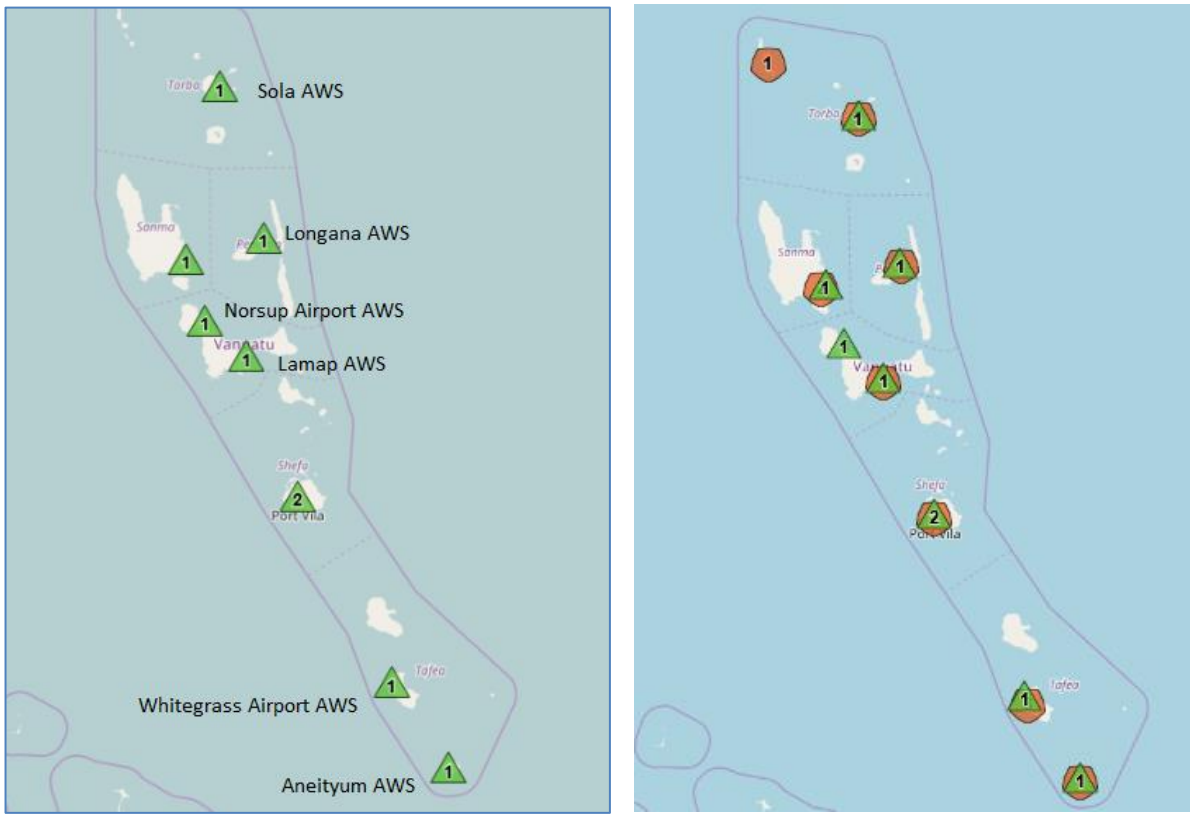


Figure 4-1: Locations of new AWS installed under VCAP (left panel). The right panel shows the co-located manual reporting sites. The number 2 shown over a symbol indicates there are two observing sites in that location.

Figure 4-2: Whitegrass Airport AWS looking NNE.

5 AWS real time data

The NEON telemetry server

The NEON Remote Terminal is a small self-contained unit which connects to the automatic weather station sensors, logs readings from them and transmits the data to a central server via satellite or cellular telephone network.

The Neon system allows the Ethernet NRT to push logged data from the data logger at various user defined intervals, in this case 10-minute, to a web based system which allows the user to view logged data in near real time, as is illustrated below. All data are stored on the NEON web server and the data are accessible using the NEON web interface. Login details for NEON services can be provided according to VMGD requirements.

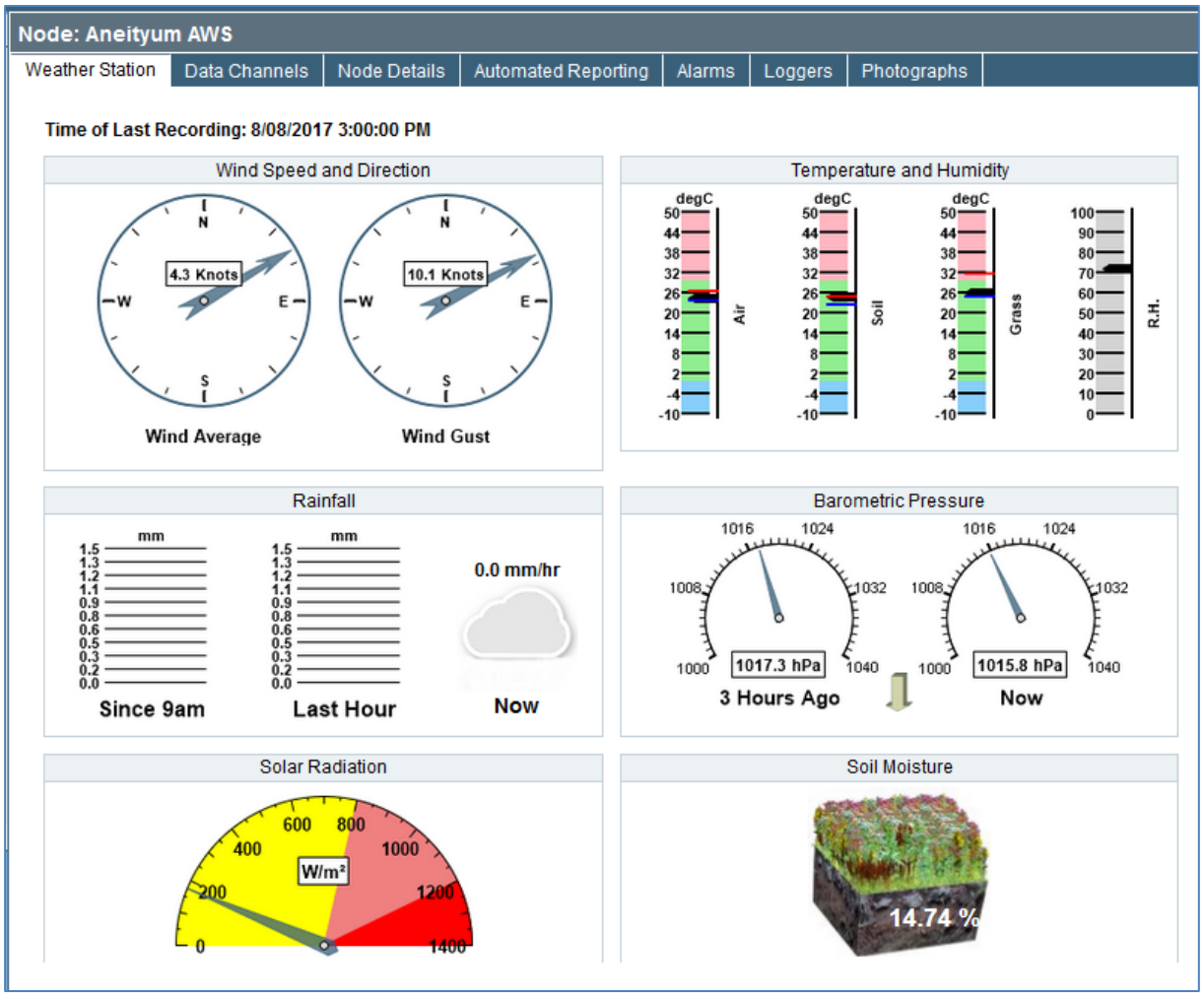
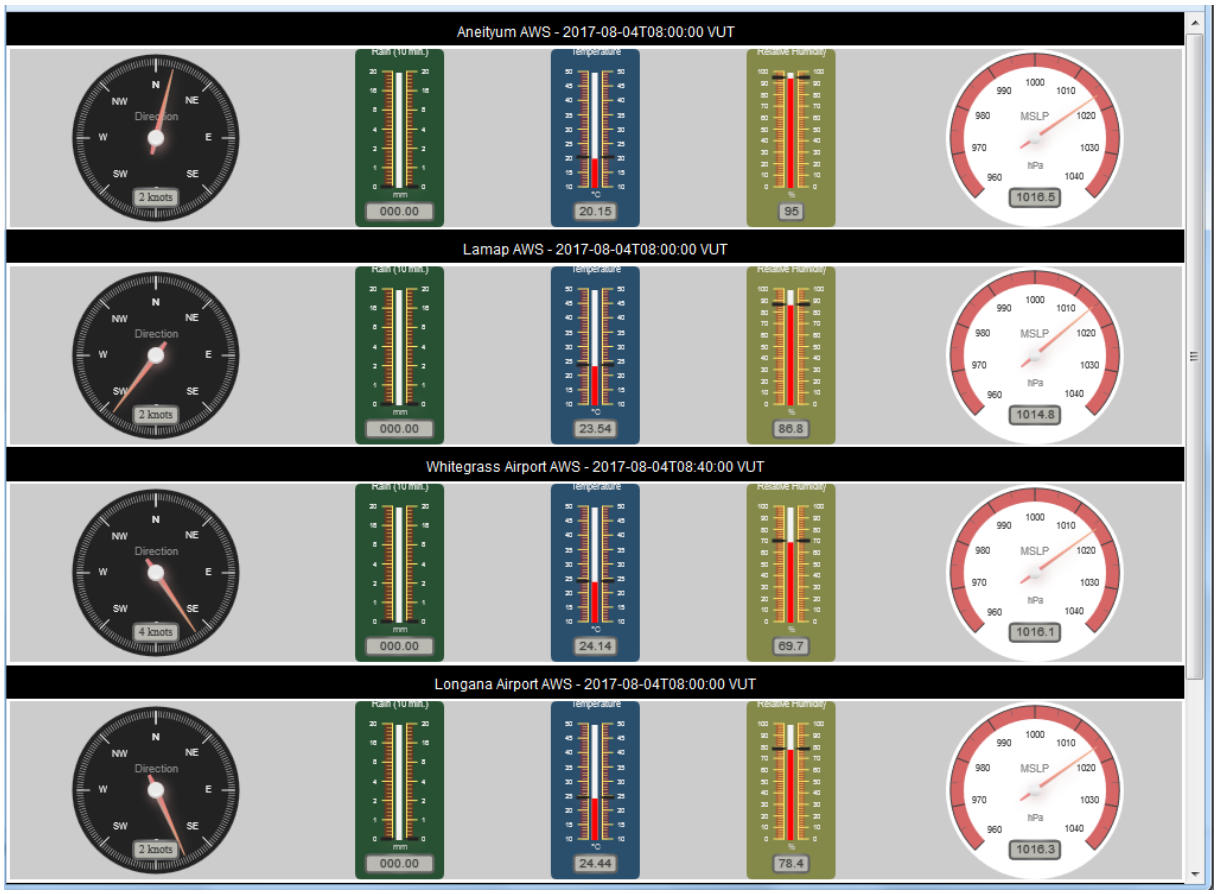


Figure 5-1: NEON dashboard for viewing near real-time data.

A combined dashboard display for the VCAP AWS sites has been set up drawing data in real time from the NEON server. An example display for four sites is shown below, and available at the following link:

http://clidesc.vmgd.gov.vu/clidesc/MetData/gauges_niwa.php



A similar dashboard has been set up to view data from the JICA stations at Bauerfield and Pekoa AWS:

http://192.168.60.30/clidesc/MetData/gauges_jica.php

See also the VCAP Progress Report 2 (Reference 3) and Section 7.1 below.

6 Products and services generation with CliDEsc

During August 2017, the upgraded CliDEsc software suite was installed on a new rack-mounted server (HP DL360) located in the VMGD server room.

The CliDEsc product generator application login page is found at:

http://clidesc.vmgd.gov.vu/clidesc/

User authorisation is managed at the CliDEsc Admin level by the manager of the Climate Section.

CliDEsc products can be generated using data from CliDE (or other databases), sourcing data from other web based data services, or from special data sets stored in CliDEsc internal files.

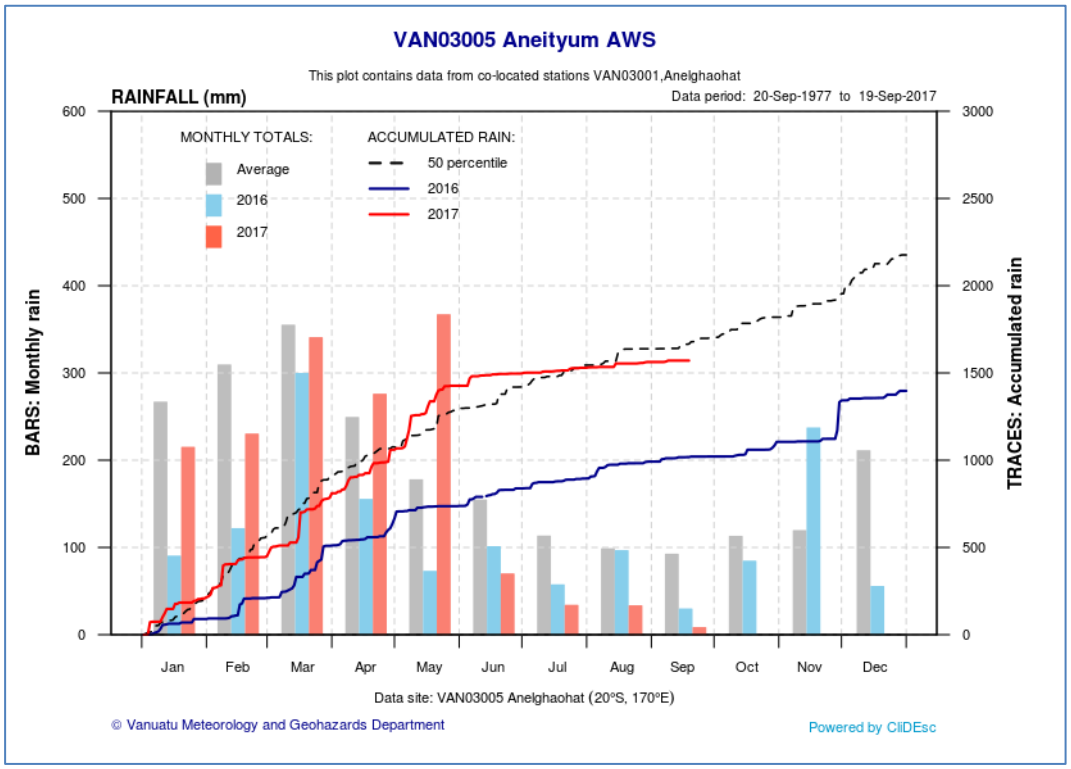
Approximately 50 CliDEsc generator products are now installed (see on-line CliDEsc Product Catalogue), and are accessible for VMGD staff to use. Note that some of these are demonstration products to explore ways of providing useful data visualisations that meet client expectations and level of understanding, and to help manage specific risk management needs. (See Future product innovations, Section 6-2.)

The generation of CliDEsc products is menu driven at the User Interface. Users combine station and product selection to create time series of a range of data. Various products, including maps, use data from several or many stations.

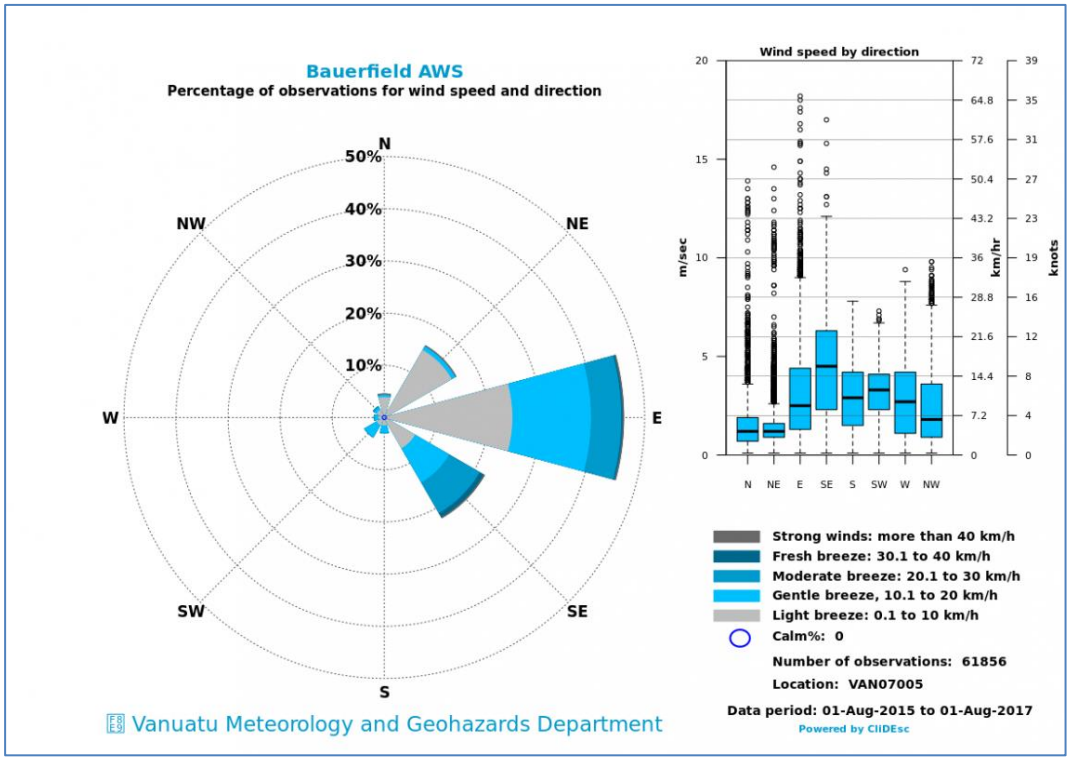
CliDEsc is designed to allow experienced users to register additional products as under Admin access authority.

6.1 Data time series

The CliDEsc User Guide (Reference 10) contains example views of data time series. An example is simple time series of rainfall data is provided below. In addition to the output visualisation, the data used are conveniently available in text format for download.



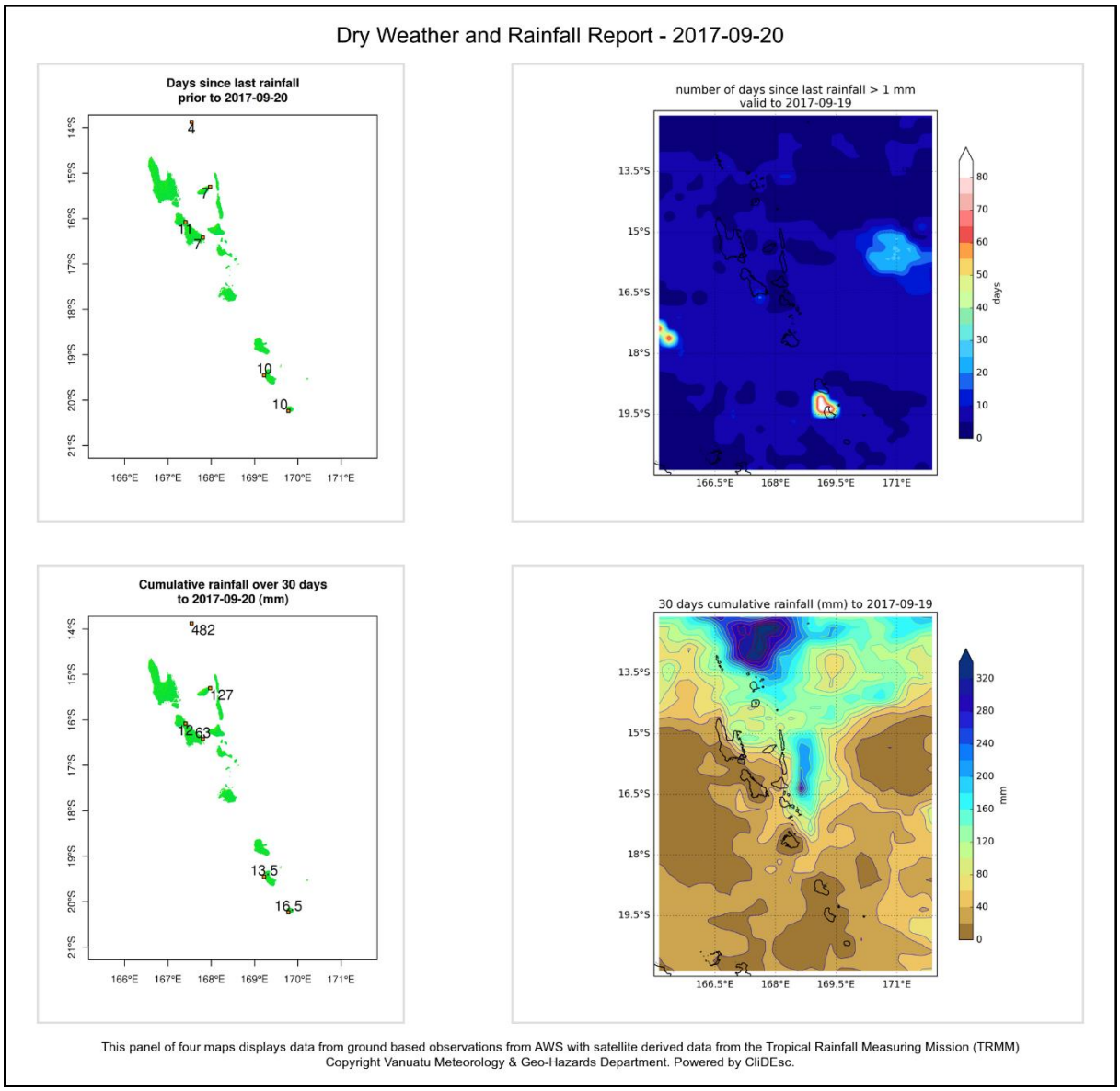
Customised products can be easily developed in CliDEsc to meet specific user requirements, such as the common wind analysis format shown below.



There are also a number of products under on-going design, which may be shown by VMGD climate staff to potential clients and stakeholders to seek feedback for further development of the product

generator code. NIWA is happy to support the ongoing work of improving product design as may be needed in response to requests for more customised climate information and services.

There is significant potential to to build on these examples and develop improved climate risk-management and decision-support tools and advisory bulletins.



As shown above, CliDEsc can access public facing web services to enhance or support data derived from local observations.

An example accessing a web service is shown below (Source http://www.bom.gov.au/climate/current/SOIValues.txt). CliDEsc retrieves the data in text format and renders the data image is a convenient format.

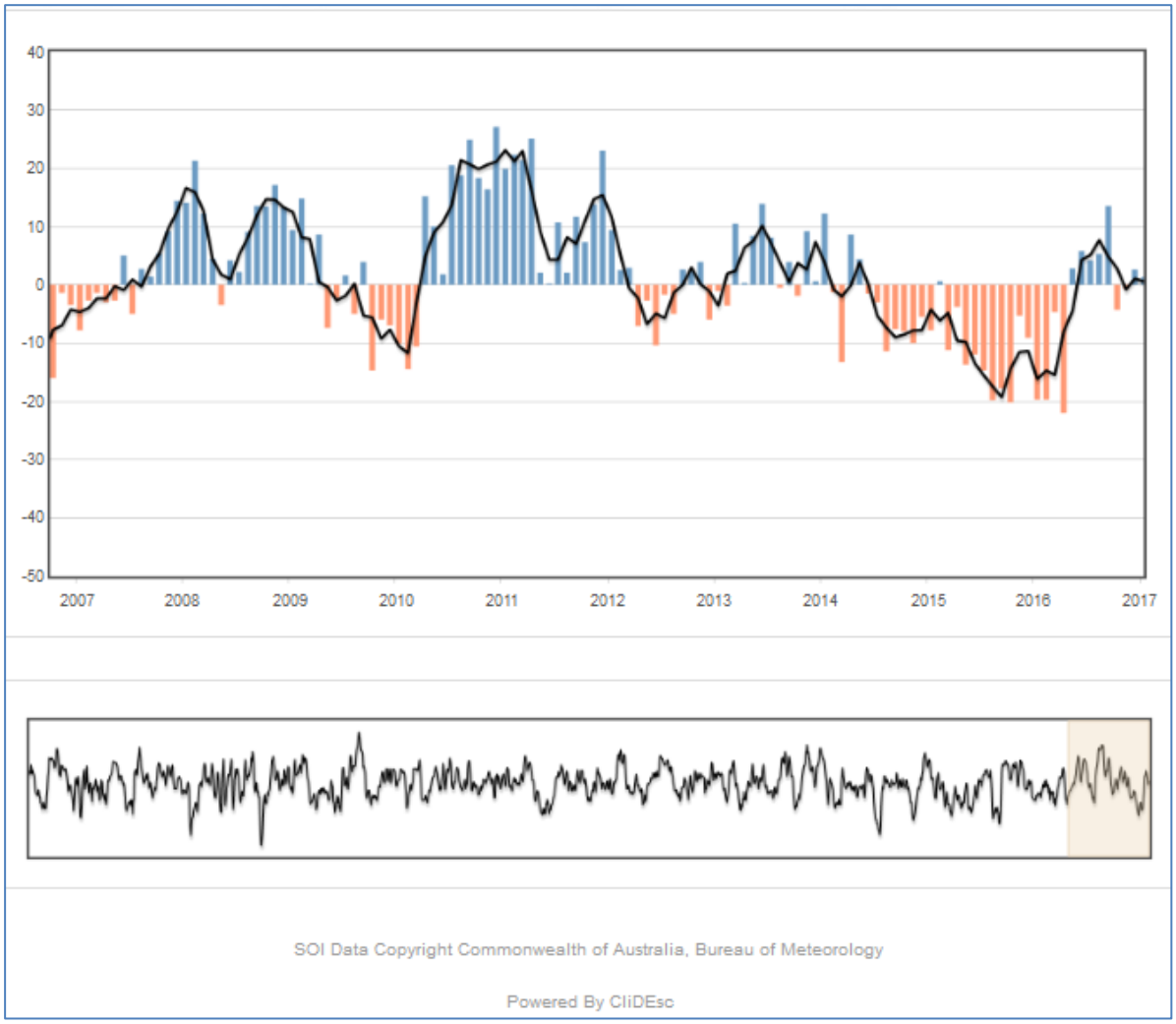


Figure 6-1: CliDEsc rendering of the Southern Oscillation Index time series, sourced from the above url. By dragging the mouse across the lower panel, any period of interest during the SOI time series can be selected.

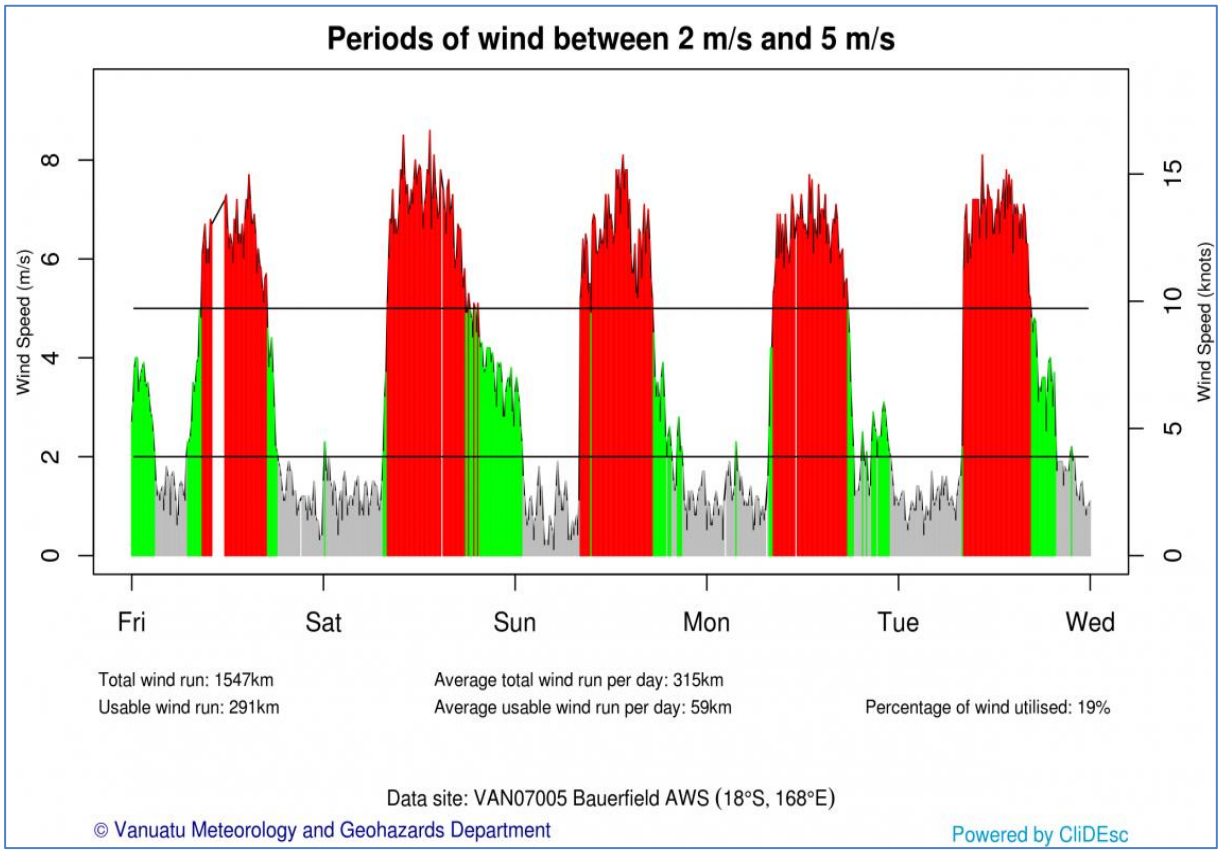
6.2 Future product innovation

CliDEsc users can develop the skills to code and install new product generators to meet specific client requirements and customised services, or enhance existing products.

The development of new products requires experimentation and exposing potential clients and users of climate information to possible data analyses, visualisations, and example tailorised products.

Regular follow up with key sector stakeholders will be essential.

The example below of an ad hoc prototype product is an example starting point for a potential new product focussing on site winds as a resource for turbine driven energy production.

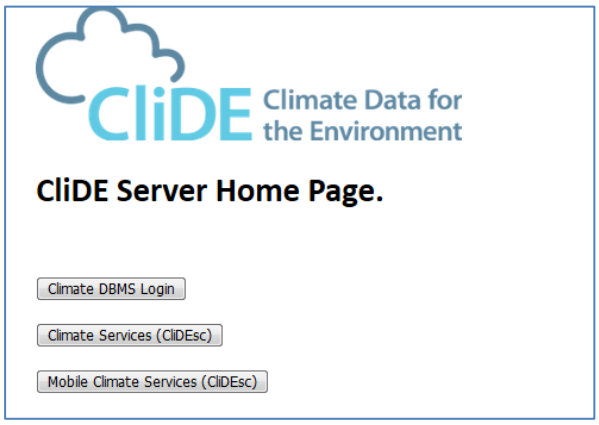


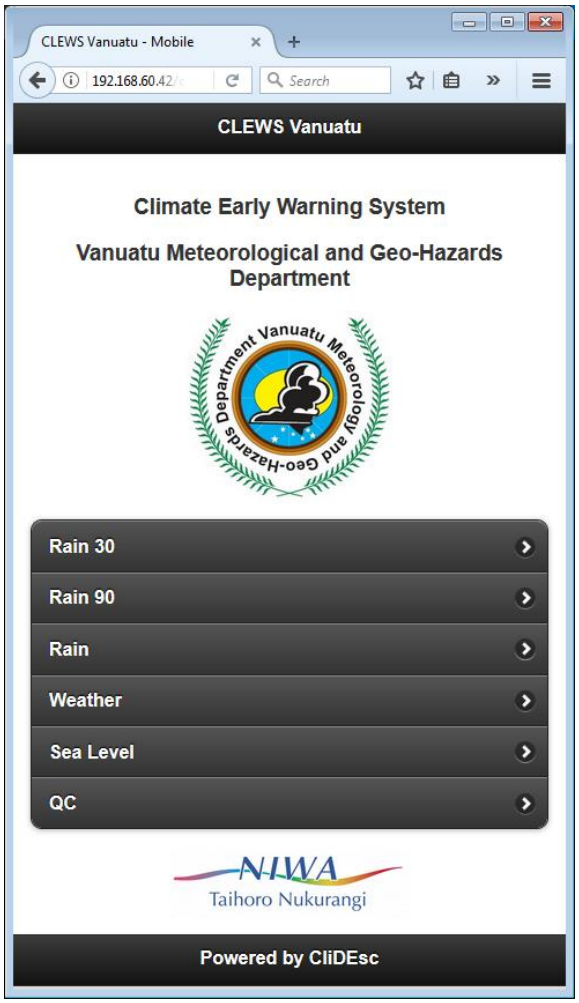
The above product is an example of the process of designing data views that can be developed to meet specific sector needs. The data could be used to calculate the probability of effective wind speeds for wind turbine energy generation.

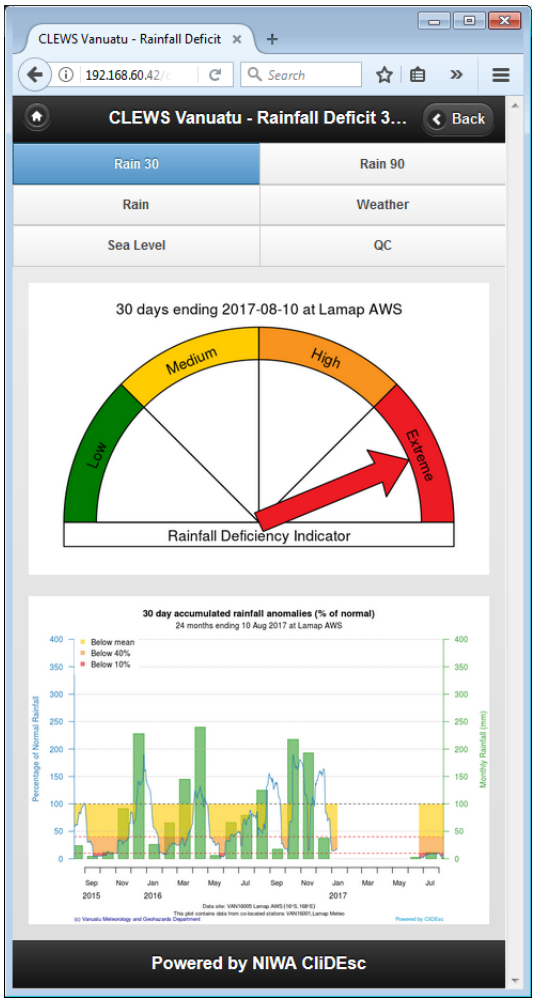
6.3 Mobile device web page

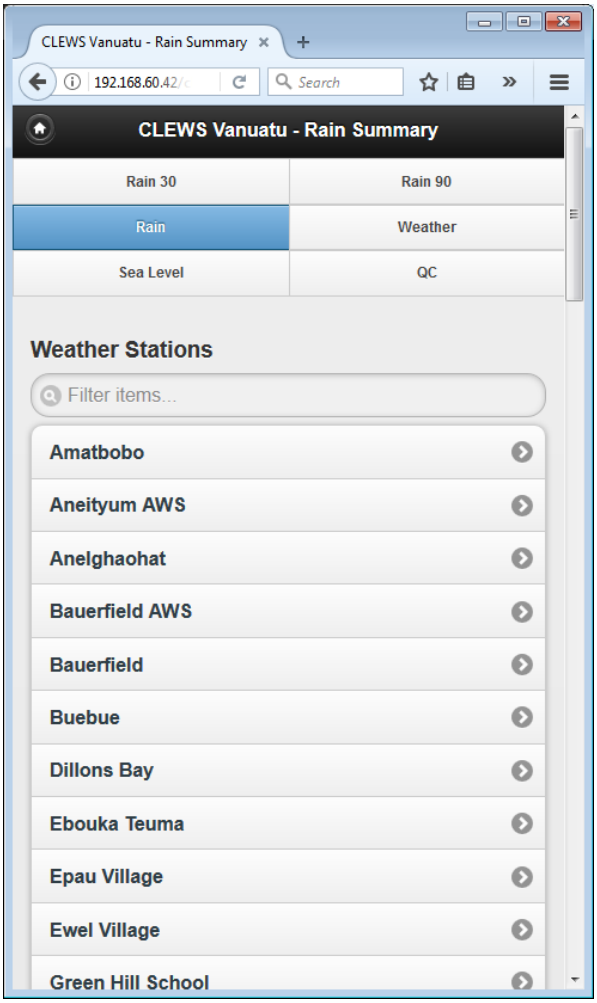
A mobile web site will be made available to display a range of different products coming from CliDEsc similar to what has been done already in Samoa, Solomon Islands and Fiji.

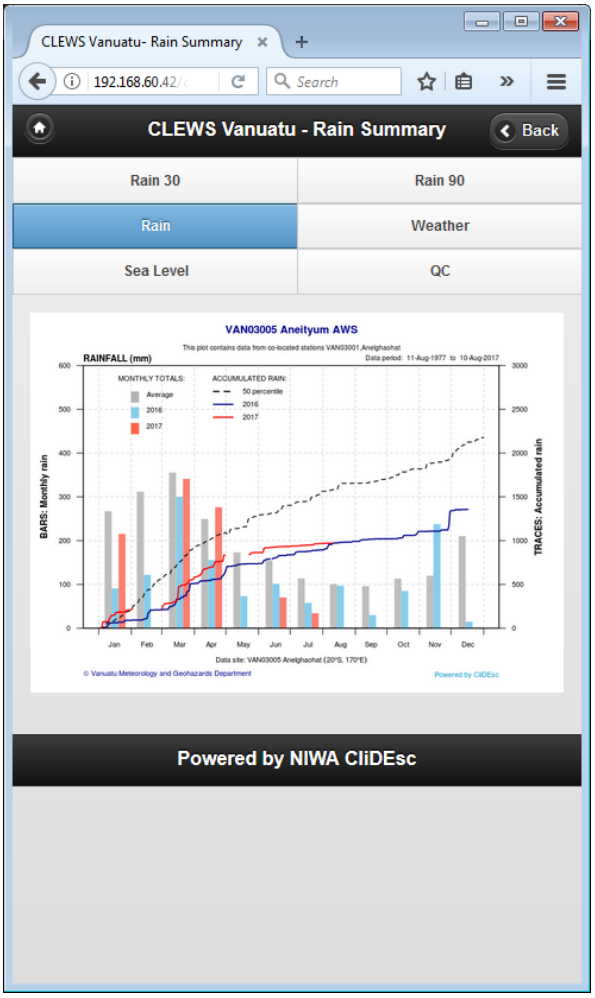
Go to http://192.168.60.30/ and click on 'Mobile Climate Services (CliDEsc).








CLEWS Vanuatu - Rain Summary
192.168.60.42/
Search
CLEWS Vanuatu - Rain Summary
Rain 30
Rain 90
Rain
Weather
Sea Level
QC
Weather Stations
Filter items...
Amatbobo
Aneityum AWS
Anelghaohat
Bauerfield AWS
Bauerfield
Buebue
Dillons Bay
Ebouka Teuma
Epau Village
Ewel Village
Green Hill School


CLEWS Vanuatu- Rain Summary
192.168.60.42/
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Rain 30
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Rain
Weather
Sea Level
QC
VAN03005 Aneityum AWS
RAINFALL (mm)
MONTHLY TOTALS:
Average
2016
2017
ACCUMULATED RAIN:
50 percentile
2016
2017
BARS: Monthly rain
TRACES: Accumulated rain
Jan
Feb
Mar
Apr
May
Jun
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Aug
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Oct
Nov
Dec
Powered by NIWA CliDEsc

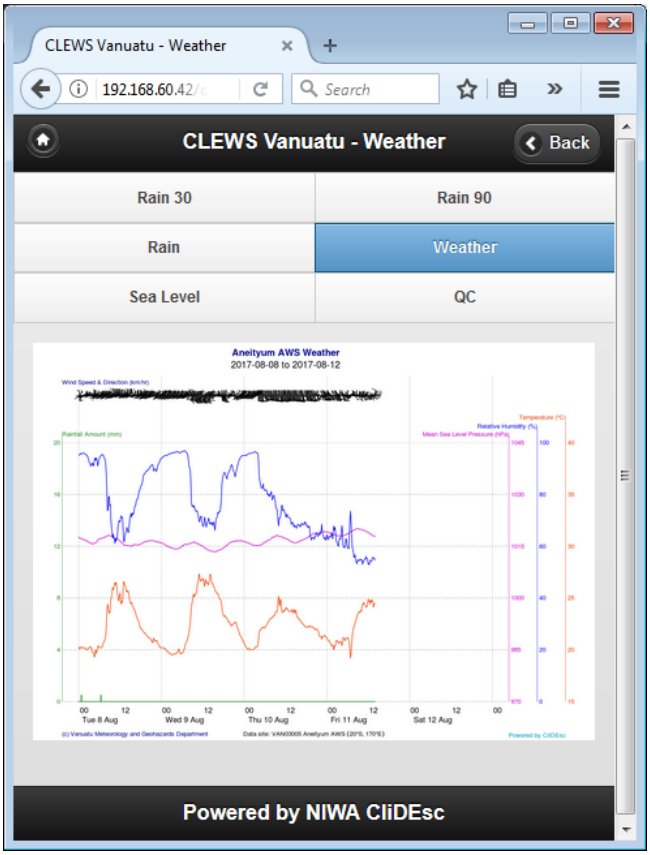


Figure 6-2: CliDEsc products formatted for a mobile device.

7 Additional data integration under VCAP

7.1 JICA stations

The JICA AWS 10-minute data are available on the MSS server as a csv file. NIWA has installed software to access the data on this server, do some basic quality control, and push the data every hour to CliDE, obs_aws table. A series of sample files has been captured for further investigation and format testing. A basic dashboard has been set up by NIWA to display the data after archiving to CliDE, see the figure below (Figure 7-1).

JICA stations now auto-ingesting to CliDE are:

VAN07005 Bauerfield AWS, Efate
VAN25005 Pekoa AWS, Santo
VAN55301 Litzlitz Sea Level, Malekula
VAN55601 Lenakel Sea Level, Tanna

Real time data display of JICA station data can be found at the following site on the VMGD LAN:

http://192.168.60.30/clidesc/MetData/gauges_jica.php

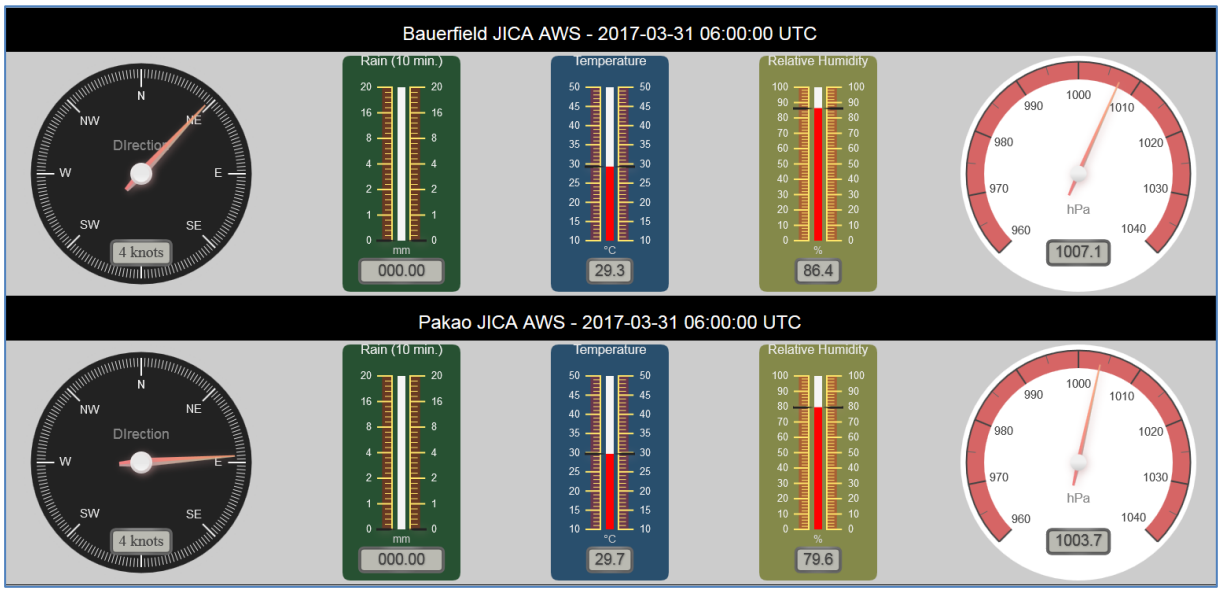


Figure 7-1: Near real-time weather dashboard display under development. This set is connected to the JICA server and will automatically refresh the display each time new data become available on the server (currently every five minutes).

The JICA station data can also now be displayed within CliDEsc (Figure 7-2), using the Meteogram, AWS product generator.

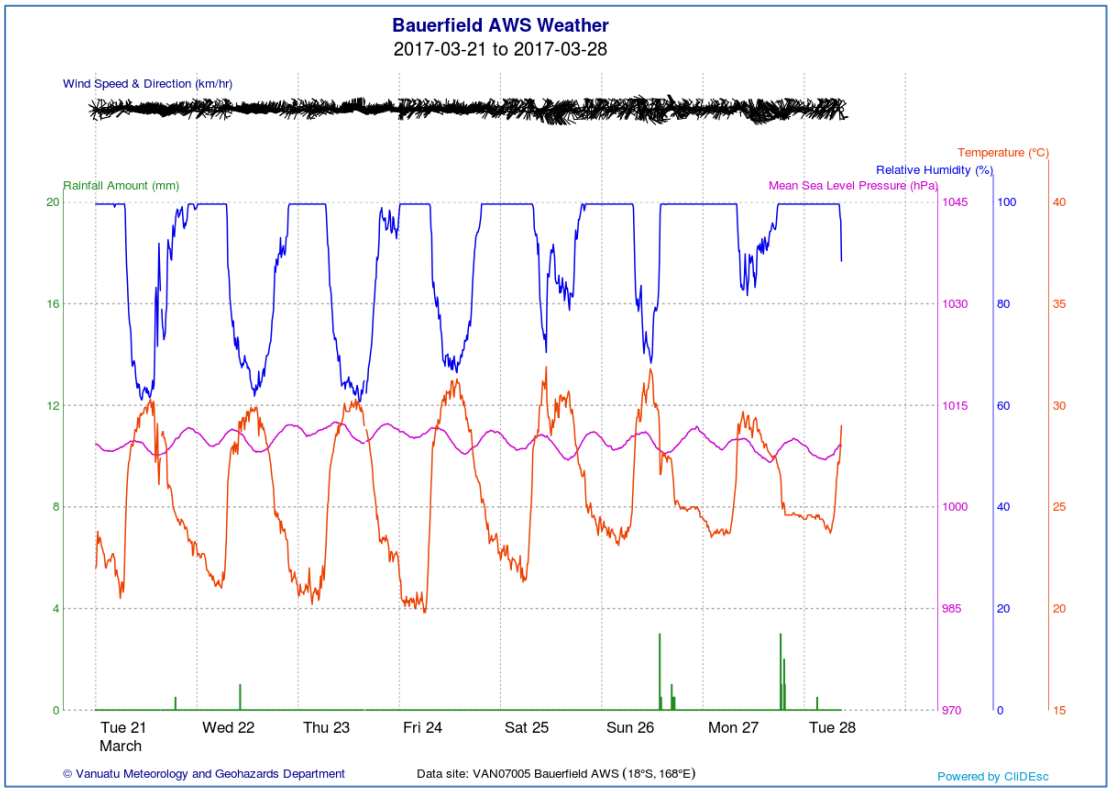
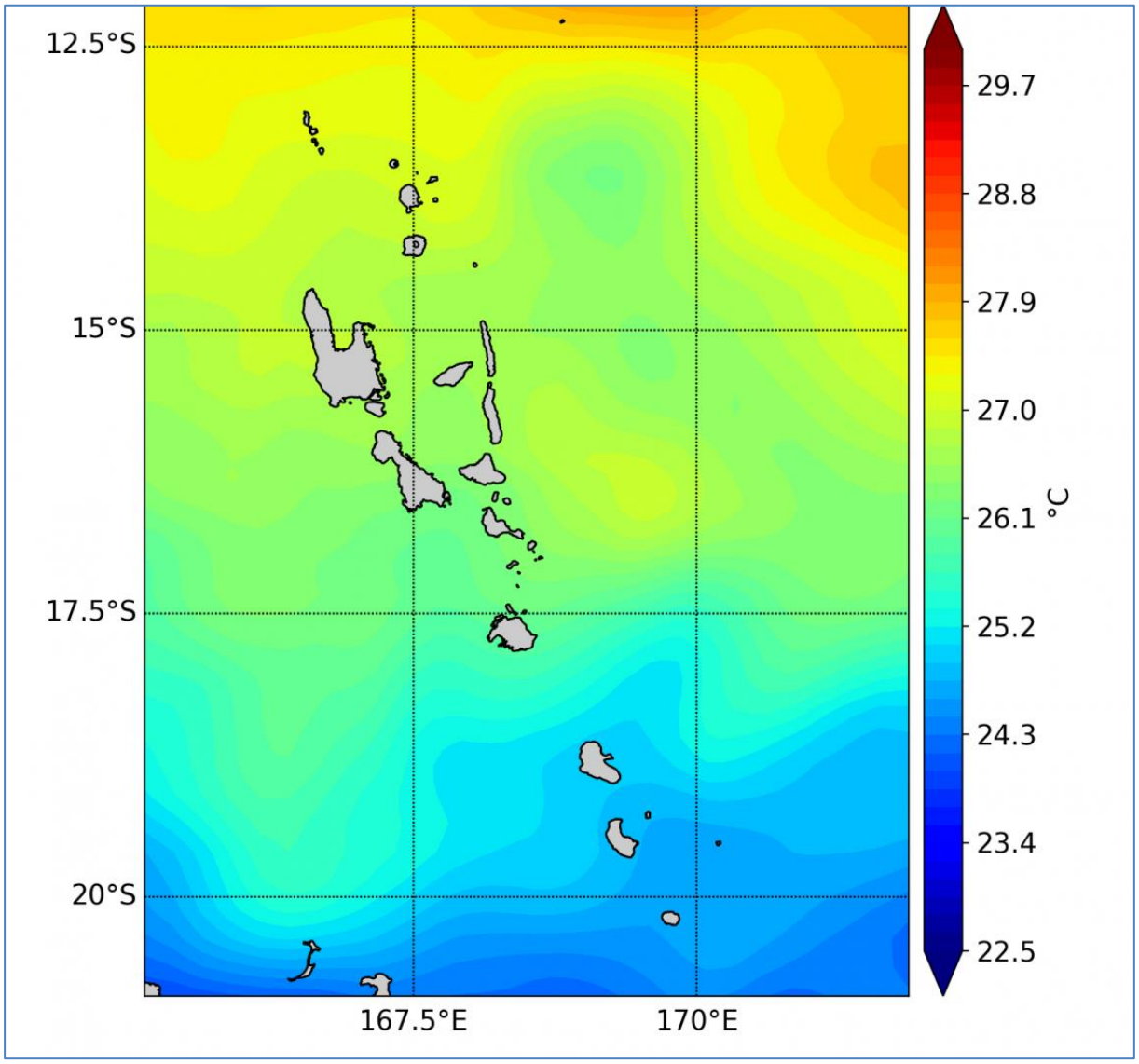


Figure 7-2: CliDEsc product showing 10-minute data from Bauerfield AWS.

7.2 NOAA Marine Data

CliDEsc includes a product to source sea surface temperature data from NOAA and visualise data for the Vanuatu region as a CliDEsc product.

An example is shown below.


12.5°S
15°S
17.5°S
20°S
167.5°E
170°E
29.7
28.8
27.9
27.0
26.1
25.2
24.3
23.4
22.5
°C

7.3 BOM Sea Frame station

At the request of VMGD staff, NIWA downloaded data for the Port Vila BOM sea-level station (station VAN07003) for 1993-2017 and ingested the data into CliDE. A display of a sample of the data is shown below (Figure 7-3).

A quality plot of a sample of the data is shown in Figure 7-4. The figure shows wind and pressure changes during Cyclone Pam, March 2015.

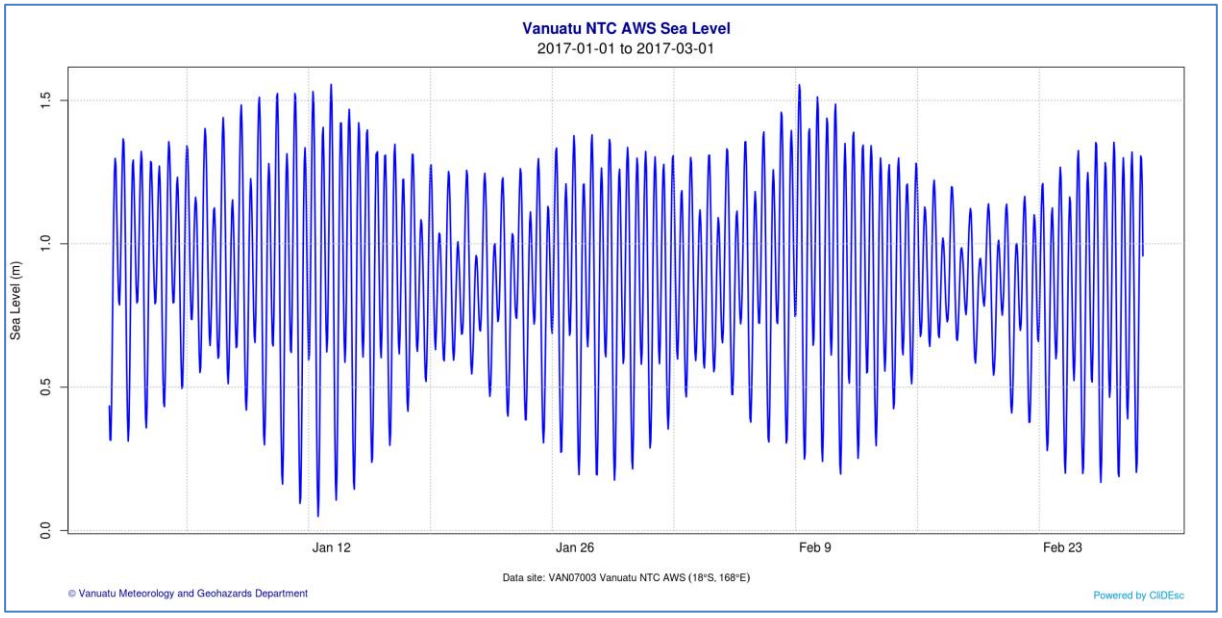


Figure 7-3: Sample sea level data for Vanuatu NTC sea-level station.

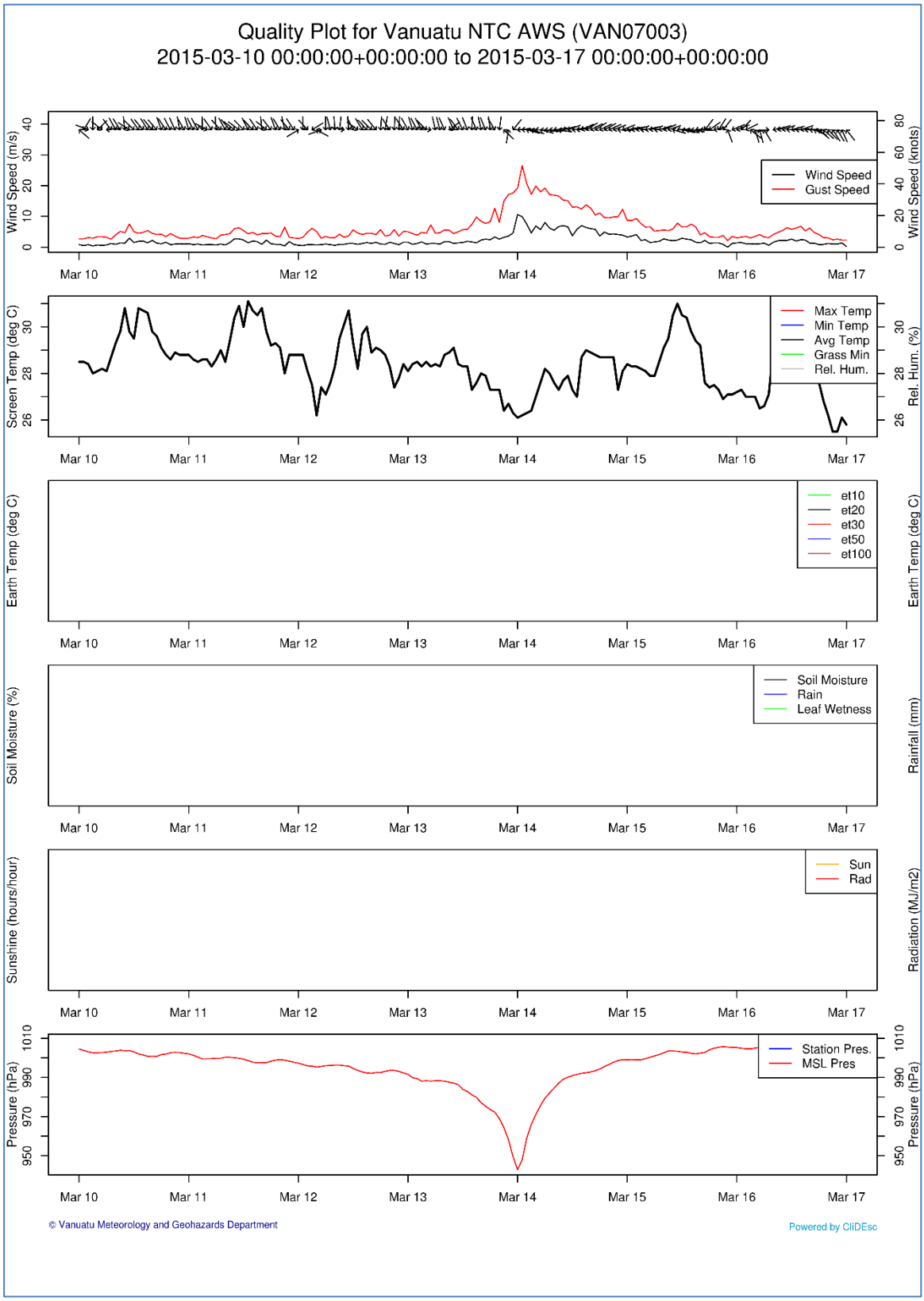


Figure 7-4: Quality plot showing impact of Cyclone Pam. The pressure dropped to 942.9 hP at midnight.

7.4 Synop and METAR automatic coding system

The Vanuatu Meteorological and Geo-Hazards Department (VMGD) requested a web form to provide them with pre-coded SYNOP and METAR messages for the newly installed NIWA stations. A web form was developed and installed at VMGD and training was provided.

The system will remove the need for staff in the field to call in their observations, saving time and potentially reducing the number of errors.

The web form is designed to pre-code the following messages:
SYNOP both MANUAL and AWS
METAR
CLIMAT

This document provides technical information about how the system works and serves as a user guide for both the field staff and quality control person. The system will be used by observers in the field and the quality control person at Bauerfield airport.

7.5 Rainfall data entry form

Under VCAP it was planned to develop a data entry form will be developed to allow volunteer observers of daily rain gauge data to submit data via a mobile web form which will directly upload to CliDE. The data will be automatically quality assured by processes within the data entry form. Use of the form will require the observer to have access to the internet.

This will overcome the delay in receiving rainfall data via field books, and eliminate the need for manual key entry. This form is currently under test and will be installed during a subsequent visit.

The development of this form was delayed due to the above work (Section 7.4 taking priority). However it can still be developed as part of the next project work programme.

8 Technical training

Successful management of climate and hydrological 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.

To assist with the development of VCAP and similar climate early warning projects, NIWA has developed a 'Workbook for Operational Competencies' – a practical guide to assist staff who are managing climate and hydrological networks to accomplish a range of operational tasks that constitute, in a logical framework and order, the connected components of Vanuatu's national climate and hydrological monitoring infrastructure and services.

The Workbook is set out in a sequence of objectives, tasks and check lists, from the planning and development of a robust climate network and high quality observational record, through to the delivery of information to aid decision making and mitigate climate risk.

Each set of tasks is referenced to sources of relevant training and technical guidance for further information. Where relevant, references are to the appropriate World Meteorological Organisation (WMO) technical guides, to ensure alignment with WMO recommended methods and competencies, and as a resource to provide supplementary training material where it is needed.

Also referenced are operational guides and manuals specific to Vanuatu's climate network infrastructure and systems – including automatic weather stations (AWS), telemetry (NEON or other systems), data ingest (eg. DataToCliDE), data management (CliDE) and product generators (CliDEsc).

The Workbook is designed to expand technical knowledge and achieve improved competencies in the context of day-to-day responsibilities and operational tasks, in order to strengthen both individual and institutional capability to deliver sustainable and improving information services.

This Workbook aims to assist the Government of Vanuatu's endeavour to improve national infrastructure and capability for enhanced weather and climate services. It 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.

8.1 Training modules

NIWA training provided for VMGD technical staff under VCAP has been guided by the *Vanuatu Climate Networks and Operational Services: Workbook for Operational Competencies,* developed by NIWA.

The scope of the topics covered in this Workbook are set out in six Training Modules. Module 1 explores the strategic and technical issues as background to the infrastructure and services needed to build climate resilience in Vanuatu. Modules 2 - 6 aim to provide the technical and hands-on training relevant to the operation of each component of the climate data and services system.

Specifically, Modules 2-5 break down the technical training into specialist operational requirements and component tasks. Module 6 then aims to bring the whole system together to deliver information and customised outputs for day to day climate risk management.

The focus of the training is on technical understanding and operational competencies. The training does not distinguish between staff with different specialist academic or technical qualifications, but aims to provide hands-on participatory experience for all operational staff.

Key outcomes are:

1. All staff involved in climate data information, services and early warning systems in Fiji have a general understanding of all aspects of the system and its national and international relevance.
2. Improved staff knowledge, skills and competencies related to key operations of climate services, including climate instruments, telemetry systems, data integration, product development, and sector engagement.
3. Increased opportunities for staff who have demonstrated competencies in carrying out key operational tasks to obtain accreditation.
4. Improved institutional capacity to sustain, maintain and operate national climate services and build climate resilience within vulnerable communities and economic sectors.
5. Each staff member is provided with a copy of this Workbook for Operational Competencies to support and record their own achievements in institutional and self-motivated training and competencies.

The training provided under the six modules is recorded in Appendices A and C.

Table 8-1: Brief description of the six training modules from the Workbook for Operational Competencies developed by NIWA.

Module 1 Climate services – strategic and technical overview (and how to use this Workbook)	Module 1 is expected to set the scene for the training, based on having a good understanding of the strategic objectives of developing a climate early warning system. The Module will encompass a working awareness of national adaptation plans, sector science and information needs, and institutional operational objectives. Participants will become familiar with the basic operational elements of a robust and effective climate information and early warning system (CLEWS).
Module 2 Instruments and measurements	Module 2 will cover basic aspects of network design but focus mainly on climate instruments and measurements, and building and maintaining climate stations. Training will include laboratory and field work. Exercises will include configuration of climate stations, and setting up and calibrating instruments for climate observations, installation requirements, trouble shooting, maintenance and metadata.
Module 3 Data transfer, telemetry and integration	Module 3 will be carried out in parallel with Module 2 and will focus 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 the FMS Weather Forecasting System.
Module 4 Data storage and quality management	Module 4 will focus on managing the data in the CliDE database management system, with a particular focus on quality assurance. Topics will 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.

Module 5 Climate monitoring, products and client services	Modules 5 will aim 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.
Module 6 Sector engagement, decision support and risk management	Module 6 will encourage 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 may include the development and installation of new CliDEsc product generators. Skills in product coding and data analysis will be encouraged.

Figure 8-1: Technical training undertaken by VMGD staff in New Zealand during the preparation of the VCAP climate station equipment.

A record of training hours, both conducted and planned, is provided in Appendix A.

Figure 8-2: Above: VMGD climate staff during CliDE/CliDEsc training.

9 Support contract

The V-CAP Contract stipulates that arrangements should be made to put in place a contract for maintenance support after the completion of the VCAP project.

10 References

1. Vanuatu Climate Early Warning System – RFT GOI/03: Proposal for supply, delivery and installation of AWS and IWFS for Vanuatu Meteorology and Geo-Hazards Department. Prepared for the Ministry of Climate Change, July 2016

2. Vanuatu Coastal Adaptation Project (V-CAP). AWS Installation – Progress Report 1. Prepared for Vanuatu Meteorology and Geo-Hazard Department. NIWA Client Report WGN2016.

3. Vanuatu Coastal Adaptation Project (V-CAP). AWS Installation – Progress Report 2. Prepared for Vanuatu Meteorology and Geo-Hazard Department. NIWA Client Report 2017082WN.

4. Vanuatu Coastal Adaptation Project (V-CAP). Climate information and services workshop. Prepared for Vanuatu Meteorology and Geo-Hazard Department. NIWA Client Report 2017xxxWN, May 2017.

5. Vanuatu Coastal Adaptation Project (V-CAP). Climate information and services workshop report. Prepared for Vanuatu Meteorology and Geo-Hazard Department. NIWA Client Report 2017xxxWN, 2 May 2017.

6. Flanagan, M (2017a): Vanuatu Coastal Adaptation Project – AWS Installation Report, Mission 1. Prepared for Vanuatu Meteorology and Geo-Hazard Department. NIWA Client Report 2017191EI, June 2017.

7. Flanagan, M (2017b): Vanuatu Coastal Adaptation Project – AWS Installation Report, Mission 2. Prepared for Vanuatu Meteorology and Geo-Hazard Department. NIWA Client Report 2017191EI, July 2017.

8. Harper, A and Gorden, K (2017): Automatic Weather Station Operations Manual. *AWS User and Maintenance Guide.* Prepared for Vanuatu Meteorology and Geo-Hazards Department.

9. Miville, Bernard (2017): SYNOP and METAR automated messages coding for Vanuatu Meteorological and Geo-Hazards Department. *Operations User Guide*

10. Porteous, A, Miville, B and Powell, J (2017): CliDEsc Documentation. *User Guide v1.0.* Prepared for Vanuatu Meteorology and Geo-Hazards Department, August 2017.

11. VMGD climate network AWS Draft Maintenance Contract. Prepared for VMGD, August 2017.

12. Vanuatu Climate Networks and Operational Services: Workbook for Operational Competencies

Appendix A: V-CAP Training Completed

Date and Training event	No of staff	M1	M2	M3	M4	M5	M6	Hours completed under V-CAP
Technical staff training in Christchurch, Jan-Feb 2017	2 (2M)	■						1
Technical staff training in Christchurch	2 (2M)		■					80
Technical staff training in Christchurch	2 (2M)			■				30
Technical staff training in Christchurch	2 (2M)				■			10
28 March, CLEWS Training	12	■						1
28 March, CliDE, CliDEsc training	6 (2F,4M)				■	■	■	3
27 March, station planning and installation	6	■	■					3
28 March, AWS equipment testing	1		■	■				4
29 March, AWS testing; spare station set up	1		■	■				4
30 March, telemetry	3		■	■				3
31 March, NEON, Dishpointer	3			■				3
29 March, CliDEsc training	6				■	■		2
30 March, CliDEsc software training	1					■		1
14 May-10 June AWS Installation Aneityum, Whitegrass and Lamap	4+	■	■	■	■			33
30 June to 15 July AWS installations Longana and Norsup	4+	■	■	■	■			12
3-8 August, Data management and reporting (climate)	6+				■	■		6
3-8 August, Synoptic and METAR reporting, automatic coding	8 (3F,5M)	■	■		■	■	■	4
3-8 August, Sector engagement and customisation	2					■	■	2
18 September, Data management and report; correction of site locations	2	■						1
19 September, CliDEsc products (climate and NDMO staff)	5 (1F,4M)					■	■	3
21 September, CliDEsc products and system training	7 (3F,4M)					■	■	3

Appendix B: Implementation Log Frame

The following table is a record of all implementation activities for the V-CAP project.

Date	Activity	Outputs	Item Project Deliverable (Tender Response Schedule TRS)
22 June 2016	Tender submitted for Supply, Delivery and Installation of Automatic Weather Stations throughout Vanuatu and Integrated Forecasting System for Vanuatu Meteorological And Geo-Hazard Department.		RFT G01/03
6 July 2016	Submitted amended Tender, excluding taxes and duties in tendered prices (at request of Tenders Board)		
13 October 2016	Supply Contract final draft signed by NIWA		
14 October 2016	Supply Contract SCG02 agreed and signed by Minister of Climate Change, Government of Vanuatu		
29 November to 2 December, 2016	NIWA project staff visit to VMGD, Port Vila. Review of itemised Scope of Work.	Progress Report 1 ▪ Work plan and implementation timeline ▪ Field installations and materials ▪ Data integration, IT hardware and operations ▪ Training scope and schedule	TRS 9-1
7 December 2016	NIWA team technical meeting, Christchurch	Implementation work plan update and allocation of resources, technical personnel, equipment orders, training schedule, project phasing.	TRS 3, 4, 5, 8, 9

Date	Activity	Outputs	Item Project Deliverable (Tender Response Schedule TRS)
23 January to 17 February, 2017 VMGD tech training in New Zealand	Two VMGD technical staff attended NIWA Instrument Systems Training, Christchurch, New Zealand (Jeremy, Pattison) Week 1 of training. J Bani and P Naut arrive Christchurch for training. Installation of software on laptop and the NIWA Stardroid and SDI-12 phone apps. Instrument basics, wiring, configuring and testing. Troubleshooting and repairing wind instruments. WMO siting classification.	Technical training for 2 staff M1 (Strategic settings) 4 hours M2 (Instruments and Measurements) 80 hours M3 (Data transfer, telemetry and integration) 30 hours M4 (Data storage and quality management) 10 hours Module 2 – Topics 2, 3, 4, 5, 6, 7 and 8 Module 3 – Topic 2	TRS 4-6
	Week 2 of training Networks and planning. Neon - Communications and data logger setup. Starlog V4 - Data logger programming. SDI-12 Device configuration. Connecting sensors to logger and comms for end to end bench testing.	Module 1 – Topics 1, 2, 3, 4, 5, 6 and 7 Module 2 – Topics 2, 3, 4, 5, 6, 7 and 8 Module 3 – Topics 1, 2, 3 and 4	
	Week 3 of training AWS assembly and bench testing. - Includes Smarti configuration, instrument calibration, NEON setup, logger programming and reprogramming, communications setup and any trouble shooting Visit to Arthurs Pass EWS - Inspection and site maintenance, including field testing of instruments, sensor exchange, checking and updating station documentation (MetaData) and WMO siting classification. CliDE - overview (administration, station setup and registration, metadata, data tables and types, data entry, data QA, data reports)	Module 2 – Topics 2, 3, 4, 5, 6, 7 and 8 Module 3 – Topics 1, 2, 3 and 4 Module 4 – Topics 1, 2, 3, 4, 5 and 6	

Date	Activity	Outputs	Item Project Deliverable (Tender Response Schedule TRS)
	Week 4 of training AWS assembly and bench testing. - Includes Smarti configuration, instrument calibration, NEON setup, logger programming and reprogramming, communications setup and any trouble shooting Dishpointer - Used to find locations of new AWS and to determine antenna angles.	Module 2 – Topics 2, 3, 4, 5, 6, 7 and 8 Module 3 – Topics 1, 2, 3 and 4	
18 February 2017	J Bani and P Naut depart Christchurch.		
22 February 2017	Container packing completed. Climate station equipment picked up from Christchurch by DHL	Shipping ex New Zealand	
3 March 2017	Equipment/container shipped from Auckland by Southern Moana, Voyage 299		
19 March 2017	Vessel arrival Port Vila		
19-31 March 2017	NIWA implementation team working at VMGD Alan Porteous, John Powell, Bernard Miville, Andrew Harper (from 23 March)		
20 March 2017	CliDEsc installation	CliDEsc software suite installed in CliDE server. (Note this is fully operational, but remains a temporary option until the dedicated new HP server becomes available.)	
23-31 March 2017 Pre-installation technical mission	23 March Afternoon meeting with P Mawa and J Mala re-installations. Brief overview of system and Neon demonstration. Scouting on roof for GIZ? Site.		

Date	Activity	Outputs	Item Project Deliverable (Tender Response Schedule TRS)
	24 March Meeting with Sam. Visit to suppliers for hardware and fencing supplies. PTH quote for materials is best. Meeting at PTH to confirm quantities and cutting of pipe to length for fences. Vate Industries to supply and thread pipe for masts. Visit to DHL and Wharf to follow-up on air freight and container. Assured container to be delivered today.		
	27 March Afternoon training (Module 2 – planning) on logistics to work through for installations. Patterson, Peter, Sam, Patricia, Grace and Esther attended. Quote from PTH arrived. Arranged urgent payment by NIWA Corporate. PTH unable to supply gates. Arranged with Vate Industries to manufacture gates. Contained still retained at Port Vila port.	Module 1 – Topic 4 Module 2 – Topic 4	
	28 March Container arrived last night. Verified contents arrived in good condition with Patterson. Also confirmed tools supplied as per contract. Patterson tested the spare and three AWS loggers and communications. Pipe for masts arrived from Vate Industries.	Module 2 – Topics 4 and 8 Module 3 – Topics 1, 3 and 4	

Date	Activity	Outputs	Item Project Deliverable (Tender Response Schedule TRS)
	29 March Patterson completes testing of the remaining AWS. Patterson then sets up the spare AWS in the office for familiarization. Spent time with Patricia entering new stations in CliDE and working through the equipment lists to be entered into CliDE. Demonstrated the examples and the types of MetaData required. Also worked through and left electronic copies of various manuals and guidance material from WMO, PMC, NIWA and instrument manufacturers. Joe, Patricia and Grace on SYNOP codes and data integration into national and global systems.	Module 2 – Topics 4 and 8 Module 3 – Topics 1, 3 and 4 Modules 1 – Topics 4 and 7 Module 2 - Topics 1, 2, 3,4,5,6 and 8 Module 3 – Topics 1, 3, 4, 5 and 6	
	30 March Patt in morning – instrument familiarisation, NEON setting up weather station tabs, derived channels. Also recompiled and edited scheme. Demonstration to RESPAC Sam, Joe Patricia in afternoon for planning, budgets and logistics Labelling everything in container for shipping	Module 2 – Topics 4 and 8	
	31 March Completed container work Demonstration of end to end system to Patricia Patt – working on WIFI connections. Patricia, Patt and Severine – adding NEON users and user rights Dishpointer - Used to find locations of new AWS and to determine antenna angles. PTH gear arrived – delivered to Bauerfield Some materials still to come. Shipping lists to Joe, Patricia ad Sam	Module 2 – Topics 3, 4 and 8 Module 3 – Topics 1, 3 and 4.	
27 March 2017	Container cleared from Port and transported to VMGD	Container available for opening and equipment checking, 28 March, 2017.	

Date	Activity	Outputs	Item Project Deliverable (Tender Response Schedule TRS)
28-30 March 2017	Equipment checking, hardware purchases, Port Vila and VMGD	Hardware and materials purchases. AWS unit checking, comms testing Spare station set up for telemetry channel testing and training	
28 March 2017	Technical training, CLEWS	Technical training for 14 VMGD staff Overview of CLEWS system Technical training for Climate Division 9 staff M1 (Strategic settings) 1 hour M4 (Data storage and quality management) 1 hour M5 (Climate monitoring, products and client services) 1 hour M6 (Sector engagement, decision support and risk management) 1 hour	
29 March 2017	Technical training, CliDEsc	Technical training for Climate Division 9 staff M4, M5 (CliDE and CliDEsc) 2 hour M6 (Sector engagement, decision support and risk management) 1 hour	
29 March 2017	Server installation	Dedicated CliDEsc server installed on VMGD server rack	
30 March 2017	Technical training	One-one CliDE/CliDEsc training, 2 hours.	
31 March 2017	Technical training	One-on-one product development training (using R code), 1 hour.	
1 April 2017	NIWA team departs Port Vila for NZ.		
2-3 May 2017	Information Design Workshop. NIWA Team: Alan Porteous, Juli Ungaro, John Powell, Seema Singh	Report: Vanuatu Coastal Adaptation Project – climate information and services workshop report	TRS-4, Item 6
14 May 2017	Andrew Harper arrives Vanuatu		

Date	Activity	Outputs	Item Project Deliverable (Tender Response Schedule TRS)
15 May to 10 June 2017 AWS Installation Mission 1	Briefing with Sam, Jeremy and Patricia Account for payments. Visit shipping company for pay for Whitegrass shipment- MV Touaraken. This still has not left.	Setting up AWS installation, Mission 1 Training Module 2- Topic 4	TRS-4, Item 2
16 May	Visit airline to confirm and pay for flights to Whitegrass and Aneityum. Find out that we are now not leaving Thursday but on Sunday. Still having difficulty with return flight and four of team are currently waitlisted. Enquiries made on chartering flights. Very expensive option. Visit Vanuatu Shipping Company to get quotes for shipping to Lamap, Longana and Norsup.		
17 May	There is an ICT conference in town. VMGD have display. Jeremy sets up the spare AWS with BGAN communications and explains system to general public. Make cash payment for Lamap and arrange direct payment for Longana and Norsup shipping. Marty Flanagan arrived in Port Vila. Passport was confiscated by Airport customs immigration reportedly due to not having a 'business visa' approval for entry. This was disputed at the time but passport retained by Vanuatu Immigration for two weeks until resolved by VMGD Director.	Module 2 – Topic 4 Module 3 – Topics 3 and 4	
18 May	Collect fencing materials from Bauerfield and pack gear for Lamap. We hear that the PVC pipe was not delivered to Aneityum. We arranged for a barge to deliver some more and purchase this. At same time we are advised the remaining fencing netting (9 rolls) is still 2 weeks away.	Module 2 – Topic 4	
19 May	Deliver gear for Lamap. Collect fencing materials for Sola and pack gear in preparation for remaining sites. It is possible Sola may be sent next week. Visit airline to pay for Aneityum and Whitegrass flights. Jeremy is now confirmed for return to Whitegrass. Booking made for Loic Jimmy to Whitegrass. Confirm PVC pipe is on barge and make payments. ETD is tonight. Make DSA payments to installation team.	Module 2 – Topic 4	

Date	Activity	Outputs	Item Project Deliverable (Tender Response Schedule TRS)
20 May	Make payments for Lamap flights and final arrangements for trip.		
21-24 May **Aneityum AWS installation**	21 May Installation team departs. Andrew Harper and Marty Flanagan (NIWA), Sam Tapo (V-CAP), Joe Mala (VMGD Observations), Jeremy Bani, Patterson Naut (VMGD ICT) and Kalsuak Gorden (VMGD Climate) Arrive Aneityum early afternoon. Meet with local observers Tom Kaio and Joseph Feke. Unable to work but discuss layout and work through logistics for installation with team.	Module 2 – Topic 2	
22 May	Begin AWS installation. Barge has not yet departed so still missing PVC pipe and some fencing materials. Make local arrangements for use of some alcathene tubing. Dismantled and moved HF radio antenna to make way for AWS mast. Weather was very wet, but installation team along with some local help make an excellent start and AWS foundations all completed.	Module 2 – Topic 4 and 8	
23 May	Joe departs for Whitegrass to begin preparations to get site cleared as we noticed when in transit the site was not clear and start get sand and coral to the site for foundations. Team assemble mast and install sensors, complete cabling. AWS first initialized at 1610hrs Spent some time with Kalsuak working through station documentation requirements after observing him taking notes during the day as each sensor was installed.	Module 2 – Topics 4, 5, 6, 7 and 8 <u>Aneityum AWS Commissioned</u>	TRS-4, Item 2
24 May	Final tidy up of site works, sensor verification and station commissioning. Station documentation preparation. Patterson installed Wifi transmitter aerial on AWS mast. ICT still need to install receiver and internet link with communications site on Mystery Island. Provided further training, including VMGD station observers on maintenance and fault finding. Left materials and instructions with Joseph on how to erect the mesh fencing material for completion.	<u>Training</u> Module 2 – Topics 4, 5, 6, 7 and 8	

Date	Activity	Outputs	Item Project Deliverable (Tender Response Schedule TRS)
25-28 May Whitegrass Airport AWS installation	25 May Travel from Aneityum to Whitegrass. Had to charter a plane for four of the team as they were wait-listed until 28th. Also had to send all tool on the charter as we almost had to leave our personal bags behind to.	Module 2 – Topic 4	
	Visit wharf to check on boat unloading – still no progress. Visit proposed site with Airport Manager. Used second of the sites as the first location was borderline for aviation requirements for distance from runway and glide-paths. 1:7 from glide-path markers i.e., for every 1m in height, must be 7m distant. Joe turns up late in the afternoon with the timber and pipework for the AWS and fencing materials. At least we can make a start Met up with Dave Allen walking down the road.		
26 May	Andrew, Marty, Dave, Loic, Kalsuak and Patterson go to site to begin preparations and laying out of station. The remainder of team head to wharf to get cargo off ship. They were only able to get some of the remaining gear. Sam makes alternative arrangements for cement as this is still to be unloaded. Sam also arranges for the use of a vehicle. The foundations for the mast are completed just on dark.	Module 2 – Topic 4	
27 May	The team, excluding Joe, head out to site. Have a delay getting to the site due to aircraft movements. Once we get there, complete foundations (logger housing and rain gauge) and begin installing sensors. Kalsuak runs the 4 boys preparing the fence. Mast is raised late in the afternoon.	Module 2 – Topics 4 and 5	

Date	Activity	Outputs	Item Project Deliverable (Tender Response Schedule TRS)
28 May	Completed AWS, verification checks and commissioned station. Noticed starlog scheme issue with wind direction data value. Kalsuak and local observer Bradley Bani created site plans and Bradley went through station checklist. Remainder of fencing material arrived and made start on fencing. Internet connection was down, but were able to verify Wifi ping tests. On reviewing Aneityum data, noticed some issues with soil moisture not working and 10 and 100cm swapped. Sam Tapo returned to Port Vila. Dave Allen sick.	Module 2 – Topics 4 and 5 Whitegrass Airport AWS commissioned	
29 May	We are having cash-flow problems with transport and accommodation being more expensive than expected. Our NZ cards do not work in the local ATM and are not accepted by the bank. Arranged with NIWA Corporate to transfer funds via Western Union. Made arrangement for Marty and Jeremy to get back to Aneityum. Remainder of team to return to Port Vila next day. Final checks of AWS. New starlog scheme loaded to correct issue with wind direction parameter. Patterson set up the observing staff for access to Whitegrass on Neon and time spent with Bradley on using Neon. Also, gave a brief demonstration to the Airport Manager. Wifi link to internet not operating due to suspected firewall issue with ICT. Patterson and Loic are to determine fix.	Module 2 – Topics 4 and 5 Module 3 – Topic 4	
30 May	Andrew, Patterson and Kalsuak return to Port Vila		
31 May	Andrew and Sam arranging finances for charter flights and preparation for Lamap. Settle accounts for Longana shipment of gear (Vehicles, DSA, Ship passage)		

Date	Activity	Outputs	Item Project Deliverable (Tender Response Schedule TRS)
1 June	Jeremy Bani and Marty return to Aneityum. Corrected wiring issue in earth temperature sensors (10 & 100cm). Also corrected soil moisture sensor and leaf wetness sensor as wiring was mismatched. AWS fencing bracing and mesh installation started with Joseph and two labourers. Repositioned HF radio antenna in a NW – SE orientation for correct alignment for transmissions. Jerry also installed Meteo office computer. No internet connection available yet.	Module 2 – Topics 4	
2 June	Andrew and Sam arranging finances for charter flights and preparation for Lamap. Settle accounts for Longana shipment of gear (Vehicles, DSA, Ship passage). Marty and Jerry completed Aneityum AWS fencing. Flew back to Tanna via charter flight. Arrived back in Vila at 1700h.		
3 June	Andrew returned home to New Zealand. Marty sick.		
4 June	Marty sick. Prepared some materials for flight to Lamap.		
5 June Lamap AWS Installation commenced	Sam, Loic, Igor, Jerry, Nelson (Ian) on morning flight to Lamap, delayed 4 hours. Finally arrived Lamap at 12pm. Excess baggage (40kg tools) had to be sent to Lamap by overnight ship. Met local observers at Lamap Meteo office, Paul (semi retired) and Arno. Discussed layout and worked through logistics for installation with team at proposed location. Proceeded with installation, achieving completion of main anchor blocks concreted and majority of site laid out. 4x local labourers employed to mix concrete and dig fence holes. Finished late in the evening but made a very good start.	Module 2 – Topics 2 and 4	

Date	Activity	Outputs	Item Project Deliverable (Tender Response Schedule TRS)
6 June	Complete concreting foundations (logger housing, anchors and rain gauge) and begin installing sensors. Sam runs the 4 boys preparing the fence. Mast is raised late in the afternoon. Neon logger was powered and initialised by Jerry. Fencing is erected and enclosure made animal proof overnight.	Module 2 – Topics 2 and 4 Module 3 – Topics 3 and 4	
7 June	Completed instrument calibration checks, fencing completed, site enclosure tidied up. Final checks and confirmation with viewing data on NEON. Instructed Arno regarding site maintenance and Observer's weekly checklist.	Module 2 – Topics 2 and 4 Module 3 – Topics 2, 3 and 4 Module 2 – Topics 3 **Lamap AWS commissioned**	
8 June	Packed equipment and cleaned office. Truck transport to Lamap airport for return flight to Vila. Again, excess baggage (90kg tools and equipment) had to be left behind at Lamap (with Arno) due to plane being overloaded. This will be sent to Baufield on a flight next week.		
9 June	Marty met briefly with Sam. Discussed plans and time frame for mission 2. Proposed to start on 3 July for next three AWS installations. Left Sam with $150,000 vatu cash to make payment for shipment of remaining equipment.		
10 June	Marty returned home to New Zealand.		
AWS Installation Mission 2 **30 June to 15 July 2017**	Marty arrived in Port Vila on 30 June, in time to pay for pre-booked flights to the northern island locations. Christian arrived on 1 July. No entry issues with immigration were encountered this time on arrival at airport customs. Building materials (pipework, timber and fencing) and the AWS equipment had been already delivered to the locations, except for the Sola AWS material (Figure 2-1). The Sola equipment had been transported as far as Espirito Santo port in late June, then placed in storage at Luganville due to limited shipping options to Sola. This delay resulted in the equipment not being available in Sola for installation as originally scheduled, and NIWA staff had to leave Vanuatu before this installation could be completed.	Mission 1 installation report	

Date	Activity	Outputs	Item Project Deliverable (Tender Response Schedule TRS)
Sunday 2 July	Due to a booking mistake with the Air Vanuatu flights, two VMGD staff were asked to depart for Longana on Sunday. This proved advantageous as it enabled Kalsuak Gordon, Loic Jimmy and local Meteo observer (Hilton Henry) to make excellent preparations on-site for labour resources, chainsaw hire and landowner's permissions, to undertake the clearance work required to remove mature trees and large vegetation at the chosen AWS location.		
Monday 3 July	The remainder of the installation team (Jeremy Bani, Christian Hyde and Marty Flanagan) departed for Longana. The team packed a truck for the first load transported to site. It was confirmed a 3m solar support pipe was indeed missing from shipped equipment delivered to site. The proposed AWS site was very overgrown (Figures 2-2, 2-3) with mature trees standing. We spent all of the morning (10am- 2pm) clearing enough area to plan and layout design of AWS station. Two men with chainsaws were hired to fell large trees. Hilton arranged additional labour boys to assist with clearing work. We started mixing concrete for foundations at 3.30pm. We finished at 7pm with all main anchor foundations poured. Very good work by all.		
Tuesday 4 July	We were onsite at 8.15am. We finished off concreting rain gauge base and trenched conduit and laid cabling for main junction runs. Loic installed the Stevenson screen stand then installed wifi aerial and cabling on mast. Jerry wired in junction cabling (Figure 2-4). Hilton arranged labourers and more concreting materials (sand, coral and water). Kalsuak recorded instrument serial numbers then directed fence installation. More trees felled and site clearance continued. Fence posts cemented in. Top mast assembled by Jerry and Loic, sensors installed and conduit. Mast erected at 2pm. Wiring and sensor installation continued. Loic installed power supply and started site. Jerry completed NEON logger initialization. Site active 5pm. Fence posts, bracing and two strands of wire completed to keep cattle out of enclosure for the night.	Training Module 2,3, equivalent 2 hours	

Date	Activity	Outputs	Item Project Deliverable (Tender Response Schedule TRS)
Wednesday 5 July	We arrived down at AWS site at 0815am. A cow had got into the enclosure early morning but caused no damage. Jerry, Loic and Christian completed AWS sensor calibrations. Offset corrections for grass minimum (+0.9) and all earth temperatures (+0.3) applied by calling NIWA to update NEON scheme. All other sensors within specification. Kalsuak and Hilton completed AWS site classification and site diagram /plans. Remaining tall trees felled and mesh fencing completed around compound. Photos taken (Figures 2-5, 2-6). Left completed AWS site at 2pm. Packed and wrapped equipment for transport to Norsup on Thursday.	Training Module 2,3, equivalent 2 hours	
Thursday 6 July	Longana AWS site completed and commissioned. All team travel from Longana to Norsup, via Santo stop-over. Half of the installation tools were left behind in Longana, due to the plane being already overweight.	**Longana Airport AWS commissioned**	
Friday 7 July Norsup AWS installation commenced	Hired truck for morning to travel as a team of five. Located a potentially good AWS location in plantation land at NE end of Norsup airport runway, with minimal trees to clear (Figure 2-7). Met with land owner's (David Russet) representative (Pietelo). Drove back with him to potential location and received final approval to build station. Agreed to cutting down of 12 – 15 coconut palms. Pietelo also offered hire of tractor mower to clear area. Drove to Norsup hospital and found stored AWS equipment and materials (at Dr Mackenzie's house). All accounted for (plus missing Longana solar pole). After lunch, returned to AWS location. Tractor mower already clearing area. Measured out and planned AWS layout and enclosure area. Kalsuak, Loic and Jeremy all involved in this process. Transported some building materials to location. Built boxing and dug foundation holes. Very dense, compact soil made difficult digging.	Training Module 2,3, equivalent 2 hours	

Date	Activity	Outputs	Item Project Deliverable (Tender Response Schedule TRS)
Saturday 8 July	Plantation staff cut down 14 coconut palms as required, within 30m from AWS enclosure fence line (Figure 2-8). Hired two trucks for the day. Another 3x trips to transport all equipment stored at Norsup hospital. Other truck made 5x trips to bring coral / sand / water to site. 5 boys hired for labouring. Started mixing concrete after lunch for foundations and fence posts, taking all afternoon to complete this job. Loic and Jeremy laid out site equipment, prepared conduit, installed junction box wiring. Kalsuak managed concrete mix and fence post installation overseeing hired labourers. All concreting completed by day's end, except 6x fence posts. Very dense soil to dig holes. Finished at 6pm.	Training Module 2,3, equivalent 2 hours	
Sunday 9 July	Hired truck for day plus three boys for labour. Jeremy unwell so had morning off. Kalsuak continued managing enclosure fence construction and directing labour boys. Loic, Christian and Marty completed AWS assembly, wiring in sensors and communications. Mast raised at 1pm. Power supply installed and NEON logger initialised at 2pm. All sensors calibrated and site commissioned at 4pm (Figures 2-9, 2-10).	Training Module 2,3, equivalent 2 hours Airport AWS commissioned	
Monday 10 July	Marty and Jerry departed early for reconnaissance trip to Sola AWS location. Got to Santo only as Sola flight was cancelled. Loic, Kalsuak and Christian completed Norsup AWS site fencing and site meta data, site diagrams and tidying up. Loic injured his head on the corner of solar panel whilst removing concrete boxing timber. Made hospital visit for attention. Calibration offset for Grass minimum sensor uploaded to NEON scheme. As mentioned, the Sola AWS was not installed as planned due to shipping delays in delivering the equipment to the Torba province location in the expected timeframe. Marty made the decision to cancel flights for all the team travelling to Sola. Three of the team remained in Norsup to complete commissioning the AWS. Marty and Jeremy flew to Sola to inspect the proposed AWS site location and determine logistics on-site.	Training Module 2,3, equivalent 2 hours	

Date	Activity	Outputs	Item Project Deliverable (Tender Response Schedule TRS)
Tuesday 11 July	Flight for Loic, Kalsuak and Christian was cancelled due to non-availability of an aircraft. Had to stay another day in Norsup. Sam Tapo also arrived in Norsup for preparations of the official AWS openings. Marty and Jerry inspected Sola AWS location. Met with Torba Provincial Secretary General Mr Reynold. He was aware of the project and confirmed his support for the AWS installation. Proposed AWS location NE of runway is in very dense bush. It will be a big job to clear area before installation can proceed. Landowners' agreements have been settled verbally.		
Wednesday 12 July	Loic, Kalsuak and Christian returned to Vila. Excess tools and equipment too much to fit on small plane. Sent back to Port Vila via sea freight by Sam Tapo. Returned to Sola AWS location with Ali Eldads (husband of Alvine – Sola Meteo Officer) and scoped out a suitable area for site installation. Found an area of higher, dry ground 50m in from fence line (Figures 2-11, 2-12, 2-13). A large area of thick bush will need to be cleared before installation can commence. Ali agreed to help arrange community involvement with labour resources and sand / coral supply. Source of fresh water for concreting at stream near airport terminal. Marty and Jerry's return Air Vanuatu flight from Sola cancelled. Uncertainty of flight reliability which was rescheduled for Saturday 15 July, so NIWA hired an air charter next day from Sola to Santo.		
Thursday 13 July	Christian met with Patrica Mawa. Travelled to proposed GIZ AWS location at Takara (old airfield site, NE Efate) to assess site suitability. Then departed home for NZ in afternoon. Marty and Jerry returned to Santo via Air Taxi charter flight. Returned to Port Vila at 5pm.		

Date	Activity	Outputs	Item Project Deliverable (Tender Response Schedule TRS)
Friday 14 July **End of Mission 2**	Marty met with Osborne and Patrica. Secured flight refunds from Air Vanuatu for cancelled flights. V-CAP arranging ship to pick up AWS equipment and materials from Santo storage and deliver to Sola. Once delivered and the site has been cleared of vegetation, a team of VMGD staff will travel to Sola for the installation work. It is anticipated these staff are now suitably trained to fully undertake and complete an AWS installation. Phone support from NIWA will be provided during this phase of installation and commissioning.		
Post Mission 2 NOTES	At the end of Mission 2, all the five installed AWS stations were operating on the backup satellite (BGan) telemetry system at a 60-minute polling frequency. Currently satellite telemetry is being used until the planned primary communications pathway (wifi links and internet communication) is in place at each location. Over the months of July and August 2017, the ICT group of VMGD will be completing the necessary work schedule to enable internet communication to each location Meteo office and configuring the wifi linkages to transmit AWS data via the primary communications pathway, as proposed under V-CAP. Once the primary internet wifi links are operational, the NEON polling frequency can be returned to 10 minute periods. It is expect the Sola AWS installation will be completed by mid-August, once equipment has been delivered to the location and the VMGD Team are able to travel for this work.	Mission 2 Installation Report	
Date to be confirmed	VMGD team Loic, Kalsuak, Sam, installed Sola Airport AWS	Sola Airport AWS commissioned	
31 July to 12 August 2017 **CliDEsc upgrade mission**	NIWA team Alan Porteous, Bernard Miville, John Powell upgraded to CliDEsc 2 on the CliDEsc server.		
Thursday 3 August	CliDEsc training with Climate Group, 1.5 hours. Introducing CliDEsc2		

Date	Activity	Outputs	Item Project Deliverable (Tender Response Schedule TRS)
Friday 4 August	CliDEsc training with Forecasting Group, 1.5 hours. Synoptic and METAR automatic coding and quality assurance	Operations Guide: Synop and METAR automated messages coding for Vanuatu Meteorology and Geo-Hazards Department	
Monday 7 August	CliDEsc training with Forecasting Group, 1.5 hours. Synoptic and METAR automatic coding and quality assurance, Session 2		
Tuesday 8 August	CliDEsc training with Climate Group, 1.5 hours. Station chains and monthly reports.		

Appendix C: Daily schedule for technical training programme, Christchurch

Week one: 23 January to 27 January

	Monday	**Tuesday**	**Wednesday**	**Thursday**	**Friday**
0830 - 1000	Welcome and introductions. In briefing discussion on expectations.	Wind direction introduction. - cable termination and connection fitting.	Wind speed introduction. - cable termination and connection fitting	Lincoln EWS – siting classification and discussion (JB) Wifi modem (PN)	Wind speed - servicing, repairing and testing used sensors
1000 - 1015	Morning tea	Morning tea	Morning tea	Morning tea	Morning tea
1015 - 1200	Continuation of introductions and workshop orientation. Campus health and safety induction.	Wind direction continued. - connection fitting continued - sensor operating principles - testing sensor output using DMM and W200P test lead.	Wind speed introduction. - cable termination and connection fitting	Lincoln EWS – siting classification and discussion (JB) Wifi modem (PN)	Wind speed - servicing, repairing and testing used sensors
1200 – 1245	Lunch	Lunch	Lunch	Lunch	Lunch
1245 - 1500	Vaisala HMP155A Temp/RH introduction. - sensor cable termination - sensor operating principles - testing output with digital multi-meter (DMM) Installed NIWA Stardroid and NIWA SDI-12 apps on technicians' Android smartphones and introduction. Bluetooth serial extender introduction. Acclima soil moisture introduction. - sensor cable termination - sensor operating principles - testing output using Bluetooth serial extender and smartphone - changing SDI-12 address on sensor using smartphone.	Wind direction continued. - completion of testing using DMM - begin sealing of connectors	Wind direction - servicing, repairing and testing used sensors	Botanic Gardens – siting classification and discussion (JB) Wifi modem (PN)	Wind speed - servicing, repairing and testing used sensors
1500 - 1515	Afternoon tea	Afternoon tea	Afternoon tea	Afternoon tea	Afternoon tea
1515 - 1700	LiCor Li-200 sol radiation sensor introduction. -cable termination. Leaf wetness sensor introduction. -cable termination.	Wind speed introduction. - cable termination and connection fitting	Wind direction - servicing, repairing and testing used sensors	Wind speed - servicing, repairing and testing used sensors	Wind speed - servicing, repairing and testing used sensors

Week two: 30 January to 3 February

	Monday	Tuesday	Wednesday	Thursday	Friday
0830 - 1000	Wind speed - servicing, repairing and testing used sensors	Module 1 – networks and planning	Hughes 9502 modem setup and testing.	NRT communication configuration	Completed sensor wiring. Fine tuning and completion of all cable terminations quality checking of connections.
1000 - 1015	Morning tea	Morning tea	Morning tea	Morning tea	Morning tea
1015 - 1200	Wind speed - servicing, repairing and testing used sensors	Module 1 – networks and planning	Hughes 9502 modem setup and testing. Wifi setup and testing.	NRT communication configuration	Initial sensor checks to confirm all operating. Troubleshooting for sensors not working.
1200 – 1245	Lunch	Lunch	Lunch	Lunch	Lunch
1245 - 1500	Module 1 – networks and planning	Module 1 – networks and planning	NEON setup and configuration. All stations added to NEON, schemes loaded and metadata all updated and checked.	NRT communication configuration	Smarti configuration using Bluetooth serial extender. Wifi current consumption testing and reseting.
1500 - 1515	Afternoon tea	Afternoon tea	Afternoon tea	Afternoon tea	Afternoon tea
1515 - 1700	Module 1 – networks and planning	Module 1 – networks and planning	NEON, NRT configuration and intro to StarLog	Junction box and sensor connections to NRT end to end for Aneityum AWS. Wiring diagram interpretation.	Completed Smarti setup and confirmation all sensors working. Started hook up of second station.

Week three: 6 February to 10 February

	Monday	Tuesday	Wednesday	Thursday	Friday
0830 - 1000	AWS assembly and bench testing. (Includes Smarti configuration, instrument calibration, NEON setup, logger programming and reprogramming, communications setup and any trouble shooting)	AWS assembly and bench testing. (Includes Smarti configuration, instrument calibration, NEON setup, logger programming and reprogramming, communications setup and any trouble shooting)	AWS assembly and bench testing. (Includes Smarti configuration, instrument calibration, NEON setup, logger programming and reprogramming, communications setup and any trouble shooting)	AWS assembly and bench testing. (Includes Smarti configuration, instrument calibration, NEON setup, logger programming and reprogramming, communications setup and any trouble shooting)	AWS assembly and bench testing. (Includes Smarti configuration, instrument calibration, NEON setup, logger programming and reprogramming, communications setup and any trouble shooting)
1000 - 1015	Morning tea	Morning tea	Morning tea	Morning tea	Morning tea
1015 - 1200	AWS assembly and bench testing. (Includes Smarti configuration, instrument calibration, NEON setup, logger programming and reprogramming, communications setup and any trouble shooting)	AWS assembly and bench testing. (Includes Smarti configuration, instrument calibration, NEON setup, logger programming and reprogramming, communications setup and any trouble shooting)	AWS assembly and bench testing. (Includes Smarti configuration, instrument calibration, NEON setup, logger programming and reprogramming, communications setup and any trouble shooting)	AWS assembly and bench testing. (Includes Smarti configuration, instrument calibration, NEON setup, logger programming and reprogramming, communications setup and any trouble shooting)	AWS assembly and bench testing. (Includes Smarti configuration, instrument calibration, NEON setup, logger programming and reprogramming, communications setup and any trouble shooting)
1200 – 1245	Lunch	Lunch	Lunch	Lunch	Lunch
1245 - 1500	Public Holiday	AWS assembly and bench testing. (Includes Smarti configuration, instrument calibration, NEON setup, logger programming and reprogramming, communications setup and any trouble shooting)	AWS assembly and bench testing. (Includes Smarti configuration, instrument calibration, NEON setup, logger programming and reprogramming, communications setup and any trouble shooting)	AWS assembly and bench testing. (Includes Smarti configuration, instrument calibration, NEON setup, logger programming and reprogramming, communications setup and any trouble shooting)	AWS assembly and bench testing. (Includes Smarti configuration, instrument calibration, NEON setup, logger programming and reprogramming, communications setup and any trouble shooting)
1500 - 1515	Afternoon tea	Afternoon tea	Afternoon tea	Afternoon tea	Afternoon tea
1515 - 1700	Public Holiday	AWS assembly and bench testing. (Includes Smarti configuration, instrument calibration, NEON setup, logger programming and reprogramming, communications setup and any trouble shooting)	AWS assembly and bench testing. (Includes Smarti configuration, instrument calibration, NEON setup, logger programming and reprogramming, communications setup and any trouble shooting)	AWS assembly and bench testing. (Includes Smarti configuration, instrument calibration, NEON setup, logger programming and reprogramming, communications setup and any trouble shooting)	AWS assembly and bench testing. (Includes Smarti configuration, instrument calibration, NEON setup, logger programming and reprogramming, communications setup and any trouble shooting)

Week four: 13 February to 17 February

	Monday	Tuesday	Wednesday	Thursday	Friday
0830 - 1000	AWS assembly and bench testing. (Includes Smarti configuration, instrument calibration, NEON setup, logger programming and reprogramming, communications setup and any trouble shooting)	AWS assembly and bench testing. (Includes Smarti configuration, instrument calibration, NEON setup, logger programming and reprogramming, communications setup and any trouble shooting)	AWS assembly and bench testing. (Includes Smarti configuration, instrument calibration, NEON setup, logger programming and reprogramming, communications setup and any trouble shooting)	AWS assembly and bench testing. (Includes Smarti configuration, instrument calibration, NEON setup, logger programming and reprogramming, communications setup and any trouble shooting)	Wrap up meeting.
1000 - 1015	Morning tea	Morning tea	Morning tea	Morning tea	Morning tea
1015 - 1200	AWS assembly and bench testing. (Includes Smarti configuration, instrument calibration, NEON setup, logger programming and reprogramming, communications setup and any trouble shooting)	AWS assembly and bench testing. (Includes Smarti configuration, instrument calibration, NEON setup, logger programming and reprogramming, communications setup and any trouble shooting)	AWS assembly and bench testing. (Includes Smarti configuration, instrument calibration, NEON setup, logger programming and reprogramming, communications setup and any trouble shooting)	AWS assembly and bench testing. (Includes Smarti configuration, instrument calibration, NEON setup, logger programming and reprogramming, communications setup and any trouble shooting)	Wrap up meeting.
1200 – 1245	Lunch	Lunch	Lunch	Lunch	Lunch
1245 - 1500	AWS assembly and bench testing. (Includes Smarti configuration, instrument calibration, NEON setup, logger programming and reprogramming, communications setup and any trouble shooting)	AWS assembly and bench testing. (Includes Smarti configuration, instrument calibration, NEON setup, logger programming and reprogramming, communications setup and any trouble shooting)	AWS assembly and bench testing. (Includes Smarti configuration, instrument calibration, NEON setup, logger programming and reprogramming, communications setup and any trouble shooting)	AWS assembly and bench testing. (Includes Smarti configuration, instrument calibration, NEON setup, logger programming and reprogramming, communications setup and any trouble shooting)	Free time
1500 - 1515	Afternoon tea	Afternoon tea	Afternoon tea	Afternoon tea	Afternoon tea
1515 - 1700	AWS assembly and bench testing. (Includes Smarti configuration, instrument calibration, NEON setup, logger programming and reprogramming, communications setup and any trouble shooting)	AWS assembly and bench testing. (Includes Smarti configuration, instrument calibration, NEON setup, logger programming and reprogramming, communications setup and any trouble shooting)	AWS assembly and bench testing. (Includes Smarti configuration, instrument calibration, NEON setup, logger programming and reprogramming, communications setup and any trouble shooting)	AWS assembly and bench testing. (Includes Smarti configuration, instrument calibration, NEON setup, logger programming and reprogramming, communications setup and any trouble shooting)	Free time

Appendix D: Site shipping lists

The following items comprise the shipping list for each site, including items imported from New Zealand, and items purchased in Port Vila.

Aneityum AWS

1	Large stainless steel housing labeled with station name (complete with logger)
1	Square galvanised mounting stand for solar panel and housing with plate on top
2	65 Ah batteries
1	100W solar panel
1	Small Stevenson screen
1	Stand for Stevenson screen
1	Braces stand Stevenson screen
1	PVC probe for earth temperature sensors
1	Copper coated earth rod
1	Aneityum Box 1 - buckets with Iplex fittings, misc fittings, rg mount, sat antenna and mount)
1	Aneityum Box 2 - sensors and wifi units
1	80mm x 3.25m pipe with pivot fitted one end, 80-50mm reducer other end
1	40mm x 3.25m pipe with protection socket one end.
2	50mm x 6m pipe with socket each end
3	Anchors
1	Cradle
1	Winch mount
1 pair	Wifi mount (2 x 2m x 40mm pipe)
11	6m 25mm pvc pipe
1	1kg nails
1	Boxing timber (full set)
10	40kg bags cement

Fencing

6	2.8m x 50mmNB post with caps
22	2.6m x 40mm NB post with caps
10	2.8m x 32mmNB post
6	Green PVC chain link mesh 1800 x 2.8 x 50
6 roll	High tensil wire 1.6mm 1kg
10	M8 turnbuckle
1 roll	3.15mm tie wire
1	Gate
2	Elgate Tee, Thru 50NB x Butt 32NB
10	Elgate Tee, Thru 40NB x Butt 32NB
4	Elgates Corner, Thru 50NB x Butt 32NB x Butt 32NB

Sola Airport AWS

1	Large stainless steel housing labeled with station name (complete with logger)
1	Square galvanised mounting stand for solar panel and housing with plate on top
2	65 Ah batteries
1	100W solar panel
1	Small Stevenson screen
1	Stand for Stevenson screen
1	Braces stand Stevenson screen
1	PVC probe for earth temperature sensors
1	Copper coated earth rod
1	Sola Box 1 - buckets with Iplex fittings, misc fittings, rg mount, sat antenna and mount)
1	Sola Box 2 - sensors and wifi units
1	80mm x 3.25m pipe with pivot fitted one end, 80-50mm reducer other end
1	40mm x 3.25m pipe with protection socket one end.
2	50mm x 6m pipe with socket each end
3	Anchors
1	Cradle
1	Winch mount
1 pair	Wifi mount (2 x 2m x 40mm pipe)
11	6m 25mm pvc pipe
1	1kg nails
1	Boxing timber (full set)
10	40kg bags cement

Fencing

6	2.8m x 50mmNB post with caps
22	2.6m x 40mm NB post with caps
10	2.8m x 32mmNB post
6	Green PVC chain link mesh 1800 x 2.8 x 50
6 roll	High tensil wire 1.6mm 1kg
10	M8 turnbuckle
1 roll	3.15mm tie wire
1	Gate
2	Elgate Tee, Thru 50NB x Butt 32NB
10	Elgate Tee, Thru 40NB x Butt 32NB
4	Elgates Corner, Thru 50NB x Butt 32NB x Butt 32NB

Longana Airport AWS

1	Large stainless steel housing labeled with station name (complete with logger)
1	Square galvanised mounting stand for solar panel and housing with plate on top
2	65 Ah batteries
1	100W solar panel
1	Small Stevenson screen
1	Stand for Stevenson screen
1	Braces stand Stevenson screen
1	PVC probe for earth temperature sensors
1	Copper coated earth rod
1	Longana Box 1 - buckets with Iplex fittings, misc fittings, rg mount, sat antenna and mount)
1	Longana Box 2 - sensors and wifi units
1	80mm x 3.25m pipe with pivot fitted one end, 80-50mm reducer other end
1	40mm x 3.25m pipe with protection socket one end.
2	50mm x 6m pipe with socket each end
3	Anchors
1	Cradle
1	Winch mount
1 pair	Wifi mount (2 x 2m x 40mm pipe)
11	6m 25mm pvc pipe
1	1kg nails
1	Boxing timber (full set)
10	40kg bags cement

Fencing

6	2.8m x 50mmNB post with caps
22	2.6m x 40mm NB post with caps
10	2.8m x 32mmNB post
6	Green PVC chain link mesh 1800 x 2.8 x 50
6 roll	High tensil wire 1.6mm 1kg
10	M8 turnbuckle
1 roll	3.15mm tie wire
1	Gate
2	Elgate Tee, Thru 50NB x Butt 32NB
10	Elgate Tee, Thru 40NB x Butt 32NB
4	Elgates Corner, Thru 50NB x Butt 32NB x Butt 32NB

Whitegrass Airport AWS

1	Large stainless steel housing labeled with station name (complete with logger)
1	Square galvanised mounting stand for solar panel and housing with plate on top
2	65 Ah batteries
1	100W solar panel
1	Small Stevenson screen
1	Stand for Stevenson screen
1	Braces stand Stevenson screen
1	PVC probe for earth temperature sensors
1	Copper coated earth rod
1	Whitegrass Box 1 - buckets with Iplex fittings, misc fittings, rg mount, sat antenna and mount)
1	Whitegrass Box 2 - sensors, wifi units, 7Ah batt
1	Whitegrass Box 3 - junction boxes, rad mount
1	80mm x 3.25m pipe with pivot fitted one end, 80-50mm reducer other end
1	40mm x 3.25m pipe with protection socket one end.
2	50mm x 6m pipe with socket each end
3	Anchors
1	Cradle
1	Winch mount
1 pair	Wifi mount (2 x 2m x 40mm pipe)
11	6m 25mm pvc pipe
1	1kg nails
1	Boxing timber (full set)
10	40kg bags cement

Fencing

6	2.8m x 50mmNB post with caps
22	2.6m x 40mm NB post with caps
10	2.8m x 32mmNB post
6	Green PVC chain link mesh 1800 x 2.8 x 50
6 roll	High tensil wire 1.6mm 1kg
10	M8 turnbuckle
1 roll	3.15mm tie wire
1	Gate
2	Elgate Tee, Thru 50NB x Butt 32NB
10	Elgate Tee, Thru 40NB x Butt 32NB

Lamap AWS

1	Large stainless steel housing labeled with station name (complete with logger)
1	Square galvanised mounting stand for solar panel and housing with plate on top
2	65 Ah batteries
1	100W solar panel
1	Small Stevenson screen
1	Stand for Stevenson screen
1	Braces stand Stevenson screen
1	PVC probe for earth temperature sensors
1	Copper coated earth rod
1	Lamap Box 1 - buckets with Iplex fittings, misc fittings, rg mount, sat antenna and mount)
1	Lamap Box 2 - sensors
1	Lamap Box 3 - cross arm, wifi units
1	80mm x 3.25m pipe with pivot fitted one end, 80-50mm reducer other end
1	40mm x 3.25m pipe with protection socket one end.
2	50mm x 6m pipe with socket each end
3	Anchors
1	Cradle
1	Winch mount
1 pair	Wifi mount (2 x 2m x 40mm pipe)
11	6m 25mm pvc pipe
1	1kg nails
1	Boxing timber (full set)
10	40kg bags cement

Fencing

6	2.8m x 50mmNB post with caps
22	2.6m x 40mm NB post with caps
10	2.8m x 32mmNB post
6	Green PVC chain link mesh 1800 x 2.8 x 50
6 roll	High tensil wire 1.6mm 1kg
10	M8 turnbuckle
1 roll	3.15mm tie wire
1	Gate
2	Elgate Tee, Thru 50NB x Butt 32NB
10	Elgate Tee, Thru 40NB x Butt 32NB
4	Elgates Corner, Thru 50NB x Butt 32NB x Butt 32NB

Norsup Airport AWS

1	Large stainless steel housing labeled with station name (complete with logger)
1	Square galvanised mounting stand for solar panel and housing with plate on top
2	65 Ah batteries
1	100W solar panel
1	Small Stevenson screen
1	Stand for Stevenson screen
1	Braces stand Stevenson screen
1	PVC probe for earth temperature sensors
1	Copper coated earth rod
1	Norsup Box 1 - buckets with Iplex fittings, misc fittings, rg mount, sat antenna and mount)
1	Norsup Box 2 - crossarm, wind sensors, wifi units
1	Norsup Box 3 - sensors, junction boxes
1	80mm x 3.25m pipe with pivot fitted one end, 80-50mm reducer other end
1	40mm x 3.25m pipe with protection socket one end.
2	50mm x 6m pipe with socket each end
3	Anchors
1	Cradle
1	Winch mount
1 pair	Wifi mount (2 x 2m x 40mm pipe)
11	6m 25mm pvc pipe
1	1kg nails
1	Boxing timber (full set)
10	40kg bags cement

Fencing

6	2.8m x 50mmNB post with caps
22	2.6m x 40mm NB post with caps
10	2.8m x 32mmNB post
6	Green PVC chain link mesh 1800 x 2.8 x 50
6 roll	High tensil wire 1.6mm 1kg
10	M8 turnbuckle
1 roll	3.15mm tie wire
1	Gate
2	Elgate Tee, Thru 50NB x Butt 32NB
10	Elgate Tee, Thru 40NB x Butt 32NB
4	Elgates Corner, Thru 50NB x Butt 32NB x Butt 32NB

Common to all sites

Note this list is not to be shipped in advnce but to be taken on flights at time of vist

1	100m roll data cable with crimps (for Wifi)
1	25m roll 32mm flex conduit
1	100m roll of auto cable (for wifi power supply)

See Checklist of gear to take into field.doc
Also copied below

Field references (Travelling standards)

Vaisala PTB330TS air temp/humidity and pressure
Hydrological Services rain gauge calibrator
- NIWA rain gauge counter for use with HS calibrator
- Charged 12V 1.9Ah battery
- Water for rain gauge calibrations

Center 375 RTD Inspector's or reference thermometer for water or ice point checks
- Flask for water/ice

LI250A – Licor hand held solar radiation field reference

Field kit

Padlock
Keys (gate, logger box)
Laptop (fully charged)
- Correct software and logger programs loaded
- Correct cables to connect to data loggers
- Power adaptor/invertor

SDI-12 to USB device (Bluetooth serial adaptor)
Multimeter (with Frequency output)
GPS unit
Protractor and angle finder
Compass
Range finder
Camera
Mast Winch (I-trans safety winch)

Field Tools

225mm Torpedo Level
13mm spanner (x2)
Screw Driver set (Small - 3mm flat head and Phillips)
Screw Driver set (larger screw drivers)
Weidmuller 4.0 x 100 (for klippon terminals)
Fuller square drive screw driver
Kokon 167m 5mm socket driver
Kokon 167m 5.5mm socket driver
10mm, 13mm socket with driver and 250mm extension
Spanners/Cresents (assorted sizes) 4mm to 250mm
5m tape measure
30m tape measure
Post Level

6” pliers
10” pliers
Hex Key set
PVC pipe cutter
Side cutters
Craft knife
Pull through string
6.5mm, 10mm, 13mm drill bits
32mm and 35mm hole saws
Hammer
Saw
Hacksaw
12V soldering iron
RJ45 crimp tool
PZ4 crimp tool
Hex crimp tool

Field Maintenance misc items

PVC tape
Zinc-it cold galv spray can
Lubricant (WD40 or CRC)
Cable ties
20mm flex conduit (grass min)
32mm flex conduit
RTV (gap filler) and caulking gun
Paint brushes
White paint (for thermometer screen)
White paint (for mast)
Red paint (for mast)
Water container
Cleaning materials – cloth, cleaning liquid, cleaning brush
Insect spray (Mortein) – for ants etc.
Grass/Hedge cutters
Kit containing assorted bits (ferrules, fuses, diodes, connecters, M4, M6 and M8 screws etc.)
Band-it tape, tool and crimps
Grease
Denso tape

Misc tools

14 or 18V Cordless Drill
600mm Pipe Wrench (x2)
Sledge hammer
Long bar (Crow bar)
Pick
Spade
Edging Trowel
Flat Trowel
Bolt cutters
Band-it tool, tape and clips
4” flat head nails

	Boxing timber
	Rope
Personal gear	
	Wet weather gear
	Sunscreen
	Insect repellent
Other	
	Battery
	Solar regulator
	Umbrellas
	Ground sheets