NIWA
Taihoro Nukurangi

A drought risk visualisation toolkit for Pacific Island countries

DFID-GFDRR Challenge Fund Phase II Final Report

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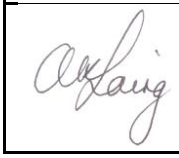	Approved for release by:	Andrew Laing

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Executive summary

The World Bank Group contracted NIWA to develop an open source, real time, probabilistic Drought Risk Visualization Toolkit (DRVT) for Pacific Island Meteorological Services. The project is funded by the Department for International Development (DFID), under the Science for Humanitarian Emergencies and Resilience (SHEAR) project, and the Global Facility for Disaster Reduction and Recovery (GFDRR), as part of a **Challenge Fund** to '*deliver an innovative demand-led toolkit of new open data and tools to support risk identification and decision-making to build resilience to natural hazards*'.

Activities under **Phase I** of the project were conducted during calendar 2016 in three partner countries, Samoa, Fiji and Solomon Islands. The toolkit (DRVT) consisted of a package of open source scripted product generators, which were installed on an existing in-country database server (CliDE) and integrated with the open source climate services platform, CliDEsc.

During **Phase II** of the contracted work, conducted during 2017 and early 2018, and reported in this document, partnerships were engaged with three additional countries, Papua New Guinea, Vanuatu and Kiribati. Visits were undertaken to each country to work with local staff to continue to improve data archiving procedures and data quality control work, and conduct training in database management and climate services development. CliDEsc including the DRVT products was upgraded in Samoa, Fiji, Solomon Islands, Papua New Guinea and Vanuatu, and installed for the first time in Kiribati, with associated staff training.

1 Name of project, target countries, USD amount and time frame of Phase II grant

Name of project: A drought risk visualisation toolkit for Pacific Island countries (DRVT)
Target countries: Samoa, Fiji, Solomon Islands, Kiribati, Vanuatu, Papua New Guinea
USD amount: $144,420
Time frame of Phase II grant: January to November 2017, with agreed variation to March 2018

2 Description of tool, approach, toolkit

a. Was it demand-led? If yes, how?

All activities conducted under Phase II of this project have been at the request of the partner countries.

During the past decade, the UN-initiated National Adaptation Programmes of Action (NAPA) have provided a process for Least Developed Countries (LDCs) to identify national priorities for activities to adapt to weather extremes such as drought, and changes in climate on varying time scales. In the Pacific, country NAPA programmes have been developed based on extensive in-country, community consultation undertaken by relevant Ministries and community agencies. These consultations determined and prioritised key environmental concerns and risk management initiatives, including the need to establish climate early warning systems (CLEWS), for community and national resilience.

The six partner countries that are engaged with NIWA under this project—Samoa, Fiji, Solomon Islands, Papua New Guinea, Kiribati, and Vanuatu—all frequently experience droughts and shortages of potable water, and have identified early warning of drought as a priority requirement for the management and mitigation of drought risk. In all cases the primary provider of drought early warning advice is the respective National Meteorological Service in each country, and these agencies have made (and continue to make) requests to NIWA for improved and additional drought analysis tools.

b. Did you work with local beneficiaries in Phase II to develop your tool? If yes, how many local beneficiaries and how were they involved?

As in Phase I of this project, our main focus during Phase II has been to work with staff at National Meteorological Services (NMS) in Samoa, Solomon Islands, Fiji, Vanuatu, Kiribati, and Papua New Guinea. Our objective was to enhance the capability of climate services staff to develop customised information to enable them to better interact with users of the data and services, to mitigate drought risk. Typically, the uptake of risk management information by local beneficiaries and communities depends on communication through ministry programmes, public broadcasts and special advisories, and is some cases by NGO workers.

NMS climate services staff are responsible for data collection, processing, quality assurance, analysis and interpretation to the public and user communities. There is typically a lack of robust processes and analytical tools to routinely monitor and publish risk updates and advisories. Staff capability and resources are in most cases stretched to provide basic climate services, let alone deal with emergencies that require rapid and confident advice to be prepared and acted upon. An important component of the work under this project was to support staff in enhancing their workplace skills and capability.

We consulted with staff on their routine data management tasks, and tailored the DRVT software package to improve the accuracy, timeliness, usefulness, and interpretability of information being produced. Where possible, we were able to automate manual data analysis tasks, the aim being to free up staff time to focus more on reporting and interpretation.

Samoa

In Samoa, this project has been coordinated with the Samoa Meteorology Division (SMD) of the Ministry of Natural Resources and Environment (MNRE), and has built on previous developments and outcomes from the NAPA-led programmes.

Intended beneficiaries of the NAPA programmes, of which the DRVT installation is now an operational component, are both the rural and urban communities of Samoa, particularly coastal villages which are vulnerable to drought and coastal storms.

Samoa's National Disaster Management Office (NDMO), a division of MNRE, is responsible for ensuring the ongoing coordination, development and implementation of Disaster Risk Management programmes and activities in Samoa, including managing drought.

While SMD publishes climate information and warning advisories on its public web site, it is the NDMO that facilitates community driven processes to identify hazards and risks that villages are exposed to, and organises village disaster committees and response teams, and provides training for collective action and disaster recovery.

In the context of drought, work is ongoing in SMD to fine tune the DRVT outputs (such as agreed threshold levels of dryness that trigger responsive actions) to meet NDMO information requirements. SMD will continue to refine and calibrate this type of information with the NDMO, and will draw on public reporting from communities where drought develops to help ensure that the DRVT tools reasonably reflect the reality on the ground.

Solomon Islands

In Solomon Islands, the development of drought monitoring and early warning has been coordinated through the Solomon Islands Meteorological Service (SIMS), under the Ministry of Environment, Climate Change, Disaster Management and Meteorology. Other project stakeholders included: Solomon Islands National Disaster Management Office; Solomon Islands Climate Change Office; Solomon Islands Ministry of Agriculture and Livestock; and Solomon Island Water Resources Division (WRD) of the Ministry of Mines, Energy and Rural Electrification (MMERE).

In March 2017 WRD brought together representatives from three remote urban areas and three rural communities to meet with NIWA scientists under the Solomon Islands Water Sector Adaptation Project (SIWSAP). The six communities—Taro township, Choiseul Province, Gizo township, Western Province, Tigoa township, Rennell and Bellona Province, Tuwo community, Fenualoa Island, Temotu Province, Ferafalu community, Manaoba Island, Malaita Province, and Santa Catalina community, Aorigi Island, Makira-Ulawa Province—are all vulnerable to frequent drought and shortages of potable drinking water. Over-abstraction of ground water in coastal areas leads to higher rates of intrusion of salt water into the freshwater aquifers (lens), particularly in small atolls and low-lying islands that rely on rainfall or groundwater for their freshwater supply. Community representatives called for more information to support water management, including real-time information on low rainfall, periods of dry weather, poor water quality and low ground water. The DRVT products will derive and deliver this information from the monitoring sites currently being installed under the

SIWSAP programme. Also participating in this consultation were officials from the Ministry of Health and Medical Services, who are supporting at-risk communities during times of drought and water shortages.

Solomon Islands National Disaster Management Office is currently (2017-2018) developing a National Drought Plan (NDP), in partnership with Solomon Islands Meteorological Service and other agencies, including the Australian Red Cross. Once ratified by the Solomon Islands Government, the operation of the NDP will require specific drought monitoring and analysis information to be issued by SIMS, including using rainfall deficit thresholds for 30-day (1-month) and 90-day (3-month) periods based on the widely-used decile methodology. This drought analysis procedure, and the capability to create a national map of this information, have been installed as part of the DRVT suite of software, and will thus enable SIMS to operationally produce the information required for the NDP.

Communicating drought risk advisories to the agricultural sector is managed through the Ministry of Agriculture and Livestock, and an MOU is being developed between them and the SIMS to enable the ongoing exchange of meteorological and agricultural drought risk information. MAL field officers work with farmers and food marketing arrangements in agricultural communities.

Fiji

In Fiji, the primary partner was the Fiji Meteorological Service (FMS) which is the lead agency for monitoring and managing drought risk in the country. FMS works closely with the National Disaster Management Office (NDMO) and is assisting with the development of the country's Drought Response Plan. The Plan aims to *'inform drought preparedness, response, mitigation and adaptation measures through a government lead multi-sectoral approach to reduce and prevent the adverse effects of drought on the populations of Fiji.'*

FMS is also supporting efforts of the Fiji National Fire Authority (NFA) to manage periods of heightened fire risk during dry weather. The Authority typically deals with hundreds of fires each year during the dry months. The work with FMS is ongoing to assist both NDMO and NFA with their drought information needs, and to develop communication pathways that suit their operational requirements.

Another major user of climate information is the forestry industry in Fiji, representatives of which have approached FMS to advise on the risk of low rainfall and drought conditions in areas under forest.

Vanuatu

Studies have shown that young children are the most at risk during periods of drought in Vanuatu, particularly during prolonged drought when crops fail and water sources dry up. Children and female family members in remote coastal communities are typically the most vulnerable.

Improving the resilience of coastal communities in Vanuatu is a particular focus of recent projects being led by the Vanuatu Meteorology and Geo-Hazards Department (VMGD), a division of the Ministry for Climate Change Adaptation, Meteorology, Geo-Hazards, Environment, Energy and Disaster Management. NIWA has installed the CliDEsc DRVT software at VMGD, and is working with VMGD climate staff on a suite of additional customised products to support the management of periods of low rainfall and its impacts in six national sectors requested by the Ministry – Agriculture, Hydrology, Tourism, Marine, Health and Energy.

Papua New Guinea

NIWA's primary partner in Papua New Guinea with this project has been the PNG National Weather Service (NWS). Droughts occur frequently in Papua New Guinea, and have significant impact on the national economy and on agricultural communities, particularly in highland regions which are also frost prone during cooler months. PNG's National Disaster Management Office is responsible for managing early warning of, and subsequent recovery from, severe climate events such as drought, and works closely with NWS to manage the analysis and communication of drought risk. The NWS issues monthly public climate bulletins which include updated drought monitoring and advisory information. Installation of the DRVT software has included interpretation of satellite data showing the distribution of rainfall over Papua New Guinea, and these maps and other climate products now form part of the drought monitoring programme.

Kiribati

In Kiribati, we worked with the Kiribati Meteorological Service (KMS) based in Betio, South Tarawa. Kiribati is largely comprised of many low-lying atolls, with chronic water shortages and significant risk of prolonged drought. Traditionally, water supplies to meet basic needs have been drawn from shallow, open wells, dug in the atolls, but these are becoming increasingly contaminated from sea water and waste water intrusion. Several major projects have been undertaken in recent years to develop more resilient water management in Kiribati, including water quality investigations and modelling, distribution of water tanks for roof top water harvesting, and improved rainfall monitoring in the capital and remote outer islands. NIWA is currently engaged under the Office of the President, through the Ministry of Environment, Lands and Agricultural Development, to work with KMS to install automatic weather stations in several outer islands, and to improve KMS capability to provide climate services to the people of Kiribati.

A Drought Response Plan for Tarawa (the main populated island) was adopted in 2011. Developed by the Water Engineering Unit of the Ministry of Public Works and Utilities with support from the Secretariat of the Pacific Community (SPC), the plan brings together a range of different sectors to deliberate on climate information from the KMS. Improved drought warning capability at KMS will support this Drought Response Plan, and benefit the people of Kiribati nationally, particularly communities most at risk of poor water security.

c. What is 'new'? In other words, what did challenge fund monies support in Phase II?

1. CliDEsc upgrade

The monies enabled installation of the improved CliDEsc DRVT user interface in all six partner countries, for three of which – Kiribati, Papua New Guinea and Vanuatu, CliDEsc was installed for the first time. The new version of CliDEsc (CliDEsc 2) was developed under a separate internally funded NIWA project, and completed by June 2017. Challenge Fund Phase II resources enabled NIWA staff to visit the six partner countries to install CliDEsc 2 during August 2017 to February 2018.

A screen shot of the CliDEsc 2 interface in Solomon Islands is shown below (Figure 2-1). Easy-to-use menus allows users to generate climate visualisation outputs for individual or groups of stations, and for individual or multiple data types.

Phase II funds also supported the purchase and installation of desktop servers for Kiribati (Figure 2-2), Solomon Islands, and Fiji as part of the CliDEsc upgrade. Similar servers were installed in Papua New Guinea, Vanuatu and Samoa, funded from other projects. The integration of these servers with

in-country IP protocols and web access enables NIWA to provide remote support for the CliDEsc software, for subsequent product generator upgrades, and if help is requested by the respective National Meteorological Services.

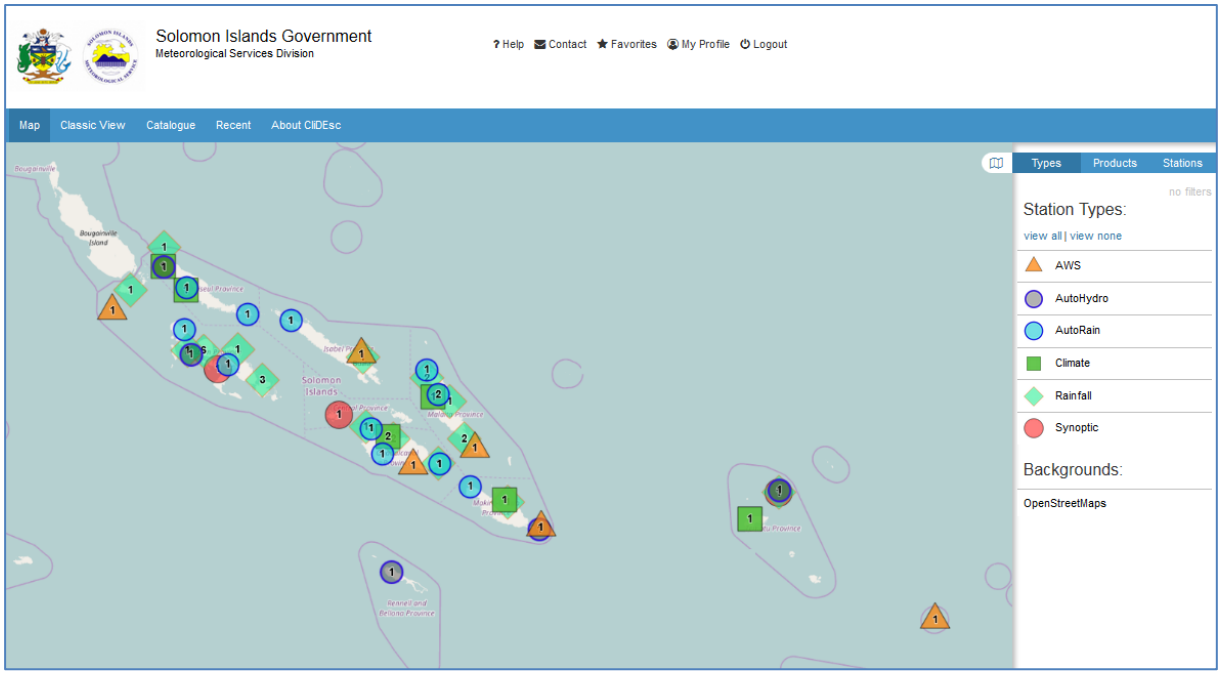


Figure 2-1: Solomon Islands CliDEsc landing page.

Figure 2-2: Computer rack at Kiribati Meteorological Service, showing the CliDEsc DRVT and CliDE climate data base servers, indicated by the orange and blue arrows respectively.

2. Improved DRVT products

The project enabled us to install and implement new or improved DRVT products which had been discussed or trialled during Phase I. We worked with local staff and, where possible, their client users of climate information, to demonstrate how drought risk information can be derived from remote observations, and options for visualisation of the information, as time series, tables and maps.

The example below (Figure 2-3) from Papua New Guinea indicates drought status at rainfall observation sites, based on a derived index that is tuned to reflect conditions that are experienced locally at these locations.

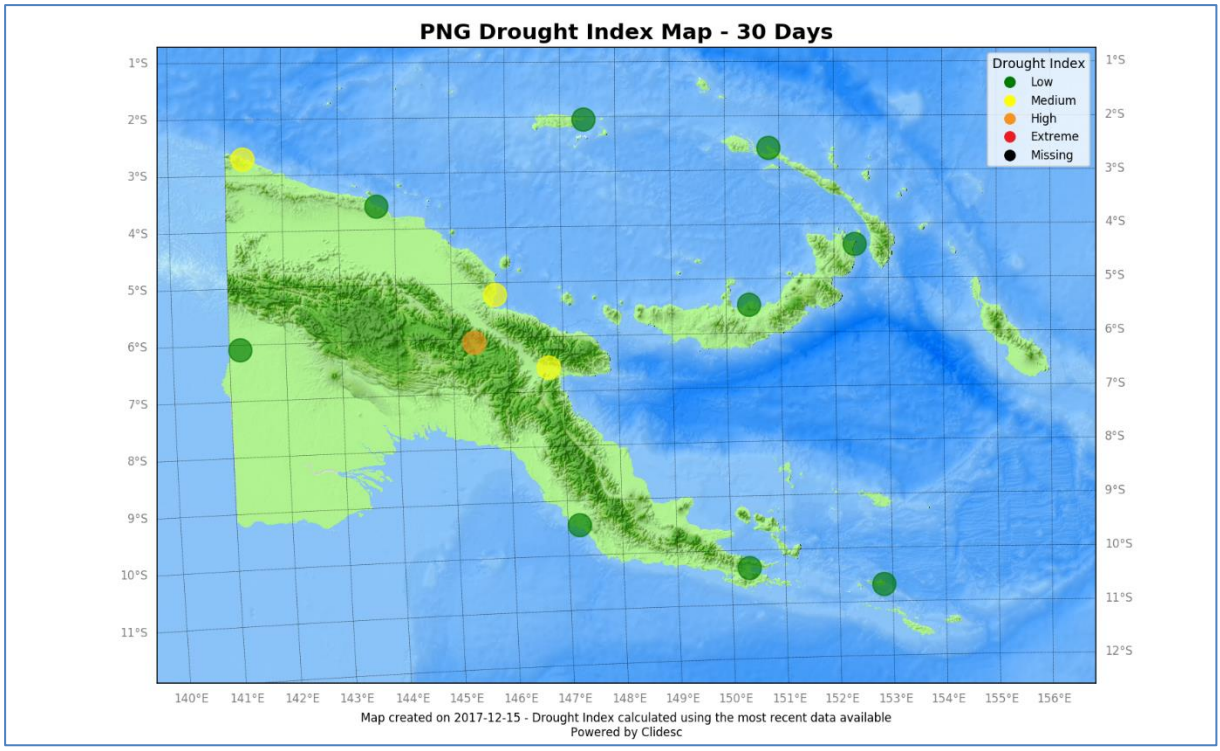


Figure 2-3: CliDEsc DRVT product showing an index of drought risk at PNG National Weather Service reporting sites.

3. Staff training

Each installation of CliDEsc 2 was accompanied by staff training over several days to consolidate familiarity gained during Phase I, or introduce new staff to CliDEsc for the first time. Additional training was required during Phase 2 to manage the CliDEsc Content Management System, where staff can register new products, manage user access, manage automated distribution, edit the product catalogue, and perform many other administrative functions. Where possible we introduced new CliDEsc DRVT products to potential clients and users to evaluate the information and plan the development of new drought monitoring services.

4. Sector engagement critical for future development

Phase II funds also supported working with VMGD staff to meet potential users of climate information in agriculture, hydrology and water management, hospital health services, tourism, and energy departments. In all cases there is a demand for climate and weather information, particularly rainfall data, and the DRVT suite is helping address this information gap.

d. How does it support risk identification and decision-making?

The DRVT tools installed in the CliDEsc product generator are part of the end-to-end climate early warning system, illustrated below, that is operational in the six partner countries. The system manages the climate data from observations (1) through to external users and stakeholders (9). The CliDEsc product generator (6) is typically installed as a virtual machine on the communications server (4) and is accessible to climate staff via web services.

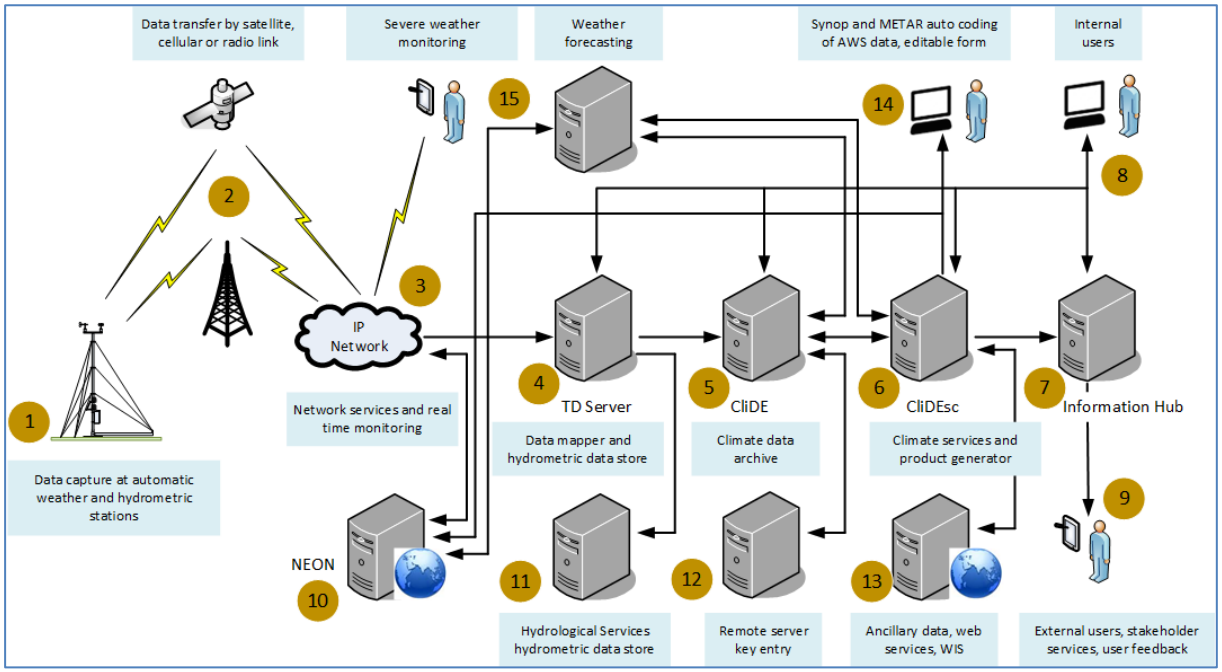


Figure 2-4: Generalised schematic view of the Climate Early Warning System infrastructure and processes.

The CLEWS structure brings all components of climate services together. It enables analysis of observed data in near real time so that climate staff can make immediate assessments of monitored information in the context of long term risk – without having to resort to manual methods such as time-consuming spread sheet tables.

The DRVT tools build on this capability, thus enabling basic statistical and time series techniques to be undertaken at the click of a button, with the generation of graphical outputs for easy visualisation and interpretation. Staff can then more readily and more immediately pass this information to key users and consumers of climate risk information.

The CliDEsc DRVT tools also enable computer-generated formatting and publication of drought information to web services, including formats suitable for mobile devices, such as the example below (Figure 2-5)

e. Describe the degree to which it is openly-available and how users can access it.

The DRVT toolkit has been distributed to the six partner countries unencumbered with commercial software licencing. The use and development of the tools is managed openly in-country, with access rights managed by NMHS climate services staff. Outputs are generally made freely available, via web pages or other means of distribution, and by agreement such as through Memoranda of Understanding between government departments and the respective national meteorological

agencies. The software packages of the DRVT are accessible on the CliDEsc platform in each country, and are managed under the jurisdiction of the respective Meteorological Services. Meteorological Services staff who have the required programming skills, are free to modify scripts to improve customisation and interpretability.

An example application for user access to drought and other environmental information is the cell phone app developed for Samoa in collaboration with a Japanese voluntary agency working with Samoa Meteorology Division (see below Section 11-2, Figure 11-1). The app presents both weather and climate information, including DRVT outputs of a 90-day accumulated rainfall index, and a Forest Fire Danger Class table, for Samoa's automatic weather station network. The app, 'Samoa Weather' is available on Google Play Store for public download, and has a 4.8 approval rating. Apart from national Television and Radio, the app is probably the most widely used means of accessing weather, climate, and environmental hazard information in Samoa.

Another example, shown for Solomon Islands below (Figure 2-5), is a web service formatted for mobile devices, which displays automatically produced drought risk and other data from the CliDEsc platform. (See https://docs.niwa.co.nz/eco/solomon/m/.) These services are available currently through the NIWA IT system but we are working with Solomon Islands Meteorological Service to support their local web pages once these have been suitably developed.

Figure 2-5: Publicly available drought risk information formatted for a mobile phone. The display is updated each day by the CliDEsc DRVT platform. Similar applications are available for other partner countries .

f. Discuss how it enables (or will enable) users to make more effective disaster management and resilience decisions.

Effective drought management requires early detection and building of awareness, assembly of resources to mitigate impacts, and developing long term resilience through analysis of risk and by learning from events.

The DRVT system improves routine and systematic analysis of the historical climate record and real time observations as a core component of CLEWS (Figure 2-4), and enables improved 'turn-around' time for getting information drafted and made available for decision support. Many climate analysis and visualisation processes can be automated, and this frees up staff time to provide responsive advice more quickly and thoroughly.

The DRVT tools can help to distinguish both spatial and temporal variation in drought evolution, thus improving the ability to focus responsive actions on the most vulnerable locations and communities.

For example, in Samoa, coastal land often exhibits drought-like conditions while inland high-country rainfall is still plentiful.

A key advantage enabled by the DRVT installation is that, once the tools are fully customised and operational, outputs can be generated in seconds, rather than the hours previously required in some cases to generate the information through labour-intensive manual processing.

Phase II of this project has created a robust platform with a range of drought visualisation tools. Future developments will customise these tools more closely to the information needs of disaster managers. For example in Kiribati, various studies under separate projects have shown that the appropriate trigger levels for drought response actions are:

- Level 1 response (orange alert): three-month rainfall less than 40% of normal
- Level 2 response (red alert): 12-month rainfall of less than 25% of normal

Under a concurrent project, the Kiribati climate network is being upgraded by installing several automatic weather stations on drought prone islands. Once these data come on-line, the Kiribati DRVT outputs will be calibrated to monitor the above trigger levels for national drought actions in Kiribati.

3 Description of partnerships (active in Phase II, but which could have started in Phase I), in particular those involving local partners.

Did you work in partnership(s) with a local partner(s)? If yes, please provide the name(s) of the local partner(s) and the nature/strength/sustainability of the partnership.

Our project-implementing primary partnerships were with the Directors and staff of the respective National Meteorological and Hydrological Services (NMHS), as listed in the Sections below. In each country the respective NMHS facilitated and accompanied our meetings with other agencies to whom they supply climate information and early warning advice, enabling NIWA to work closely with these additional groups.

Fiji

Primary partner: Fiji Meteorological Service (FMS), under the Ministry of Rural and Maritime Development, and National Disaster Management.

NIWA has been working with FMS for more than three decades, providing meteorological and hydrological instrumentation and modelling, collaboration on in-country services, and collegial support in numerous international climate adaptation projects and initiatives. The relationship is strong and ongoing. For example, over the past few months, NIWA has provided four technical training programmes to FMS staff, and in-country technical support for environmental instrument operations and maintenance. In the past decade or so, NIWA has worked with FMS and other government agencies in Fiji to install close to 80 remote environmental monitoring sites, and, at cost, provides ongoing support for system operational integrity and data management.

Kiribati

Primary partner: Kiribati Meteorological Service, under the Office of the President, Government of Kiribati.

NIWA's work in Kiribati over recent decades has included (i) the installation of the World Meteorological Organisation's CliCom data management system in the 1990s; (ii) a project under the Kiribati Adaptation Programme to provide information for climate risk management (High Intensity Rainfall and Drought) during 2008-2010, (iii) a multi-country programme funded by the Ministry of Foreign Affairs, New Zealand Government focussing on providing seasonal drought advice to five low-lying atoll countries in the Pacific including Kiribati, 2016 and 2017; (iv) a current project 'Enhancing Food Security in the Context of Climate Change in Kiribati, GEF Project ID:5414, which has a strong focus on monitoring and early warning for drought and water quality. Under this project, NIWA will be managing the telemetry services and data ingest to the CliDE data base system (the modern replacement to CliCom).

Papua New Guinea

Primary partner: National Weather Service, under the Department of Transport and Infrastructure

In addition to the DFID-GFDRR Phase II work with the NWS in PNG, NIWA is also working with NWS and the PNG Conservation and Environment Protection Authority (CEPA) on a pilot flood forecasting programme in the Bumbu catchment of Morobe Province, under a project facilitated by UNDP. Under this project, NIWA has extended the automatic weather station network in PNG, and is supporting integration of data from other existing remote stations to. The pilot phase of the project will lead to further engagement by NIWA with environmental monitoring in PNG. Technical collaboration between NIWA, NWS and CEPA is being further strengthened with the upcoming training in New Zealand of four technical staff from NWS and CEPA. The training is for four weeks and is funded by the New Zealand Government under the Ministry of Foreign Affairs Short-Term Training Scholarships programme, and will be conducted by NIWA in New Zealand in May 2018.

Samoa

Primary partner: Samoa Meteorology Division (SMD), under the Ministry of Natural Resources and Environment (MNRE)

NIWA has been engaged in climate services work with SMD and MNRE since the launch of Samoa's NAPA programme in mid 2000s. Over the past 10 years NIWA has worked with SMD to install or

upgrade 55 automatic environmental monitoring stations, and, as and when project funds allow, will continue to support Samoa's SMD and Water Resources Division to develop real time services, based on the monitored data, to manage the risk of drought (and other climate hazards such as extreme rainfalls and floods) in Samoa.

Solomon Islands

Primary partner: Solomon Islands Meteorological Service (SIMS), under the Ministry of Environment, Climate Change, Meteorology and Disaster Management

Prior to recent collaboration with the SIMS, NIWA has had a long-term engagement with environmental studies and services in the Solomon Islands, particularly in the field of hydrology. NIWA's predecessor agencies worked for several decades with the former Geology Division of the Solomon Islands Ministry of Natural Resources, including periods of in-country engagements in the 1970s and 1980s. More recently NIWA has worked with the Solomon Island Water Resources Division, now a department of the Ministry of Mines, Energy and Rural Electrification (MMERE).

Since 2013, NIWA has been contracted to work in partnership with SIMS to enhance their climate monitoring network under the SWoCK[1] project (see the video link below).

https://www.youtube.com/watch?v=wayWZ_2-Vyo

The SWoCK project was followed by a further collaboration with SIMS on a project focussed on water security in the Solomon Islands (SIWSAP[2]). This project is on-going, and the GFDRR Phase II work has enabled NIWA to install the upgraded CliDEsc DRVT suite. Under SIWSAP, a further two visits to Solomon Islands are planned to work with both SIMS and WRD staff to further customise and enhance climate and hydrological reporting in the country.

NIWA currently manages the contractual arrangements for telemetry services for the Solomon Islands climate and hydrological monitoring networks. NIWA's partnerships with SIMS and WRD is thus ongoing.

Vanuatu

Primary partner: Vanuatu Meteorology and Geo-Hazards Department, under the Ministry for Climate Change Adaptation, Meteorology, Geo-Hazards, Environment, Energy and Disaster Management

In 2016 NIWA worked with VMGD and other stakeholders in Vanuatu to develop a roadmap[3] to improve climate services and build community resilience to climate change, especially in vulnerable coastal communities. In 2017, under the climate resilience project VCAP, NIWA was contracted to install six automatic weather stations, integrate the data with VMGD's existing database management and weather forecasting systems, and develop climate services for six economic and civil sectors – Agriculture, Hydrology, Health, Marine, Tourism and Energy. A continuation of this project, funded by the EU, contracted NIWA to supply a further three AWS systems. In the course of this work, two VMGD staff received two weeks of instrument calibration and maintenance training at NIWA's instrument laboratories in Christchurch. NIWA will continue to liaise with VMGD on the customisation of climate services, including improved analysis and advisories from CliDEsc and DRVT.

[1] Strongem waka lo Community fo Kaikai (*SWoCK*): Resilience in Agriculture and Food Security in the Solomon Islands
[2] Solomon Islands Water Sector Adaptation Project (SIWSAP)
[3] Vanuatu Framework for Climate Services. Prep by A Tait and G Macara, NIWA, in consultation with VMGD. Funded by the Secretariat of the Pacific Regional Environment Programme (SPREP), 2016.

Figure 3-1: Sector representatives discussing information needs at the VCAP climate information and services workshop, Port Vila, Vanuatu, May 2017.

4 Description of capacity building of local stakeholders.

Did you conduct training in Phase II for local communities or beneficiaries in the use of your tool? If yes, please describe the type of the training and the number/type of beneficiaries trained. Did you measure change in knowledge as a result of your training? If yes, please provide results. Did you follow up in any way after the training to see if what you discussed was put into practice? If yes, please explain.

During Phase II training including hands-on use of the CliDEsc user interface and product generation was conducted in all six partner countries. NIWA developed and provided a comprehensive CliDEsc User Guide which catalogues the drought (and other) products and the data processing behind each tool. NIWA is continuing to develop the Workbook for Operational Competencies for Pacific Island Climate Networks and Operational Services, and used it with the National Meteorological Services as part of the project. The workbook is a step-by-step guide to managing climate services infrastructure, and encourages staff to work towards World Meteorological Organisation Guidelines for climate services competencies. The Workbook training is set out in 6 modules, as outlined in the table below.

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.

The aim of the workbook is to strengthen staff skills and confidence in their day to day work, and help to ensure there is on-going operational integrity and sustainable delivery of climate services including operation of the DRVT tools.

As a result of this project, use of the Workbook for Operational Competencies as a training tool has been tested by operational staff and consolidated for ongoing development and use.

Figure 4-1: CliDEsc DRVT training with the climate services group at Papua New Guinea National Weather Service.

The effectiveness of the training will become more evident in the future as staff start to make more use of the DRVT and other CliDEsc tools in their day to day work. In Fiji, outputs specifically requested by staff are now being used on a regular basis, and little training was required to initialise

their use. In Samoa, monthly reports that required several hours of manual analysis are now produced in CliDEsc – staff using the software became familiar with this process after just one training session. In most cases, staff find it relatively easy to use the CliDEsc DRVT tools. The more challenging work is to engage with users of climate information to design customised products that exactly suit user needs (the content of Module 6 in the Workbook Competencies tabled above).

Country	No of staff trained	Climate staff	IT technical staff	Female/Male
Samoa	12	10	2	3/9
Fiji	8	4	4	2/6
Solomon Islands	7	5	2	2/5
Kiribati	8	6	2	4/4
Papua New Guinea	9	2	2	4/5
Vanuatu	14	10	4	6/8

Figure 4-2: CliDEsc DRVT training for climate and information technology staff at Kiribati Meteorological Service Betio office, South Tawara. Attendees were four female and four male.

5 Did you leverage private or public sector resources?

If yes, please describe the source of the leverage as well as the total USD amount of combined cash and in-kind contributions. If relevant, please describe the nature of your relationship with the source(s) of leverage.

This project is closely aligned with a number of ongoing or recently commenced climate services projects and other programmes in the Pacific Region:

5.1 RESPAC support for instrument maintenance and technical training

Leveraged component approximately US$60k during 2017/18

Funding was made available to support training in climate station instrument and telemetry systems maintenance, and data quality assurance. NIWA provided a two-week technical training programme in Fiji, including laboratory instrument training and field work to identify and repair instrument and communications faults.

5.2 Kiribati Food Security Project

Leveraged component approximately US$120k during 2017/18

The *Enhancing Food Security in the Context of Climate Change in Kiribati* is being funded by the Least Developed Country Fund (LDCF). It aims to build the adaptive capacity of vulnerable Kiribati communities to ensure food security under conditions of climate variability and change.

Component One of the project will assist Kiribati to address urgent institutional capacity building needs primarily on the national level. This will include helping to set in place an improved regulatory environment, strengthened institutional planning and policy frameworks, and generation of data required to support informed decision-making.

Under Component Two, the project will assist Kiribati to address climate change vulnerabilities by implementing and demonstrating community-based adaptation measures for four islands: Abemama, Nonouti, South Tarawa and Maiana. This will set in place models for land and lagoon resources management based upon informed planning and management processes, increase awareness of rural communities regarding fisheries management and climate change impacts, develop community-based monitoring systems to inform decision-making, serve as an early warning system for climate change impacts, and be linked to island-wide vulnerability assessments. The project will also work with extension officers responsible for both agriculture and fisheries resources. This will include building the capacities of officers, responsible government agencies, island councils, and rural stakeholders through formal training programs. Model programs for more sustainable and climate resilient practices will be tested, assessed, and ready for national replication.

The Kiribati Meteorological Service (KMS) has prioritized extending and upgrading its meteorological and hydrological observation networks to strengthen its capacity to obtain, manage, and deliver environmental data and operational climate early warning services for Kiribati.

The new infrastructure and related data management services will address the need for increased access to widespread, reliable and timely weather and climate information to assist with food security decision-making.

5.3 Solomon Islands Water Sector Adaptation Project

Value of leveraged component approximately US$600k

An LDCF project to upgrade the hydrometric network of the Solomon Islands Water Resources Division was awarded to NIWA and implemented during 2017/18. Six new hydrometric stations have been installed in drought vulnerable island communities, and data will be integrated to CliDE in near real time. Drought risk products are being developed using both climate and hydrometric (ground

water) monitoring. Two further visits by NIWA to Solomon Islands are planned over the next few months to complete the product design and installation in CliDEsc.

5.4 Vanuatu Coastal Adaptation Project (V-CAP)

Value of leveraged component approximately US$600k

This project, fully entitled Adaptation to Climate Change in the Coastal Zone in Vanuatu, was funded by the Global Environment Facility and implemented jointly by UNDP and the Vanuatu Ministry of Climate Change Adaptation, Meteorology, Geo-Hazards, Environment, Energy and Disaster Management. Under a component contract of approximately US$600k, NIWA installed six automatic weather stations scattered across the country, and provided data integration to the VMGD data management system, and training for technical staff on AWS installation, operations and maintenance.

5.5 Adapting to climate change and sustainable energy (GIZ ASCE)

Value of leveraged component approximately US$100k

The Government of Vanuatu, under funding provided by the EU and administered under the GIZ-ASCE project, contracted NIWA to install an additional 3 AWS to supplement the network installed under V-CAP.

5.6 Papua New Guinea flood warning project

Value of leveraged component approximately US$900k

During 2017 the first phase of the establishment of a Flood Early Warning System for the Bumbu River catchment, Morobe Province, and the installation of weather monitoring equipment in five provinces of PNG was completed. While the focus of the project is extreme rainfall events and flood warning, the project implementation provided associated benefits for drought warning the DRVT suite through improved computing facilities at PNG National Weather Service and access to near real time weather information to bolster NWS climate analysis capacity.

5.7 Climate data rescue

In the Pacific region, recovery of historical climate data, often from old paper records and digital files, and archiving and quality control of real time observations, have been enhanced by the deployment of the CliDE Climate Data Management System (CDMS). CliDE is an open source, free CDMS developed by the Australian Bureau of Meteorology, and now deployed in 18 Pacific Island countries and in Timor Leste. This has been a multi-million dollar project and is on-going.

5.8 CliDE software and hardware upgrades

Estimated US$300-400k per year, ongoing

Bugs etc During 2016, all three project countries have received CliDE server hardware and software upgrades, through the Bureau of Meteorology and funded by the Australian Department of Foreign Affairs and Trade. This upgrade improved the stability and capacity of the platform, an essential requirement that has now enabled more complex visualization tools, including the DRVT, to be created.

5.9 Global Framework for Climate Services

World Meteorological Service (WMO): WMO has developed the Global Framework for Climate Services (GFCS, http://gfcs-climate.org/), a new initiative to help coordinate the enhancement of climate services globally. The GFCS incorporates a systematic approach to mitigate climate risk through national and region development of:

- User interface platform
- Climate services information systems (such as the CliDE/CliDEsc information and early warning system
- Observations and monitoring
- Research, modelling and prediction
- Capacity building.

The GFCS sectoral priorities are agriculture and food security, disaster risk reduction, water and health, with a key focus on climate extremes such as drought. The DRVT products will improve the capacity of Pacific Island meteorological services to meet the objectives of the GFCS programme.

6 How did your project consider gender in any aspect of project planning or implementation? Was a gender analysis or assessment conducted?

If yes, did your project address any gap identified in the assessment? If yes, please describe how. All Phase II projects are required to integrate gender into their work. Please use what you wrote in your inception report on gender as the starting point for this section.

Reports from several Pacific countries indicate that the droughts in small island states are particularly difficult for women in rural communities, especially those who are expected to be the main providers of water and food to their families. For example, in the context of the ethnic tensions in the Solomon Islands, the 'safety and security of women and girls was compromised as they needed to travel further to collect water during dry periods, also leading to less time for other activities.' In Papua New Guinea, Oxfam reported that there was increased domestic tension and violence in highland areas affected by drought. The DRVT project outcomes indirectly contribute to lessening such tensions caused by drought events.

The DRVT project has been implemented by both male and female members of NIWA science staff. We have worked equally with men and women in the meteorological services in our six partner countries. In some cases, such as the NDMO in Samoa, major agencies of Government are headed by women, and are key drivers of outcomes for women. Women were also consulted as a matter of priority during the development of the project.

NIWA also strives to be gender inclusive by ensuring that women are represented in consultations, workshops, and trainings. This is often accomplished by urging project partners to invite representatives from national women's groups to consultations and training events.

The projects in the Pacific that the DRVT work has been associated with have been strongly gender inclusive. An example is the SWoCK[4] project which targeted support for women, particularly in their role as primary food produces. See the video *Women and Climate Change Adaptation* at the following link: https://www.youtube.com/watch?v=QoVZDMeGIls.

7 Discussion of how tool or approach can be brought to scale in the future.

7.1 Deployment to new Pacific Small Island states

The DRVT tool, as part of the CliDEsc suite of product generators, can be readily redeployed to countries where the CliDE database, or any other advanced database management system, is in place. Features of CliDEsc, such as specific time series views, tables and map layers are readily transferrable, and can be easily customized to each additional country.

Pacific countries other than the six partners under the GFDRR Phase II have requested the implementation of CliDEsc, and NIWA is ready to assist with this should project funds become available.

7.2 Technical training for climate services staff

Ongoing technical training for NMHS is essential to build staff confidence and capacity to provide improved climate services, and to realise the potential enhancement and outcomes of CLEWS operations. Training of technical staff will help to secure reliable instrument maintenance, data quality, and dependable DRVT product generation and drought advice.

During Phase II, NIWA has continued to develop the Workbook for Operational Competencies for Pacific Island Climate Networks and Operational Services, and have used it with the National Meteorological Services as part of the project. The workbook is a step-by-step guide to managing climate services infrastructure, and encourages staff to work towards World Meteorological Organisation Guidelines for climate services competencies. The aim of the workbook is to strengthen staff skills and confidence in their day to day work, and help to ensure there is on-going operational integrity and sustainable delivery of climate services including operation of the DRVT tools.

As a result of this project, use of the Workbook for Operational Competencies as a training tool has been tested by operational staff and will be further developed for ongoing use. The use of this workbook as a training tool will enhance the scaled-up deployment of the CliDEsc DRVT suite to additional Pacific countries.

7.3 Remote system support

By agreement with respective NMHS in each partner country, NIWA can support the CliDEsc DRVT remotely from New Zealand in cases when issues arise, or for new development. This means that when new product ideas are discussed and requested by the partner countries, NIWA can remotely support the writing of the product code and assist with new product registration, testing and deployment on the in-country servers. This can reduce travel costs in any ongoing support

[4] Strongem waka lo Community fo Kaikai (*SWoCK*): Resilience in Agriculture and Food Security in the Solomon Islands

programmes that are implemented. In addition, it allows experienced NIWA IT specialists to advise in-country staff when needed.

7.4 Customisation of climate services and advice

Climate risk managers have particular information needs that require customisation. New product design and development will be key to the ongoing use of the CliDEsc DRVT suite. NIWA has received requests to help with the development of special advisories that include both observed and forecast data. These outputs will enable risk managers to base operational decisions on both the current status of conditions, and on how the monitored situation is likely to change.

NIWA has helped Pacific countries to develop geo-referenced maps (eg. Figure 7-1) using proprietary spatial interpolation software. NIWA is planning to integrate open source software into the CliDEsc DRVT platform which will enhance the use of geo-referenced products in the Pacific Islands.

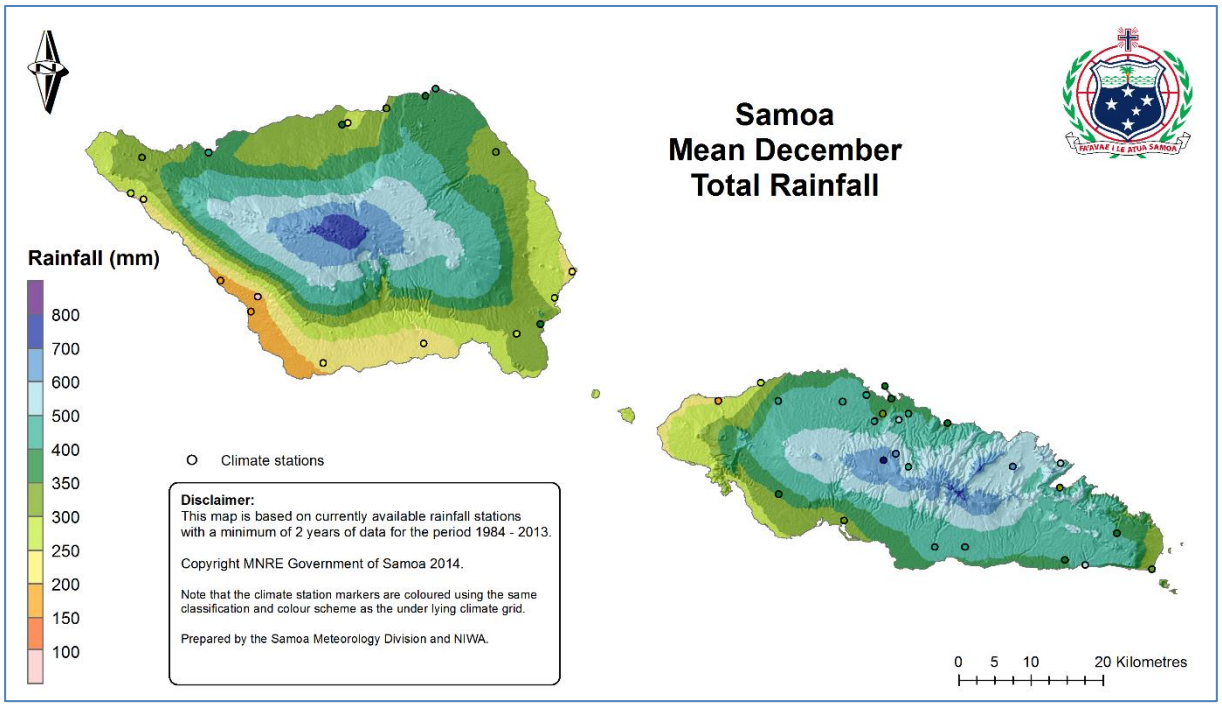


Figure 7-1: Long term mean December rainfall developed using proprietary GIS spatial interpolation software. The integration of open source interpolation software into CliDEsc will improve accessibilty for Pacific Island countries.

8 What were main points of learning from this phase of the project?

Phase II of the project has enabled the consolidation of the earlier work in Phase I. While some new DRVT products have been developed, more time than anticipated was needed to support in-country operational infrastructure to enable successful deployment of CliDEsc 2 and enhanced climate services. Staff often needed support to resolve breakdowns with computing hardware that was not functioning, or networking issues that prevented data access or sharing of computing resources.

The project has highlighted that the need for meteorological services to enhance their investment in maintaining robust data reporting and management systems, including routines to improve data auditing and quality standards. We have had to spend considerable time with staff to encourage awareness and understanding of all components of the CLEWS system, and in that context help them address data quality and latency issues. We also needed to develop and install new processes to ingest data in near real time following observation, in order to ensure there were sufficient (and up-to-date) data for the DRVT tools to give useful and current risk management information.

Many staff tasks are routine and repetitive, and to encourage staff willingness to embrace new challenges and ways of doing things has taken time and required significant additional support and training. Staff training has also been needed to recognise and explore the potential for generating new and more comprehensive information using the CliDEsc DRVT product suite.

More time than was expected was needed to help users of climate information understand the purpose and content of the DRVT outputs. Most clients of the meteorological services had had little prior exposure to customised products developed from climate information, and the DRVT outputs were novel. However, the additional time taken with users frequently resulted in improved customisation of the tools, and better eventual understanding and uptake. There was insufficient time within the Phase II project to implement the new product customisation requirements that are now being requested.

9 Additional Monitoring Data regarding Tool Uptake

a. Is your tool openly available to the broader user community? If yes, please provide the name of the platform.

The version of CliDEsc (CliDEsc 2) upgraded during Phase II, has been provided for free and open access *within* the partner agency Ministries in each country respectively. Access to the wider public community is at the jurisdiction of the respective Ministries. Normal practice at present is that information derived from CliDEsc, including the DRVT suite, is distributed to the public at no cost.

b. How many downloads of your tool have occurred throughout both Phase I and Phase II? How is this being measured?

The tool is installed locally in the NHMS and requires connection to local IT infrastructure and services to operate. It is not designed for individual users to download.

c. How many decision makers have accessed your tool throughout Phase I and Phase II? Of these, how many access your tool on a regular basis? How is this measured? (it can be through conversations, email, direct observation or another way)

Regular users of CliDEsc are local climate and forecasting staff, and other Ministry staff connected within the respective Local Area Network. The system is typically accessed on a daily (work day) basis as it is part of routine services. External users, such as NDMOs, Fire Services etc, are provided with pre-customised outputs normally via web services, typically on demand, or routinely as part of monthly public climate summaries.

d. Have any policies, plans or investments been informed/influenced by your tool? If yes, please provide a bit more detail on how your tool has informed/influenced investment/policy/plans; if possible, provide USD amounts of local budgetary changes or other investments. If the influence was policy-based, please describe the policy change your tool informed. If the influence was in planning, please provide detail.

The project has served to integrate the drought monitoring and early warning services being developed through the National Meteorological Services and the National Disaster Management Offices, and the respective national drought response plans that are currently being developed. The DRVT has been customized to provide specific drought information time series, maps and advisories to service national drought response information requirements, particularly drought index thresholds to trigger response actions. This work contributes directly to the National Drought Response Plans and standard operational procedures being developed in each country.

In Fiji, this included involvement in the National Disaster Management Office's committee that is developing the country's Drought Response Plan. NIWA and FMS climate staff consulted with the Drought Response Committee, and NIWA is supporting the development at FMS of customised DRVT outputs that will help monitor the onset and spatial extent of drought in Fiji.

The Fiji Drought Response Plan aims to 'inform drought preparedness, response, mitigation and adaptation measures through a government lead multi-sectoral approach to reduce and prevent the adverse effects of drought on the populations of Fiji'. To support this work, the project has included in the Fiji DRVT software package a national drought risk map based on the daily fire risk calculated at each automatic weather station on Fiji's national climate network. As more climate stations come on-line, they will automatically be included in the generation of this product.

In Samoa the National Drought Response Plan is being developed by the NDMO. Again, as part of the project, a number of meetings were held with the NDMO which has provided help to the Samoa Meteorology Division to customise the DRVT product suite to meet NDMO requirements.

In Solomon Islands, the Solomon Island Meteorological Service (SIMS) plans to distribute drought information routinely through the Ministry of Agriculture and Livestock under a Memorandum of Understanding. Protocols have yet to be developed to meet requirements of the Solomon Islands NDMO. Once the NDMO drought response plan is developed, the DRVT tools will be customised to suit its requirements. As noted earlier, a National Drought Plan is also being developed, requiring specific analytical and advisory inputs from SIMS that will be used directly for drought severity evaluation and implementing appropriate support levels for impacted communities.

The economy of Papua New Guinea, and the welfare of agricultural communities, are typically impacted by drought events every year. Recent drought studies in PNG have highlighted seasonal drought variability, for example as a result of the state of the El Nino Southern Oscillation, and areas of the country which are typically most at risk. The DRVT outputs will be used in advance planning and early warning of drought, including automated monitoring of conditions on-the-ground, a process that at present relies on manual data analysis.

The Kiribati Government is undertaking a major upgrade of its climate monitoring network with the installation of new climate stations, and an additional network of logging rain gauges, both in the main centres of population and in the outlying islands of the country. Data from these installations will be integrated with Kiribati's national climate database (CliDE) and processed using the CliDEsc

DRVT software at KMS. Outputs from the system will help the Kiribati Government to plan and implement relief to communities suffering drought.

The Government of Vanuatu in early 2018 is launching a new project funded under the Green Climate Fund, a component of which aims to 'expand the use of climate information services (CIS) to tourism, agriculture, infrastructure, water management and fisheries. Specific project goals include building technical capacity to harness and manage climate data, developing practical CIS tools, fostering their use and disseminating tailored climate information.' The upgrading of the CliDEsc DRVT software as part of CLEWS, under the Phase II funding, has created the platform on to develop the above objectives.

Was your sustainability goal for the project achieved? Please provide the metric used and explain the results achieved.

The DRVT installation builds on existing infrastructure and is therefore not an additional burden on sustainability of current meteorological service operations. The new tool addresses needs and gaps in climate risk information identified in national policies aimed at building capability in environmental monitoring, climate early warning systems, and related services. Sustainability will be driven by the demand for services to mitigate climate risk, build resilient communities, and ultimately save lives.

e. Do you have an exit strategy for your project? If yes, please explain.

While the completion of Phase II closes the current project, the six partner countries need support to ensure the DRVT product range is routinely used, and further customised and expanded to meet user expectations and needs. NIWA has been supporting South Pacific meteorological services for several decades, through implementing development projects, and engagement with regional science and environmental agencies. This support can only continue as resources permit, including through technical and scientific training, project engagement, and sharing of technical support.

Increasing global understanding of the vulnerability of Pacific small island states to climate variability and change is leading to the development of internationally supported projects to strengthen the resilience of the region and its communities to meet these risks. These projects will build on developments achieved under the GFDRR Phase II funding.

10 Please detail how the budget was spent through the course of phase II

The following lines of expenditure are an approximate breakdown.

	GFDRR Funding	*In kind Funding [1]*	*Other Funding [2]*	**Total Funding**
CONSULTING SERVICES (fees, travel, per diem)	106,620		380,000	486,620
TASK TEAM SUPERVISION (List key personnel and their related expenditure)				
DISSEMINATION (Translation, editing, publication, etc.)	2,500	1000	20,000	23,500
LOGISTICS (Training, workshops, consultations, etc.)	27,500	30,000	250,000	307,500
GOODS AND WORKS	7,000	1,000	2,000,000	2,008,000
OTHER (please specify): Freight, mobile phone, courier, incidentals Indirect Cost	800		5,000	5,800
TOTAL	**144,420**	**32,000**	**2,655,000**	**2,831,420**

[1] In-kind funding includes estimates of national staff time in meetings and workshops, in-country travel cost to meet with key stakeholders and officials, and international liaison, such as with regional partners such as the Australian Bureau of Meteorology, SPREP (Secretariat for the Pacific Regional Environment Programme), SPC (Secretariat for Pacific Communities) and UNDP (United Nations Development Programme).

[2] Other funding includes inter-project leverage, (Section 5) and direct NIWA support.

11 Please attach any additional project related documents you may have to the final report.

Included here are some example outputs from CliDEsc DRVT (Section 11-1 to 11-4). Also included, (Section 11-5) is a copy of a Climate Early Warning System (CLEWS) presentation given at a major Pacific Island Climate Change held recently in New Zealand.

11.1 CliDEsc Documentation

Each partner country was provided with full documentation of the CliDEsc product generation system and software. An example of the CliDEsc documentation (for Vanuatu) can be found at

https://www.dropbox.com/s/7vg1fk0if500uxm/CliDEsc%20Documentation_VU4.pdf?dl=0

CliDEsc was developed in consultation with the National Meteorological Services in the Pacific region. Designed by NIWA (The National Institute of Water and Atmospheric Research Ltd), CliDEsc is a web based tool that allows users to request data and products to be generated from a range of environmental observations and variables. CliDEsc provides sql access to CLIDE, a climate database developed by the Australian Bureau of Meteorology, and to other structured database management systems, published web pages and other ancillary data, including internal data repositories.

CliDEsc is an integral part of the Pacific Island Climate Early Warning Systems (CLEWS), and provides a User Interface to manage the 'many-to-many' connections required to:

- query data from multiple sources (CliDE and other databases, internal files and data structures, and data available through external web services);
- analyse and visualise data in time series, tables, and maps
- create customised, data-derived products to support decision making
- disseminate outputs via a range of communication channels and web services

CliDEsc provides a logical platform for integrating data processing with data sources, thus avoiding the need to extract and manage work files in disconnected product processes.

The CliDEsc platform is designed for easy access by advanced users who can develop open source (typically R, Python, and PHP) product generators, and register them in the CliDEsc product generator system.

CliDEsc is a stand-alone system, with its own authentication and user administration. The content management system underlying CliDEsc was built by Catalyst IT, New Zealand, using the Silverstripe open source Content Management System (CMS).

The CMS can be edited by SIMS staff to customise the content to National Weather Service requirements.

11.2 Samoa Weather

Samoa Weather (Figure 11-1) is a cell phone app that combines weather and other environmental hazard information, with climate images and information provided by the DRVT software.

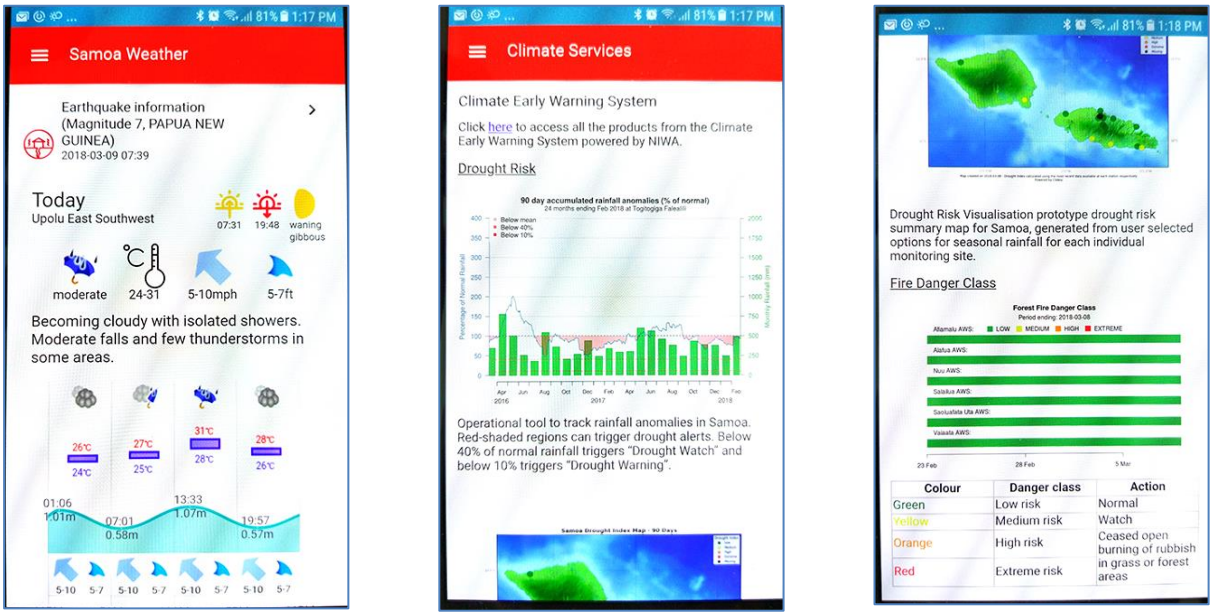


Figure 11-1: Screen shots of the Samoa Weather app showing the weather page (left), and the contiguous climate information page generated from CliDEsc DRVT.

11.3 Example Papua New Guinea monthly report using a DRVT output

The following extract from the PNG NWS monthly climate public statement and outlook, which includes a rainfall map produced as part of the Drought Risk Visualisation Toolkit.

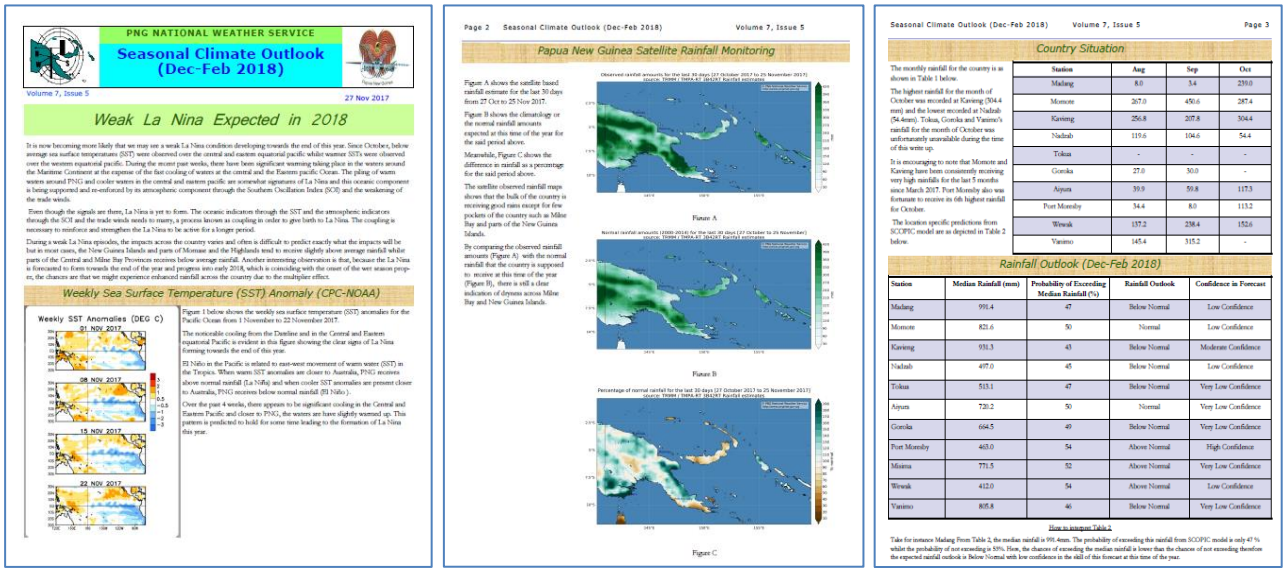


Figure 11-2: Extract from monthly climate bulletin issued by the Papua New Guinea National Weather Service, including maps (centre panel) produced as part of the DRVT product suite.

11.4 Crop climate calendar

The Crop Climate Calendar was designed in consultation with the Sugar Refinery Institute of Fiji. SRIF scientists use weather observations and climate data to advise sugar growers on crop management. Compiling information relevant to sugar growth which was previously done by hand, can now be done efficiently using CliDEsc.

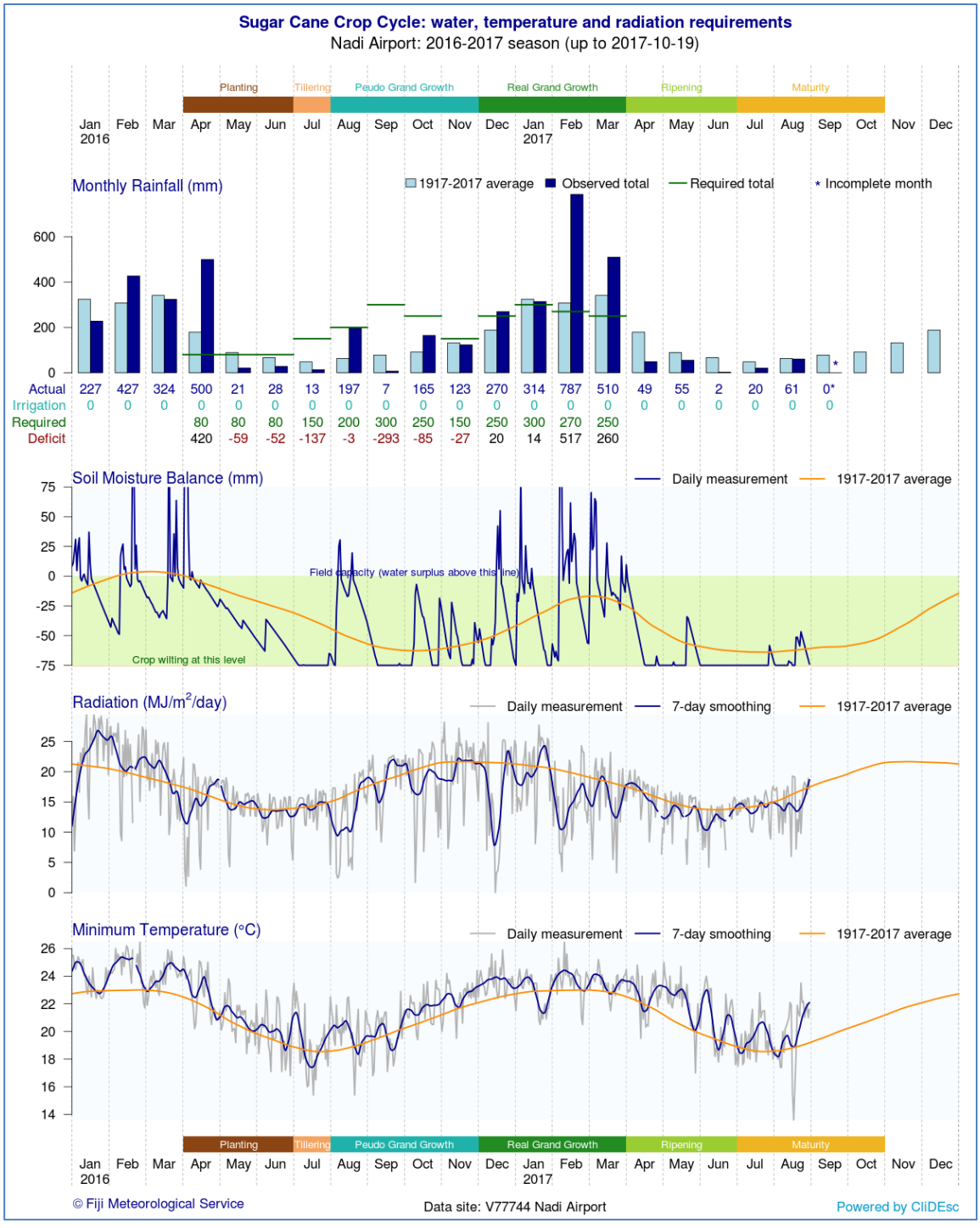


Figure 11-3: Crop climate calendar for sugar cane, designed to improve sugar cane management, particularly focussing on water management as the main risk factor.

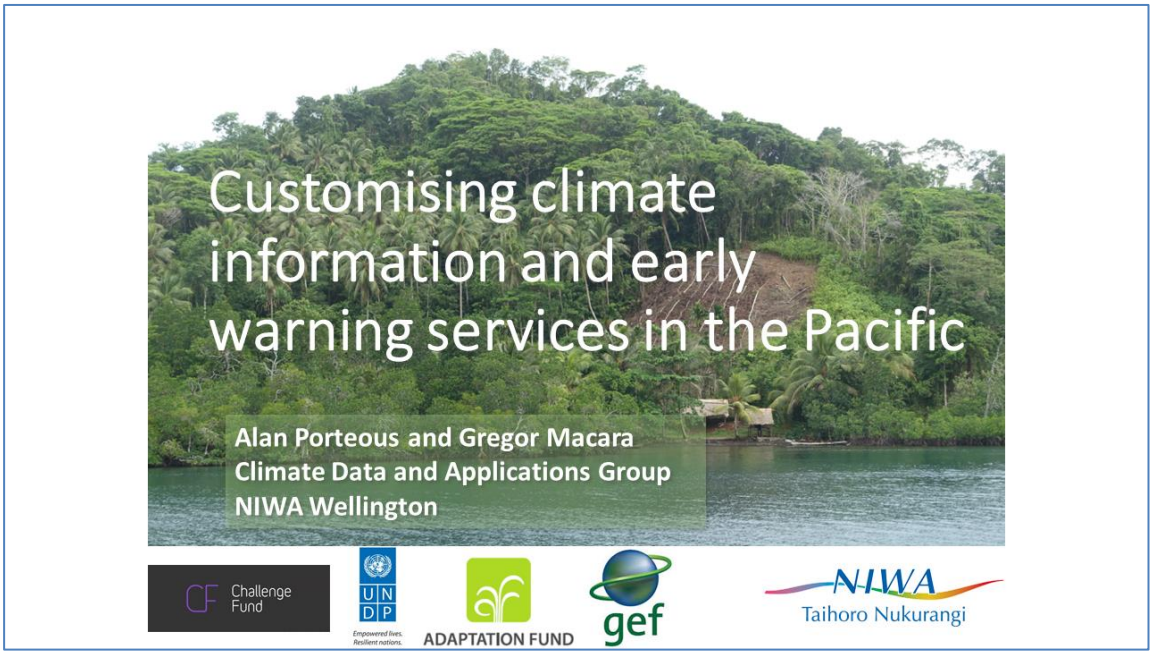
11.5 Second Pacific Climate Change Conference

The Second Pacific Climate Change Conference – Pacific Ocean, Pacific Climate – was held in Wellington 21-23 February 2018. NIWA gave a presentation on building climate services in the Pacific, summarised in the following abstract:

> Climate services provide climate information to assist decision making by individuals, organisations, sectors and society, and is essential to our ability to respond and adapt to climate events, variability and change. The Climate Early Warning System (CLEWS) initiative that was commenced in Samoa, and is now underway in six other Pacific Island countries, has developed an end-to-end data capture and climate services delivery system to help develop climate early warning and climate services, improve provision of climate-related information for sector and society decision-making, enhance resilience for health, food and water security, and, in the process, deliver on the WMO Global Framework for Climate Services. Developments have involved the installation of almost 200 automatic rain gauges, weather and hydrometric stations, direct integration of the data with weather and other operational services, automatic ingest to the Pacific climate database, CliDE, and the development of customised data analysis and early warning information on the CliDEsc software suite. Despite the development of the system, translating climate data in to sector-based risk and impact information remains a considerable challenge and one that all climate service initiatives are only beginning to make some progress in addressing.

The slide sequence from the presentation is copied below.

The presentation provided an opportunity to relate the development of climate services in the Pacific to a public audience, including a number of professionals working on issues involving Pacific climate risk mitigation. Feedback after the presentation was positive.



Background

A fully operational climate information system, designed for use in the Pacific, has the following 4 features:

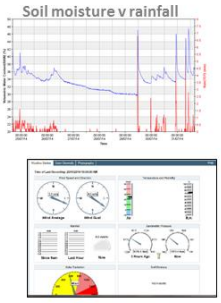
1. Ready-to-use, system-integrated tools to analyse historical environmental data
2. A data management system that automatically integrates historical and new real-time data
3. An in-line, user friendly tool kit for visualisation of historical, current and forecast data, and customisation of decision support information
4. An integrated content and communications management system that manages information delivery, and total system backup.

CLEWS – Climate Early Warning System

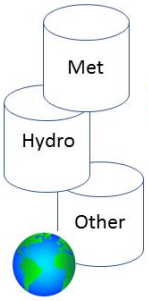
- CLEWS initiated by Samoa Ministry of Natural Resources in 2008
- Further developed in Samoa, Fiji, Solomon Islands, Cook Is, Vanuatu and Papua New Guinea Meteorological Services to specifically meet their needs
- CLEWS provides climate services and early warning capability
  - WMO GFCS

CLEWS: continuous data lineage

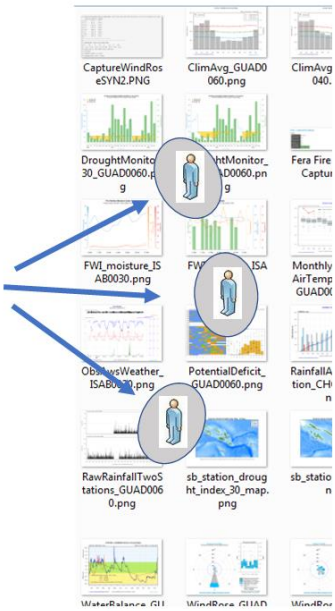
Measure the weather and environment at remote sites



See the data immediately



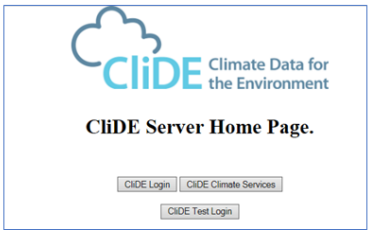
Multiple data sources and archives, and delivery channels



NIWA
Taihoro Nukurangi

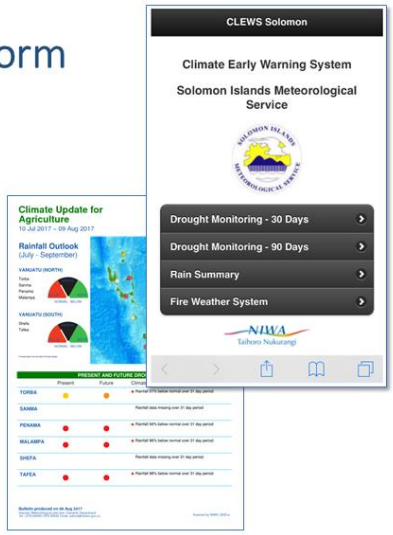
Automatic integration

- Data delivered straight in to CLIDE.
- Integration of JICA and other AWS data also into the CliDE
- Automated pre-coding of synop and METARs
- Integrate AWS and manual obs into coded format for WMO World Information System
- Improved QA

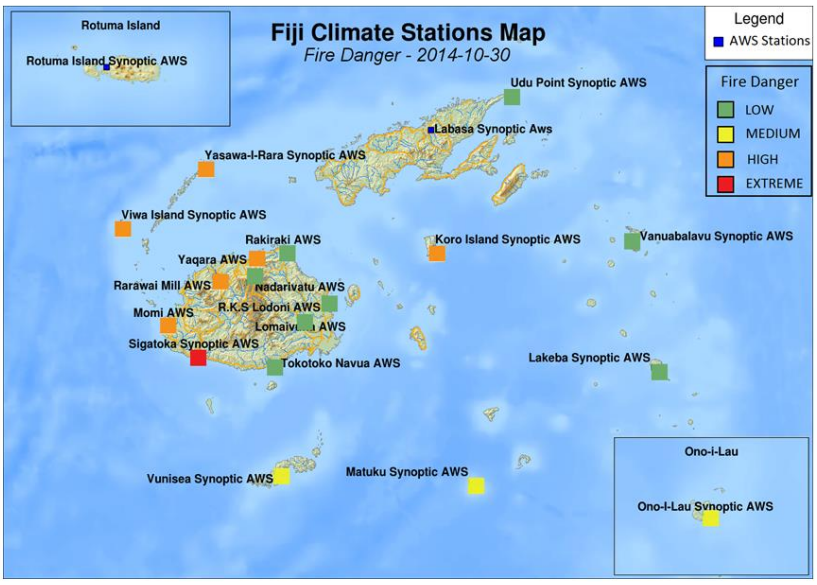


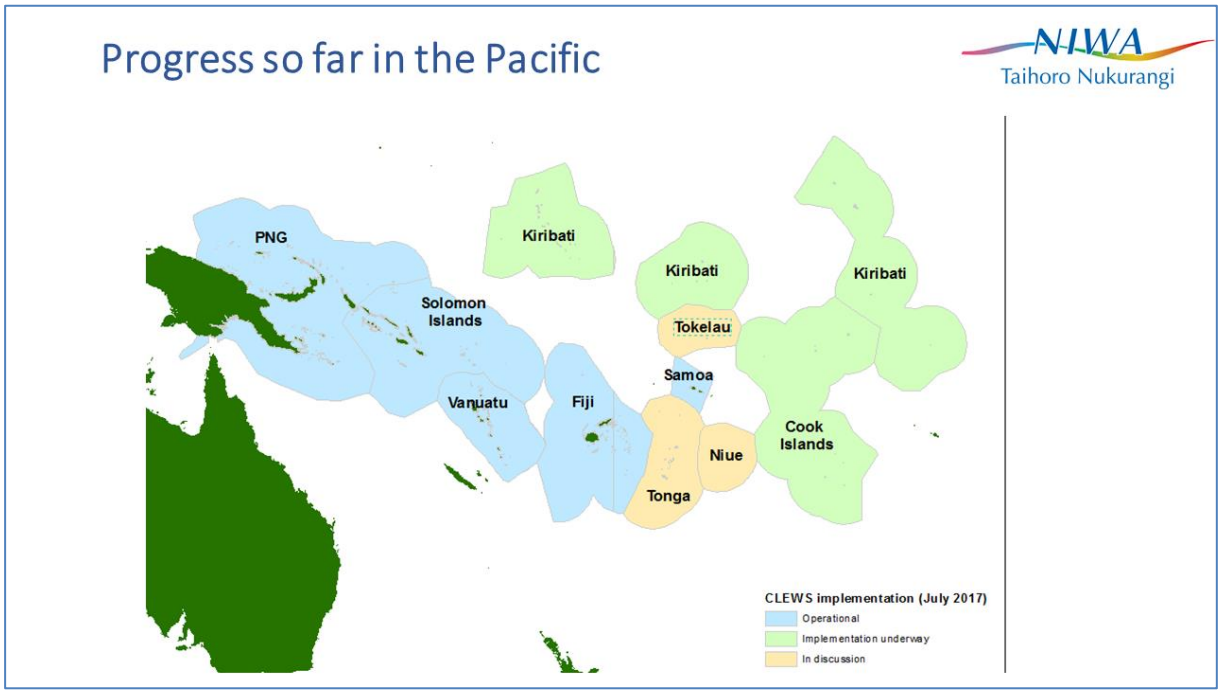
Deliver on demand products
CliDEsc product generator platform

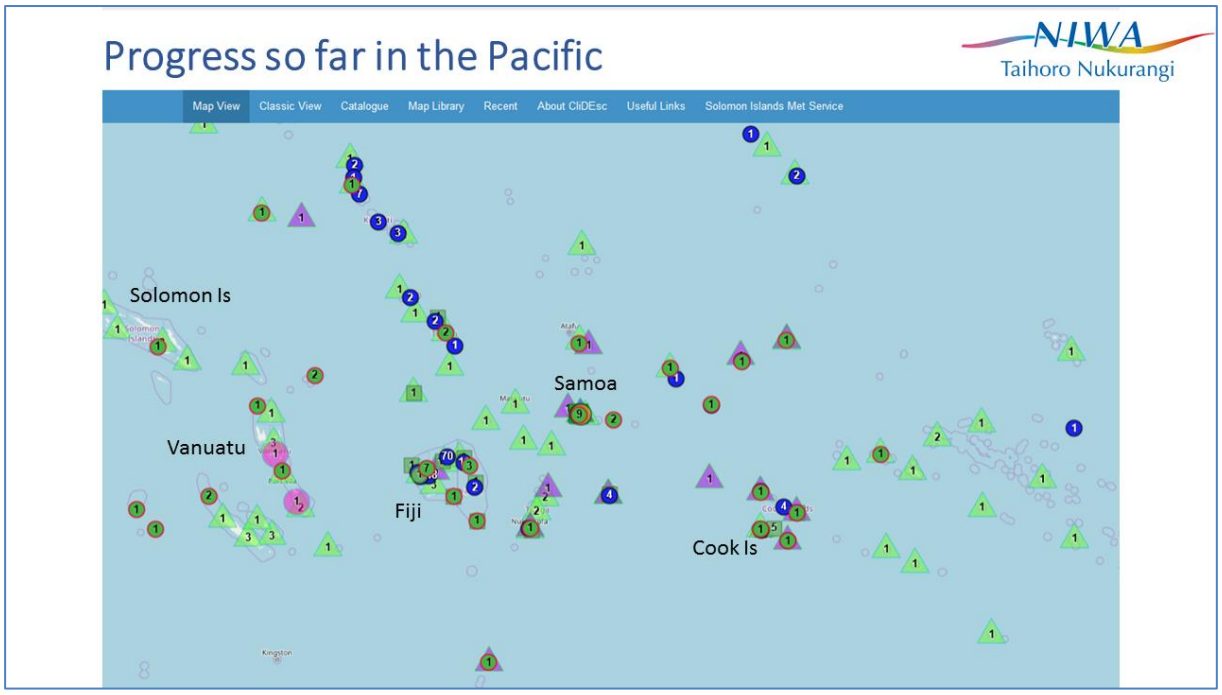
- CliDEsc = CliDE Services Client
- Products delivered via:
  - Dashboard
  - Web
  - Smartphone
  - SMS
  - Bulletin generation



Historical and real time data integration




Progress so far in the Pacific
NIWA
Taihoro Nukurangi
PNG
Kiribati
Kiribati
Kiribati
Solomon Islands
Tokelau
Samoa
Vanuatu
Fiji
Cook Islands
Niue
Tonga
CLEWS implementation (July 2017)
Operational
Implementation underway
In discussion

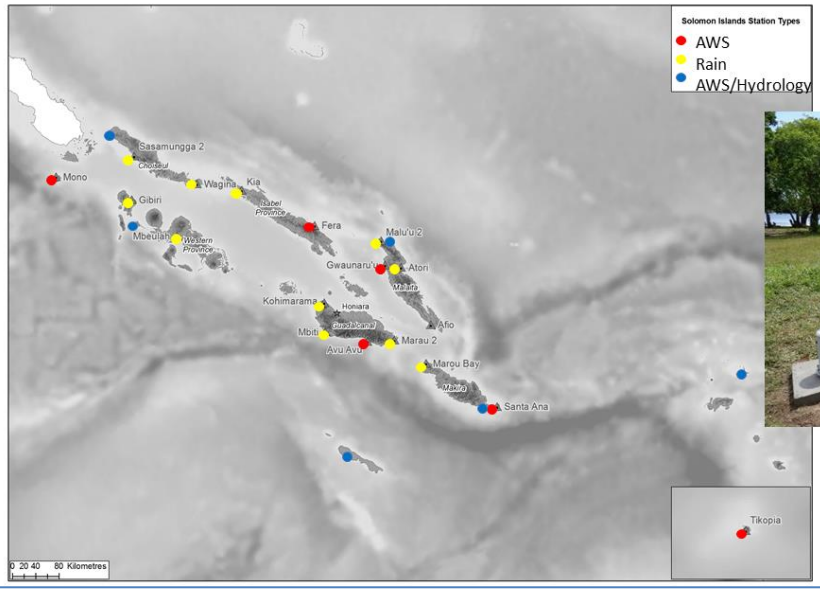

Progress so far in the Pacific
NIWA
Taihoro Nukurangi
Map View
Classic View
Catalogue
Map Library
Recent
About CliDEsc
Useful Links
Solomon Islands Met Service
Solomon Is
Samoa
Vanuatu
Fiji
Cook Is

Risk of divergent systems

Other challenges observed

- Data collection focused on the here and now
- Not much emphasis placed on sustainability
- A range of suppliers used
  - Different equipment, data formats, objectives
- Impractical project design
- Maintenance cost and QA overhead legacies

1. Strengthen the climate and hydrometric network



2. Capacity development of meteorological technicians

3. Compliance with local customs and expectations

Summary: CLEWS Achievements

- End–to–end system from data capture to information delivery
- User interface platform that is easy to operate by climate staff (a pillar of WMO GFCS)
- Provides information to meet requirements of Government departments to build resilience
- An open system that facilitates in-country engagement and expertise to build further applications
- Needs further investment to build critical operations capacity

12 Glossary of abbreviations and terms

CLEWS	Climate Early Warning System
CliCom	System of hardware and software built in the 1980s to meet World Meteorological Organisation requirements for climate data storage, which has now been replaced by more modern systems, such as CliDE
CliDE	Climate Data for the Environment – a climate data management system developed by the Australian Bureau of Meteorology which is used in 18 Pacific Island countries to archive climate data
CliDEsc	CliDE services client – the product generator software developed by NIWA to analyse and visualise climate data as time series, tables and maps. It links to CliDE and other database platforms and web services.
DRVT	Drought Risk Visualisation Toolkit
FMS	Fiji Meteorological Service
KMS	Kiribati Meteorological Service
NMHS	National Meteorological and Hydrological Services
NEON	The Neon system collects measurements from remote field instruments and sensors and transmits these measurements to a central Neon Web based system for data storage, analysis, data presentation, graphical analysis and reporting and data transfer to other external systems. NIWA, under agreements with Pacific Island Meteorological Services, uses this system to collect and transmit data from remote monitoring sites to each country's national climate and hydrological databases.
PNG NWS	Papua New Guinea National Weather Service
SIMS	Solomon Islands Meteorological Service
SMD	Samoa Meteorology Division
VCAP	Vanuatu Coastal Adaptation Project
VMGD	Vanuatu Meteorology and Geo-Hazards Division