Integrating Climate Change Risk in the Agriculture and Health Sectors in Samoa

Report from the Sector Engagement Workshop, Apia, 10-11 October, 2012

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Executive summary

In collaboration with the Ministry of Natural Resources and Environment (MNRE) and the coordinators of the project *Integrated Climate Change Risks Adaptation for Agriculture and Health Sectors in Samoa* (ICCRAHS), NIWA (The National Institute of Water and Atmospheric Research) was contracted by UNDP to facilitate a workshop for officials from the agriculture, health, forestry and tourism ministries of Samoa, during10-11 October, 2012, in Apia.

The purpose of the workshop was to collate experience on meteorological and climatological hazards and their impacts on sector activities and responsibilities in Samoa, and to determine what additional weather and climate information and services are needed to help mitigate the impact of these hazards.

A total of 48 Ministry staff and associates took part for at least one day.

This report provides tables of fully transcribed discussion responses covering key themes of the workshop:

- A table of sector impact information
- A table summarising ‘user’ needs
- A table of responses to key questions related to the components of effective early warning systems

An outcome from the workshops has been a new action plan report for the development and enhancement of the climate early warning and information system in Samoa—*Strengthening climate services in Samoa: Recommendations for the next development phase of integrating climate change mitigation and adaptation services into the agriculture and health sectors in Samoa [2013–2018]*

1 Introduction

The Integrated Climate Change Risks Adaptation for Agriculture and Health Sectors (ICCRAHS) is a project funded by UNDP/GEF. The project arose from Samoa's National Adaptation Programme of Action (NAPA), the outcome of extensive community and national consultations over a period of two years prior to 2004.

The ICCRAHS project aims to increase resilience and adaptive capacity of Samoa's meteorological, agricultural and health sectors to adverse climate change impacts. A major component of ICCRAHS is the development of a Climate Early Warning System (CLEWS), and information services to agriculture and health, to inform planning and assist in disaster risk reduction initiatives in these sectors.

In collaboration with the Ministry of Natural Resources and Environment (MNRE) and the ICCRAHS Project Coordinators, NIWA (The National Institute of Water and Atmospheric Research) was contracted by UNDP to facilitate a workshop for officials from the agriculture, health, forestry and tourism ministries of Samoa. The workshop was conducted over two days at the offices of MNRE, Apia, Samoa.

This document reports on the activities at the Sector Engagement Workshop, 10-11 October, 2012, in Apia, Samoa. The report includes fully transcribed copies of the discussion response sheets, with brief summaries of the main response themes. A brief outline is given of progress to date of the meteorological component of ICCRAHS. Finally, we include a review by participants on early warning systems, prompted by key questions from the UN Global Survey on Early Warning Systems, 2006.

A subsequent report (*Strengthening climate services in Samoa: Recommendations for the next development phase of integrating climate change mitigation and adaptation services into the agriculture and health sectors in Samoa [2013–2018])* draws on the information gathered at this workshop and recommends an action plan for the development and enhancement of the climate early warning and information system in Samoa.

2 Terms of Reference

The Government of Samoa's on-going development of Samoa Meteorological Division (SMD), supported by partnerships with agencies including GEF/UNDP, Australian Aid, Japan International Cooperation Agency (JICA), NIWA, NZ Aid, and the New Zealand Meteorological Service, has strengthened SMD's core capabilities to observe, manage and deliver meteorological data and forecasts.

At the same time, strategic planning to mitigate and adapt to climate change impacts in Samoa is well advanced, and there is a high level of sector engagement and commitment to adaptation measures.

However it is well recognised that, in a day-to-day operational time frame, little or only modest use is made of near real-time climatological data analysis, advice and services (other than in weather forecasts and severe weather warnings).

This to some degree reflects the need to raise awareness and understanding among potential sector users of what is possible. The key questions to be explored are:

- How much is known or what needs to be discovered about the application of meteorological data to current and future risk (and opportunities), particularly on tactical time scales (hours, days, weeks, months)?
- How far in advance can or should this information be made available to enable responsive action to be taken?
- What are the applicable formats and means of disseminating this information so that it can be assimilated and acted upon?
- What additional work, capacities or arrangements are required at SMD, and within sector user agencies, to improve the use of weather and climate information?

To develop an improved understanding of the work needed to address these questions, and a preferred pathway for future activities, the workshop focussed on two core themes:

1. Extreme climate and weather impacts on economic sector and community activities and structures, and what data are available or need to be collected to better understand and describe these impacts.
2. In an ideal world, what meteorological parameters, models, forecasts and advisories would be useful to help manage both extreme events and 'normal climate' related activity and planning, and how could that information be accessed and disseminated?

2.1 Workshop objectives

The UNDP-NIWA contracted Terms of Reference defined the following objectives for the workshop:

i. To conduct, facilitate sector engagement workshop with Agriculture, Health, Forestry and Tourism sectors;

ii. To compile data and information of users within each sector and define specific information needs of each party that CLEWS can provide;

iii. Review the current process in which CLEWS information is disseminated/communicated;

iv. To provide an update on the Samoa Climate Early Warning System, products and information services developed under ICCRAHS for the sectors;

v. Support the definition of further sector-tailored climate information products, and capacity development of sectoral users to enable the interpretation and effective use of the climate information provided;

vi. Formulate an effective two-way communication strategy (CS) in which CLEWS information is relayed to sectors and communities, and allows feedback to

sectoral agencies and the Met Division to further improve services and related user capacity;

vii. Showcase excellent examples of models (statistical analysis), case studies and relevant tools that have been tested and useful in enhancement of customized CLEWS products and information;

viii. Develop a comprehensive action plan for the development of further tools and capacity enhancement actions.

3 Workshop activities and summary findings

Attendees participated in the workshop from the following agencies:

Ministry of Agriculture	7
Ministry of Health	8
National Health Service	4
Ministry of Finance	3
Disaster Management Office	2
MNRE Forestry	5
Samoa Tourism Authority	2
Planning and Urban Management Agency	1
United Nations Development Programme	2
Water Resource Division	2
Samoa Water Authority	1
Department of Climate Change and Energy Efficiency (Australia)	2
MNRE other	9
GIZ/SPREP	1
TOTAL	48

3.1 Activity 1: Warm up sheets

This activity was a means of introducing climate information to the participants, in some cases using graphics from the booklet *Climate and Weather Services to Agriculture through the Climate Early Warning System* (ICCRAHS publication) and related material. The objective was to interpret information on a worksheet, and answer some basic questions either about the data presented or information that could be derived from it. The questions were also designed to provoke thinking by the participants on how climate information could be used in their work or community situation. An example warm up sheet is given in Appendix A. The annotated warm up sheets were kept by the participants to be used as reference material.

3.2 Activity 2: Collation of sectoral information

This group activity was aimed at collating information about climate and weather impacts on sectoral activity, both anecdotal and documented. The participants were drawn out on their experience of climate and weather impacts, what data were available, if any, to help understand these events, what needed to be done to explore the connection between the weather and what happened, and how this work might be achieved. The following topics and questions were addressed:

Activities or events affected by or occur as a result of extreme weather and climate (both good and bad weather)	Any data sets related to these events that may be available? What more data needs to be collected?	What needs to be done to verify the relationship between weather and climate and these events (cause and effect)	Who and how will the work be done?

Responses from this activity have been collated and presented in section 4.1 of this report.

3.3 Activity 3: Collation of user needs

This discussion focussed on sector needs. Participants worked in groups and were asked to discuss and record what meteorological parameters and information would enable better analysis of inherent risk in weather and climate sensitive activity, and improved warnings of future risk. The following topics and questions were addressed:

Climate information, service or product	Users	Means of access or dissemination	Application – how this information could be interpreted and used	Capacity development needs to put the service in place

Responses from this activity have been collated and presented in section 4.2 of this report.

3.4 Activity 4: ICCRAHS and CLEWS – update on progress so far

Under the meteorological component of the ICCRAHS project, significant progress has been made in building the capacity of the Samoa Meteorological Division (SMD) to observe, manage and deliver climate data and information. The observing network has been extended with new or upgraded automatic weather stations, data telemetry, and database management systems with full back-up services. The new climate database (CLIDE)[1] includes an easy-to-use interface for key entry of manual observations. A major effort has been launched to recover data from old paper records, and to enter these data into CLIDE and thereby complete data records for key sites. SMD staff have worked in collaboration with

[1] Climate Data for the Environment. Database developed by the Australian Bureau of Meteorology

the Australian Bureau of Meteorology, to quality assure and homogenize data series for reference climate sites.

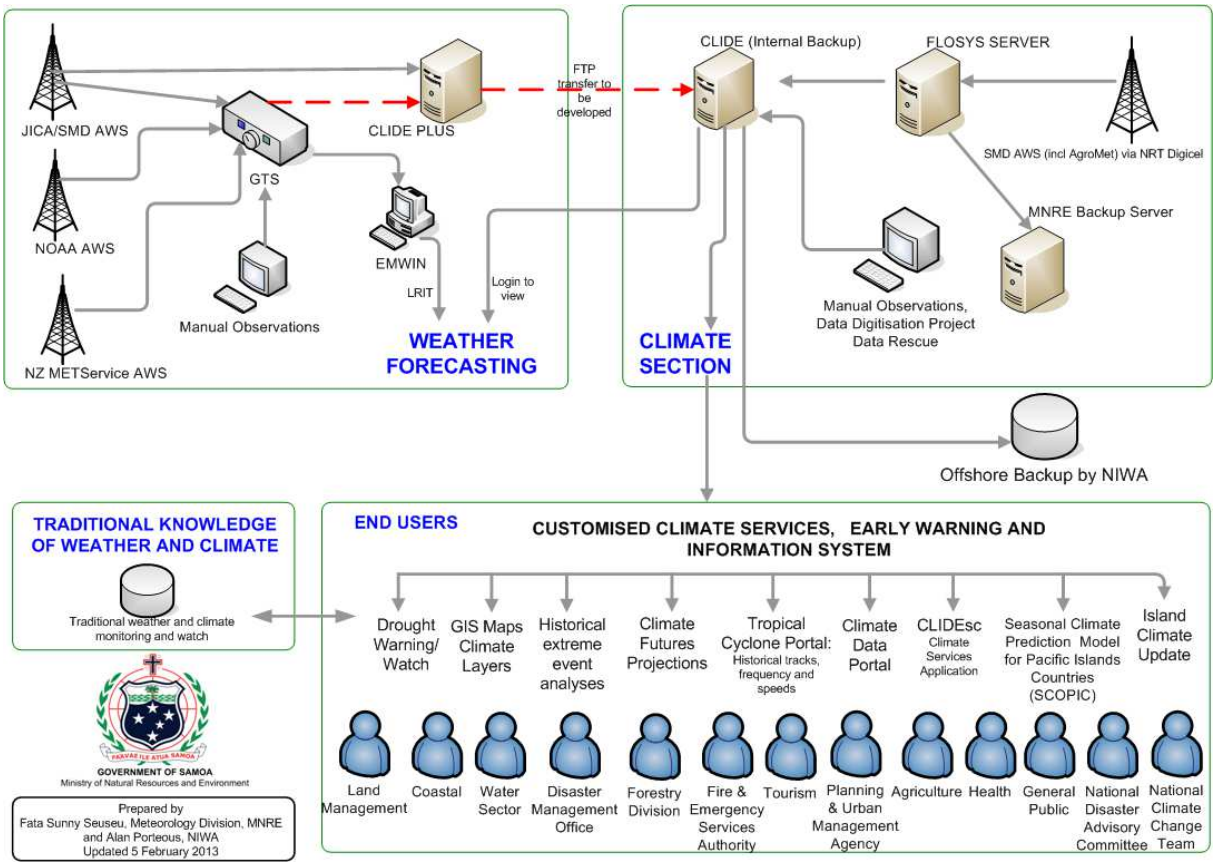

Figure 3-1: Schematic view of the information pathways being developed under the climate early warning and information system (CLEWS) in Samoa.

SMD is now in a position to engage effectively with public and sector users of climate information, to demonstrate examples of information that is available, and to work with end users to design sector-focussed climate products.

A sector-focussed *Climate Early Warning and Information System* (CLEWS) is being developed under the ICCRAHS project. Predicated on the functional capability of SMD, the CLEWS requires advanced data and information handling, including:

- Quality assured observational data with reliable national coverage;
- Homogenized long term data time series at key locations;
- Quantified dependencies between meteorological data and significant (and normal) weather and climate impacts;
- Near real time, and where possible, automated, data analysis and visualization tools;

- Pathways and protocols for dissemination of data, bulletins and other products (eg maps) to user agencies, sectors and communities, with an emphasis on customary decision-making processes;
- Plausible scenarios of future climate opportunities and risks;
- Tactical and strategic response options and responsibilities on all operational time scales;
- Understanding and communication of uncertainties – both in the science and the analyses of meteorological hazards.

3.5 Activity 5: Key questions on early warning systems

According to the Global Survey of Early Warning Systems (UN 2006), effective early warning systems '…must be people-centred and must integrate four elements – (i) knowledge of the risks faced; (ii) technical monitoring and warning service; (iii) dissemination of meaningful warnings to those at risk; and (iv) public awareness and preparedness to act. Failure in any one of these elements can mean failure of the whole early warning system.'

The workshop used the key questions from this survey, set out in the table below, to make sure that all aspects of the development of a CLEWS for Samoa were being considered.

Responses from this activity have been collated and presented in section 4.3 of this report.

Risk knowledge		Monitoring and Warning System
Systematically collect data and undertake risk assessments		Develop hazard monitoring and early warning systems
Are the hazards and the vulnerabilities well known?		Are the right parameters being monitored?
What are the patterns and trends in these factors?		Is there a sound scientific basis for making forecasts?
Are risk maps and data widely available?		Can accurate and timely warnings be generated?
Dissemination and communication		Response capability
Communication risk information and early warnings		Build national and community response capabilities
Do warnings reach all of those at risk?		Are response plans up to date and tested?
Are the risks and the warnings understood?		Are local capabilities and knowledge made use of?
Is the warning information clear and useable?		Are people prepared and ready to react to warnings?

Table 3-1: The four elements of people-centred early warning systems. SOURCE: ISDR Platform for the Promotion of Early Warning.

4 Workshop group response sheets

The tables in the following three sections (4.1, 4.2 and 4.3) are the transcribed responses from the participants of the two-day workshop.

The first table (section 4.1) is ordered according to meteorological phenomenon or *hazard* (see the bolded words in the table). The sector focus of each group is also identified (participants were asked to sit with others in the same sector). The most common hazards discussed were:

- tropical cyclones (including severe storms)
- drought
- heavy rainfall and flooding

Other phenomena discussed by some groups were:

- good climatic conditions
- high temperatures
- above normal rainfall
- climate change and sea level rise. (not “meteorological conditions”)

Many potentially relevant sector-based sources of information and data were identified (e.g. forestry site survey data after a tropical cyclone event, or information on volume and price of food imports during a drought) which could be used to assess the impacts of meteorological events. The availability and applicability of these datasets and reports need to be explored. Furthermore, the majority of responses regarding who should or could do the work to examine possible relationships between sector hazards and weather and climate data suggested partnership approaches involving relevant ministries and the Samoa Meteorological Division.

Information in the “user needs” table (section 4.2) was ordered according to sector group. Many of the desired products and services related to the provision of accurate and timely forecasts and warnings. Another common theme was the presentation of information in “common” language so that it could be easily interpreted and communicated. Regarding dissemination, participants discussed multiple methods of getting messages out to those people at risk, including a text messaging warning service and using existing networks such as that of the MWCSD[2]. Access to raw and “homogenised” meteorological data and derived products like GIS[3] data sets was also discussed by many groups. The participants reported on many potential uses of data and products, indicating that for the most part the capacity to apply the information is already established in the sectors, but that more could be done regarding training and education.

[2] Ministry of Women, Community, and Social Development
[3] Geographic Information System

The responses to the key components of an effective early warning system have been transcribed and presented in section 4.3. The participants were divided into groups again, with a mix of sectors in each group. Regarding risk knowledge, there was a general consensus that significant knowledge does exist particularly with respect to tropical cyclones, but less regarding flooding and much less regarding drought. There was a mixed response regarding the state of monitoring and warning systems in Samoa, with participants acknowledging that there is still room for improvement. Warnings of tropical cyclones are generally very well disseminated and communicated, but there is work to be done regarding other hazards. Also, simple messages (in English and Samoan) were identified as being critical for effective communication of risk. Lastly, response capability is quite high for tropical cyclones (people generally know what to do when they receive a warning, eg baton down houses and check emergency supplies), but the workshop participants agreed that it is generally not well known what to do if warned about, or even during, a drought.

4.1 Review of sector impact information

Sector group	Activities or events that are affected by or occur as the result of extreme weather and climate	Any data sets related to these events that may be available? What more data needs to be collected?	What needs to be done to verify the relationship between weather/climate and these events?	By whom and how will the work be done?
Agriculture and Forestry (group 4)	**Good climatic conditions** can lead to an increase in agricultural productivity (eg Taro, especially good conditions from July to October)	Reports from MAF (determines the time frame of when taro is harvested and stored for export)	Look at relationship between taro export volume and rainfall	Met Division and MAF
Health (group 2)	**Tropical cyclones** (heavy rainfall, high winds and swell) can cause severe injuries to people, and death	Hospital admissions data; Number of deaths	Look at the health effects of past TC events	Ministry of Health and Met Division
Agriculture and Forestry (group 4)	**Tropical cyclones** can cause vast damage to agricultural crops (eg bananas and breadfruit) and trees	Site surveys in damaged areas; Percent of forest / agricultural area damaged (estimates?)	Look at effect of TC events on production volume and quality	Need effective communication of warnings from Met Division; Reliable and understandable information given to farmers on likely impacts
Agriculture (group 5)	**Tropical cyclones** can impact agricultural production (eg root crops ripped up; Increase incidence of diseases (after event)	2004 cyclone report; CBS bulletin report on imports (BoS)	Does the volume and price of imported food correlate with the drop in local agricultural production	Bureau of Statistics (unsure?)
Forestry (group 8)	**Tropical cyclones** can cause wind damage to forests; Salt spray can damage trees	Records of forest damage (Forestry Division)	Correlation between wind speed, pressure, duration of high winds and level of damage; Look at changes with elevation	Forestry Division could examine forest damage, with help and data from Met Division
Tourism and Planning (group 7)	**Tropical cyclones** (or severe thunderstorms) can cause wide-spread damage and require actions to protect and/or evacuate visitors; Lowers the number of visitors after the event, due to the mess	Need good Met data (rainfall, wind, swell height); Need to know the typical (and expected) frequency of thunderstorms each season; Visitor stats (Research and Stats Division of Samoa Tourism Authority); Damage reports (eg to infrastructure)	Need to look at all these variables for each cyclone event	Disaster Management Office
Agriculture (group 5)	**High temperatures** can cause heat stress to animals	Production data (eg calving rates, conception rates)	Need to define what temperatures lead to heat stress	Met Division and MAF
Health (group 2)	**Heavy rainfall and flooding** can compromise water quality leading to diarrheal diseases; Blocked streams and drains (from	Number of injuries from flash floods; Number of diarrheal, typhoid and dengue admissions; Water quality data;	Examine relationship between climate and water quality (monthly?) and disease patterns (daily?); Need familiarisation / education of	Ministry of Health can strengthen surveillance programme; Met Division to provide data

	flood debris) can result in stagnant water leading to dengue and typhoid risk	Surveillance reports (eg PATIS)	climate terms; IEC (?) reports to be made available at the community level	(or access to data); Collaborate with DMO to utilise their resources to mobilize health resources
Agriculture and Forestry (group 4)	**Heavy rainfall and flooding** can increase the number of pests and diseases for vegetables; Can flood low lying crops; Can cause soil erosion in steep areas	Monthly reports on crop diseases / quality of produce; Fieldwork observations by forestry inspectors	Look at effect of rainfall on harvest volume	Need good exchange of information between Met Division, MAF and Forestry Division
Water Resources (group 6)	**Heavy rainfall and flooding** can cause damage to parts of the country and require actions to protect and/or evacuate visitors from that area	River flow data (unsure how many catchments are gauged); Flood model data (return periods of floods of different magnitude); Damages from floods	Need to understand how much rainfall (and over what period) will cause flooding; Is this different for different catchments? What level of damage do different flood magnitudes cause?	Water Resources Division
Forestry (group 8)	**Heavy rainfall** can result in erosion and landslides	Records of landslides from Land Management Division (unsure if exist?); Need good DEM (elevation data); Maps of water courses, rivers	Correlation between soil type, slope, vegetation cover and rainfall (including antecedent conditions)	Land Management Division
Agriculture (group 5)	**Above normal rainfall** for more than 2 weeks can impact on the quality of vegetables and increase bacterial and fungal diseases	Market survey data (volume and price?)	Look at sustained periods of rainfall and market data (probably a lag)	Don't know
Health (group 2)	**Drought** can lead to stagnant water, more mosquito breeding sites and high risk of diseases like dengue, zoonotic events (eg. Lepto) and Hepatitis A	Mosquito count data; Stream and river flow data; Laboratory data (disease confirmation)	Need to examine the relationship between rainfall, presence of stagnant water and mosquito abundance	Don't know
Health (group 3)	**Drought** may be related to increased risk of typhoid, dengue, filariasis, conjunctivitis, respiratory disease, asthma	Syndrome surveillance data (eg. PATIS); Water sanitation data; Laboratory data; Pharmaceutical orders	Need to identify high risk areas; Look at effect of high humidity on health risk	Vector control unit; MoH and NHS plus expert guidance from WHO
Agriculture and Forestry (group 4)	**Drought** hinders the growth of plants and trees, and reduces success of planting	Monthly field monitoring (survival of trees and plant species); Monthly report from Farmers Association; Information collected from annual farmers surveys (Upolu and Savaii); Market survey data	Study relationship between rainfall, soil moisture and percentage of dead saplings (trees) and crops	Combined work between Met Division, MAF and Forestry Division

Agriculture (group 5)	**Drought** can lead to low agricultural quality and yield; Increases the abundance of Army worms, which eat taro leaves	Market survey data for Upolu (no survey data for Savaii);	Look at relationship between market survey data and rainfall (not simple); Would be more accurate if on-farm survey data were available	MAF can do this kind of analysis, but need free access to met data (MAF must pay for it)
Water Resources (group 6)	**Drought** can lead to low stream and river flows and low groundwater levels; Difference between El Nino and La Nina events	Stream and river flow data; Fieldwork and observations (eg of groundwater); Tidal data; Land use data (has an impact on recharge and runoff, particularly in the upland region)	Need to determine rainfall – stream flow relationships (catchment models); Need to determine rainfall and/or stream flow thresholds for stagnant water (low) and turbidity (high)	Water Resources Division (hydrology officers collect data from rain and river gauges and boreholes every month)
Tourism and Planning (group 7)	**Drought** can cause water shortages (drinking, cooking, daily use)	Data on water tank levels / water use (hotels, tourism operators); Data on water truck deliveries; Price of water	Look at water levels and rainfall data during the drought period	Don't know
Forestry (group 8)	**Drought** conditions lead to a greater forest fire risk	Possible records of past forest fires (unsure if exist); Information held in Monthly Progress Reports, plus Quarterly and Annual Reports (Policy and Planning Division); Forest Fire Index (lapsed); Satellite imagery (NDVI?)	Compare rainfall data with forest fires records for specific locations; Look at other meteorological data sets like soil moisture, temperature, and wind.	Forestry Division has knowledge and good understanding of forest fire risk; Met Division can supply data
Finance (group 1)	**Climate change and sea level rise** are likely to affect coastal infrastructure (eg roads), resources (eg water), the environment (eg coral bleaching) and the resilience of communities	Land Transport Authority survey data; Consultations with communities; Data and reports from MNRE and other agencies	Public consultations and awareness campaigns	Land Transport Authority; Samoa Water Authority; MNRE; Ministry of Works and Transport Infrastructure; EPC; Ministry of Finance;
Tourism and Planning (group 7)	**Sea level rise** is likely to increase problems with coastal erosion and damage to coastal infrastructure	Examine the CIM (Coastal Infrastructure Management) plans; STA Inspection Reports; Vulnerability & Adaptation Assessments	Monitor sea level over long time periods and look if damages are changing. Also notice changes resulting from strong on-shore winds and storm surges.	Don't know

4.2 Summary of user needs

Sector group	What kind of climate information, service or product is needed?	Who are the users?	What is the means of dissemination?	Application – how could this information be interpreted and used?	What are the capacity development needs to put this service in place?
Finance (group 1)	Annual climate summary reports; Daily weather forecasts; Tropical cyclone and flood warnings; Advice on what to do when an event is forecast	Everyone! (eg tourists, children, church and communities, teachers)	Climate and weather warning text messages; Climate change education in schools; Email, newspapers, TV, radio, facebook / internet, posters	Need simple terminology about weather and climate in English and Samoan; Improve communication of the need for "being prepared" for extreme events (backup power, food and water supplies, medical kits)	Communication programmes to get the message of preparedness to the people
Health (group 2)	Maps of maximum probable precipitation and wind speeds; Accurate and timely (at least 48 hours) cyclone and storm warnings; Drought warnings (staged, based on current and forecasted conditions)	Hospitals / Health (NHS / MoH) – prepare for injuries – stock up on supplies – organise response teams; Families – ensure adequate food, water, medicine, batteries, candles – first aid kits well stocked – prepare for evacuation – secure buildings	Radio (most important); Text messaging / phone; TV; Social media / internet; Bulletins / notices (for drought); Utilise MWCSD networks to reach communities (Ministries ⇔ Matai ⇔ Community)	Schedule emergency staff; Procure supplies; Seek assistance from international partners (financial and technical); Advise families on long term relocation to "safer" areas; Improve building and infrastructure (including sanitation) design standards; Improve protocols for emergency response	Include use of weather and climate information in SOPs and National Disaster Management Plan; Improve coordination with other sectors (eg DMO, NGOs, Met, EPC, MWCSD, communities, etc); Climate change education (integrate into school curriculum); Need access to meteorological data (Clide database), plus training on how to use it
Health (group 3)	Clear definitions of climate and weather terms (eg drought, wind speed, rainfall); A CLEWS manual for health	MoH, NHS, SNKF workers, service managers, pharmacists, doctors, Communities	Monthly bulletins (sector focal points with specific responsibilities); Information and Communication Division; Distribution of CLEWS manual (etc) to all stakeholders (printed and electronic)	Design or improve an Emergency Plan / Disaster Management Plan; Lead to more research on the links between weather and climate and diseases	Capacity building for people in health sector (eg nurses); More awareness campaigns; Advocacy programs for villages; Linkages to HEAPS (Health Education and

					Provisional Services); Brochures and newsletters
Agriculture and Forestry (group 4)	Good seasonal forecasts of wind direction, rainfall, temperature, soil moisture; Access to climate data	MAF (Crops Division), Forestry Division, Planning officers, Farmers, Local communities, Research section	Radio, TV, Text messaging, Advise extension officers, Internet; Direct access to CLIDE database by Crops Division (electronic)	Plan and prepare for harvest (and other) times; Limit the potential negative effects of different weather conditions; Determine the choice of crops (eg preferred root crops: yams, taro) Promote "inter-cropping"; Quickly disseminate information to farmers to respond to risk	Information given out should be simple and understandable, with clear messages; Offer training / capacity building program for key personnel in sectors (eg on GIS)
Agriculture (group 5)	Free access to Met data; Validate soil / crop maps and fill in gaps (SRIM)[4] in consultation with farmers; Update 1984 soil survey; Maps of rainfall, temperature and wind (other variables?) for El Nino and La Nina years (wet and dry seasons)	MAF, Extension officers, Farmer Associations	Email; Newsletters; Radio and TV; Phone and Text messaging; An information hub	Improve Emergency Management plans; Aid management and decision making; Planning purposes	Information should be disseminated both in meteorological terms and "Samoan" terms
Water Resources (group 6)	Understanding of rainfall thresholds which have known impacts; A weather and climate briefing every 3 months by Met Division to other ministries and divisions (what has happened over the last 3 months and what is expected over the next 3 months)	Water Resources Division; Community groups (eg farmers)	Ministry newsletter; Radio and TV; Presentations to key "focal point" personnel in other divisions / departments; Inclusive consultations and workshops	Implementation of Water Resources Division response plans (eg to floods); Managing risks using advanced warnings; Improve systems; Interpret information and disseminate to users	Need to review human resources, available technology; Need induction program for new recruits; Need to understand and distinguish between risk and impact
Tourism and Planning (group 7)	Timely and accurate weather forecasts; Climate outlooks on wind, rainfall, tides, swells, drought;	Everyone! Specifically project planners, STA, PUMA, surfers and other marine activities operators, fale operators,	Radio, TV, internet; Newsletters; Pamphlets; Seminars and workshops	Everyday information and planning (eg for activities); Post information on tourist boards at hotels, websites;	Training of communications officers in relevant divisions on how to simplify

[4] Soil Resources Interpretative Reference Manual for Samoa.

	Simplified messaging in both languages; Flood warnings; Data on frequency of thunderstorms etc.; Climate change information (maps etc) in both languages; Seminars and presentations from Met Division on weather and climate information	hoteliers		Use information to increase awareness and for effective planning (eg by Land Transport Authority, MWTI)	messages; More monitoring (eg of river flows) and research; Training of the interpretation of weather and climate information; Include information in educational programs and curriculums
Forestry (group 8)	Climate change projections for Samoa (eg maps); Daily forest fire index data; Climate stations in forest sites; Good seasonal forecasts integrated with traditional knowledge; Correlation between traditional knowledge and climate data	Forest planners / officers; Forest services; Field assistants (Forestry Division); Farmers and communities	Digital maps to be integrated with SAMFRIS[5]; Email; Climate information integrated with other data; Bulletins for field officers / assistants	Identify and plan for high risk / priority areas for forest management; Update forest fire index data; Provide more accurate data on forest climate; Advice on available options (crops, trees, husbandry techniques)	More GIS capacity; Training; Collaborate with FESA[6] / DMO[7] regarding forest fire warnings; Setup new stations, plus monitoring and maintenance; Cooperation between MAF and Forestry Division

[55] SAMFRIS: Samoa Forest Resource Information System
[6] FESA: Fire and Emergency Services Authority
[7] DMO: Disaster Management Office

4.3 Early warning systems: review of key questions

4.3.1 Risk knowledge

Systematically collect data and undertake risk assessments	
Are the hazards and vulnerabilities well known?	
Day 1, Group 1	Yes they are. For example, for fires when there is a drought; Tropical cyclone damage and risks are well known.
Day 1, Group 2	Tropical cyclones are well known and communicated; Droughts – some impacts are not understood as a consequence of climate or weather patterns.
Day 2, Group 9	Hazards are generally well known; CIM plans exist – coastal infrastructure plans; Vulnerability assessments have been done by the Met Division; Flood zones and coastal erosion maps have been prepared; PPG phase for tourism; Vulnerability and Assessment plans have been done; Mapping section in MNRE has a lot of this information; There is no accurate correlation of weather extreme events to impacts.
What are the patterns and trends in these factors?	
Day 1, Group 1	The risk of forest fires have increased more than before because there are more people, there's a higher risk, or the change in temperature (high temperature); Don't know about Tropical Cyclones.
Day 1, Group 2	Forest fires: Maybe the change in risk is derived more from the amount of people than from climate; Mosquito density: Filariasis – High capacity for reproduction. Higher risk with increase in precipitation and temperature. Outbreaks coincide with rainfall patterns. Risk is reasonably well known.
Day 2 Group 9	Improvements to infrastructure and planning have reduced the impacts of extreme events; There are other demands (population growth, infrastructure) that modify the risk to climate hazards (also deforestation, land use change); Tourism – increased number of tourists.
Are the risk maps and data widely available?	
Day 1 Group 1	Not widely available; Often not accessible; There is little warning through media, eg. TV, Radio; We think the western part of Savaii (Asau) is more vulnerable to fires (driest part of the big island).
Day 1 Group 2	Knowledge and availability of information is very different at the ministry than at the community level.
Day 2 Group 9	Risk maps are available but dissemination and awareness is not very good; Lack of updating of the existing tools; More data are required; Sometimes it is hard to identify who is keeping track of the different events and the associated impacts.

4.3.2 Monitoring and early warning systems

Develop hazard monitoring and early warning systems	
Are the right parameters being monitored?	
Day 1, Group 3	Yes and no: - Needed: humidity; temperature; rainfall; bird flu survey (MOH, MAF); zoonotic diseases. - Yes: water quality; disease surveillance (water borne and vector borne); screening programmes (including dental); hot spots for mosquito breeding sites.
Day 1, Group 4	No. Animal diseases are not being monitored.
Day 2, Group 9	Many things are being monitored but by different divisions and not put in common place; Impacts of extreme weather events could be better monitored; Stream flow measurements are important for tourism and also for water production. Need to monitor water flows and water falls. These are clear indicators; Wind direction is important to be monitored and communicated.
Is there a sound scientific basis for making forecasts?	
Day 1, Group 3	From climate, yes. Need to include public health. Eg influenza prevalence; Medically, no; Agriculture, yes. Need water, temperature, humidity, and radiation.
Day 1, Group 4	Agriculture: there are scientific studies that link crop growth to climate; Health: this does not exist yet.
Day 2, Group 9	There is a need for more automatic weather stations in Savaii and upland areas.
Can accurate and timely warnings be generated?	
Day 1, Group 3	Yes and no. Issues: bird flu pandemic, zoonotic diseases? Who will be responsible and take ownership?
Day 1, Group 4	We could have better information; The seasonal forecasts could have better accuracy; There is a National Disaster Plan that specifies dissemination and communication.
Day 2, Group 9	Have statistical analyses been done about accuracy of forecasts? Early Warning Systems for cyclones and high speed winds are good and timely. Also for tsunamis; Need to monitor antecedent conditions, so know what risks are now (eg. River flows, soil moisture). Then can add forecasts to this current risk and provide some guidance; How accurate are the climate change projections for Pacific Islands? - Good, but they are scenarios so there is a range of possible outcomes. - Need work on down-scaling climate change projections to local conditions. There used to be a very accurate Forest Fire Risk Index but it is not being used any more. Now FESA is making decisions on management without using sound information.

4.3.3 Dissemination and communication

Communication of risk information and early warnings	
Do warnings reach all of those at risk?	
Day 1, Group 5	Yes – cyclones are advertised on TV and over radio; Tsunami – sirens within the town area and church bells within the village communities; However, just once, there was a text message. No – flood warnings not working very well (really late); Drought – there is no pre-warning, only actioned when it happens. Radio programmes on dry areas of the country. Forest fires – only preventive actions where penalties are imposed. Need to put warnings into easy ways to communicate to villages (policies and terminology); MOH needs more work on their planning from information from climate change eg. Between rainfall and diarrhoea.
Day 1, Group 6	Forest fires – there are warnings from the Fire Service; No good early warning system for fast flooding; No good for diseases like diarrhoea, dengue, etc. Need for better forecasting capacity; Sectors need to make more use of the climate information. Correlate climate information with sectoral data so that it can be used in planning; Need for simple language – difference between Early Warning System and preventive actions.
Day 2, Group 9	Yes, for cyclones; tsunamis. No, for floods and droughts. Plain language mapped information needed – not using terms like 50 miles north-west of ….
Are the risks and warnings understood?	
Day 2, Group 9	Generally yes. Also depends on the type of event. Sometimes hard to understand the location (eg 50 miles north-west of…). Hard to understand the warnings because of the way it is communicated. They are still using miles for the cyclone and tsunami warnings. They should move to kilometres. Wind direction could be given as coming from X to Y locations (not from NE at X knots). Wind speeds should be in km/hr.
Is the warning information clear and useable?	
Day 1, Group 5	Yes. People are aware of what to do and how to act for cyclones and tsunamis, but need to build the capacity on other risks such as flooding, droughts and forest fires.
Day 2, Group 9	There is a need to define RESPONSIBLE people for communication (“focal points”).

4.3.4 Response capability

Build national and community response capabilities	
Are response plans up to date and tested?	
Day 1, Group 7	Some – eg. Forecast a high period diarrhoea: water safety plan is one of the responses. Ongoing. We have good response plans for cyclones; practice exercises have been conducted.
Day 1, Group 8	There is a water safety plan.
Day 2, Group 9	DMO has defined plans for different types of hazards; – eg. Sending emails to the different sectors (EPC, forestry, health, water authority); Weakest for drought – need a staged response system.
Are local capabilities and knowledge made use of?	
Day 1, Group 7	It is stated in the water safety plan; Awareness – on advertisements; television; radio. For cyclones – yes!
Day 1, Group 8	Big progress in terms of capacity of staff; This issue is new for the health sector but can be very useful.
Day 2, Group 9	There is a local coordination system in villages.
Are people prepared and ready to react to warnings?	
Day 1, Group 7	People need to be advised if there is a need for any water treatment; More awareness; For cyclones – we have cyclone response plans.
Day 2, Group 9	Yes, for some hazards (tsunami and cyclones); There is a standard reminder for preparedness at the beginning of cyclone season. Food security is followed up by FAO; Drought risk is less known and preparedness and reaction is not that effective.

5 Conclusion

The goals of the sector engagement workshop were:

> (a) to examine and discuss extreme climate and weather impacts on economic sector and community activities and structures, and what sector-based data are available or need to be collected to better understand and describe these impacts; and
>
> (b) to document what meteorological parameters, models, forecasts and advisories would be useful to help manage both extreme events and 'normal climate' related activity and planning, and how could that information be accessed and disseminated.

Both of these goals were successfully achieved. The group discussions were lively and the collated responses represent an important new resource.

The short presentation on CLEWS further demonstrated how the capability for SMD to acquire, manage and deliver weather and climate information has been greatly strengthened in the last few years. Similarly, discussions emphasised sector planning to adapt to long term climate change in Samoa is well advanced.

The workshop showed that the need to develop resilient agriculture and health sectors (as well as other sectors such as forestry and tourism) in Samoa is well recognised. Work is now needed on bridging the information gap between the meteorological data provider, SMD, and sector users, for further building robust climate change impact scenarios, and more urgently, for effective use of climate data and information on tactical time scales (days, months, seasons).

The workshop provided a wealth of information to inform planning for further work. This information has been included in a subsequent report—*Strengthening climate services in Samoa: Recommendations for the next development phase of integrating climate change mitigation and adaptation services into the agriculture and health sectors in Samoa [2013–2018].* This subsequent report will contribute to planning for the development and enhancement of the climate early warning and information system for Samoa.

6 Acknowledgements

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7 References

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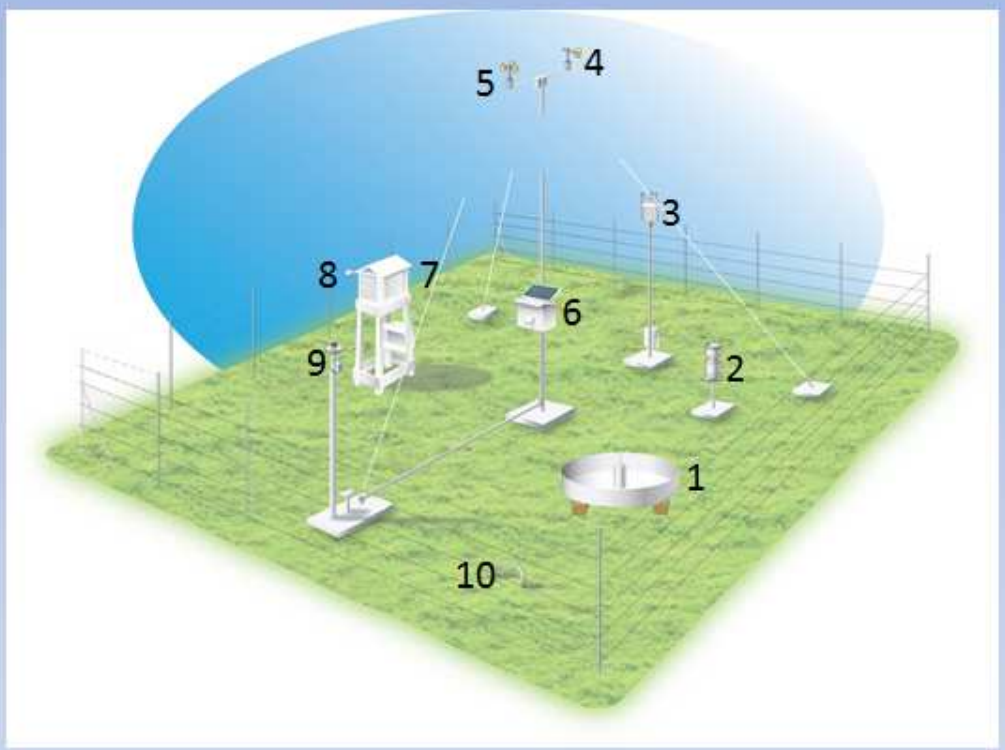
Appendix A An example warm-up sheet

Warm up sheet

Climate instrument enclosure



Can you identify:

____ Instrument screen	____ Automatic rain gauge
____ Solar panel	____ Radiometer
____ Cup anemometer	____ Evaporimeter
____ Leaf wetness sensor	____ Multi-sensor (wind, relative humidity, air temperature)
____ Wind vane	____ Soil temperature probe