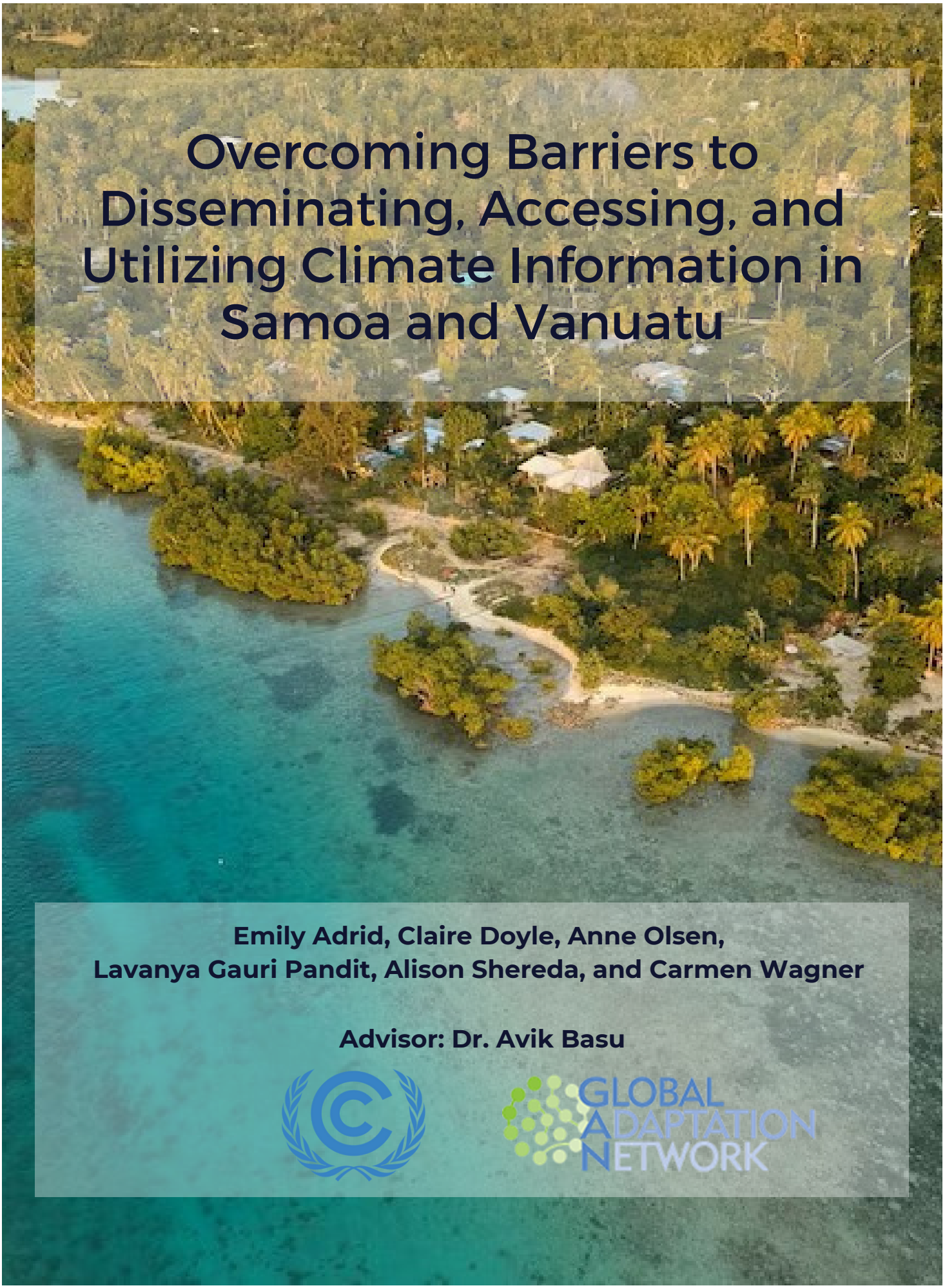

Overcoming Barriers to Disseminating, Accessing, and Utilizing Climate Information in Samoa and Vanuatu

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GLOBAL ADAPTATION NETWORK

Contents

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This research would not have been possible without the support and expertise of the many people involved at every stage of the process, and we want to express our gratitude to everyone who contributed. We particularly want to thank Dr. Avik Basu, our project advisor, from the University of Michigan for his invaluable guidance, feedback, and advice in the development, implementation, and analysis of this research; Dr. Hannah Barrowman, formerly a Researcher at APCP, for sharing her wealth of knowledge and providing thorough input throughout the project; Anna Kilponen, Regional Liaison for Asia Pacific at UNEP-GAN, for her consistent technical support and advice; Lilian Daphine Lunyolo, ECCFP Fellow, and Rojina Manandhar, at the UNFCCC, for their detailed feedback and guidance, particularly on the project's alignment with the UNFCCC; and Rachel Nunn-Crichton and Yvette Kerslake, Technical Advisors at the Secretariat of the Pacific Regional Team, for connecting us with stakeholders and providing regional support. We also want to extend a sincere thank you to our Research Assistants, Virana Bogiri from Vanuatu and Grace Ah Young-Grey from Samoa, for connecting us with interview respondents and assisting us with the data collection process. Without Virana and Grace, we would not have been able to complete this project, and we are incredibly grateful for the work they were able to do.

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Best,
Alison, Anne, Carmen, Claire, Emily, and Lavanya

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United Nations Framework Convention on Climate Change (UNFCCC). This research was conducted under the auspices of the UN Climate Change and Universities Partnership Programme (UPP) hosted by the Nairobi Work Programme (NWP) of the UNFCCC. The UPP facilitates collaboration between Universities and technical organizations aiming to address knowledge gaps hindering adaptation action in various regions of the world. As previously mentioned, this work was framed around the UNFCCC's Lima Adaptation Knowledge Initiative (LAKI), which aims to improve information sharing between scientists, policymakers, and stakeholders that allow for improved access to data and more effective climate change adaptation (UNFCCC, 2021b).

United Nations Environment Programme's Global Adaptation Network (UNEP-GAN). This research was also conducted under the guise of UNEP-GAN, which is an umbrella organization and platform used to disseminate and exchange climate change adaptation knowledge in collaboration with its regional networks, such as the Asia-Pacific Adaptation Network in Asia-Pacific. Additionally, UNEP-GAN is actively involved in several adaptation initiatives like the LAKI.

Australia Pacific Climate Partnership (APCP). This research has been conducted in collaboration with APCP, an Australian-funded development program working to deliver climate and disaster resilience and low carbon growth (APCP, n.d.). Since 2018, APCP has worked to ensure that aid provided to Pacific Island countries is climate and disaster-resilient, link Australian action in the Pacific with other country and regional programs, and collaborate with scientific agencies to tailor and broker climate and disaster information. APCP also works to address critical gaps in CIS, governance, and social inclusion.

Secretariat of the Pacific Regional Environmental Program (SPREP). SPREP provided a link to actors on the ground, given its presence in Samoa and Vanuatu and its strong connections to communities in those places. The regional organization comprises 21 member states and facilitates collaboration around climate, environment, and sustainable development. As part of its Inform Project, SPREP works to ensure that environment and climate information is communicated effectively to stakeholders across the region (SPREP, 2023a).

Abstract

Climate change has a disproportionate impact on the Pacific islands, which makes climate information services (CIS) especially vital for climate and disaster resilience in this region. CIS generate and distribute climate-related information to aid communities in preparing for the consequences of climate change. However, in Pacific Small Island Developing States (PSIDS), not all end users are able to fully access and use these services. This study investigates the barriers to the equitable dissemination, access, and utilization of climate information in Samoa and Vanuatu, employing a literature review and 38 informational interviews to better understand the experiences of CIS producers and end users. Results show several obstacles that impact CIS in Samoa and Vanuatu, including limited institutional capacity, women's unequal role in decision-making, limited and vulnerable physical infrastructure, and disparities between Western scientific knowledge and traditional knowledge (TK). Additionally, the study highlights three initiatives from Samoa and Vanuatu, showcasing best practices for CIS in each country. Based on these findings, recommendations are provided to address current barriers to climate information dissemination and ultimately improve the climate resilience of communities in Samoa and Vanuatu.

List of Tables and Figures

Tables

Figures

Abbreviations and Acronyms

APCC	APEC Climate Center
APCP	Australia Pacific Climate Partnership
BOM	Australia Bureau of Meteorology
CCCs	Community Climate Centers
CDCRM	Community Disaster & Climate Risks Management Program
CLEWS	Climate Early Warning System
CREWS	Climate Risk and Early Warning System
CIS	Climate Information Services
COSPPac	Climate and Oceans Support Program in the Pacific
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DAC	Disaster Advisory Committee
DKIF	Data Knowledge Information Facility
DRR	Disaster Risk Reduction
EARWatch	Early Action Rainfall Watch
ENSO	El-Niño Southern Oscillation
EWS	Early Warning Systems
FINPAC	Finnish-Pacific Project Adapting to Climate Change in Oceania
FMI	Finnish Meteorological Institute
GCF	Green Climate Fund
GFCS	Global Framework for Climate Services
LAKI	Lima Adaptation Knowledge Initiative
LDCs	Least Developed Countries

NAB	National Advisory Board on Climate Change and Disaster Risk Reduction
NDMO	Vanuatu National Disaster Management Organization
NGO	Non-Governmental Organization
NMHSs	National Meteorological and Hydrological Services
PACCSAP	Pacific-Australia Climate Change Science and Adaptation Planning
PISFCC	Pacific Islands Students Fighting Climate Change
PMC	Pacific Meteorological Council
PSIDS	Pacific Small Island Developing States
RCC	WMO Pacific Regional Climate Center Network
Samoa DMO	Samoa Disaster Management Office
Samoa MET	Samoa Meteorological Service
SFESA	The Samoa Fire and Emergency Services Authority
SIDS	Small Island Developing States
SMA	Soil Moisture Analysis
SPREP	Secretariat of the Pacific Regional Environment Programme
SRCS	Samoa Red Cross Society
StPC	Shifting the Power Coalition Network
TK	Traditional Knowledge
UNDP	United Nations Development Programme
UNDRR	United Nations Office for Disaster Risk Reduction
UNEP	United Nations Environment Programme
UNEP-GAN	United Nations Environment Programme Global Adaptation Network

UNFCCC	United Nations Framework Convention on Climate Change
Van-KIRAP	Vanuatu Klaemet blong Redy, Adapt mo Protekt
Van-CIS-RDP	Climate Information Services for Resilient Development Planning In Vanuatu
VCAN	Vanuatu Climate Action Network
VMGD	Vanuatu Meteorology and Geo-Hazards Department
WMO	World Meteorological Organizations
WWW	Women's Weather Watch
WITTT	Women I Tok Tok Tugeta

1 The Importance of Climate Information Services for Resilience in the Pacific

From intensifying storms to record-breaking temperatures, the impacts of climate change are increasingly threatening the lives and livelihoods of people across the globe. The World Meteorology Organization (WMO) reports that there are five times more disasters today than 50 years ago, a trend propelled in part by climate change (Baker et al., 2022; MPTF, n.d.). Indeed, United Nations Secretary-General António Guterres has warned that climate change is "supercharging extreme weather events across the planet" (United Nations, 2022c). These climate impacts, in turn, are costing lives, contributing to displacement, and resulting in billions of dollars of loss (Baker et al., 2022; Climate Refugees, 2023; MPTF, n.d.). As climate-related risks grow, minimizing the toll requires a broad set of tools, including accurate, usable, and relevant climate information on which to base decisions.

1.1 Impact of Climate Change on Pacific Islands

Pacific Island communities are among the most exposed to climate and environmental risks worldwide (IPCC, 2022; Mahon et al., 2019). They experience a wide range of natural hazards, including slow-onset phenomena like sea-level rise, ocean acidification, drought, and coastal erosion, as well as sudden-onset hazards like flooding, tropical cyclones, and earthquakes (IPCC, 2022; Nunn, 2009; World Meteorological Organization, 2017b). In fact, the Asia-Pacific region is considered the world's most disaster-prone region—someone living in this region is five times more likely to be affected by disasters (UNESCAP, 2022; WMO, 2022a). From 1970 to 2020, disasters in the Pacific Region affected roughly 6.8 billion people and caused at least 2 million deaths—or an average of 41,373 lives per year (Baker et al). Accelerating climate change is only expected to intensify these phenomena, magnifying their intensity or frequency.

Such environmental and climate stressors have profound implications for food and water security, migration, cultural preservation, local livelihoods, and development in Pacific Island nations (Mcleod et al., 2019; Nunn, 2009). The World Bank reports that, as of 2013, Pacific Island nations made up 8 of the 20 countries with the highest annual losses in GDP due to disasters (World Bank, 2013). In the current global warming scenario, Pacific SIDS faces USD 1.1 billion in losses yearly, which could jump to USD 1.3 billion under a "moderate" scenario (Srivastava & Basu, 2023).

While Pacific Small Island Developing States (PSIDS) have responded to climate risks with innovative solutions, they also face unique challenges in their adaptation efforts due to the small surface area of islands, the large distances between islands, and remoteness (Mcleod et al., 2019; Nunn, 2009). As is the case across the globe, people living in remote areas in the Pacific (Huang, 2020; Mcleod et al., 2019; Nunn, 2009) as well as vulnerable groups like women (Cassinat et al., 2022; Kaur et al., 2016; Raj et al., 2020; Samoa Red Cross Society, 2017; UNDRR, 2022b) face disproportionate risks from climate impacts.

1.2 Climate Information Services

Climate Information Services (CIS) are one key tool for countries—within and outside of the Pacific—to prepare for climate-related risks like extreme weather events (World Meteorological Organization, 2017b). CIS are the mechanisms by which climate information are generated, transferred, and then applied among scientists, communities, and decision-makers (typically in the form of climate outlooks, summaries, websites, or bulletins) to manage climate impacts (Machingura et al., 2018; Mahon et al., 2019; Vaughan & Dessai, 2014). These services require data from national and international sources on temperature, rainfall, soil moisture, and ocean conditions, as well as maps, vulnerability assessments, and long-term climate and weather projections (GFCS, 2018). Depending on the end user's needs, CIS may also integrate non-meteorological data and information, particularly related to agriculture, health, population distribution, roads and infrastructure, and other socio-economic factors (GFCS, 2018).

CIS can take many forms, including Early Warning Systems (EWS), which are integrated communication systems that enable the monitoring, forecasting, and communication of hazard events (Potter et al., 2018; United Nations, 2022a). EWS facilitates disaster risk reduction (DRR) and climate change adaptation, enabling communities to initiate timely and appropriate actions to alleviate the risks posed by climate-related hazards while helping public officials and administrators protect lives, land, infrastructure, and livelihoods (UNEP, 2020; United Nations, 2022a). EWS is especially crucial in the Asia-Pacific, given its high exposure to disasters.

Ultimately, CIS are needed across the globe for effective prevention, management, and response to the accelerating impacts of natural disasters and climate change disaster risk (Jackson et al., 2017; Pacific Community et al., 2016; Tanner et al., 2015). Furthermore, the disproportionate impact of climate change on PSIDS makes CIS a particularly critical tool for resilience in the Pacific; through robust CIS, Pacific countries can enable effective decision-making for climate adaptation, disaster management,

and DRR (Finucane, 2009; Jackson et al., 2017; Pacific Community et al., 2016; Tanner et al., 2015; Webber, 2017).

CIS Products and Dissemination Pathways in the Pacific. Climate information services in the Pacific encompass a wide range of products. They include daily weather forecasts, climate change projections, Early Action Rainfall Watch (EARWatch) bulletins, the Pacific Climate Change Data Portal, the Southern Hemisphere Tropical Cyclone Data Portal, the Pacific El-Niño Southern Oscillation (ENSO) Update, the Seasonal Climate Outlook for Pacific Island Countries, and many more (Cunningham et al., 2021; SPREP, 2017b).

These CIS products in the Pacific are produced and disseminated in part by the National Meteorological and Hydrological Services (NMHSs), the official and authoritative source for weather and climate data and the primary source of weather and disaster warnings (WMO, 2016). Across the Pacific, NMHSs work together under the Pacific Meteorological Desk Partnership, which facilitates regional collaboration on climate services through 1) communication on national and regional needs, 2) joint planning, and 3) coordinated governance through the Pacific Meteorological Council (PMC) (SPREP, 2021b). Regional collaboration is also fostered through the WMO Pacific Regional Climate Center Network (RCC). Currently in its demonstration phase, the RCC is a central hub for various services, such as regional long-range climate forecasts, climate change projections, and climate monitoring. Finally, the Pacific Island Outlook Forum offers a bi-annual opportunity for stakeholders from the region to discuss how climate outlooks can be applied to and used by critical socioeconomic sectors of society (SPREP, 2017b).

Alongside NMHS, diverse stakeholders contribute to or directly produce and disseminate CIS products in the Pacific region. For instance, the EARWatch bulletins, which provide information and alerts on rainfall, drought, and prolonged dry conditions (Climate Centre, 2018; Vanuatu Daily Post, 2019), are generated with support from the Australian Department of Foreign Affairs and Trade. Actors in the Pacific that play important roles in generating and disseminating climate information include the Australia Bureau of Meteorology (BOM), national climate change and disaster management ministries and divisions, the Secretariat of the Pacific Regional Environmental Program (SPREP), the Commonwealth Science and Industrial Research Organisation (CSIRO), and the Red Cross, among many others.

User Engagement with CIS in the Pacific. While a wide range of CIS products are generated in the Pacific, the most commonly accessed CIS in the region are impact and risk assessments, rainfall bulletins, climate change projections, and advice and warnings for tropical cyclones (Cunningham et

al., 2021). According to a 2020 analysis, users from the Pacific access CIS regularly—often on a monthly, weekly, or daily basis—and rely on CIS primarily for disaster risk management, supporting strategic decisions, and supporting operational decisions (Cunningham et al., 2021). More information about how CIS operate in particular Pacific countries is detailed below in Sections 3 and 4.

Accelerating CIS Initiatives. Over the last two decades, CIS has gained attention globally as a critical investment for climate resilience and DRR. Accordingly, there have been a growing number of global and regional efforts to improve and scale up these services. In 2009, the international community created the Global Framework for Climate Services (GFCS), an initiative to bolster climate services for risk management and adaptation in 70 countries (United Nations, 2022b).

In 2015, the Sendai Framework for Disaster Risk Reduction was adopted at the UN World Conference on Disaster Risk Reduction. One of the stated goals (Target G) of the framework is to "substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to people by 2030" (UNDRR, 2015). To make progress toward this goal, international and national organizations established the International Network for Multi-Hazard Early Warning Systems. This multi-stakeholder partnership aims to "facilitate the sharing of expertise and good practice on strengthening multi-hazard early warning systems as an integral component of national strategies for disaster risk reduction, climate change adaptation, and building resilience" (World Meteorological Organization, n.d.).

Also in 2015, the WMO and several partners launched the Climate Risk and Early Warning System (CREWS) Initiative, which provides funding and technical support to further develop and improve EWS in Small Island Developing States (SIDS) and Least Developed Countries (LDCs) (CREWS Steering Committee, 2019). In 2019, the Alliance for Hydromet Development was established to build the capacity of NMHSs to observe and exchange data (Alliance for Hydromet Development, n.d.). In 2021, the WMO and a wide range of other organizational partners launched a 10-year initiative, the Systematic Observations Financing Facility, to fill remaining gaps in weather and meteorological observations in LDCs and SIDS through technical and financial assistance to NMHSs (CIF, n.d.). Moreover, in 2022, the WMO and partners announced the Early Warning Systems for All Action Plan, a $3.1 billion initiative to increase coverage of EWS before 2027, starting with the most vulnerable populations. Through targeted investment, the Early Warning Systems for All Action Plan aims to allocate funding towards four key components of EWS: disaster risk knowledge, observations and forecasting, preparedness and response, and dissemination and communication (WMO, 2022b). More than 50 countries signed a joint statement in support of the plan (WMO, 2022b).

Supplementing this array of global CIS efforts, several Pacific-specific CIS initiatives and plans have been developed to target the unique needs of PSIDS. For example, the aforementioned EARWatch bulletins were first developed in 2013 to address the limitations of other seasonal outlooks and "better communicate [these] outlooks to climate-vulnerable communities in the Pacific" (Australia Bureau of Meteorology, n.d.). The Pacific Islands Meteorological Strategy 2017-2026, which outlines Pacific NMHSs priorities, includes a focus area on "integrated observing and communication systems to support processing and preparation of weather, climate, water, and ocean information and services, including warnings" (SPREP, 2017b) The strategy also includes a focus area on Improving Climate Services. In addition, the 2017-2026 Pacific Roadmap for Strengthened Climate Service tailors the GFCS to the Pacific region and offers guidance for organizations—including NMHSs and the PMC—to strengthen CIS for seven priority sectors: Agriculture and food security, disaster risk management, fisheries, tourism, health, sustainable energy, and water (SPREP, 2017b). Table 1 outlines several other recent and ongoing efforts to improve CIS in the region.

Table 1. Pacific Region CIS initiatives

Current/Recent Initiative	Scope	Description
Climate Risk Early Warning System (CREWS): Strengthening Hydro-Meteorological and Early Warning Services in the Pacific (CREWS Pacific SIDS 2.0) **(Ongoing)**	Tuvalu, Nauru, Republic of Palau, Marshall Islands, Solomon Islands, Cook Islands, Micronesia, Federated States of Fiji, Kiribati, Niue, Vanuatu, Tonga	**WMO, and partners, funded by CREWS.** Globally, the CREWS Initiative provides funding and technical support to SIDS and LDCs to significantly increase the "provision of weather and climate services and the capacity to generate and communicate effective impact-based, multi-hazards, gender-informed, early warning systems to protect lives, livelihoods, and assets" (CREWS Steering Committee, 2019). CREWS Pacific SIDS 2.0 is a $4.8 million regional CREWS project that builds off the first CREWS Pacific SIDS project (2017 - 2021) to strengthen early warning systems (WMO, 2021b).
The Climate and Oceans Support Program (COSPPac): Phase 2 **(Ongoing)**	Cook Islands, Federated States of Micronesia, Fiji, Kiribati, Marshall Islands, Niue, Nauru, Papua New Guinea, Palau, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu	**Government of Australia (funder), in partnership with Pacific Island stakeholders.** COSPPac supports Pacific Island countries in analyzing and interpreting climate, ocean, and tidal data to better "manage and mitigate" climate and environmental impacts. The program includes a decision-support tool called the Seasonal Climate Outlooks in Pacific Countries (used by NMHSs), a regular opportunity for information-sharing through the Online Climate Outlook Forum, and a Drought Monitoring and Response System, among other initiatives (COSPPac, n.d., 2022a).
Enhancing Climate Information and Knowledge Services for Resilience in 5 Island countries of the Pacific Ocean **(Ongoing)**	Cook Islands, Niue, Palau, Marshall Islands, and Tuvalu	**United Nations Environment Programme and partners, funded by the Green Climate Fund (GCF).** This $47.4 million project, approved by GCF in 2020, aims to "[improve] capacities to monitor, model and predict climate impacts" in the target countries. The initiative's broader goal is to "enhance climate information and knowledge services for resilience in Pacific Ocean countries" (UNEP, 2020).

Current/Recent Initiative	Scope	Description
Enhancing Early Warning Systems to Build Greater Resilience to Hydrometeorological Hazards in the Pacific SIDS **(Ongoing)**	Fiji, Papua New Guinea, Solomon Islands, Timor-Leste, and Vanuatu	**WMO and partners, funded by the Green Climate Fund.** Estimated at $10-50 million, this 5-year project is intended to enhance EWS for hydrometeorological hazards such as tropical cyclones, floods, drought and sea predictions (VMGD, n.d.).
The Republic of Korea-Pacific Islands Climate Prediction Service Phase 2 (ROK-PI CliPS-2) **(Ongoing)**	Samoa, Fiji, Cook Islands, Niue, Federated States of Micronesia, Kiribati, Marshall Islands, Nauru, Palau. Papua New Guinea, Solomon Islands, Tonga, Tuvalu, Vanuatu	**Pohang University of Science and Technology, SPREP, and the APEC Climate Center (APCC), funded by the Government of Korea.** ROK-PI CliPS-2 is a $1.8 million project to boost the capacity of Pacific Island NMHSs to use "high-quality climate prediction information." The project also entailed updating and enhancing the region-specific climate prediction system developed during the initial ROK PI CliPS project (SPREP, 2023b).
Shifting the Power Coalition (StPC) **(Ongoing)**	Fiji, Papua New Guinea, Samoa, Solomon Islands, Tonga, Vanuatu	**The Australian Department of Foreign Affairs and Trade (DFAT) and Pacific Women, in partnership with 13 women-led organizations.** Made up of 13 organizations based in the Pacific, StPC supports the leadership of diverse women in disaster and climate change preparedness, response, and recovery—including through accessing climate information and services. StPC fosters South-South exchanges and builds on women's existing expertise and power. It also emphasizes intersectionality and thus focuses on young women, women with disabilities, and women in rural areas. The 13 partners include the Pacific Disability Forum, Vanuatu Young Women for Change, and the Young Women's Christian Association of several countries, among other organizations (ActionAid Australia, 2023; SPREP, 2020).

Current/Recent Initiative	Scope	Description
Finnish-Pacific Project Adapting to Climate Change in Oceania (FINPAC) **(2013-2017)**	Cook Islands, Federated States of Micronesia, Fiji, Kiribati, Marshall Islands, Nauru, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu, and Vanuatu	**Coordinated and implemented by SPREP, Finnish Meteorological Institute (FMI), and International Federation of the Red Cross (IFRC), funded by the Government of Finland and WMO.** FINPAC sought to strengthen the capacity of NMHSs in the Pacific to improve weather and climate services for end users. The project was implemented in one community in each of the target countries and emphasized direct community engagement by the government to develop early warning systems and disaster response plans (Ministry for Foreign Affairs of Finland, 2018).

1.3 LAKI: Guiding Context for This Research

Despite these efforts to accelerate CIS globally, several gaps remain. For instance, gaps related to data and basic observations persist, particularly in lower-income countries. According to Petteri Talaas, Secretary General of the WMO, "At the moment there are severe gaps in the observing system, especially in Africa, Caribbean, Pacific Islands and in some parts of Latin America. This means that the quality of the early warning services is poorer and has a negative impact on weather forecasts worldwide" (WMO, 2021a). The WMO also reports gaps concerning multi-hazard early warning systems, with only 46% of member countries reporting the existence of such systems (UNDRR & WMO, 2022). Within the Pacific, communities' diverse needs and capacities necessitate demand for many tailored products, yet service provision is difficult due to high costs in the region (Australia-Pacific Climate Change Action Program, 2020).

The Lima Adaptation Knowledge Initiative (LAKI) is a joint action pledge aimed at bridging priority knowledge gaps that hinder implementation and scaling up climate adaptation action (UNFCCC, 2021b). The initiative is a joint action pledge between the United Nations Environment Programme Global Adaptation Network (UNEP-GAN) and the United Nations Framework Convention on Climate Change (UNFCCC) Secretariat under the Nairobi Work Programme. The LAKI utilizes priority-setting workshops to convene multi-stakeholder expert groups to identify priority knowledge gaps and catalyze activities to bridge the identified gaps in collaboration with global and sub-regional partners. At the onset of this project, LAKI had been implemented in six subregions: the Andean subregion, the Gulf Cooperation Council subregion, the South African subregion, the Hindu Kush Himalayan Subregion, the Indian Ocean islands, and the North African subregion.

During a priority-setting workshop organized by UNEP, SPREP, and the UNFCCC in February 2021, the LAKI for the Pacific subregion identified a series of knowledge gaps specific to the Pacific region and catalyzed collaborations to close these gaps (SPREP, 2021a). 65 identified knowledge gaps were grouped into four major clusters: 1) lack of (or limited) data, 2) lack of access to existing knowledge, 3) lack of actionable knowledge, and 4) lack of tools and methods to process knowledge into actionable forms (SPREP, 2021a). This study addresses the following LAKI knowledge gaps: lack of access to EWS by youth and remote communities, lack of access to meteorological data in climate change decision-making, and lack of integrated EWS to facilitate information flow before and after events (UNFCCC, 2021a). More detailed information about these three gaps can be found in Table 2.

Table 2. LAKI Pacific SIDS Knowledge Gaps

Thematic Area	Gap Description	Knowledge Users
Social protection and gender (marginalized/vulnerable groups)	Lack of access to Early Warning Systems by youth and remote communities	Social workers, local government, town and country planning, natural disaster management officers, NGOs, CSOs, faith-based organizations, youth groups, remote communities, women and women's group
	Lack of integrated Early Warning Systems to facilitate information flow before and after events	
Information and communications technology	Lack of access to meteorological data in climate change decision-making	All relevant sectors, civil society organizations, farmers and farmer groups, local government and extension officers, Development NGOs, and donors

The Pacific subregion for LAKI includes 14 SIDS, Australia, New Zealand, and seven Pacific island territories. More specifically, the SIDS participating in LAKI are Cook Islands, Fiji, Kiribati, Marshall Islands, Micronesia, Nauru, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu, and Vanuatu (UNFCCC, 2021a).

This study focuses on Samoa and Vanuatu. These countries were selected for this research due to their involvement in LAKI, with the goal of having countries from different regions in the Pacific (i.e., Polynesia and Melanesia) represented. In addition, we aimed to prioritize countries that are less studied to date. Due to our collaboration with SPREP, selecting these countries also enabled more streamlined support and guidance: Samoa hosts SPREP's headquarters, Vanuatu is home to one of SPREP's sub-regional offices, and The Pacific Climate Change Centre at SPREP also has strong connections with stakeholders in the two countries.

1.4 Country Background

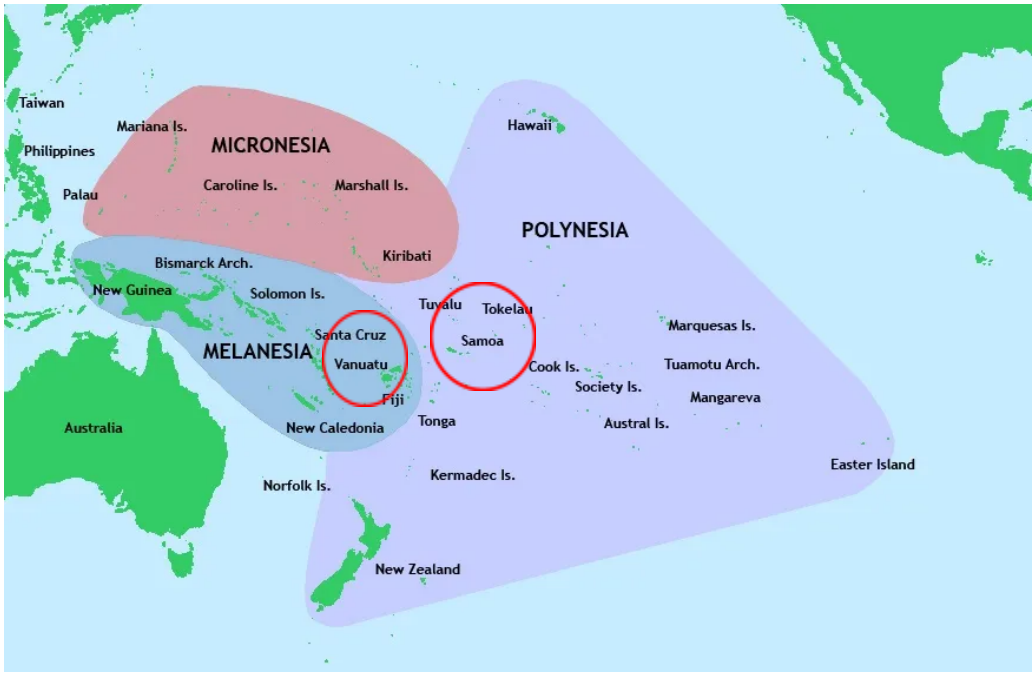

Figure 1. Map Over the Pacific Islands, with Red Circles Showing Samoa and Vanuatu (Difference Between, 2015)

Samoa is a PSIDS located centrally within Polynesia, halfway between New Zealand and Hawai'i, within the South Pacific Convergence Zone, which is a rain band that greatly affects the rain season and monsoon trough, as well as cyclones throughout the season. It comprises two main islands, Savai'i and Upolu, and several smaller islands and uninhabited islets. Samoa's economy—and many people's livelihoods —depend on the agricultural and tourism sector. 25% of Samoa's GDP comes from tourism, and increasing climate change impacts can affect how many tourists can visit during the year (Acorn, n.d.). Additionally, 90% of Samoa's exports come from agriculture, and the sector employs two-thirds of the labor force. Because agriculture is extremely vulnerable to climate change, future forecasts of intensifying cyclones, droughts, and rain events could harm Samoa's economy. Changes in the frequency and length of extreme rain events, rising temperatures, and sea level rise are expected to devastate farms located in low-lying areas. Further, drought and the increased severity of tropical cyclones harm rice fields and crops, contributing to greater soil erosion. In the long term, Samoa will have to navigate decreased food availability on the islands, coupled with an increase in the market prices for food, which will have implications for food security and nutrition (International Monetary Fund, 2022).

Previous storm events have caused extreme destruction. The 1990 and 1991 Cyclones Ofa and Val, and 2012 Evan collectively resulted in $611 million in damage (World Bank, 2021). Cyclone Evan is particularly notable because it catalyzed greater investment in CIS in Samoa. Following the cyclone, the total post-disaster economic loss, including recovery, reconstruction, and DRR, came to SAT 465 million (USD 203.9 million), mainly due to intense cyclone-related flooding (Government of Samoa, 2013). In the aftermath of the disaster, 4,763 people were displaced, and 4,242 people required financial assistance (Government of Samoa, 2013). The most impacted sectors were the transportation, agricultural, infrastructure, environmental, electricity, and tourism sectors. With so many people employed in agriculture specifically, the disaster left many unemployed or scrambling for employment (Government of Samoa, 2013). International organizations were called in to help Samoa, and a post-disaster needs assessment was created in 2013 to assess what Samoa needed to respond more effectively to future cyclones. One conclusion from the assessment was that CIS, specifically EWS, should be included in DRR and financed to better prepare Samoans for the changing climate (Fakhruddin & Schick, 2019).

Vanuatu is a PSIDS located in Melanesia, consisting of 83 islands and spanning approximately 1,100 km (680 miles). The largest islands are Espiritu Santo, Malakula, and Éfaté. Éfaté is home to Port-Vila, Vanuatu's capital city and largest urban area. According to the World Risk Report (2021), Vanuatu is the most exposed nation to disaster risk and experiences a variety of climate change hazards, including tropical cyclones, heavy rain, flooding, extended periods of drought, rising sea levels, warming temperatures, and ocean acidification. These impacts put pressure on coastal ecosystems and livelihoods that depend on natural resources.

Vanuatu's heavy economic reliance on agriculture makes it particularly sensitive to extreme weather and climate change impacts. Roughly two-thirds of the population depends on small-scale agriculture, which accounts for over one-fourth of the GDP (World Bank Group, 2021). Other key economic activities include fishing and tourism. In 2015, Tropical Cyclone Pam caused widespread devastation, displacing roughly 65,000 people and destroying over 90% of food crops (United Nations, n.d.-b). In April 2020, category 5 Cyclone Harold made landfall across the northern islands and caused significant disruptions to the agricultural sector and rural communities (Paget, 2020). More recently, category 4 Cyclones Judy and Kevin made landfall in Vanuatu in a rare double cyclone event within two days in March 2023. These extreme climate events indicate the need to increase CIS accessibility and utilization for those working in vulnerable sectors to improve disaster preparedness and recovery efforts.

Additional information about Samoa and Vanuatu is presented in Appendix B.

1.5 Communities of Focus

There is a particular lack of access and usability of CIS by communities with disproportionate socioeconomic and climate vulnerabilities, especially women (Cassinat et al., 2022; Kaur et al., 2016; Raj et al., 2020; Samoa Red Cross Society, 2017; UNDRR, 2022b) and remote communities (Huang, 2020; Mcleod et al., 2019; Nunn, 2009), in Samoa and Vanuatu – hereafter known in this report as 'vulnerable communities.' However, we understand that other communities face similar barriers, and some of the barriers identified in this study broadly apply to other communities across both countries. We also take an intersectional approach acknowledging overlapping and compounding disadvantages for women with disabilities and women in remote communities (Gartrell et al., 2020; UNDRR, 2022b).

Women are important contributors to climate resilience worldwide. For instance, women typically hold important traditional knowledge (TK) from personal experiences adapting to the environment over generations and have important roles in upholding TK, making them integral to effective climate information production and dissemination (Mcleod et al., 2018). However, according to the United Nations Office for Disaster Risk Reduction (UNDRR) (2022a), many women in Pacific communities are excluded from decision-making processes within their own families, local and national systems, and governance. This is especially true for older women and women with disabilities. Women in the Pacific region, especially those in remote areas, typically lack equal access to communication technology and thus are unable to access crucial climate information in a timely manner (UNDRR, 2022a). Moreover, men tend to receive information directly from the government and non-governmental organizations (NGOs) while women tend to receive information through more informal networks, which may impact their ability to react promptly. Delayed access to information about climate hazards leads to women's disproportionate exposure to risk, including loss of livelihoods, lives, and security, during and after disasters (SPREP, 2020; UNDRR, 2022a). Additionally, women are usually responsible for caring for children and elderly family members. They are less likely to evacuate alone, as they will often wait to rescue valuables and family members (UNDRR, 2022a). Women's engagement in care and informal work can also make it difficult for them to be financially self-sufficient and recover from climate disasters. Ultimately, excluding the perspectives and insights of Pacific Island women results in less equitable and robust climate policies (Mcleod et al., 2018).

Remote communities are also particularly disadvantaged regarding CIS in the Pacific Islands. It is difficult to reach remote communities due to logistical, technological, and weather-based obstacles, such as high transportation costs, communication difficulties, and potential disasters (Mcleod et al., 2019). This makes it extremely difficult to warn them of incoming disasters and provide aid in the

aftermath of a disaster. Despite the investment of CIS in the Pacific, important gaps remain in reaching and disseminating information to remote islands, as well as addressing their information needs.

While this report focuses on women and remote communities, youth and people with disabilities may also face barriers related to CIS (Lima Adaptation Knowledge Initiative, 2021; Power et al., 2019). However, youth are also seen as agents of change and could potentially increase understanding of CIS (Samoa Red Cross Society, 2017). While these groups were not a focus of the interviews conducted in Samoa and Vanuatu, barriers faced by youth and people with disabilities remain an important area of study for future research.

1.6 Study Aims

This study aims to achieve three objectives. First, it seeks to understand how CIS in Samoa and Vanuatu generate and distribute climate information and how decision-makers and end users utilize this information. This includes identifying gaps in climate information, assessing the accessibility, usability, appropriateness, and availability of regional climate data, examining the technical capacity of CIS, and analyzing communication between stakeholders. Second, the study aims to identify best practices for CIS in Samoa and Vanuatu, focusing on the needs of vulnerable communities. Finally, the study aims to provide recommendations to organizations, agencies, and networks throughout the Pacific region to enhance the effectiveness of CIS.

Report Roadmap. *Section 2 (Methods)* outlines the research area and the methods employed in conducting the study. *Section 3 (Case Study: CIS in Samoa)* and *Section 4 (Case Study: CIS in Vanuatu)* discuss the results of our interviews, which are supplemented by the literature review, and identify key barriers to disseminating, accessing, and utilizing climate information in Samoa and Vanuatu. These sections also highlight three notable initiatives from Samoa and Vanuatu: Climate Early Warning Systems (CLEWS), Van-KIRAP, and Women's Weather Watch (WWW). *Section 5 (Comparing CIS Barriers in Samoa and Vanuatu)* identifies key similarities and differences in the barriers experienced by interview respondents in Samoa and Vanuatu. *Section 6 (Recommendations to Improve Climate Information Services in Samoa and Vanuatu)* integrates the study findings into several suggestions to enhance the dissemination, accessibility, and utilization of climate information for various stakeholders, thereby increasing adaptive capacity and resilience to the effects of climate change.

2 Methods

The study addresses several research questions related to CIS in Samoa and Vanuatu. These questions identify the current state of CIS in the region and vulnerable communities' unmet climate information needs. The study also examines the flow of information, how decision-makers and end users engage with CIS, and barriers to effectively and efficiently disseminating, accessing, and utilizing climate information. Additionally, the study aims to identify best practices in generating and disseminating relevant, usable climate information to end users and explore new approaches that regional and national could adopt. The study also considers the potential for these approaches to be scaled across the Pacific region. We conducted a literature review and stakeholder interviews to answer these research questions.

2.1 Literature Review of CIS Barriers

The literature review helped determine what barriers exist and what best practices have already been identified—both in the region and globally—in CIS, especially concerning vulnerable communities in Samoa and Vanuatu. We identified relevant academic journal articles through search engines, such as Google Scholar, the Pacific Climate Change Portal (PCCP), and JSTOR. Our search criteria included key terms and phrases, including 'SIDS climate risk & early warning systems,' 'early warning systems and climate adaptation,' 'technology access in the Pacific Islands,' 'women accessing climate information services, 'Pacific, climate change, adaptation,' 'climate information services,' and 'climate change community-based adaptation in the Pacific.' Along with journal articles, we identified relevant information in reports from Samoa and Vanuatu's national governments, regional NGOs, and local and regional news sites. The information gathered through the literature review is woven into the results and recommendations section to support findings from stakeholder interviews.

2.2 Stakeholder Interviews

Our interviewee selection criteria targeted knowledge holders within three main categories:

1. NMHSs, national climate change ministries, departments and divisions, and policymakers in the two countries specializing in CIS;
2. NGOs and other local/regional organizations that work with vulnerable communities (e.g., women, disabled people, youth) in disseminating climate information;
3. Community members and local groups who receive and interact with CIS.

To sample a broad set of stakeholders in each of these groups in each country, we relied on internet searches, snowball sampling (characterized by networking and referral), and our partner's networks to identify government officials, NGOs, and community members in Samoa and Vanuatu (Parker et al., 2019). The team's clients and partners, specifically the Australia Pacific Climate Partnership (APCP), connected the team with colleagues at CSIRO and each country's NMHS. We also hired two paid research assistants from Samoa and Vanuatu. The research assistants had extensive networks and were able to connect us with potential interviewees. They also provided in-country support for the research team by conducting interviews. The interview process lasted from June to October 2022. The team conducted a total of 38 interviews: 20 in Samoa, 14 in Vanuatu, and four in Australia. We created two sets of interview questions: the first for producers of CIS and the second for users of CIS. The interview questions were altered based on the interviewee's specific expertise, but the question topics remained consistent (Appendix A). Table 3 highlights the organizations interviewed as a part of this research.

Table 3. Organizations Interviewed

Organization Interviewed	Number of Interviews
Australia	
Australia Bureau of Meteorology (BOM)	1
Commonwealth Scientific and Industrial Research Organization (CSIRO)	2
University of Queensland	1
Samoa	
350 Pacific Climate Warriors Samoa	1
Conservation International	1
National University of Samoa	6
Other small NGOs[1]	3
The Pacific Community	1
Samoa Conservation Society	1
Samoa Disaster Management Office (DMO)	1

[1] To maintain the privacy, of our interviewees, we will not name the small NGOs

Organization Interviewed	Number of Interviews
Samoa Fire and Emergency Services Authority (SFESA)	1
Samoa Meteorology Division (MET)	1
Samoa Ministry of Natural Resources and Environment (MNRE)	1
Samoa Observer	1
Samoa Red Cross Society (SRCS)	1
United Nations Development Programme (UNDP)	1
Vanuatu	
Action Aid Vanuatu	1
Island Minds Ltd.	1
Secretariat of the Pacific Regional Environment Programme (SPREP)	1
United Nations Development Programme (UNDP)	1
Vanuatu Climate Action Network (VCAN)	2
Vanuatu Meteorology and Geo-Hazards Department (VMGD)	5
Vanuatu National Disaster Management Organization (NDMO)	2
Women's Weather Watch (WWW)	1

2.3 Data Analysis

We adopted an inductive coding approach to analyze our interview data. This involved examining the transcripts to identify common themes and sentiments across the interviews, which we used to develop codes. These codes were then grouped into categories using Atlas.ti, allowing us to identify major themes and categorize the codes across the interview data.

We conducted two frequency analyses to examine the codes and code groups. The first analysis determined the total number of times each code or code group was mentioned, while the second analysis determined the number of individuals who mentioned each code or code group. We also disaggregated the data by country and stakeholder group to provide a more nuanced understanding of the findings.

2.4 Limitations

Our study faced several limitations that affected the scope and analysis of our research. One of the main challenges was the difficulty of reaching and connecting with people in Samoa and Vanuatu, particularly those without internet access. Our research team relied on local research assistants to connect with interviewees, especially those from the community. We conducted interviews using remote platforms like Zoom whenever possible and relied on research assistants to conduct in-person interviews. Due to these circumstances, our study was limited to only 34 interviews across Samoa and Vanuatu and four in Australia. The representativeness of our findings should be taken in light of this limited sample.

Another limitation was the differences in the interview process between the two countries. The Vanuatu team followed a strict set of questions and topics, while the Samoa interviews covered a wider range of topics. Additionally, most of the Vanuatu stakeholder interviews were conducted exclusively by the U-M team, whereas the research assistant in Samoa conducted a majority of interviews without the U-M team present. These differences in data collection make a direct comparison between Vanuatu and Samoa challenging. As a result, we have described findings from each country in separate case studies.

2.5 Ethical Considerations

Because of the minimal risk associated with this study (HUM00215247), this project is considered exempt by the University of Michigan Institutional Review Board - Health Sciences and Behavioral Sciences (IRB-HSBS). To protect the identity of interview respondents, interview notes and transcripts have not been shared with anyone outside of the U-M team, which includes six master's students and two research assistants. In the deliverables associated with this project, all interview data is anonymized.

3 Case Study: CIS in Samoa

3.1 CIS Dissemination Pathways

The Samoa Meteorological Service (Samoa MET), a division of the Ministry of Natural Resources and the Environment, is the government agency responsible for receiving, producing, and disseminating information related to climate, weather, monsoons, and geo-hazards. In addition to constant weather monitoring, Samoa MET works closely with regional and international partners, like the New Zealand Met Service and the Australia BOM, to prepare and disseminate climate information products. The climate forecasts and models that Samoa MET uses to produce CIS come from international partners, including CSIRO in Australia and the United Kingdom Meteorology Office. CIS are disseminated to various end users using three main approaches, depicted in Figure 2.

Approach 1 details the dissemination pathway Samoa MET uses to disseminate climate information to the majority of end users. After receiving climate models and forecasts, the information is used to produce various products, including seasonal climate outlooks, tropical cyclone outlooks, EARWatch reports, and social media posts. Seasonal climate outlooks provide information on anticipated rainfall, temperature projections, and El Nino Southern Oscillation (ENSO) forecasts for a designated time period (e.g., from March to May 2023). Meanwhile, tropical cyclone outlooks highlight projections for the intensity of tropical cyclones in the upcoming season as well as the potential impacts of these cyclones. EARWatch reports, designed for disaster managers, include a summary of recent rainfall patterns and projections for the coming months.

The Samoa MET also shares weather and climate information on Facebook, including severe weather advisories, earthquake notifications, and updates on La Niña and El Niño. These products are available in both English and Samoan on the Samoa MET website and social media, as well as through SMS, television, radio, and the Samoa MET App.

The Samoa Ministry of Natural Resources and the Environment produces a quarterly Climate Change Report Card, which includes a climate outlook section that features rainfall, temperature, and cyclone data for the reporting period. The report also compares the data to averages and makes projections based on observed trends. For example, the August 2021 report projected slight warming for Samoa in the upcoming three-month period (September to November 2021) based on climate models.

Approach 2 details the dissemination pathway of the Climate Early Warning System (CLEWS), which disseminates climate information not just to individuals across Samoa but also to specific sectors of the economy, including the water, fisheries, forestry, public health, and tourism sectors. We will discuss this further in the Featured Initiative section below.

In addition to providing climate information to the people of Samoa, Samoa MET also provides information and materials to Fiji and collaborates with the Fiji Meteorology Service to share climate forecasts with Tokelau, a small island located north of Samoa where Samoan is also spoken. Samoa MET translates the forecast received initially from CSIRO and the UK Meteorology Office. This dissemination pathway is illustrated by Approach 3.

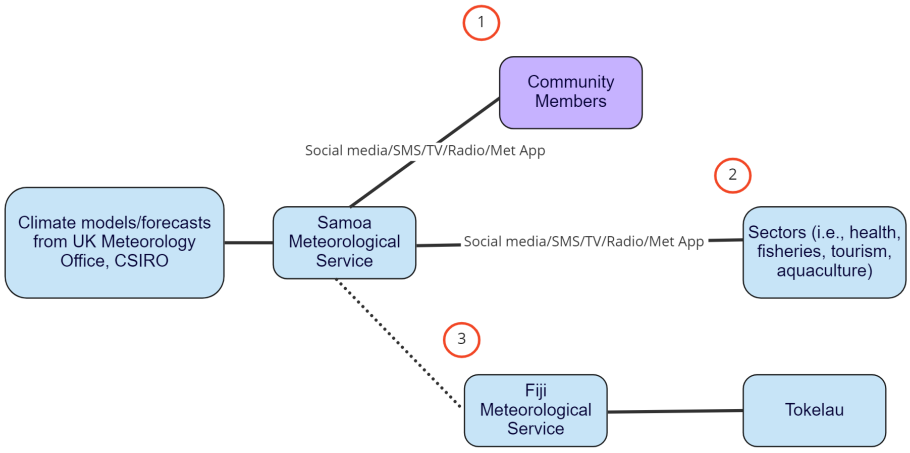

Figure 2. Samoa Climate Information Dissemination Pathway

In the event of a severe hazard or potential emergency, alerts from the Tsunami Center based in Hawaii and the Emergency Managers Weather Information Network are sent to the Samoa Disaster Management Office (DMO) via mobile, email, and fax (Mow et al., 2017). In coordination with DMO, Samoa MET briefs the Disaster Advisory Council (DAC), which contains a representative from all government ministries and agencies. After the Committee is updated, alerts about the hazard are disseminated to each village's mayor (*Pulenu'u*, in Samoan) using pre-programmed SMS, radio, TV, and email. The mayor then mobilizes their village's warning signals, including church bells, school bells, and sirens, to alert their community (Mow et al., 2017).

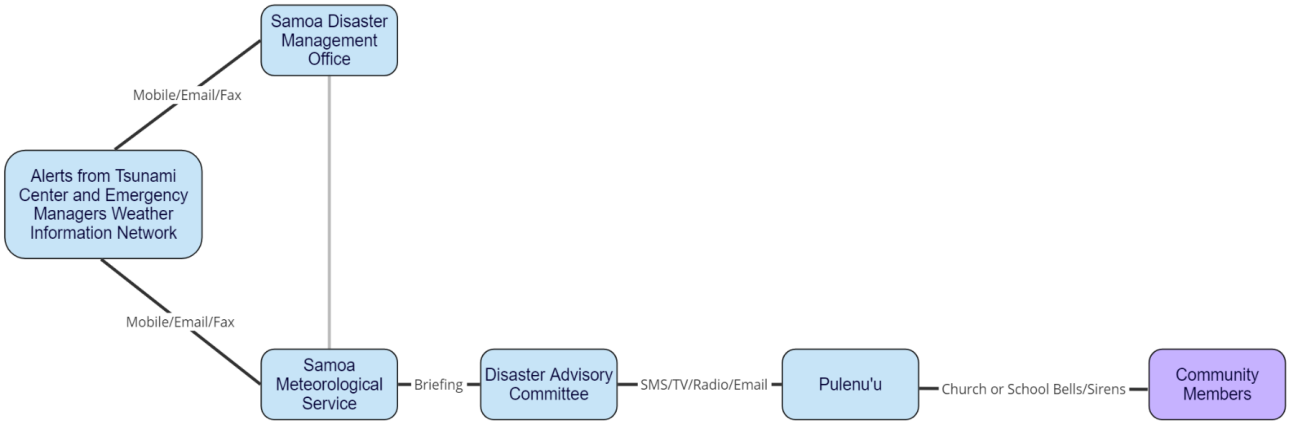

Figure 3. Samoa Hazard Alert Dissemination Pathway

In addition to specific mechanisms of dissemination, several organizations and government bodies are helping connect climate information with DRR, disaster preparedness, and climate adaptation activities in Samoa. For instance, the Community Disaster and Climate Risk Management (CDCRM) program is a multi-agency program implemented by the Samoa Disaster Management Office (Samoa DMO) and the Samoa Red Cross Society (SRCS) first developed in 2011. CDCRM aims to "achieve a satisfactory level of readiness for members of the community, to respond more effectively to the impacts of emergencies and disasters, and to strengthen disaster risk management capacity of community leaders and members of the various identified responding teams" (Samoa Red Cross Society, 2021b). In collaboration with partnering agencies, Samoa DMO and the SRCS conduct training with individual villages over a week, focusing on responding to disasters and understanding the different dynamics when disasters occur. The program aims to cover all villages in the country (SPREP, 2015).

Samoa MET currently relies on several methods of communication to disseminate CIS to end users. As illustrated in Figure 4, interview respondents discussed the use of social media (mentioned by 14 people), television (mentioned by 12 people), radio (mentioned by ten people), and SMS text messaging (mentioned by nine people) by Samoa MET. Regarding social media, Facebook is the most common platform used to disseminate climate information and emergency warnings, utilized by Samoa MET and NGOs across the islands. In a household survey conducted by Mow et al. (2017), 65% of respondents used Facebook, demonstrating that social media is an important source of climate and disaster information across Samoa. Radio and television have been identified as the most important sources of information in an emergency (Mow et al., 2017), primarily due to their reliability and use by older generations. Additionally, the vast majority of Samoans own a mobile phone, while

approximately one-third of the population own a smartphone (Mow et al., 2017). This demonstrates that basic mobile phone services, like SMS, are effective information dissemination methods. The importance of having a diverse set of channels for climate information is confirmed by SPREP and CSIRO, which found that participants want to access climate information through a range of media, including email and SMS (most commonly used), as well as digital content, radio, television, and business meetings (Cunningham et al., 2021).

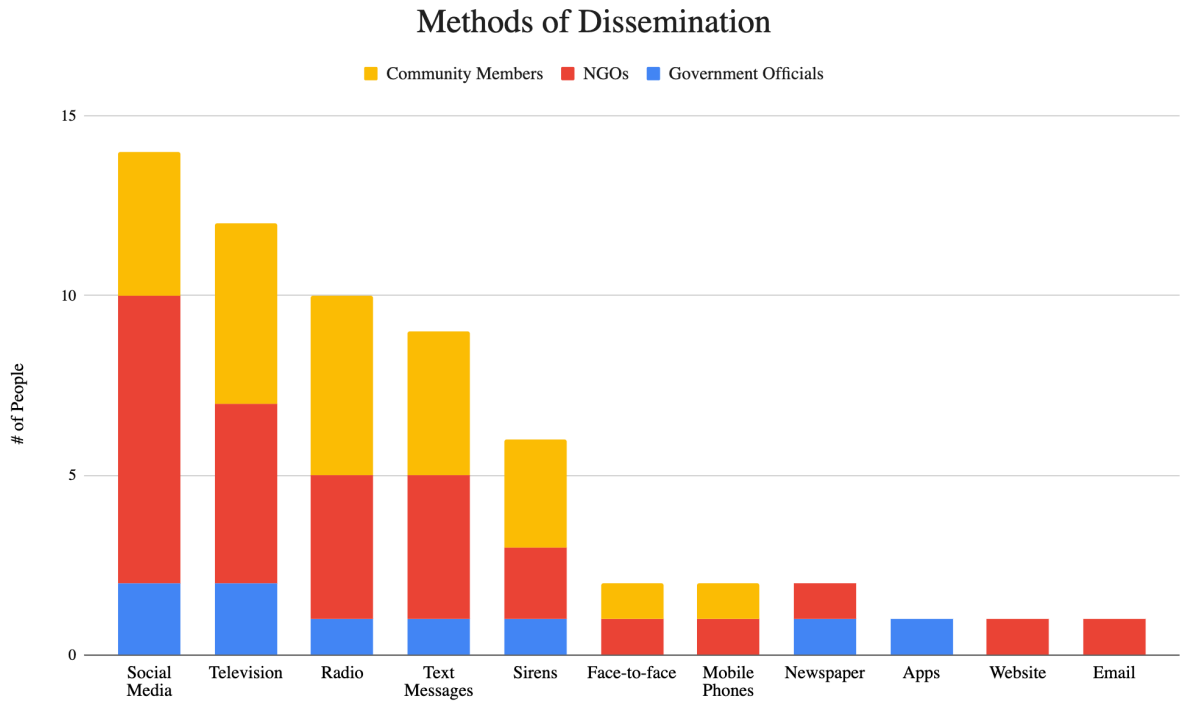

Figure 4. Methods of CIS Dissemination in Samoa

While the Samoa MET does not have a systematic process for soliciting feedback and community engagement on CIS from end users, there are examples of community-government communication avenues and community input initiatives around CIS. For instance, one government representative described how Samoa MET receives feedback via Facebook about its climate information products and systems. The 2013-2017 FINPAC project, which the Government of Finland and WMO funded across 12 Pacific countries (including Vanuatu and Samoa), helped build links between the government and communities to enable their engagement in vulnerability assessments, community early warning systems, and disaster response (Ministry for Foreign Affairs of Finland, 2018).

While government agencies are the central conveyors of climate information in Samoa, entities like SPREP, the SRCS, and international actors have been collaborating with the government to help make

climate information less technical, more usable, and more understandable formats for communities. For instance, the FINPAC project, which was implemented in Samoa by the SRCS, the Samoa MET, and SPREP, aimed to build the capacity of NMHSs and boost community awareness and understanding of climate information. The project sought to make "climate and weather information more accessible, relevant, and user friendly" for end users like fishers and farmers (Samoa Red Cross Society, 2017; SPREP, 2015). One project output was installing a weather forecast and analysis tool, SmartMet, developed by the Finnish Meteorological Institute (FMI). Another output was installing the SmartAlert software, a tool to develop warnings for severe weather. Beyond using SmartAlert to improve its website, Samoa MET also used the software to develop its Met App to reach end users. The FINPAC initiative, intended to reach one community in each country, reached a total of 514 people, including 251 women and eight people with disabilities in Samoa (Samoa Red Cross Society, 2017).

Despite these collaborative efforts between government agencies and other organizations in Samoa to improve CIS, the 2021 LAKI workshop suggests there are still critical gaps.

It is worth noting that Objective 6 of Samoa's 2020-2030 Climate Change Policy seeks to make progress on many of the gaps discussed in the section below (MNRE, 2020). The objective, titled "Improved Data and Information Management on Climate Change for Informed Decision-Making," includes the following relevant strategies: Promoting technology access to climate change information; Establishing a national climate change database portal—the Data Knowledge Information Facility (DKIF); Integrating TK into the DKIF; Improving access to information and data; Supporting the effective, collection, digitizing, quality control, storage and dissemination of climate-related data and information, and; Establishing a national climate change forum.

3.2 Barriers to Disseminating, Accessing, and Utilizing CIS

Based on the interviews and literature review, there are several barriers to (1) disseminating CIS to local communities, especially the end users, to inform them of climate trends and hazards, (2) accessing CIS, and (3) making CIS usable by local community members.

Table 4 summarizes the categories of barriers and the number of people mentioning the barriers of our interviewees within Samoa, including government officials, NGOs, and community members.

Table 4. Barriers Addressed by Samoan Interviewees

	# of Samoan Government Officials who mentioned the barrier, at least once	# of Samoan NGO Representatives who mentioned the barrier, at least once	# of Samoan Community Members who mentioned the barrier, at least once	# of Total Interviewees who mentioned the barrier, at least once
Number of Interviewees	4	8	8	**20**
Dissemination				
Lack of Funding	3 (75%)	5 (62.5%)	2 (25%)	**10 (50%)**
Lack of Institutional Capacity	3 (75%)	2 (25%)	1 (12.5%)	**6 (30%)**
Limited and Vulnerable Physical Infrastructure	0 (0%)	3 (37.5%)	1 (12.5%)	**4 (20%)**
Delayed Delivery of CIS	0 (0%)	1 (12.5%)	3 (37.5%)	**4 (20%)**
Lack of Coordination Between Organizations	0 (0%)	2 (25%)	0 (0%)	**2 (10%)**
Accessibility				
Remoteness	0 (0%)	0 (0%)	2 (25%)	**2 (10%)**
Utilization				
Gender Inequality in Decision-making	3 (75%)	4 (50%)	8 (100%)	**15 (75%)**
Expertise Divide Between Western Scientific Knowledge and TK	0 (0%)	8 (100%)	7 (87.5%)	**15 (75%)**
Local Language Translation	0 (0%)	3 (37.5%)	3 (37.5%)	**6 (30%)**
Lack of Trust	1 (25%)	1 (12.5%)	3 (37.5%)	**5 (25%)**
Lack of Awareness	0 (0%)	2 (25%)	1 (12.5%)	**3 (15%)**

Note. This table summarizes the number of people that mentioned each barrier by Government Officials, NGOs, Community Members, and Total. The percentage of people that mentioned each barrier in each group is in parentheses.

3.2.1 Barriers to Disseminating CIS

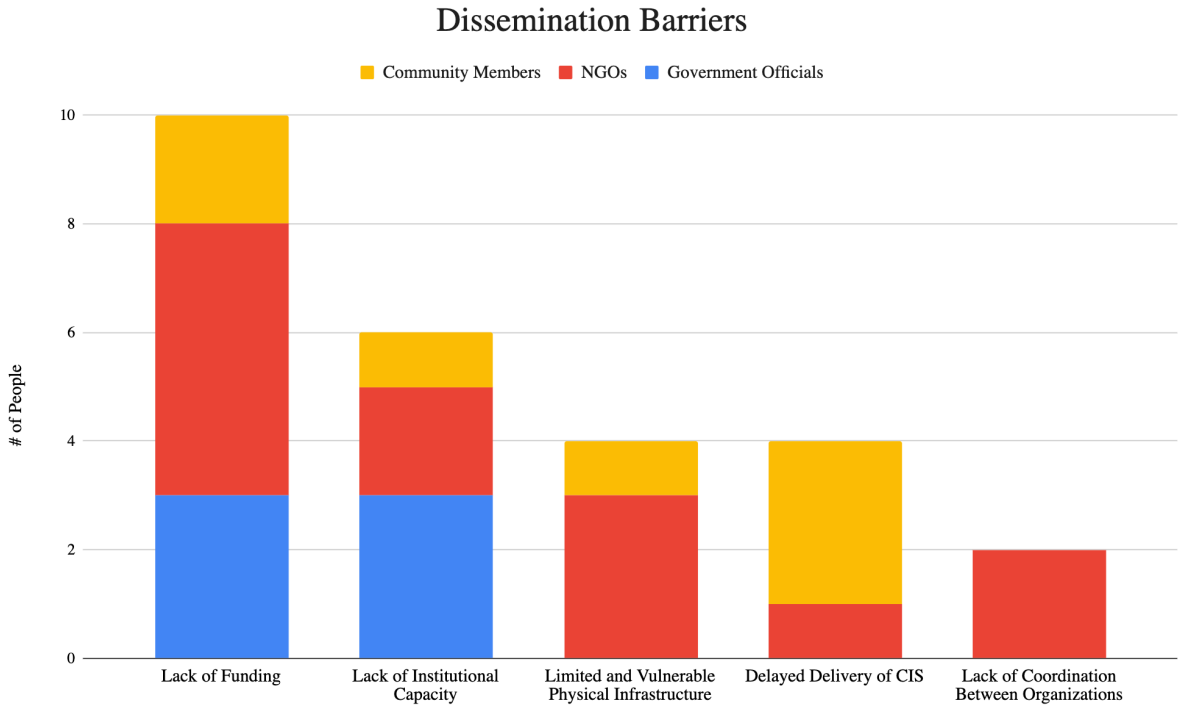

Figure 5. Number of People Mentioning Dissemination Barriers in Samoa

Our interviews found that lack of funding, institutional capacity, and physical infrastructure were major barriers to the effective dissemination of climate information. Delayed delivery of CIS products and a lack of coordination between organizations were also noted as barriers, though less frequently. All three stakeholder groups mentioned these barriers, but NGO representatives and community members had the most mentions.

More specifically, the most mentioned barrier was a **lack of funding** by ten of our interviewees. According to a government official, the Samoan government and NGOs rely heavily on their international development partners for funding. Funding can be inconsistent and intermittent, leaving organizations scrambling to figure out how to keep initiatives running when funding is unavailable, or when there is a funding gap. Donations can also be particular; sometimes, donors' priorities and money flow do not reflect what is needed in the countries and on the ground (Fortwangler, 2007).

> *"...the donors only [give] a certain fund at a certain time. And then after that deliverance... you're unsure whether there will be additional support for later on, or whether the local NGO or an organization they've invested in will continue the work."* - NGO Representative

> *"[Funding isn't] always continuous. So you would have funding for doing this work for five years. And then there might be a gap of a year or two years, and the staff that you had working on the first [project] disappears."* - NGO Representative

In our interviews, six interviewees mentioned **institutional capacity**. Three government officials noted that their employees do not have sufficient knowledge about climate change and CIS. They may not have an adequate educational background or are not provided with useful and necessary training at their workplace. Fakhruddin et al. (2019) concluded that high training costs and limited availability of the required skilled staff are difficult to maintain when funding is insufficient. Some interviewees mentioned that they rely on international development partners to substitute for the lack of internal institutional capacity.

> *"I find [it] challenging in Samoa when we don't have the expert[ise] within our country. We have to advertise it to overseas people. [Still, when] they come in, they have to be familiarized with the environment and try to understand the challenges as well."* - NGO Representative

Limited and vulnerable physical infrastructure is also a barrier for Samoa. Physical structures—such as evacuation centers, cell phone towers, or roads—are essential to CIS and DRR and can be destroyed during extreme weather events. This was mentioned by three NGO representatives and one community member. Limited and vulnerable infrastructure becomes a barrier when infrastructure is not rebuilt after a disaster because of a lack of funding or capacity to rebuild it. Some physical infrastructure, such as access to roads and internet towers, will impact access to CIS. In contrast, other infrastructure will impede disaster response and affect community members' ability to respond to natural disasters and weather events. This will worsen when cyclones and other disasters intensify in the face of climate change.

> *"I would put money towards infrastructure and improving and building an actual evacuation space ... making sure that people are safe. ... Also includ[ing] an infrastructure, kind of like an independent early warning system, where it ... just shoots straight out into the village, where villages receive firsthand [information], ... that way, the information just travels a lot quicker and more efficiently."* - Community Member

Another barrier within dissemination is the **delayed delivery of CIS**. One NGO representative and three community members mentioned this, but no government officials mentioned this. If disaster warnings are not received in a timely manner by villages, the quality of the information could be moot, and it may be too late for the community members to make decisions and take action. As Samoa receives most of its climate forecasting data from abroad, it takes longer for a warning to reach the end user. Text messages might be sent out too late, or the dissemination pathway for the warning is too long and complicated. For instance, one community member mentioned how they were stuck in the countryside during Cyclone Gita in 2018, as they had not received a warning before leaving their house.

> *"I think all [warnings] came a bit late, like, you know, the siren, the text messages, and everything just came late when the wave [had] already hit the villages."* - NGO Representative

Lack of coordination occurs when government officials and NGO representatives do not frequently or effectively communicate or synergize their efforts. Lack of coordination can lead to several challenges that impede the dissemination of climate information, including redundant projects and tools, missed opportunities for funding and projects, and fatigue in the receiving communities. This barrier was only mentioned by two NGO representatives and no government officials or community members.

> *"We feel pity for the community, after the Red Cross, [Adventist Development and Relief Agency] ... goes to the same community, one after the other, and it's putting pressure on [the community members]. But if we go with all [organizations together], they can say what [they] want to say and help them. [I] think everyone there should [use] that collective approach. We can all come together, help our people, put together our skills and our resources."* - NGO Representative

3.2.2 Barriers to Accessing CIS

From our interview findings, we did not find substantial barriers to accessing CIS in Samoa. The only accessibility barrier mentioned by our interviewees was **remoteness**, which two people mentioned. For Samoans living in remote or rural areas, the main challenges faced are technology-related. More specifically, some Samoans living in rural areas may not have access to cell phones and televisions, so certain CIS products may not be accessible.

3.2.3 Barriers to Utilizing CIS

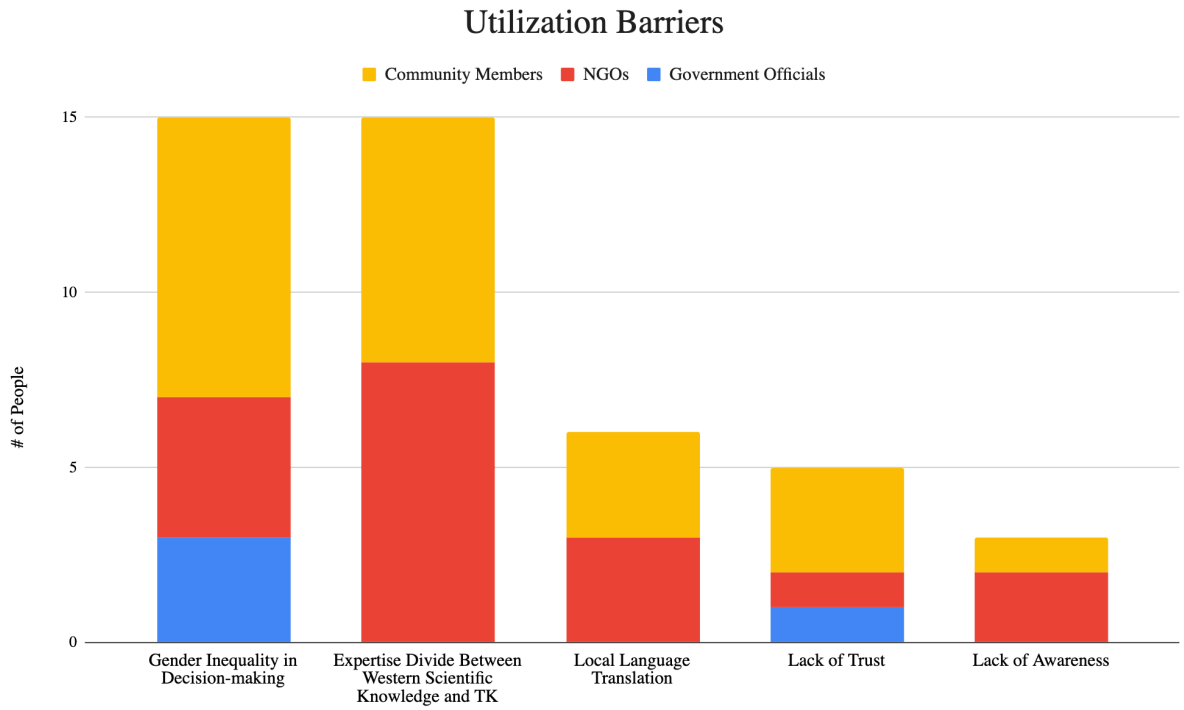

Figure 6. Number of People Mentioning Utilization Barriers in Samoa

We found that gender inequality in decision-making, an expertise divide between Western scientific knowledge and TK, local language translation, and lack of trust and awareness are the major utilization barriers.

Gender inequality in decision-making was mentioned by 15 people, with all of the community members (8) mentioning it. Climate information interfaces with gender in distinct ways, and our interviews highlighted inequality in gender roles and leadership as barriers to effective CIS in Samoa.

While descriptions of gender roles varied, interviewees generally revealed that women are intimately involved in caretaking and know the needs of their community. Nevertheless, men tend to have the "final say," even in the domestic sphere. Relatedly, many women still face barriers to decision-making in their communities, which can influence how Samoan women engage with and respond to CIS. Interviewees reported that some villages in Samoa still do not allow women to become chiefs, while in other villages, women are less present or involved in climate leadership and village councils compared

to their male counterparts. In some cases, women reported sharing their opinions through their husbands but are not directly involved in climate decision-making.

> *"There are still villages here in Samoa that don't allow women to become chiefs at all. In fact...[many] would not let women become chiefs until maybe 20 years ago. There's a traditional view that women take care of the home."* - Community Member

> *"Women know firsthand the needs of the children that they look after and the elders that they look after. They can relate a lot more to make sure that [the children and elders] are safe, especially during evacuation procedures and natural disasters."* - Community Member

This data on gender inequality in decision-making suggests that women in Samoa are generally able to access climate information, but are not always able to fully participate in decisions about how CIS are designed—i.e., what climate information is collected, how information is structured and given—or how the information is used to mitigate climate risks.

Women's restricted access to climate leadership could limit their ability to shape the design of CIS, which has implications for the usefulness of CIS to women. For instance, a 2022 study suggests that men and women in Samoa may prioritize different climate change impacts and thus prioritize different climate information, as men tend to be more concerned with high temperatures and ocean management, while women tend to be more concerned with storms and related dangers (Cassinat et al., 2022). Without the robust inclusion of women in CIS design, important information that is particularly useful to women could be missed in CIS products and communications.

In short, women's limited ability to engage with and act on climate information in Samoa could alter—and ultimately hinder—the country's structure and delivery of CIS. Nevertheless, despite the challenges Samoan women face in utilizing CIS, they have contributed significantly to CIS, climate change programs, and climate policies (Mcleod et al., 2019). Several respondents noted that female climate leadership has improved in the country, with more women becoming chiefs and spearheading climate adaptation and mitigation work. Some organizations, including 350 Samoa, intentionally structured their organizations to emphasize female leadership.

The **expertise divide between Western scientific knowledge and TK** was one of the most mentioned barriers and was addressed by 15 interviewees. TK is the understanding and skills developed by the Samoan communities in close connection with land and nature throughout generations (IPCC, 2022). It also includes continuous hands-on learning, experiential learning, and informal education.

The adaptive quality of the teaching style allows them to modify their behavior to account for changing climatic conditions within the Samoan language and knowledge (Mcleod et al., 2018). Community members, NGOs, and government officials are experts in specific concepts through formal training or lived experience (S. Kaplan, 2015), with expertise varying across these three groups. Community members and NGOs tend to be experts in TK and knowledge specific to their livelihood (i.e., agriculture and fisheries), while government officials are typically experts in Western scientific knowledge. Each of these stakeholder groups has different areas of expertise and knowledge, which can present challenges when creating materials that can be understood and utilized by all end users.

While government officials did not mention interpreting and understanding Western scientific knowledge as a barrier to utilizing CIS, 50% of the NGO representatives and community members mentioned it. Better incorporating TK into CIS could help minimize Western scientific knowledge within information products, yet interviewees reported that CIS does not systematically reflect TK.

> *"They've seen it with their own eyes, but they don't know the science [behind] the scientific terms ... and they don't know why it's happening scientifically. But they can see it, they live it. We just need to make sure that the information is tailored more to their experiences, and not to science."* - Community Member

Many Samoans have only finished a secondary level of education, and Western scientific knowledge is often not taught in earlier grades. Despite ongoing efforts to make the language more understandable by communities, the use of technical language—like West, North, Latitude, and Longitude—persists in some CIS products, making it difficult for some to understand the information presented in CIS.

> *"[The] majority of Samoans, especially in the rural areas, probably haven't finished secondary level, ... a lot of the older generation only finished year eight, primary level. So they don't have ... the knowledge [that] I have to understand what an early warning means. When they say it's Southwest of here ... they can't relate to that, because they don't have that basic knowledge."* - Community Member

> *"Yes, there are way too many scientific terms. When I first started climate journalism, I had a hard time trying to define this or that and trying to translate it into an everyday language that everyone could understand. I think some of the terms are too technical."* - NGO Representative

Local language translation in CIS (mentioned by six interviewees) was discussed by interviewees because English is not the first language for Samoans, and 90% of the population exclusively speaks

Samoan. This creates a barrier when NGOs, government officials, and staff from international organizations come to the villages and teach or talk to the community members in English. A community member also mentioned that many warnings or teaching pamphlets are in English, making it hard for them to interpret CIS and other materials.

> *"They should also make [CIS] in the mother tongue (Samoan). If you're going to go to a rural area and try to teach English, I'm telling you [that] 99% of people will not understand you. English is not our first language, it is our second. And if you want to be relatable towards people, you should at least know how to speak their language first."* - Community Member

Additionally, the Samoan language does not have words for certain climate-related terminology, like tropical depression or climate change, and different organizations will make up words for these terms. As a result, these terms are not fully understood by the community members. This creates confusion, yet the Samoa MET has slowly introduced scientific terms in Samoan.

> *"We don't have the Samoan word for climate change ... we had to invent a word. And when people started asking what it was, that's ... how you introduce it. So it's a lot of the sciencey words like climate change, environmental disasters, longitude, latitude, Southwest, and Southeast, [that don't] have Samoan words that people already knew of. ... It's difficult to translate from English to Samoan ... Samoa MET has translated a lot of the English words that they use into Samoan, but a lot of the Samoan people in the rural areas don't quite understand it. To them, it's out of context ... it's just too difficult for them to understand and put together a clear picture."* - Community Member

A **lack of trust** by community members towards the government or NGOs was mentioned by five interviewees across all stakeholder groups. Even when community members receive climate information, they may not trust it to be accurate. Therefore, they may not take adequate measures to prepare for extreme weather or other anticipated climate hazards. Government officials from Samoa or NGO representatives coming to Samoan villages may be viewed as outsiders and community members do not trust the knowledge and information given to them.

> *"[There is a] very traditional mindset of 'I don't want to listen to you because you don't live in my village. You don't understand the things that happen in my village as much as I do.'"* - Community Member

Lastly, a **lack of awareness** among community members about the availability of CIS was mentioned by three interviewees. Our interviewees stated that some community members are unaware that climate information is available to them and, therefore, cannot take action regarding information from CIS. End users may also have difficulty receiving the relevant information or come across information that is not useful before encountering informative and useful information from Samoa MET.

> *"That's I guess, the current challenge, the discoverability of what it is that they're after ... I mean, Google is one thing, but you might not necessarily land on the best of information. So yes, there is probably still a challenge in directing different community groups to the information that they need."* - NGO Representative

3.3 Best Practices

3.3.1 Featured Initiative: Climate Early Warning System

The Climate Early Warning System (CLEWS), was established in 2009 by the New Zealand National Institute for Water and Atmosphere with funding from the Global Environment Fund administered by the United Nations Development Programme (UNDP) (SPREP, 2017b). This system was originally developed to minimize the exposure of communities and livelihoods to the gradual impacts of climate change and natural disasters, including tropical cyclones and droughts (Government of Samoa & UNDP, 2008). According to Samoa MET, CLEWS enables "improved access to climate information, improved climate service to vulnerable economic sectors and to build resilience through DRR and climate change adaptation inter-linkages" (Samoa Meteorology Division, n.d.). CLEWS integrates historical experience, TK, science-based observations and forecasts, and modern communications technologies to warn people about changing risk levels resulting from climate change (SPREP, 2017b).

Originally developed for the agriculture and health sector, CLEWS has been extended to provide information to other sectors of the Samoan economy, including the water, fisheries, forestry, and tourism sectors (SPREP, 2017b). CLEWS provides these sectors with a climate outlook three months in advance, which is then updated monthly (Scheele et al., 2020). According to Mulipola Ausetalia Titimaea, former Director of the Samoa MET, "[the Samoa MET] provided [each sector] with climate forecasts three months ahead so, for farmers, if there was going to be a dry rainfall system, they could plan for this, with the public health if a wet rainfall system is expected, they can plan for possible vector-borne diseases," (SPREP, 2014).

One CLEWS product tailored to the agricultural sector is the soil moisture analysis (SMA), which details the most recent soil moisture level in selected areas of the country. As the impacts of climate change continue to intensify, the soil is expected to become drier (Harrisson, 2019), and monitoring these impacts for farmers is necessary. The SMA advises local communities, farmers, and government agencies (e.g., SFESA, Ministry of Agriculture and Fisheries, Samoa Tourism Authority, MNRE) to manage resources and adaptation planning related to the agricultural sector (Samoa Meteorology Division, 2018).

CLEWS addresses barriers to utilizing CIS by integrating TK into sector-specific products and has developed relevant, usable climate information tailored to the livelihoods and sectors of the economy that are disproportionately affected by climate change and natural disasters.

3.3.2 Best Practices Beyond CLEWS

In addition to the CLEWS, interview participants and literature revealed CIS best practices occurring in Samoa. These notable programs and practices include:

- CDCRM is a hands-on program that enhances the participation of women and children in disaster response. The program encourages women to lead the evacuation of communities and highlights the importance of women for effective disaster resilience and community preparedness.
- Since 2015, Samoa has utilized Community Integrated Management Plans, which identify prioritized adaptation actions by each of Samoa's 368 villages to enhance climate resilience in the areas of infrastructure, the environment and biological resources, and livelihood and governance (Government of Samoa, 2021; Samoa Ministry of Natural Resources and Environment, 2018). These plans exemplify bottom-up community engagement in adaptation and governance wherein communities and technical experts work together to inform village-level capacity building for climate resilience.
- As addressed in our interviews, Samoa MET uses a variety of communication platforms to disseminate CIS (e.g., social media, SMS, radio, and television), which ensures that this information reaches a broad swath of people across Samoa.
- NGOs such as the Samoa Conservation Society create hands-on environmental programs that are intended to be more relatable to daily life and help expand environmental understanding in Samoa. For example, the Samoa Conservation Society's Green Livelihoods program worked directly with youth in individual villages to raise awareness of environmental threats and discuss options for sustainable livelihoods. One key component of this program was that it was

not focused on teaching but rather on facilitating a dialogue about environmental issues in Samoa (Mayron, 2020).

- In 2019, Samoa MET published a Samoa-language glossary of meteorological terms, the first of its kind in the Pacific. The glossary establishes local words for English meteorological terms and describes each definition. Table 5 contains some examples of translations and descriptions from this glossary.

Table 5. Samoa Meteorology Glossary Examples

English	Samoan	Definition
El Nino	Ele Nino	*O le fetafeaiga o le suasami vevela ole ekueta mai vaega o Ausetalia agai atu I Amerika I Saute. E afua mai pe a vaivai savili mai sasa'e I vaega latalata I le ekueta ae faasolo ina malosi savili mai sisifo. E maitauina ai le faaitiitia o timu I Samoa ma oo atua i I tulaga matutu ma le tuiefu.* The circulation of tropical equatorial waters from parts of Australia to South America. It starts when the winds from the east are weak in areas close to the equator and the winds become stronger.
Meteorological Drought	Tau ole Tuiefu	*faaumiumi ua sili atu ma le 3 masina oi lalo atu ole fua faatatau ole timu* Prolonged more than 3 months of below average rainfall

English	Samoan	Definition
Ocean Acidification	Fa'availaau-o'onaina ole Atu Vasa	*Lamatia ole atu vasa ona ole tele ole kasa kaponi* The oceans are in danger because of the large amount of carbon dioxide
South Pacific Convergence Zone	Sone ole Pasefika i Saute mo Fetaiagia o Savili ma timuga	*Atululuga o fetaiaiga o savili ma timuga ole pasefika i saute* Rise of the South Pacific winds and rains

Note. The selected terms from the Samoa Meteorology Glossary provide definitions in Samoan. For the purpose of this report, they have been translated into English.

4 Case Study: CIS in Vanuatu

4.1 CIS Dissemination Pathways

Vanuatu is a leader in the Pacific region in providing climate-related services. In 2016, the Vanuatu Framework for Climate Services was developed by the Vanuatu Ministry of Climate Change to "ensure climate services for Vanuatu are of world-class standard, sustainable, are reaching all end users, and are effectively helping people manage and adapt to climate variability and change in Vanuatu," (SPREP, 2016b). This framework is consistent with the following CIS-related strategies and plans: Vanuatu National Adaptation Program for Action, Vanuatu Climate Change and Disaster Risk Reduction Policy 2016 to 2030, Vanuatu National Sustainable Development Goals, and the Pacific Islands Meteorology Strategy. Evidently, there are concerted efforts across Vanuatu to better incorporate CIS into national strategies to address climate change.

The Vanuatu Meteorology and Geo-Hazards Division (VMGD) are central to Vanuatu's CIS initiatives. The VMGD provides meteorological and geo-hazards services that are "widely available and accessible, effectively applied, beneficial, and highly valued by all communities," (VMGD, 2023). VMGD produces a variety of climate outlooks and bulletins, including Vanuatu Climate Outlooks (3-month, 6-month, 12-month), Seasonal Tropical Cyclone outlook, Daily Action Rainfall Outlook, ENSO Update, EARWatch, and sector-tailored climate outlooks (i.e., AgroMet Bulletin (agriculture), Vanuatu Ocean Outlook and Fisheries Climate Outlook (fisheries), Tourism Climate Outlook (tourism)). According to a Vanuatu government official, sector-tailored outlooks are very practical to community members because they are easy to understand and applicable to decision-making related to climate adaptation and DRR.

The climate data that informs these outlooks comes from observation stations using upper air observation and surface observation located across seven islands. These outlooks and bulletins are disseminated to end users in multiple ways. Figure 7 depicts three approaches VMGD uses to disseminate climate information to community members.

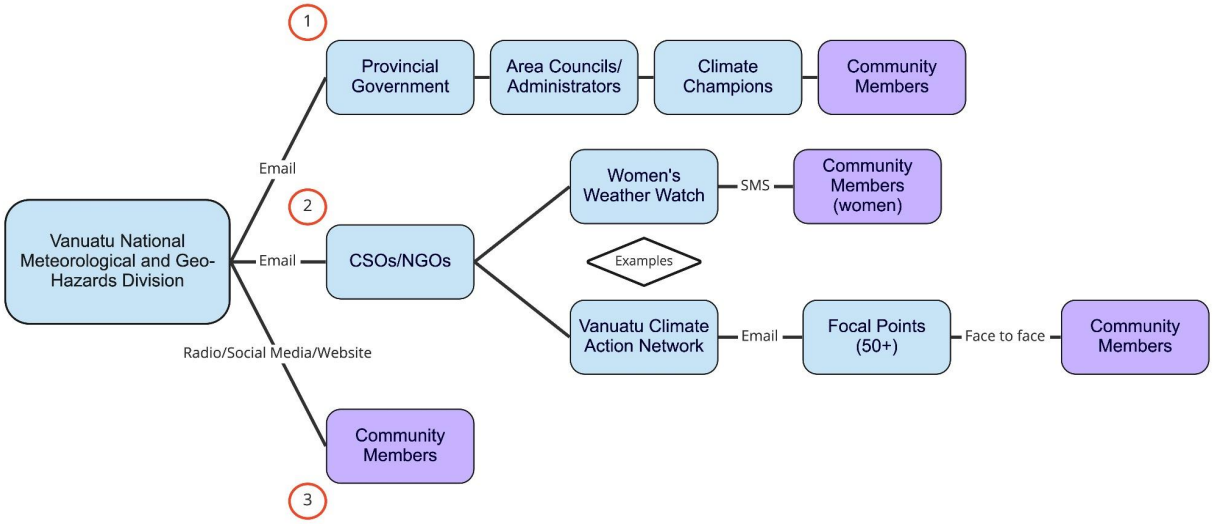

Figure 7. Vanuatu Climate Information Dissemination

Approach 1 details the dissemination pathway created by the Climate Information Services for Resilient Development Planning in Vanuatu (Van-CIS-RDP) or Vanuatu Vanuatu Klaemet Infomesen blong redy, adapt mo protekt Project (henceforth Van-KIRAP). Van-KIRAP is a project funded by the GCF and aims to build the technical capacity in Vanuatu to harness and manage climate data; develop and deliver practical CIS tools and resources; support enhanced coordination and dissemination of tailored information; enhance CIS information and technology infrastructure; and support the application of relevant CIS through real-time development processes (SPREP, 2017a). To improve the accessibility and utilization of climate information in the remote areas of Vanuatu, Van-KIRAP is building twelve Community Climate Centers (CCCs) on remote islands that communicate directly with VMGD. Two CCCs are in operation in two provinces: Torba and Sanma. VMGD disseminates outlooks via email to provincial governments, which are further disseminated to Area Councils (smaller bodies of community leaders). When CCCs receive information, climate focal points within the CCCs then disseminate information to community members. We will discuss this further in the Featured Initiative: Van-KIRAP.

Approach 2 describes the dissemination pathway VMGD uses to disseminate information through NGOs. VMGD has an expansive email listserv that includes local NGOs like Women's Weather Watch (WWW) and Vanuatu Climate Action Network (VCAN). When WWW receives climate information from VMGD, they simplify the information and send it back to VMGD for approval. Once approved, this revised bulletin or outlook is sent to women in remote communities via SMS text messaging. Additionally, VCAN has more than 50 focal points across the country working for various community

organizations. Outlooks or bulletins are sent from VMGD to VCAN, then to focal points, and finally to community members within the focal point's networks.

Approach 3 is the most direct dissemination pathway to community members. VMGD disseminates climate information directly to community members via social media, email, SMS text, and radio, which are the most widely used methods of receiving climate information. When Cyclone Pam hit in 2015, VMGD could not access remote communities via SMS or internet-based communications, so radio was the most effective way to disseminate information to these communities. VMGD also posts climate outlooks and bulletins on social media, particularly Facebook, so those with a reliable internet connection can easily access climate information. The Internet, however, is only accessed by about 25% of the population. Additionally, mobile phone usage has increased considerably over the past couple of decades. In 2021, almost 80% of the population had a mobile phone subscription, which makes SMS text messaging an increasingly compelling method to disseminate climate information. It is important that VMGD has multiple methods to reach people, so if one method fails, there are still ways to share information with communities in Vanuatu directly. Figure 8 illustrates the most frequently used method of dissemination according to our interviews.

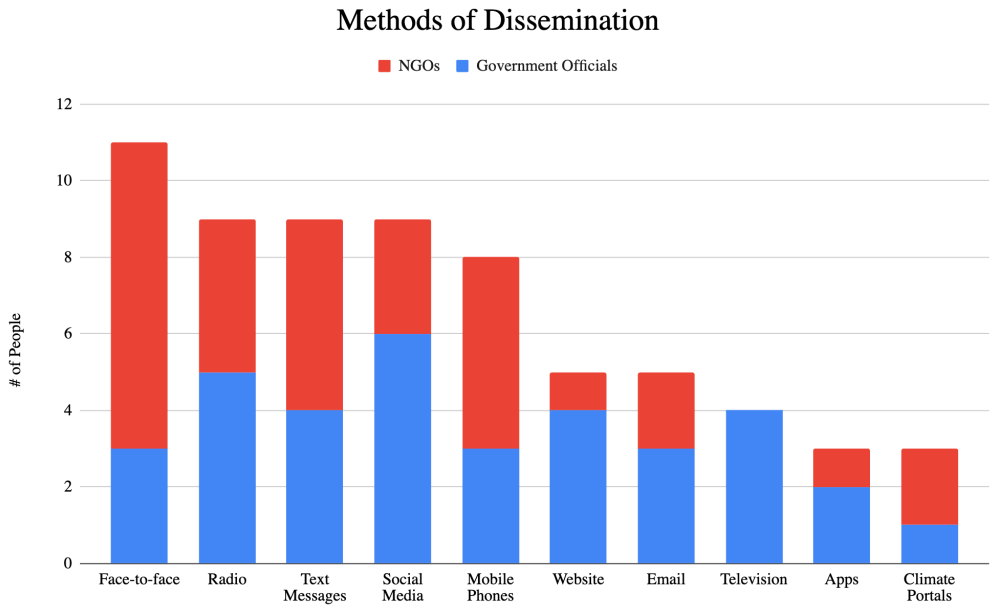

Figure 8. Methods of CIS Dissemination in Vanuatu

Despite these existing climate information projects and dissemination pathways in Vanuatu, the 2021 LAKI workshop suggests there are still critical gaps.

4.2 Barriers to Disseminating, Accessing, and Utilizing CIS

Based on the interviews and literature review, there are many barriers to (1) accessing CIS, (2) disseminating CIS to local communities, especially those in remote areas, to inform them of climate trends and hazards, and (3) making CIS usable by local community members.

Table 6 summarizes the categories of barriers and the number of interviewees that mentioned each barrier in Vanuatu, including government officials and NGOs.

Table 6. CIS Barriers Addressed by Vanuatu Interviewees

	# of Vanuatu Government Officials who mentioned the barrier, at least once	# of Vanuatu NGO Representatives who mentioned the barrier, at least once	# of Total Interviewees who mentioned the barrier, at least once
Number of Interviewees	6	8	**14**
Dissemination			
Lack of Internet/Data Access	5 (83.3%)	7 (87.5%)	**12 (85.7%)**
Lack of Institutional Capacity	6 (100%)	5 (62.5%)	**11 (78.5%)**
Lack of Funding	1 (16.7%)	4 (50%)	**5 (35.7%)**
Limited and Vulnerable Physical Infrastructure	3 (50%)	2 (25%)	**5 (35.7%)**
Lack of Coordination Between Organizations	1 (16.7%)	2 (25%)	**3 (21.4%)**
Delayed Delivery of CIS	1 (16.7%)	2 (25%)	**3 (21.4%)**
Accessibility			
Remoteness	6 (100%)	7 (87.5%)	**13 (92.9%)**
Women's Unequal Access to CIS	1 (16.7%)	5 (62.5%)	**6 (42.9%)**

	# of Vanuatu Government Officials who mentioned the barrier, at least once	# of Vanuatu NGO Representatives who mentioned the barrier, at least once	# of Total Interviewees who mentioned the barrier, at least once
Utilization			
Expertise Divide Between Western Scientific Knowledge and TK	4 (66.7%)	8 (100%)	**12 (85.7%)**
Local Language Translation	6 (100%)	3 (37.5%)	**9 (64.3%)**
Limited Feedback Mechanisms	4 (66.7%)	5 (62.5%)	**9 (64.3%)**
Limited Perceived Value of CIS	3 (50%)	5 (62.5%)	**8 (57.1%)**
Lack of Trust	2 (33.3%)	2 (25%)	**4 (28.6%)**
Gender Inequality in Decision-making	0 (0%)	4 (50%)	**4 (28.6%)**
Lack of Awareness	0 (0%)	2 (25%)	**2 (14.3%)**

Note. This table summarizes the number of people that mentioned each barrier by Government Officials, NGOs, and Total. The percentage of people that mentioned each barrier in each group is in parentheses. We were unable to interview community members during our process, and therefore do not have interview data from community members. In this case, NGOs serve as intermediaries for disseminating CIS to community members.

4.2.1 Barriers to Disseminating CIS

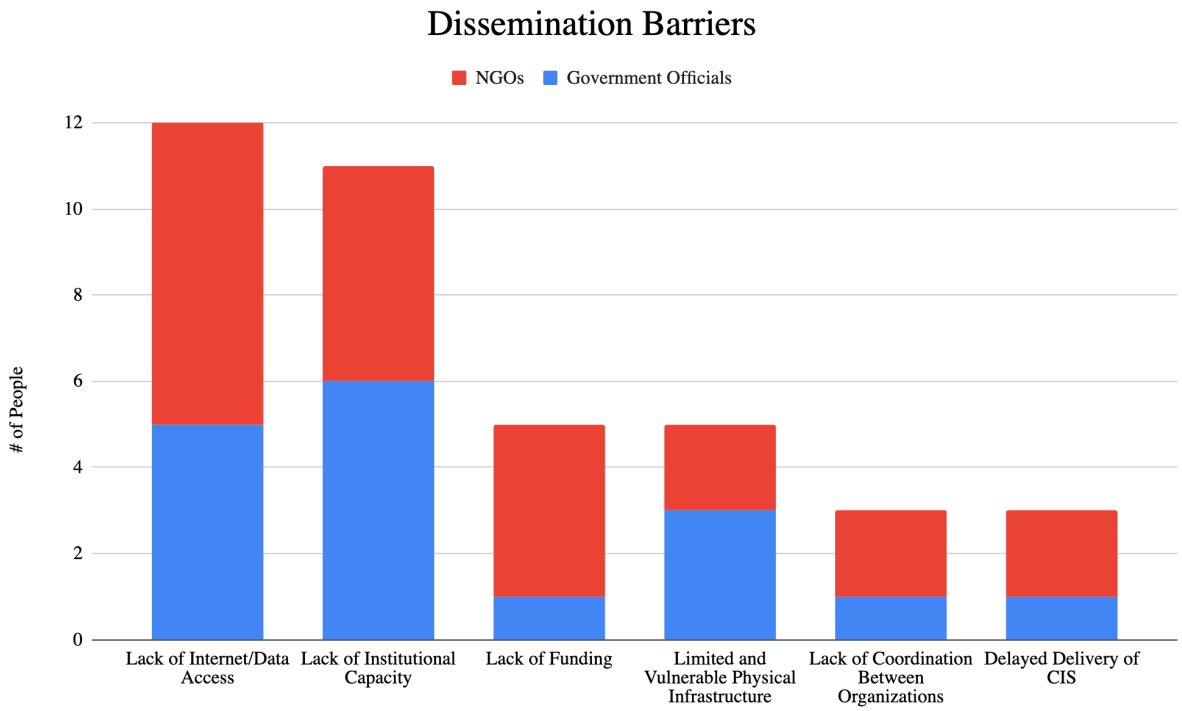

Figure 9. Number of People Mentioning Dissemination Barriers in Vanuatu

We found that a lack of internet/data access, lack of institutional capacity, lack of funding, limited and vulnerable physical infrastructure, lack of coordination between organizations, and delayed delivery of CIS are the major dissemination barriers in Vanuatu. Both NGO representatives and government officials mentioned these barriers.

The most mentioned dissemination barrier was a **lack of internet/data access** by 12 interviewees. It is a major barrier primarily due to the remoteness of Vanuatu. On many smaller islands, internet access and connectivity are limited, which makes it difficult to disseminate CIS to communities on these islands over the internet, social media, email, and text, especially in the event of disasters that may need timely dissemination (e.g., cyclones and tsunamis).

> *"We have 83 islands and the network is separated to reach those 83 islands. They are remote areas with not enough [internet] towers for mobile telecommunication companies... It's always a challenge to get our service to the people in the very remote places."* - Government Official

Our data also pointed to **a lack of institutional capacity** within VMGD. 11 interviewees mentioned this dissemination barrier. Due to a lack of personnel, technical expertise, internal training, and data collection instruments and technologies, the VMGD has limited capacity to reach remote communities. Many VMGD employees are overextended, and different skills and knowledge are needed to improve climate information production and dissemination.

Furthermore, the CCCs currently in development by the Van-KIRAP project require personnel trained to disseminate information to remote community members. According to our interviews, the success of this dissemination depends on what knowledge personnel hold and whether they are willing to learn new knowledge. The same can be said for VMGD, who are responsible for CIS production and dissemination and require ongoing learning and training to improve climate information dissemination.

Interviewees also mentioned the lack of software engineers, app developers, web developers, and other technical experts within the VMGD. These technical experts are needed to develop quicker ways to disseminate climate information through apps, websites, and other forms of media. More accurate and better quality in-country data collection instruments and technologies could also help the VMGD improve the production and dissemination of climate information, especially for specific sectors and communities across Vanuatu's landscapes and seascapes.

> *"In terms of resources, we ... need to look at how we strengthen our technical expertise, human capacity, human resource capacity and ... the [technology] that we're using to disseminate that information. How we will translate those into planning [are] some of the areas that we need to improve, as well as data collection, how we would collect good information or data so that we can use [that] data to produce good information. We need to increase our capacity in those areas."* - Government Official

> *"If we can get the [Community] Climate Center model to be successful, I think that's going to be really challenging, because I think that's, unfortunately, going to be very dependent on the particular individual who is in that role. I think that ... people in different places have different skills and interests. I think it's going to be really hard to find people who have the requisite knowledge themselves, and also the willingness to learn new knowledge."* - NGO Representative

Five interviewees also mentioned a **lack of funding**. The VMGD's budget is low, and most of it goes into paying staff overtime. Instead, VMGD relies on CIS-related projects funded under GCF, SPREP, and other organizations, which becomes an issue when this funding is no longer available.

> *"What has happened is that ... VMGD relies heavily [on project funding], and the annual allocations from the government are also very low. A number of years now VMGD has been over the operational budget, because a lot of the budget goes into paying overtime for the staff command 24/7 operations, which has not allowed them to have sufficient budget to interact with the different audiences, with the sectors, [and] with the communities. They have to rely on project financing, project funding, and funding from SPREP to go out and do these things."* - NGO Representative

Limited infrastructure on remote islands and climate-vulnerable infrastructure is another challenge for dissemination of climate information, as mentioned by five interviewees. More frequent extreme weather events, like Cyclone Pam in 2015, will continue to damage climate-vulnerable physical infrastructure, including television and radio broadcasting towers and cellular towers (Le Dé et al., 2018), making it more difficult to reach community members on remote islands through these communication channels. Interviewees mentioned a need for physical infrastructure on remote islands to disseminate information face-to-face, which tends to be the most successful method of dissemination in remote communities as opposed to internet-based dissemination. Face-to-face dissemination involves having personnel on each island talk to community members about climate change, weather forecasts, and disaster impacts. Physical infrastructure, such as Van-KIRAP's CCCs, makes face-to-face dissemination easier and allows climate information to flow to remote communities through all forms of communication. However, physical infrastructure facilitating face-to-face dissemination is not currently present on all inhabited islands.

> *"In terms of infrastructure, [we are] lacking infrastructure setup and development, especially around radio. Communication is also lacking on some of the outer islands, the most remote communities do not have cell towers or telephone coverage."* - NGO Representative

A **lack of coordination between organizations** was mentioned by three interviewees. NGOs and other local organizations are essential intermediaries for disseminating CIS to end users that the government cannot reach. However, interviewees identified a lack of coordination between the government and outside organizations in disseminating CIS. A lack of coordination can lead to redundant projects and tools and missed opportunities for complementary work to disseminate CIS better. NGOs and other focal points tend to work closely and directly with community members in remote and rural areas. For example, WWW is vital for disseminating climate information to women in remote communities. Without coordination between organizations and government agencies, dissemination of climate information to remote communities becomes even more difficult.

> *"We need to engage [with] more NGOs [at] our institution, because ... to do [out]reach we need NGOs. We need more stakeholders and NGOs involved to get this information out to [community members]."* - Government Official

Lastly, **delayed delivery of CIS** was mentioned by three interviewees. Climate disasters can materialize quickly and changes in the direction or severity of cyclones can happen overnight. Remote islands with limited internet access may prevent prompt climate information dissemination to avoid disaster risk.

> *"I think [for] the first early warning system, there are a few locations where there would be [critical opinions], but ... it depends on where you are located and how fast you get the information."* - Government Official

4.2.2 Barriers to Accessing CIS

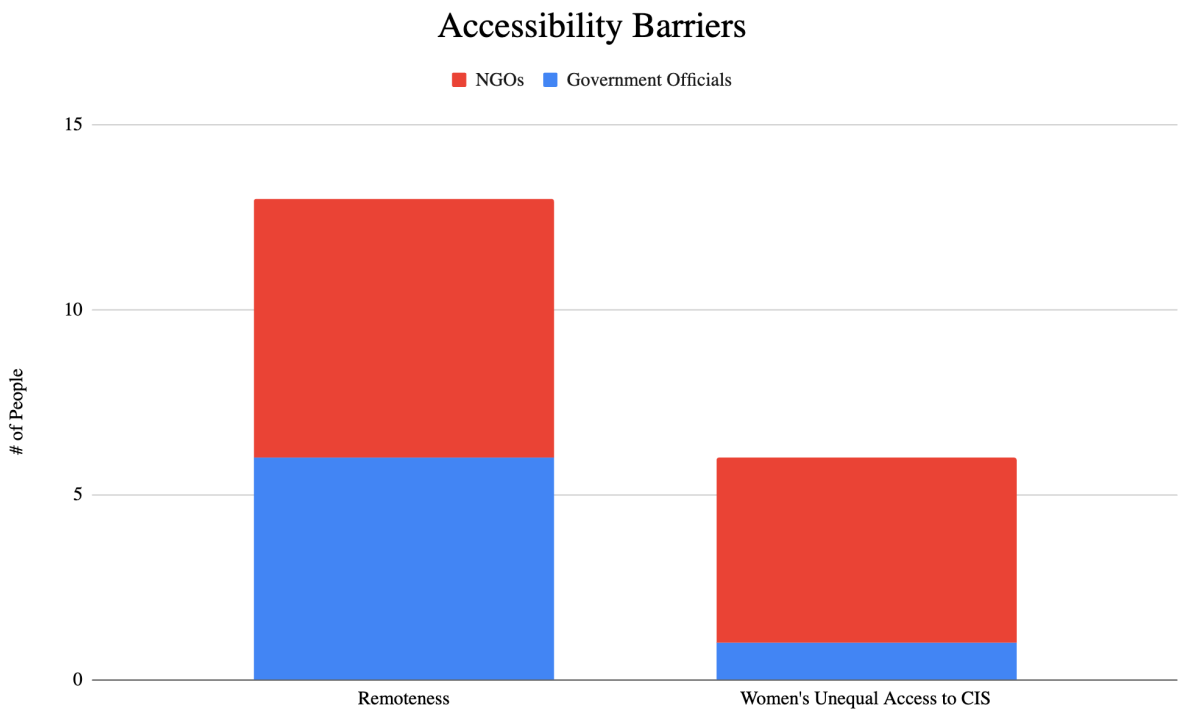

Figure 10. Number of People Mentioning Accessibility Barriers in Vanuatu

We found that remoteness and women's unequal access to CIS are the main accessibility barriers in Vanuatu. Both NGO representatives and government officials mentioned remoteness as a barrier, while primarily NGO representatives mentioned women's unequal access to CIS.

Our interview data pointed to the **remoteness** of Vanuatu as a major barrier to accessing CIS. Because three-quarters of Vanuatu's population lives in remote areas, there are several challenges to reaching the majority of the population (World Bank, 2023). Mcleod et al. (2018) found that a lack of internet access, logistical issues, high costs of transportation, and on-the-ground implementation of programs across islands are specific and pressing challenges for remote communities accessing climate information. The VMGD and other organizations in Vanuatu confirmed these findings, with remoteness mentioned by 13 interviewees.

Many interviewees mentioned that face-to-face communication is the preferred form of CIS communication. However, due to remoteness, face-to-face communication about quickly developing and changing climate hazards and disasters may not be possible. In these situations, internet access and the use of mobile phones have become the most helpful.

> *"Climate information in Vanuatu is quite rare in terms of information sharing down to community levels because most of the islands are scattered and fairly remote. So it's hard to capture all communities. Especially with the network coverage we're using."* - Government Official

Our data also pointed to **women's unequal access to CIS**, mentioned by six interviewees. Gender roles throughout Vanuatu lead to several accessibility issues for women. Due to the prevalence of a traditionally patriarchal society, women have limited access to resources, including mobile phones or radios. Typically, only male family members own mobile phones or radios, restricting women's access to climate information.

> *"There's not a lot of women who own radio. And radio can only be owned by their husband, the grandfather, or the chief, and the community leader might have the radio. But the women hardly have a radio because ... they were not taught [at] an early stage that you could also enjoy life [like] the men who have enjoyed life."* - NGO Representative

Furthermore, CIS design, production, and dissemination tend to be dominated by men. Therefore, CIS are more tailored to men's needs and priorities, which likely influences how and if women receive CIS. Because women are typically excluded from full participation in political and economic life, they are largely absent from leadership roles. This hinders if, how, and when women receive climate information (UNDRR, 2022b). This is especially true on remote islands, where traditional gender norms are followed closely, and only men attend workshops and receive CIS. Granderson (2017) found

that the patriarchal and hierarchical nature of chiefly systems in Vanuatu, specifically villages in Tongoa, serve to exclude women from conversations on climate change and positions of power, which limits women's access to information.

> *"So women have more knowledge because in [terms of] traditional knowledge ..., [women] do the farming, they are out in the environment. So they're more exposed to impacts than men who will just stay home."* - NGO Representative

Furthermore, **women with disabilities** face compounding disadvantages (Gartrell et al., 2020; UNDRR, 2022a). Gartrell et al. (2020) examine the exclusion of women with disabilities in DRR processes and planning, despite international commitments–specifically the Sendai Framework–to increase disability-inclusive disaster risk reduction. This study found that women with disabilities are the least able to access disaster preparedness, response, and recovery support. Further, the likelihood of gender-based violence increases for women living with disabilities following disasters (Gartrell et al., 2020). The compounding challenges faced by women with disabilities pose challenges to accessing CIS.

> *"Being a woman is already a challenge in our community - being a woman and being disabled is a bigger challenge - women are being looked down [on], belittled."* - NGO Representative

4.2.3 Barriers to Utilizing CIS

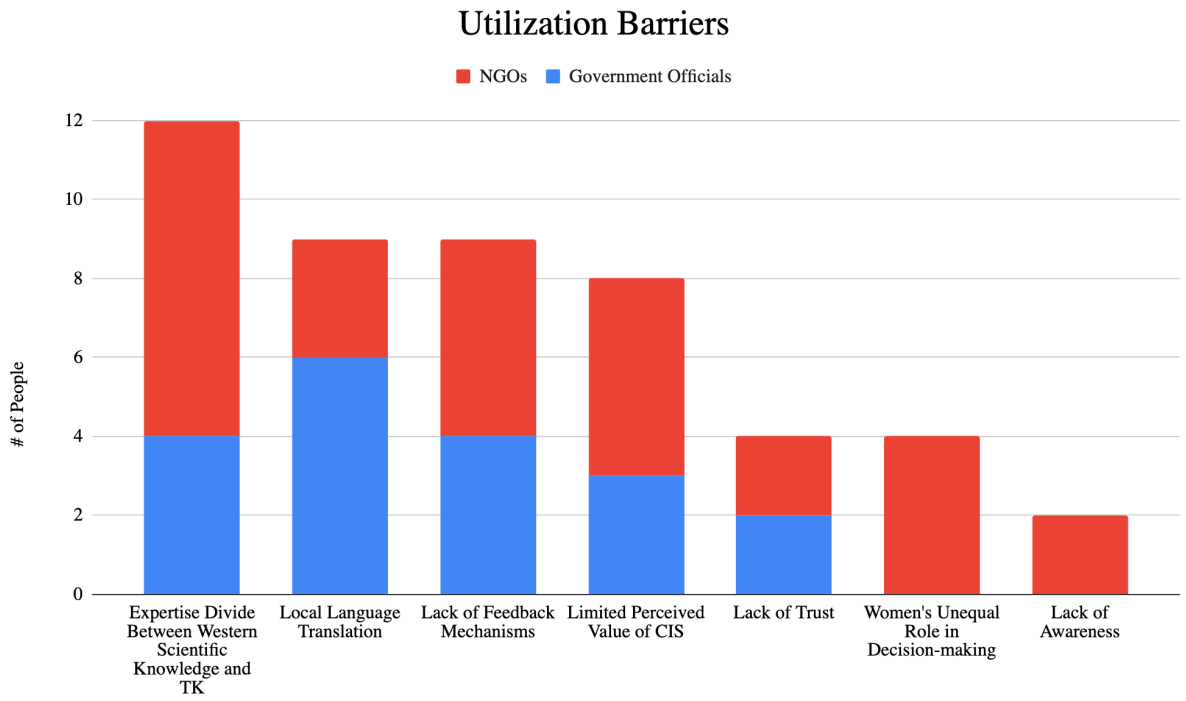

Figure 11. Number of People Mentioning Utilization Barriers in Vanuatu

Barriers to utilizing CIS include an expertise divide between Western scientific knowledge and TK, local language translation, limited feedback mechanisms, the limited perceived value of CIS, a lack of trust, women's unequal role in decision-making, and a lack of awareness.

The most mentioned utilization barrier was the **expertise divide between Western scientific knowledge and TK**, mentioned by 12 interviewees. A significant portion of the information used in CIS are very technical and scientific, which may be difficult for community members to understand and use. The VMGD are experts in meteorological and climate science, while community members tend to be experts in TK. This gap in expertise between the VMGD and community members limits the usability of climate information products. For example, outlooks and bulletins conveying information exclusively using Western science terminology–using concepts like "Gale Force" and language like "longitude" and "latitude"–to describe meteorological and climate information may not be clear to community members without scientific backgrounds. Conveying information like "wind that is strong enough to knock down X tree," could replace statements like "wind will be at X mph," which may have little meaning to community members.

> *"[Community members] had no clue what [VMGD were] saying about longitude, latitude, Gale Force, wind, those are not their language, those are pretty much English languages. … We already have seen that there is a big gap … they had no clue what information they have been receiving, "oh, just the Met [service] giving something", they had no idea what the content was or that the content they were given is very important … because they do not understand the language"* - NGO Representative

Furthermore, TK is largely absent from the decisions about what type of data should be collected, included, and used to inform CIS. Both literature and interviewees note that many remote community members in Vanuatu primarily use TK to inform weather and climate adaptation-related decisions (Chambers et al., 2019; Rarai, 2018; Walshe & Nunn, 2012). Chambers et al. (2019) find that communities using TK for climate forecasting experience reduced social-economic disruption and lower death rates than expected during climate disasters. Both government officials and NGOs recognized the importance of TK in Vanuatu and believed it should supplement Western scientific knowledge and data. Yet, historically, VMGD has not integrated this knowledge into CIS production.

> *"Before [VMGD], there [was] already a traditional method of identifying cyclones and any natural disaster in our communities. They've identified the traditional methods for early warning systems, by looking at plants and animals. For example, if they [are in their household], if you see plenty of ants, that means the rain will come any minute."* - Government Official

> *"How can we use the indigenous knowledge of looking at the changes [over] time … So especially now, during this global climate change, we're looking at the whole season of change culturally … Indigenous people are looking at changes over [time]. This is one of the things that we see as powerful … you build on what they [know] … and put in information [where there] is a gap."* - NGO Representative

Local language translation was mentioned by nine interviewees. There are three official languages of Vanuatu (Bislama, English, and French), but over 100 local dialects across Vanuatu's remote islands (United Nations, 2023). A majority of CIS are initially disseminated or produced in English or French and need to be translated to Bislama and other local dialects by NGOs, climate champions, or focal points. After products are translated into these languages, some scientific precision in CIS may be lost when the information is translated into a language that does not have the same words, making it difficult for community members to use and act in response to climate information.

> *"Our products are mainly [in] English. But when we communicate to the communities we will communicate in Bislama to them. But we only have one product which is in Bislama. We still have to translate our products into Bislama. Can we make sure that the scientific meaning is still there?"* - Government Official

A **lack of effective feedback mechanisms** were mentioned by nine interviewees. VMGD receives some feedback in the form of surveys from targeted sectors (i.e., farmers and fisherfolk) about the most relevant type of climate information that should be provided in CIS products (i.e., rainfall and weather projections). VMGD also uses MailChimp to send climate information products over email, which allows them to trace how many people click on and open emails. However, this kind of tracking does not allow VMGD to know if the information is being disseminated further to communities.

> *"We're not really ... going back and then ... doing a survey to really identify whether people are using ... [the] information that we're providing or they're not using it, [if] they're applying it to practical, so I don't think so, you know, that's a challenge for us."* - Government Official

Eight interviewees mentioned the **limited perceived value of CIS**. With the community members they can reach, the VMGD and NGOs find that many community members are more concerned with how climate change and disasters impact them rather than the science of climate information. Many community members may not understand the importance of using climate information or know what they can do to act in the face of a disaster. LAKI also identifies a lack of actionable CIS knowledge, tools, and methods to transfer knowledge into action (Lima Adaptation Knowledge Initiative, 2021). For example, farmers may access climate information, but may not find it useful if they do not have the tools or knowledge to respond meaningfully.

> *"But [climate information] isn't being translated into actionable insights. And it isn't connected to people's daily lives."* - NGO Representative

> *"And what I have found is that the information that we are providing to the communities is not well integrated and highly regarded as useful information by the communities. I think the challenge lies in making the communities understand the importance of using that information."* - NGO Representative

> *"So I think the other part is people like us who are ... climate information providers and scientists, we should be able to communicate the risk information better. We're not really doing that well. And instead of using or providing climate information in probabilistic forecasts or ballistic ways, it's very difficult for communities to use that information ... We want to communicate information in a way that people will link directly to an impact and will be more effective."* - NGO Representative

Four interviewees mentioned that some community members **lack trust** in CIS and the VMGD. Both NGO representatives and government officials noted that this lack of trust may come from community members' reliance on TK rather than Western scientific knowledge (Chambers et al., 2019). Thus, community members may not take necessary action in response to climate disasters and sudden weather changes.

> *"There is a perception by a number of people in Vanuatu, that [VMGD] is inferior ... to perhaps some of the commercial apps, that they're not reliable. And that some of the information they give out is not timely or relevant."* - NGO Representative

> *"We need to gain more interest and gain trust from the public that we [VMGD] are the only institution providing weather information and you can trust us to provide this information ... also we need to step up our game ... to provide timely forecast warning."* - Government Official

Women's unequal role in decision-making is another utilization barrier, mentioned by four NGO representative interviewees. Several interviewees also discussed how women are left out of conversations and decision-making related to CIS. Women's absence from leadership roles related to CIS production and dissemination can make climate information less relevant and actionable for women (Mcleod et al., 2018; UNDRR, 2022a). Granderson (2017) found that some chiefly village systems also exclude women from decision-making processes, which limits women's ability to give input on how to make CIS more relevant and actionable.

> *"If you are left behind, no one can help you. You're on your own and already within the [social] structure, as women, we don't have places and voices to talk in the spaces where the community leaders are discussing and making a decision. We are not at a council of chiefs, it's taboo for women to be there."* - NGO Representative

> *"In terms of culture, there are certain islands in Vanuatu [that] have really strong cultural expectations. In Tanna, we have learned that only men are part of decision-making ... in some of the communities. So, when we are running community workshops, normally the men are the only participants we communicate with and we have noted that the women are restricted. They don't have an opportunity to participate."* - NGO Representative

Lastly, a **lack of awareness** of CIS was mentioned by two interviewees. Some community members are unaware of the existence or availability of climate information, even if it is available and free to them. Furthermore, there is less awareness of medium- and long-term climate forecasts in CIS compared to short-term forecasts and warnings from the VMGD. Therefore, less action is taken regarding medium- and long-term climate forecasts, which is very important as the impacts of climate change worsen.

> *"[There is] not enough awareness on the availability of [climate] information that is readily available and free."* - NGO Representative

4.3 Best Practices

There are notable regional projects and collaborative efforts that address the barriers outlined in the Case Study above. This report highlights two examples (Van-KIRAP and WWW) that aim to alleviate barriers, specifically for women and remote communities. Elements of each project offer best practices for disseminating, accessing, and utilizing CIS in Vanuatu.

4.3.1 Featured Initiative: Van-KIRAP

The Van-KIRAP project is a 4.5-year project by the Green Climate Fund (GCF) and implemented through SPREP. Partners, including the BOM and CSIRO in Australia and the APEC Climate Center (APCC) in South Korea, provide specialized technical inputs to the project (SPREP, 2017b). Beginning in 2018, the overarching objective of the project has been to increase the ability of decision-makers, development partners, communities, and individuals across five target sectors (agriculture, fisheries, infrastructure, tourism, and water) to plan for and respond to the long- and short-term impacts of climate variability and change. According to a VMGD staff member, the two main deliverables of the project are i) establishing a communication strategy whereby climate information reaches the last mile and demonstrates the value of climate information to community members and ii) developing CIS products, such as the Van-KIRAP data portal, to respond to the short- and long-term impacts of climate change. The 20 million USD project was intended to finish in 2022. However, after a funding extension request, the project remains funded through December 2023.

Van-KIRAP Objectives

- Build the technical capacity in Vanuatu to harness and manage climate data
- Develop and deliver practical CIS tools and resources
- Support enhanced coordination and dissemination of tailored information to five important economic sectors (agriculture, fisheries, tourism, water, and infrastructure)
- Enhance CIS information and technology infrastructure
- Support the application of relevant CIS through real-time development processes, for more resilient outcomes

(SPREP, 2017; 2022)

There are ten intended outputs of the Van-KIRAP project. This report will highlight three outputs pertaining to the most common discussion points and responses from the interview data. Specifically, we will elaborate on Output 1.1: Strengthening CIS through data and interfaces, Output 2.2: CIS are incorporated into community practices, and Output 3.1: TK is incorporated into CIS in Vanuatu. Significant work is being done through the other seven outputs, but this Featured Initiative will highlight only three.

Output 1.1 mandates that Van-KIRAP strengthens CIS through data, interfaces, and a variety of activities. For example, the Vanuatu Climate Futures portal (also known as the Van-KIRAP portal) intends to provide access to information on current (seasonal) and future (multi-decadal) climate forecasts relevant to planning and decision-making for the five priority sectors noted above. With assistance from CSIRO, the portal aims at addressing the CIS needs of the five key sectors. The portal is currently in its beta version, but when it is fully operational, it can be a tool that facilitates more systematic coordination between government agencies and development partners.

One of the most compelling aspects of Van-KIRAP is how it operationalizes Output 2.2 (Incorporation of CIS into community practices). Van-KIRAP intends to establish 12 CCCs (two in each of Vanuatu's six provinces - one at the provincial level and one at the Area Council level). The CCCs will be located in existing provincial and community buildings and aim to improve the accessibility of climate information to remote and rural communities. At each climate center, a climate focal point will be the point of contact between the VMGD and local community members. The climate focal points are trusted leaders of existing community councils or networks (i.e., voluntary rainfall network, community disaster, climate change committee, and Red Cross Volunteer). An interviewee from SPREP also noted that the focal points provide training and information sessions to surrounding communities about how CIS work and how climate information can be utilized in their daily lives. The CCCs make climate information more accessible, while the climate focal points can facilitate increased utilization of climate information to reduce disaster risk.

According to a staff member of VMGD, they meet virtually every month with the focal points to disseminate climate information and provide other administrative assistance. Establishing CCCs and climate focal points is a meaningful and substantial investment toward making CIS more accessible to remote communities. It provides a more streamlined dissemination pathway to ensure climate information reaches remote communities. However, it remains to be seen if all twelve climate centers will be fully operational by December 2023. Moving forward, it will be important to evaluate the impact of the CCCs on the accessibility and utilization of climate information in community practices.

Output 3.1 (Incorporation of TK into CIS in Vanuatu) addresses the barriers related to TK integration into CIS. In November 2020, Van-KIRAP published its Traditional Knowledge Strategy and Implementation Plan, which provides a guiding framework to "enhance the capacity of VMGD to coordinate and ensure that all TK related to weather, climate, and disaster risk response activities are delivered effectively in partnership with government agencies, NGOs, regional technical agencies,

donor partners, and research institutions," (Seuseu et al., 2022). The Strategy builds on the best practices, processes, and lessons learned from COSPPac, but it also involves i) expanding the TK collection of the five priority sectors; ii) facilitating a robust and systematic monitoring, verification, and forecasting system; and iii) tailor climate information to be more relevant and user-friendly for the five priority sectors. The Strategy outlines how TK data collection can occur at the CCCs. The climate focal points can work with community members in surrounding areas to support data collection, communication, and awareness of TK related to each of the five priority sectors.

The TK plan acknowledges that neither traditional nor Western strategies alone are likely to address DRR in Vanuatu successfully. Embracing the strengths and weaknesses of these different knowledge systems can reduce the vulnerabilities to climate hazards by producing products based on end user-driven collaboration (VMGD et al., 2020). In October 2022, a workshop hosted by SPREP and the Australia BOM trained VMGD staff on how to incorporate TK into the Van-KIRAP products. The workshop provided a variety of training sessions about how to incorporate TK into the Vanuatu Climate Watch App. The app is part of a suite of data and interfaces (referenced in Output 1.1) that will make climate information more accessible to TK users with internet access.

Van-KIRAP has already addressed many of the barriers outlined by our interviewees related to the accessibility and utilization of climate information, along with the dissemination of climate information. This project has been tailored specifically to Vanuatu's unique characteristics – its vast geographic area and large remote population. Additionally, the framework and outputs of the project provide a model that can be scaled to other countries in the Pacific region.

Table 7 highlights the Van-KIRAP outputs and indicators most relevant to the barriers outlined in our interview data. The Appendix includes the full list of Van-KIRAP outputs and indicators.

Table 7. Van-KIRAP Outputs and Indicators

Output	Indicator	Related Barrier
Output 1.1. Strengthening Climate Information Services through data and interfaces	User interfaces have been strengthened to support CIS decision-making	- Lack of Institutional Capacity - Lack of Coordination Between Organizations

Output	Indicator	Related Barrier
Output 2.2. CIS are incorporated into community practices	Communities are engaged and utilizing CIS at 12 sites	- Remoteness - Lack of Coordination Between Organizations - Limited and Vulnerable Physical Infrastructure - Limited Perceived Value of CIS
Output 3.1. TK is incorporated into Climate Information Services in Vanuatu	CIS tools and products incorporate TK and climate science and uptake by communities	Expertise Divide Between Western Scientific Knowledge and TK

Note. See appendix for the full list of Van-KIRAP outputs and indicators

4.3.2 Featured Initiative: Women's Weather Watch

Women's Weather Watch or Women Wetem Weta (WWW) is an information and communication system that was adopted in Vanuatu based on the Fiji Women's Weather Watch after Tropical Cyclone Harold in 2020 (World Meteorological Organization, 2017a; Bhandari, 2020). Recognized as a gender-based best practice by the WMO, the system was developed with and for rural women to help them better access meteorological and climate information—making them better prepared for disasters (ActionAid Australia, 2023). WWW shares reports via SMS messaging to ensure local and national disaster response is inclusive and accountable for all rural women.

WWW is a platform born out of collaborative efforts by ActionAid Australia, Shifting the Power Coalition Network (StPC) members in Port Vila, Women I Tok Tok Tugeta (WITTT) network (Women Talking Together Network), and Vanuatu National Disaster Management Organization (NDMO) (ActionAid Australia, 2023). Each collaborator plays a unique role in the Pacific Islands regarding gender-responsive climate adaptation and DRR efforts. For instance, ActionAid Australia is an Australian Government gender action platform that supports women in Vanuatu through the WITTT, a locally-led women's platform to support disaster preparation (Spotlight Initiative, 2022). The WITTT responds to issues that limit women's leadership on climate change adaptation, DRR, and resilience through the WWW platform. Other programs, such as the WITTT Sunshine, focus on the unique needs and concerns of women with disabilities. WITTT supports its collective efforts to ensure an inclusive humanitarian response that protects their rights and responds to their needs (Women I TokTok Tugeta & ActionAid Vanuatu, 2020).

WWW provides early warnings, public health messages, and actionable information through SMS and mobile radio and reaches over 25% of women across Vanuatu (Women I TokTok Tugeta & ActionAid Vanuatu, 2020). The model provides WWW members the opportunity and tools to study weather patterns, receive updates from the VMGD and NDMO, simplify and translate the messages into their local language, and disseminate information within their respective communities and outer islands. Members can also use this data to collaborate with the national emergency response system and create DRR plans and climate adaptation strategies at the community level.

The WWW hub in the country's capital, Port Vila, is a message bank where information received from the VMGD and the local women leaders is stored and shared. One of the most salient features of the platform is the robust feedback system through which women can exchange texts with WWW staff to provide live updates about conditions on the ground. Women in the community also have the opportunity to request assistance in emergencies allowing for more timely, targeted, and relevant assistance.

> *"It is a two-way communication process that enables women to become leaders in disaster planning and adaptation. For example, women leaders will message the hub that a cyclone is approaching, and [that they] don't have a water supply. We relay this information to the Department of Water so they can help the community. Similarly, women will message about crops being damaged by a pest. We convey this information to the Department of Agriculture, who in turn informs us of what the community needs to do or if they will send officials on the ground to ensure food security."* - NGO Representative

Women in the WWW network convene in sister circles, groups of up to 20 women in each village. There are 60 leaders in the WWW network, each overseeing up to eight sister circles (Hannagan, 2023). The network communicates weather alerts in local languages that are better contextualized for their understanding. The messages are targeted and specific, depending on the women's location. For example, communities living close to the Volcano will receive different messaging than those in coastal areas. Figure 12 displays the dissemination pathway from VMGD to the women in communities.

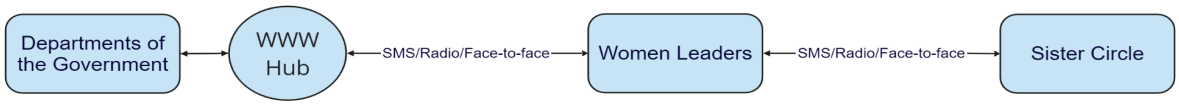

Figure 12. WWW Climate Information Dissemination Pathway

WWW is recognized as a climate information dissemination and feedback model for countries across the Pacific. It has increased the visibility of women's leadership in disaster preparedness and response processes and has helped shift attitudes toward recognizing the crucial role of women in society. WWW is a prime example of how technology empowers women in the face of climate change and improves communities' resilience to climate change and natural disasters.

5 Comparing CIS Barriers in Samoa and Vanuatu

Through our interviews and literature review, several similarities and differences emerged regarding the barriers to disseminating, accessing, and utilizing climate information in Samoa and Vanuatu.

First, regarding barriers to the dissemination of climate information, we found that both countries encounter a lack of funding, a lack of institutional capacity, a lack of physical infrastructure, delayed delivery of climate information, and a lack of coordination between organizations. Additionally, Vanuatu faces barriers related to a lack of internet access, which was not addressed by interviewees in Samoa. Thus, the emphasis on barriers related to dissemination in Vanuatu is likely a result of a large number of remote communities across the islands.

Based on our interviews, we found that while Samoa did not have barriers related to the accessibility of CIS, this was a major emphasis in Vanuatu. The main accessibility barrier in Vanuatu is remoteness, which stems from the difficulty VMGD faces in reaching those living in remote areas. Gender inequality was also a major barrier to accessing CIS in Vanuatu. However, we found that this barrier did not exist in Samoa.

Lastly, barriers to utilizing CIS were incredibly salient in both Samoa and Vanuatu. Community members navigate issues related to the use of technical language, the expertise divide between Western scientific knowledge and TK, gender inequality in decision-making, lack of trust, lack of awareness, and challenges related to local language translation. Samoa's main gender-related barrier is related to the utilization, while women in Vanuatu navigate barriers related to accessibility and utilization. Gender inequalities in Vanuatu limit women's access to climate information, and women in both Samoa and Vanuatu face barriers to act on climate information. Additionally, interview respondents from Vanuatu identified barriers related to feedback mechanisms and the limited perceived value of CIS.

In both Samoa and Vanuatu, several initiatives are currently working to address the barriers our interviewees and literature review identified. First, by tailoring climate information to specific sectors of the economy, CLEWS and Van-KIRAP are working to develop relevant and usable CIS for various livelihoods. These interventions also address barriers related to the utilization of CIS by integrating TK and climate forecasts. Additionally, Van-KIRAP and WWW provide solutions to accessibility barriers, enhancing the provision of CIS to women and remote communities, as well as dissemination barriers.

In our case studies above, we identified many barriers to disseminating, accessing, and utilizing climate information in Samoa and Vanuatu. These barriers are encountered by the NMHSs and governments that produce CIS, NGOs that serve as intermediaries, and community members that rely on CIS to respond to natural disasters and climate impacts effectively. A detailed summary of the barriers identified in this study is presented below in Table 8.

Table 8. CIS Barriers Identified in Interviews

Barrier Category	Barriers	Description	Example
Dissemination	Lack of Funding *Samoa: 10 people* *Vanuatu: 5 people*	There is insufficient and inconsistent funding year-round for governments and NGOs to carry out CIS-related programming.	*"...the donors only [give] a certain fund at a certain time. And then after that deliverance... you're unsure whether there will be additional support for later on, or whether the local NGO or an organization that they've invested in will continue the work"* - NGO Representative (Samoa)
	Limited and Vulnerable Physical Infrastructure *Samoa: 4 people* *Vanuatu: 5 people*	There are limited roads, internet towers, and physical dissemination spaces. Existing infrastructure is often vulnerable to climate hazards.	*"I would put money towards infrastructure and improving and building an actual evacuation space ... making sure that people are safe. ... Also includ[ing] an infrastructure, kind of like an independent early warning system, where it ... just shoots straight out into the village, where villages receive firsthand [information], ... that way, the information just travels a lot quicker and more efficiently."* - Community Member (Samoa)
	Lack of Institutional Capacity *Samoa: 6 people* *Vanuatu: 11 people*	The government, NGOs, and other organizations are missing capacity within their institution to effectively disseminate CIS, including personnel, technical expertise, internal training, and data collection instruments and technologies.	*"You might know that Samoa is not a developed country, we rely on our international development partners"* - Government Official (Samoa)

Barrier Category	Barriers	Description	Example
Dissemination (cont.)	Lack of Internet and Data Access *Samoa: 0 people* *Vanuatu: 12 people*	Many communities do not have equitable or reliable access to the internet, especially in remote areas.	"*We have 83 islands and the network is separated to reach those 83 islands. They are remote areas with not enough [internet] towers for mobile telecommunication companies... It's always a challenge to get our service to the people in the very remote places.*" - Government Official (Vanuatu)
	Lack of Coordination between Organizations *Samoa: 2 people* *Vanuatu: 3 people*	Governments, NGOs, and international organizations executing projects related to CIS do not communicate about or coordinate their operations frequently or efficiently enough.	*"We need to engage [with] more NGO [at] our institution, because ... to do [out]reach we need NGOs. We need more stakeholders and NGOs involved to get this information out to [community members]."* - Government Official (Vanuatu)
	Delayed Delivery of CIS *Samoa: 4 people* *Vanuatu: 3 people*	Community members often do not receive climate information, especially EWS, in a timely fashion. This inhibits their ability to take action.	*"I think all [warnings] came a bit late, like, you know, the siren, the text messages, and everything just came late when the wave [had] already hit the villages."* - NGO Representative (Samoa)

Barrier Category	Barriers	Description	Example
Accessibility	Remoteness *Samoa: 2 people* *Vanuatu: 13 people*	In Vanuatu, approximately 74% of the population lives in remote or rural communities, making it difficult to reach many end users.	*"Climate information in Vanuatu is quite rare in terms of information sharing down to community levels because most of the islands are scattered and fairly remote. So it's hard to capture all communities. Especially with the network coverage we're using."* - Government Official (Vanuatu)
	Women's Unequal Access to CIS *Samoa: 0 people* *Vanuatu: 6 people*	In Vanuatu, women do not have equal access to climate information compared to their male counterparts	*"There's not a lot of women who own radios. And radios can only be owned by their husband or grandfather, or the chief like the community leader might have a radio. But the women hardly have a radio because ... they were not taught [at] an early stage that you could also enjoy life [like] the men who have enjoyed life."* - NGO Representative (Vanuatu)

Barrier Category	Barriers	Description	Example
Utilization	Lack of Awareness *Samoa: 3 people* *Vanuatu: 2 people*	A lack of knowledge and awareness of information available, as well as not knowing what information one might need.	*"That's I guess, the current challenge, the discoverability of what it is that they're after ... I mean, Google is one thing, but you might not necessarily land on the best of information. So yes, there is probably still a challenge in directing different community groups to the information that they need"* - NGO Representative (Samoa)
	Expertise Divide between Western Scientific Knowledge and TK *Samoa: 15 people* *Vanuatu: 12 people*	CIS often includes technical language tailored to people with Western scientific knowledge, and the production of CIS does not always adequately incorporate traditional knowledge.	*"They've seen it with their own eyes, but they don't know the science [behind] the scientific terms ... and they don't know why it's happening scientifically. But they can see it, they live it. We just need to make sure that the information is tailored more to their experiences, and not to science."* - Community Member (Samoa)
	Lack of Trust *Samoa: 5 people* *Vanuatu: 4 people*	Community members do not always trust information that comes from the government.	*"We need to gain more interest and gain trust from the public that we [VMGD] are the only institution providing weather information and you can trust us to provide this information ... also we need to step up our game ... to provide timely forecast warning."* - Government Official (Vanuatu)

Barrier Category	Barriers	Description	Example
Utilization (cont.)	Local Language Translation *Samoa: 6 people* *Vanuatu: 9 people*	CIS products are not always translated into local dialects.	*"We don't have the Samoan word for climate change ... we had to invent a word. And when people started asking what it was, that's ... how you introduce it. So it's a lot of the sciency words like climate change, environmental disasters, longitude, latitude, Southwest, and Southeast, [that don't] have Samoan words that people already knew of. ... It's difficult to translate from English to Samoan ... Samoa MET has translated a lot of the English words that they use into Samoan, but a lot of the Samoan people in the rural areas don't quite understand it. To them, it's out of context ... it's just too difficult for them to understand and put together a clear picture"* - Community Member (Samoa) *"Our products are mainly [in] English. But when we communicate to the communities we will communicate in Bislama to them. But we only have one product which is in Bislama. We still have to translate our products into Bislama. Can we make sure that the scientific meaning is still there?"* - Government Official (Vanuatu)

Barrier Category	Barriers	Description	Example
Utilization (cont.)	Limited Feedback Mechanisms *Samoa: 0 people* *Vanuatu: 9 people*	NGOs, government agencies, and others involved in CIS programming do not always pursue post-project feedback from participants to understand the effectiveness of their interventions.	*"We're not really ... going back and then ... doing a survey to really identify whether people are using ... [the] information that we're providing or they're not using it, [if] they're applying it to practical, so I don't think so, you know, that's a challenge for us."* - Government Official (Vanuatu)
	Women's Unequal Role in Decision-Making *Samoa: 15 people* *Vanuatu: 4 people*	In Samoa and Vanuatu, traditional gender roles can keep women from playing an equal part in decision-making regarding climate information and climate action.	*"If you are left behind, no one can help you. You're on your own and already within the [social] structure, as women, we don't have places and voices to talk in the spaces where the community leaders are discussing and making a decision. We are not at a council of chiefs, it's taboo for women to be there."* - NGO Representative (Vanuatu)
	Limited Perceived Importance of CIS *Samoa: 0 people* *Vanuatu: 8 people*	Even when information is tailored to the end user, community members may have a limited understanding of the importance of CIS.	*"And what I have found is that the information that we are providing to the communities is not well integrated and highly regarded as useful information by the communities. I think the challenge lies in making the communities understand the importance of using that information."* - NGO Representative (Vanuatu)

6 Recommendations to Improve Climate Information Services in Samoa and Vanuatu

This study examined the barriers to equitable access to and utilization of CIS in Samoa and Vanuatu, with particular attention to the diverse needs of vulnerable communities. Because Samoa and Vanuatu experience disproportionate risks to the impacts of climate change, enhancing CIS across these islands is a vital strategy for disaster risk response and climate resilience.

Using our interview findings and the existing literature, recommendations were developed to address the barriers to disseminating, accessing, and utilizing CIS in Samoa and Vanuatu. The recommendations are divided into three categories: Funding Mechanisms, Co-Production of CIS, and Capacity Building.

These recommendations are intended for national, regional, and international level audiences. On the international scale are organizations like the UN agencies that develop and execute programs in Samoa and Vanuatu and GCF that provides funding for programs related to CIS. The national level includes NMHSs like the Samoa MET and VMGD, other government entities, and NGOs involved in the production and dissemination of CIS. Regional efforts are carried out by CSIRO, APCP, and SPREP, which are involved in several programs across the Pacific related to CIS and climate resilience.

6.1 Funding Mechanisms

Funding is often skewed toward disaster response, not disaster prevention (Pacific Community et al., 2016). Expanding CIS investments can build capacity for disaster prevention and management. In January 2023, GCF, through its Simplified Approval Process (SAP) and CREWS, validated a Scaling-Up Framework developed in consultation with national experts and development partners that could allow countries access to SAP funds if specific parameters and procedures are met. The Scaling Up Framework for Early Warnings will be operational in the third quarter of 2023, when Samoa, Vanuatu, NGOs, and other stakeholder organizations could apply for funds.

With that being said, SIDS has a difficult time receiving funding and attracting investors due to data limitations in research, high transaction costs, and smaller project sizes. The UN recommends scaling up a dedicated Enhanced Direct Access for funding projects for SIDS under GCF, as well as shifting

away from project-based approaches and instead investing in programmatic approaches that focus on building long-term capacity instead (Debnath, n.d.; United Nations, n.d.-a). One initiative that focuses on engaging international organizations in funding and technical assistance to SIDS is the United Nations for National Adaptation Plans (UN4NAPs) (UNFCCC, 2023). The initiative focuses on creating a platform for SIDS and Least Developing Countries to communicate their specific needs through their National Adaptation Plans (NAPs). UN organizations and international NGOs can then respond to the requests made and fund or provide technical assistance to the needs. This could potentially provide a better and more streamlined funding approach for SIDS. The UN4NPAS was launched in 2021 and continues working on expanding its reach to countries such as Samoa and Vanuatu (UNFCCC, 2023).

Disaster response is important, especially humanitarian aid after disasters. However, funding disaster prevention could be just as beneficial, if not more practical long term. For example, GiveDirectly has experimented with providing cash transfers before extreme weather events (Beasly, 2023). They successfully looked at satellite data and flood mapping before a cyclone made landfall in Mozambique to determine which households would require financial assistance to help prepare for the cyclone. Funding adaptation practices and disaster prevention, such as through anticipatory funding, could greatly benefit the usability and accessibility of CIS.

Funding is crucial for all changes and actions needed to prioritize the needs of local communities and ensure sustainable change within CIS. For the following recommendations, funding is a prerequisite for successful implementation.

6.2 Co-Production of CIS

Co-production of climate information involves collaboration between practitioners and local communities to produce climate information tailored to their needs and circumstances. This serves as a strategy to bridge the expertise divide between producers and users of CIS, as government officials, NGO representatives, and community members will be able to contribute their specific expertise to develop CIS containing more relevant and useful information.

One of the main ways to facilitate the co-production of CIS are through community engagement, a process crucial in all stages of CIS, from the design and development to the implementation of each system. Strong communication between the NMHSs and communities—especially for feedback from communities—allows CIS to be responsive to local needs. The FINPAC project exemplifies one effort to build this two-way communication: It featured a “novel approach” for connecting Pacific NMHSs

directly with communities to enable engagement in vulnerability assessments, community early warning systems, and disaster response (Ministry for Foreign Affairs of Finland, 2018).

WWW illustrates another successful example of two-way communication with community members. In real-time, members use text messages and radio to communicate CIS needs with the WWW hub and, therefore, VMGD. Other NGOs and NMHSs can adopt this communication model to increase feedback from community members.

> *"There needs to be a feedback mechanism for every single product and service going out. And also, encourage people to provide feedback... We want to build in mechanisms so that people can easily give their responses, and that all of these responses [and actions] can be captured."* - NGO Representative, Vanuatu

As we discuss community engagement throughout this section, it is important to note that community membership is fluid and intersects across gender, age, language, culture, ethnicity, and other sociodemographic factors. Therefore, a singular communication and community engagement approach will not be inclusive or effective (Marlowe et al., 2018). Additionally, the geographic boundaries of a community are fluid, and it is difficult to define who or what a 'local community' is regarding engagement.

1. Integrate Traditional Knowledge into CIS

Audience: Samoa MET and VMGD

Combining Western scientific knowledge with TK will be essential to providing accurate and reliable information for relevant stakeholders, vulnerable communities, and the general public (SPREP, 2017b; Sufri et al., 2019; VMGD et al., 2020; Walshe & Nunn, 2012). Integrating TK and Western scientific knowledge also builds adaptive capacity for climate change (Granderson, 2017). Across the Pacific, communities already depend heavily on TK forecasts as a form of climate information as opposed to NMHS forecasts, with the majority of Pacific Islanders utilizing both TK-based and contemporary forecasts (Chambers et al., 2019). It is important to note that both Samoa MET and the VMGD have taken steps to integrate TK into seasonal climate forecasting. For instance, one of the functions of the Samoa MET is to "lead in the collection, verification, and applications of traditional knowledge into seasonal climate forecasting," demonstrating the importance of TK to the services provided by Samoa MET (Samoa Meteorological Services, n.d.). Additionally, Samoa's Climate Change Policy includes the goal to integrate TK into the planned national climate change data portal—the Data Knowledge Information Facility (MNRE, 2020).

To better incorporate traditional and contemporary forecasts into CIS, government agencies could collaborate with communities across Samoa and Vanuatu to determine appropriate levels of TK in CIS. TK integration is a main component of the Van-KIRAP project, which released its Traditional Knowledge Strategy in 2020. Within the strategy, Van-KIRAP acknowledges that "neither indigenous nor western strategies alone are likely to successfully address environmental problems, and by embracing the strengths and weaknesses of these different knowledge systems, [they] can develop improved [DRR] strategies that reduce the vulnerability of indigenous communities ... through the production of products that are based upon collaborative end user driven relationships and mutually agreed benefits" (VMGD et al., 2020).

To facilitate collaboration with TK holders, governments, NGOs, and other organizations, the Samoa MET can establish positions for TK Officers similar to those existing within the VMGD. These officers work to preserve traditional seasonal forecasting and encourage communities to utilize both TK and contemporary forecasting methods. TK Officers have received training on integrating TK forecasts with Western science to inform monthly and seasonal predictions and even tropical cyclone predictions (SPREP, 2022). To ensure all communities in Vanuatu are involved in CIS co-production, the VMGD could expand the number of TK officers within their department to ensure communities across Vanuatu's 83 islands are properly consulted.

> *"I will recommend that the governments and other organizations that are interested in doing this in Vanuatu need to first themselves build their own capacity on understanding the indigenous way of people that are living their realities, and then build from what already exists."* - NGO Representative, Vanuatu

For instance, the integration of TK with Western scientific knowledge into CIS are also a component of the Climate and Oceans Support Program in the Pacific (COSPPac), a program through Australia's Bureau of Meteorology that works with Pacific Islands to manage and mitigate the impacts of climate variability (COSPPac, 2022a). Because communities across the Pacific have historically used TK to cope with extreme events and climate variability, COSPPac is working to combine TK and conventional forecasts to produce more valuable climate and disaster forecasts (COSPPac, 2022b). COSPPac is currently working with NMHSs in Samoa, Vanuatu, Niue, and the Solomon Islands to document existing TK to produce an integrated forecast using TK and Western climate data (COSPPac, 2022b). This existing collaboration between the Samoa MET, VMGD, and COSPPac can be leveraged to streamline the creation of CIS incorporates TK.

2. Promote Citizen Science

Audience: Samoa MET and VMGD

Citizen science, which involves active public participation in scientific research and knowledge production (Fraisl et al., 2022), has been recognized as a mechanism for bridging TK and Western scientific knowledge (Dunmall & Reist, 2018). Therefore, Samoa MET and VMGD could also promote citizen science and incorporate it into CIS, increasing the data collection abilities of governments while helping communities get more involved in CIS and climate-related changes. Citizen science can include using a mobile phone to periodically photograph key features of the landscape, including mangrove plantations and high tides at regular intervals. In addition to photographs, TK of weather and climate can also be used as observations and a mechanism to bridge the expertise divide between TK holders and CIS producers. In overcoming this gap, citizen science could be used by VMGD and Samoa MET to investigate and reconcile their observations.

> *"One of the other things that we are trying to improve communication on and building the capacity of the community people [for] is using citizen science for them to collect their own data around rainfall and temperature, [and help build] understanding [on] why collecting rainfall is important. VMGD has a Vanuatu rainfall network of community members of about 50, who we have trained to help the VMGD to collect rainfall data on a daily basis. And we have provided capacity building for the Vanuatu rainfall network, sending reports on what's happening in rainfall and climate across Vanuatu, and we are able to use that information to personalize the forecast that we provide."* - NGO Representative, Vanuatu

The use of citizen science to raise community awareness of CIS are a main component of Van-KIRAP's theory of change because citizen science could "play a major role in developing communities' understanding of the importance of CIS in decision-making and enable communities to contribute to broader project effort through data collection and other citizen science projects" (SPREP, 2019). Van-KIRAP is utilizing citizen science by encouraging community members to take photos and upload them to the Van-KIRAP portal, allowing individuals nationwide access to observational data. Therefore, promoting citizen science in both Samoa and Vanuatu increases community awareness of climate impacts and CIS and enables the development of more place-based forecasting.

3. Tailor Language for End Users

Audience: Samoa MET and VMGD

Climate information is often conveyed in a highly technical way, but community members—who tend not to have technical-scientific training—say this makes it hard to understand and respond to. The language used in CIS must be understandable and usable for end users by minimizing scientific jargon across communication mediums, including Facebook posts and climate bulletins. For example, including terminologies like longitude and latitude or Southwest and Southeast to describe locations and directions does not clearly present the impact of a particular hazard. Both the Samoa MET and VMGD could work to simplify the language used in CIS, making it easier for end users to interpret.

> *"I know that there was a time when the MET was going through this training to be able to translate the information from categories to: this cyclone will destroy the banana trees, and this cyclone will destroy a coconut tree"* - Community Member, Samoa

In addition to minimizing the use of technical language, CIS could also be developed in different local dialects. In Samoa, technical terminology used in CIS (e.g., tropical depression, climate change) does not exist in the Samoan language. Meanwhile, CIS in Vanuatu is typically produced in English, then translated into Bislama. Local NGOs are then tasked with translating bulletins and outlooks into other local dialects, which is time and resource-intensive. Translation of climate information has the potential to dilute or alter the intended meaning of information presented in different products.

> *"We use four [phases] of translation, one is the English translation, then French...then Bislama - the local language. There are 200 different languages in Vanuatu and we have to [translate] also into their local language. And that's very hard to get the products translated into those languages, especially in certain provinces."* - Government Official, Vanuatu

Therefore, increased resources could be allocated by the Samoa MET and VMGD to aid in the translation of climate information, and these agencies could work to develop resources aimed at bridging gaps in language. For example, the Samoa MET has worked to make this terminology more accessible to the general public in the Samoa Meteorology Glossary. Creating resources similar to this glossary allows for developing common CIS-related terminology in different languages while increasing awareness of various climate and weather processes.

> *"So one of the issues is the use of technical terminology. The guys working with the [Samoa MET] began working on glossaries in the local language. Trying to explain things using the local language as opposed to providing the message in English all the time. It also enabled a bit more visualization, for example, what's the difference between a category 1 cyclone and a category 2 cyclone? Having some infographics around that is also helpful."* - NGO Representative, Samoa

4. Promote Gender-Responsive CIS Approaches

Audience: International and Regional Climate Organizations, Samoa MET, and VMGD

To ensure that women and other marginalized genders receive and can utilize climate information, participation of these groups in co-producing climate information services—through inclusion in CIS design and decision-making—is crucial (Mcleod et al., 2018). Efforts to center gender should move beyond a "gender-sensitive approach" towards a "gender-responsive" approach—i.e., moving beyond simply tailoring CIS for women to using CIS initiatives as an avenue for proactively promoting broader gender equality. This includes addressing the systemic root causes of gender-based discrimination, supporting the empowerment of all marginalized gender identities, and overcoming historical gender biases.

There are numerous efforts to make CIS more gender-responsive towards women in Samoa and Vanuatu, which can be built on and applied more broadly across the Pacific. For instance, programs developed in Vanuatu could be contextualized for Samoa and vice versa.

> *"Women contribute a lot [to] changes in the community, [but] the men make [the] decisions. But I looked at women as [agents of change] when working with them. And it shows me that we still need to improve access to information on climate change, especially for women, because they make a lot of changes. They contribute [to] a lot of different [climate] developments without knowing."* - NGO Representative, Vanuatu

Women's Weather Watch (Vanuatu). Based on the aforementioned featured initiative, WWW has the potential to be scaled up and emulated in other countries across the Pacific. Its two-way communication process using SMS serves as a critical avenue for women to shape CIS to make it more gender-responsive and enables women to provide real-time feedback on its effectiveness.

Additionally, women hold an important role in maintaining TK, gained from individual experiences adapting to environmental changes across generations (Mcleod et al., 2018). Therefore, there is not only a need for climate information to include TK, but also to involve women throughout the

dissemination process. For instance, WWW provides real-time climate forecasts infused with TK and involves women "before, during, and after natural disasters, [enabling] women to be the first responders" (Bhagwan-Rolls, 2022). Enhanced involvement of women can be achieved by building partnerships with women's groups and community service organizations, which could result in collaborations to support gender-responsive integration of TK in CIS (CIF, 2021). Meanwhile, to better facilitate co-production, Samoa MET, VMGD, and other government agencies could undertake a gender needs assessment to identify and address any capacity-building needs for governments and women's groups related to CIS (CIF, 2021).

Community Disaster & Climate Risks Management Program (Samoa). In Samoa, CDCRM undertakes an inclusive approach to DRR, requiring the participation of Alii ma Faipule (the women's committee) in each of its village training sessions (MNRE, 2021). During pre-consultation meetings, facilitators inform village council members about the importance of having members of the women's committee and other community leaders participate in CDCRM training (Samoa Red Cross Society, 2021b). This approach to gender-inclusive DRR can be adapted for CIS production and dissemination across Samoa and Vanuatu. Each country could require the participation of a women's committee in village training on CIS and include women in leadership roles (like climate champions in Vanuatu) related to CIS production and dissemination. This ensures that women receive information and are part of the decision-making process.

Finnish-Pacific project adapting to climate change in Oceania. The FINPAC project included a list of gender indicators that can be tailored to future CIS-focused projects (Koop et al., 2012). These include 1) prioritizing gender visibility in the planning of NMHSs, 2) recognizing gender as an important part of climate change adaptation, 3) creating a women's network in meteorology, 4) establishing an information campaign on gender equality for policymakers, 5) identifying areas that constrain gender inclusivity at community levels, and 6) identifying traditional or cultural issues that serve as constraints of gender inclusivity. While these were identified in the original project document, most were not implemented.

Building on FINPAC's work, a comprehensive gender mainstreaming strategy could be developed during the inception stage of any CIS-focused project in the Pacific to avoid implementation issues (Koop et al., 2012). In particular, SPREP can develop a comprehensive mainstreaming strategy for use at the beginning of CIS projects and include these original indicators in future projects. Furthermore, SPREP's gender policy, implemented in 2017, focused on strengthening and maintaining an environment encouraging gender mainstreaming and promoting the integration of a gender perspective into member countries' and partners' projects. SPREP can incorporate these gender

indicators into a revised gender policy and continue promoting mainstreaming of gender issues in regional coordination bodies and networks (Ministry for Foreign Affairs of Finland, 2018).

Shifting the Power Coalition. Shifting the Power Coalition (StPC) is a group of 13 women-led organizations across six countries in the Pacific (including Vanuatu and Samoa) working to strengthen women's leadership and participation in climate action and disaster response, as well as access to climate information. The coalition reflects several best practices in promoting gender-responsiveness, including focusing on 1) the intersection of marginalized identities and 2) peer learning. Regarding intersectionality, the coalition prioritizes the particular challenges and perspectives of young women, women with disabilities, and women from rural communities. Intersectionality is critical given that Pacific women's experiences are not monolithic. For instance, women with disabilities were disproportionately impacted by Cyclone Pam in Samoa in 2015, with 74% of women with disabilities unable to reach or access evacuation centers (Power et al., 2019). Thus, organizations outside the coalition—including development organizations such as the Red Cross—could learn from StPC and ensure that their efforts to strengthen CIS look at the particular experiences of young women, women in rural communities, and women with disabilities.

The coalition also seeks to amplify women's existing power and knowledge. Much of the strength of the StPC comes from the opportunities it has created for Pacific women to define their own vision for inclusive women's leadership in humanitarian action and learn from each other. Other organizations involved in CIS efforts could reflect this approach and foster information-sharing and network-building among women (for instance, by establishing a women's meteorology network mentioned above under FINPAC).

UN Women's Resilience to Disasters (WRD) Program. As opposed to StPC operating at the grassroots level, WRD addresses significant governance and system-level gaps at the global, regional, and country levels to build climate and disaster resilience of women and girls in several Pacific countries, including Vanuatu (WRD, n.d.). More specifically, the project identifies climate and disaster-related gaps in disaggregated climate data and analysis, knowledge management, evaluation and communication, inclusive governance, risk drivers, and coordinated action. In response to these gaps, WRD aims to provide a framework tailored to unique regional and country circumstances. It intentionally builds gender-responsive disaster prevention, preparedness, and recovery systems based on structural and underlying root causes of women's risk of climate hazards. This framework can guide program designers across Pacific Island countries when developing gender-responsive CIS initiatives, including Samoa.

Expanding Gender Inclusivity. Further, CIS efforts should explicitly acknowledge and respond to the experiences of all genders, demonstrating the inclusion of sexual and gender minorities, including non-binary and LGBTQIA+ communities. Current CIS policies and programs that address gender disparities, like SPREP's Gender Policy, tend to focus exclusively on the needs and experiences of women, or—in the case of FINPAC—discuss gender but do not explicitly address the inclusion of specific genders. One way these initiatives could be expanded on is by expressly including all gender identities, as opposed to focusing on only women and men. Thus, policies and programs should seek to understand 1) how all genders receive CIS, 2) what barriers they face, and 3) how to actively improve their inclusion. These efforts should reflect the non-binary gender identity frameworks that already exist within the Pacific region (Weedon, 2019). In Samoa, for instance, gender policies should reflect the four recognized cultural genders—female, male, fa'afafine, and fa'afatama (Natural History Museum, 2022). This approach should also be used in other countries based on their unique gender frameworks.

Current efforts to promote gender-responsiveness in CIS offer a promising foundation. Future gender-responsive initiatives should expand on these approaches by moving beyond a male/female binary and include the unique experiences of all gender identities, from design to implementation.

5. Improve Monitoring, Evaluation, and Learning in CIS

Audience: International and Regional Climate Organizations, Samoa MET, and VMGD

Mechanisms for monitoring, evaluation, and learning (MEL) within CIS initiatives could be strengthened in Samoa and Vanuatu to facilitate evidence-based decision-making and ensure that efforts to improve CIS are as impactful and sustainable as possible. One way to improve monitoring, evaluation, and learning is to systematically use baseline and end-line surveys to capture pre- and post-project data. A final report on the FINPAC project also suggests that results-based reporting (as opposed to reporting on activities) should be emphasized where possible, which could be facilitated by creating results-based planning and reporting templates (Ministry for Foreign Affairs of Finland, 2018). Ideally, monitoring and evaluation activities such as site visits should extend several years beyond the project's life to measure longer-term effectiveness. Implementing these MEL practices would require projects to allocate a part of their budgets to MEL specifically.

Two examples of robust MEL processes, the FINPAC project, and Van-KIRAP, could offer guidance for implementing organizations in this space. In FINPAC, project managers sought extensive feedback about the project's effectiveness from community members and NMHS staff in the target countries, culminating in a final project report. In Van-KIRAP, a thorough mid-term review in 2021 sought to

capture findings, conclusions, and recommendations to "promote project performance improvement, accountability, learning, and evidence-based decision making and management" (FCG New Zealand, 2021).

6.3 Capacity Building

Although CIS are an important tool for minimizing the risk of climate hazards and natural disasters, there are disconnects between the institutions that develop and disseminate CIS and gaps in awareness and internet connectivity that limit end users' ability in Samoa and Vanuatu to access and utilize CIS. Building end user capacity by expanding internet coverage, encouraging coordination, and enhancing climate education will bridge existing knowledge and accessibility gaps in Samoa and Vanuatu.

6. Broaden Internet Coverage and Access

Audience: Regional development organizations and Vanuatu Government,
Tailoring messaging and information based on the audience for a specific platform ensures that CIS reach a broad swath of people across both Samoa and Vanuatu. Radio, SMS text messaging, and TV remain the most reliable ways to ensure climate information reaches the most people. These media channels are most likely to be effective when technical language is minimized.

Social media, mobile apps, and VMGD and Samoa MET websites and data portals are also common dissemination methods but are currently underutilized. According to the UN International Telecommunication Union, only 52% of people in Vanuatu had access to the Internet in 2019 (International Telecommunication Union, 2020).

> *"The internet connection or the network mobile network connections to some of the remote islands is something that our government and network authorities need to work on. Now, information is digital, and it's very challenging when we send information [to community members] through SMS texts and email. They should have received this information, but they don't have access to the internet in their community. It's still a challenge."* - NGO Representative, Vanuatu

However, innovations in satellite-based internet (as opposed to conventional broadband internet) could be an option to increase internet coverage for remote communities. In 2019, the Asian Development Bank funded Kacific1 Broadband Satellites, a Singapore-based satellite broadband operator, bringing internet connectivity to remote and rural areas in the Asia-Pacific region with little or no internet coverage. Vanuatu's Ministry of Health has already partnered with Kacific1 to provide

reliable internet to health clinics across the country. Implementing satellite broadband communication at a household level in remote and rural areas could be expensive (Botica, 2021). However, costs are projected to decrease in the near future as innovations rapidly develop. Reviewing options for investing in satellite-based internet for households across Samoa and Vanuatu could increase internet coverage and access to climate information on social media, websites, and apps.

7. Facilitate Coordination Between Stakeholders

Audience: UN Agencies, Regional Climate Organizations, and National Governments
Each country could continue facilitating inter-agency coordination and include more NGOs and community members to improve the CIS production and dissemination processes. Coordination between organizations within and between countries makes dissemination more inclusive and effective at reaching the most people.

In Samoa, the DAC is tasked with advising the government in the event of a severe hazard and contains representatives from all government agencies and ministries. In Vanuatu, the National Advisory Board on Climate Change and Disaster Risk Reduction (NAB) develops DRR and climate change policies, positions, programs, and guidelines (Government of Vanuatu, 2022). This includes several governmental organizations and an observer from the VCAN. More NGO representatives and community leaders could be included in these conversations to produce materials and guidance that are useful for most stakeholders. However, this could be done with particular attention to who is (or is not) being represented in these processes.

The Early Warning Early Action workshops in Africa from 2009-2012 brought vulnerable communities, technical departments, forecasters, and communication intermediaries together to facilitate national discussions that identified needs and designed response services (Tall, 2015). The workshops used scenarios or participatory games to encourage technical experts and community members to work together to develop solutions and support end users. Furthermore, the Global Framework for Climate Services (GFCS) initiated projects in West Africa to identify elements needed for national frameworks for climate services for vulnerable users (Tall, 2015). This led meteorological offices to reach out to key stakeholders and users across climate-sensitive sectors in each country. National Workshops on Climate Services facilitated conversations between providers and users of CIS and led to a national communication chain for climate services. This linked EWS and climate science with technical services in climate-sensitive sectors to create targeted CIS, which linked with the local community members and vulnerable communities.

Through the DAC and NAB, Samoa and Vanuatu can use these projects and workshops as frameworks for increased dialogue at the national scale between NMHSs, climate-sensitive sectors, NGOs, and vulnerable communities to support CIS responsive to the needs of women, rural communities, and other vulnerable groups. Samoa's 2020-2030 Climate Change Policy also calls for implementing a national climate change forum, which could facilitate dialogue on CIS between the government and organizations throughout Samoa. By finding opportunities to discuss climate information at inter-agency meetings, more voices impacted by climate change are at the table, and CIS can become more inclusive. Furthermore, climate change and its impacts cut across all sectors of society and require a holistic approach.

> *"Don't reinvent the wheel, there are already a lot of other organizations that are doing the exact same thing. Why not work with them? Can you guys put all [of] your funding and resources together? And then push it all into one big project? If you really want the information to hit home hard, look around into the communities, see what projects are already being implemented, and then work with those projects."* - Community Member, Samoa

Given the abundance of organizations and projects across the Pacific Islands working on EWS, CIS, and meteorological services, regional coordination across Pacific Island countries is critical for maximizing complementarity and avoiding duplication. Thus, we recommend continued and enhanced coordination between organizations working on CIS to enable more cohesive strategies, avoid repeated work, and share lessons learned across interventions. The coordination between FINPAC and COSPPac is one example of intentional coordination between projects that helped prevent duplication (Ministry for Foreign Affairs of Finland, 2018). SPREP and APCP are potential organizations that can be used to strengthen coordination between organizations and projects across Pacific Islands. In particular, SPREP has offices in many Pacific countries and can connect with government officials and other stakeholders in the countries and regional development organizations.

Regional collaboration could also be facilitated by creating a regularly updated compendium of projects like the one produced during the FINPAC initiative. Based on a week-long workshop in 2016, the FINPAC project created a compendium of CIS initiatives in the Pacific Region to document lessons learned (SPREP, 2016a). The workshop allowed climatologists and communication specialists in the region to work together and learn from each other to produce and communicate CIS more effectively. Recreating this workshop and reporting more regularly would allow greater regional coordination and lessons learned across countries.

8. Enhance Climate Education

Audience: Regional Climate Organizations, and National Governments

Facilitating partnerships between organizations would also ensure beneficial education for communities. Both countries could invest in workshops and knowledge-sharing programs with younger and older community members, as the change should occur bottom-up with help from the local communities (Ministry for Foreign Affairs of Finland, 2018).

> *"[It is important]to have more consolidation and workshops by the community level, especially from the MET office who are preparing [CIS] information. To highlight the importance of this information ... being sent out, because the government is paying ... to [create] this information. And if it is not useful for the communities it's a waste of funds, as the information is not useful. So there needs to be more awareness and capacity building down at the community level"* - NGO Representative, Samoa

The Pacific Adventures of the Climate Crab is a project between the Red Cross and the Australian Government's Pacific-Australia Climate Change Science and Adaptation Planning (PACCSAP) Program. It is an online platform that uses animation and video tools to raise awareness of El Niño and La Niña. The VMGD and CSIRO are implementing the project in Vanuatu. The Climate Crab is focused on the Pacific more broadly. However, Red Cross and PACCSAP created Cloud Nasara, specifically catering to Vanuatu, as it is translated into Bislama, English, and French. Cloud Nasara encourages discussion on how stakeholders, including community members, NGOs, and government officials, can access information from the VMGD (Australian Government, n.d.). Having easily available climate information in a language that all people understand will increase the knowledge of CIS in the local communities. The Climate Crab and Cloud Nasara are two great examples of that.

CDCRM in Samoa has seen great success in educating their communities on DRR and climate change adaptation. Samoa Red Cross plays a major role in disseminating information and holding workshops throughout the Samoan villages. In 2020, Red Cross and CDCRM had an outreach to 20,255 Samoans by having workshops and training programs in 20 villages and providing training to community leaders (Samoa Red Cross Society, 2021a). Training involves facilitating a community-driven process so the community members are involved in identifying hazards and risks in their community. They also organize each village into a disaster committee and a response team, so everybody understands their task and whom they can receive assistance from within their community. Most importantly, they target the most vulnerable groups to ensure their needs are integrated into the planning and training process (Samoa Red Cross Society, 2021a).

Educating young people is also important in enhancing climate education. One of our Australian interviewees highlighted this sentiment saying "[children are] going to be the future scientists. They're going to be the future decision-makers in these countries. And so getting their level of literacy and understanding about the science of climate change, and what services they need is important." Educating youth is important for broader community awareness, as they will bring information to their parents and family members, expanding the understanding of climate information. Youth activism is also important, and the organization Pacific Islands Students Fighting Climate Change (PISFCC) has been pushing for incredible change in the Pacific Island region. In March 2023, they were the major driving force in getting the Government of Vanuatu's proposal for an advisory opinion from the International Court of Justice adopted by the United Nations General Assembly (Pacific Islands Students Fighting Climate Change, 2023a). The PISFCC is a youth-led organization with chapters in Fiji, the Solomon Islands, Tonga, and Vanuatu, but its reach is the entire Pacific region. One of their main campaign goals is to educate and activate all youth in the Pacific to fight climate change, in which they have been very successful (Pacific Islands Students Fighting Climate Change, 2023b).

Another challenge both countries face is the lack of local scientific experts, and they often hire people from outside their borders, such as Australia or New Zealand. An NGO representative from Samoa said: "I find [it] challenging ... when we don't have the expertise within our country. We have to advertise it to overseas people, but when they come in, they have to be familiarized with the environment and try to understand the challenges as well." Investing in training new hires and employees in the government and NGOs on climate knowledge and the use of CIS could build capacity for better outreach to community members. Similar training was conducted during the FINPAC Project, where Samoa MET received training on using more local language, less technical jargon, and more graphics. According to the final evaluation of FINPAC's projects across the Pacific, the project was "the first time that [MET] staff [were] 'directly exposed' to the communities and [learned] how weather services and warning messages [could] be best tailored and communicated" (FCG New Zealand, 2021).

9. Scale Up Van-KIRAP

Audience: International Development Agencies, Regional Climate Organizations, Samoa MET, and VMGD

The different interventions created through the Van-KIRAP project address many of the barriers to disseminating, accessing, and utilizing CIS we have identified through our interviews. Because of Van-KIRAP's prioritization of community engagement, centering of TK in climate forecasting, and

development of physical and digital infrastructure for CIS, we recommend adapting these efforts in Samoa. As this project comes to an end, efforts should also be taken in Vanuatu to ensure sustainability beyond the project's lifetime.

> *"This project is the biggest one in the Pacific in terms of [CIS], so we're looking at how to...bring the government in...[since] the government has already allotted some of its resources to the project. To make sure that when the project ends and they hand...over all the resources to the government we can sustain [it].* - Government Official, Vanuatu

One notable component of Van-KIRAP is the enhancement of physical infrastructure. Creating a physical, centralized space for community members to access important and relevant climate information and data can increase the actionability and adaptive capacity of communities and households in Samoa and Vanuatu. Van-KIRAP is working to make climate information more relevant and accessible for remote communities across the country by creating CCCs in strategically located islands. Each center is intended to serve the specific needs of communities, and Van-KIRAP has sought guidance and approval from community leaders, provincial government officials, NGOs, and local stakeholders regarding the design, commissioning, and operationalization of the CCC (SPREP, 2021c). Samoa can construct CCCs in rural areas on Savai'i and Upolo, as well as on the smaller islands of Manono and Apolima while ensuring communities are consulted throughout the process of developing these centers.

Additionally, CSIRO, a contributing partner of Van-KIRAP, is creating a portal that houses data to enhance the online visualization, geospatial referencing, and analytics of CIS to provide evidence and inform sectoral decision-making related to climate risk (Frontier SI, 2021). The portal will increase access to NextGen climate information for policymakers, government and provincial agencies, and the private sector (Webb, 2021). Samoa could create a similar database that models Van-KIRAP's approach, centralizing climate information in one easily accessible location.

Vanuatu's Van-KIRAP project has shown great promise in terms of increasing access to CIS, increasing the use of TK in CIS dissemination, and more. However, tools, resources, and coordination must be maintained after the project funding ends in December 2023.

6.4 Towards Equitable Climate Information Services

As air temperatures rise and oceans warm, communities in Samoa and Vanuatu will continue to experience disproportionate impacts of climate change (IPCC, 2022; Mahon et al., 2019). Effective

climate adaptation strategies are critical for the community's survival, and when deployed effectively and equitably, CIS are a tool that can support preparedness and responsiveness to short and long-term climate hazards. However, there are still gaps in disseminating, accessing, and utilizing climate information in these countries, especially for women and remote communities. Through interviews with relevant CIS actors in Samoa, Vanuatu, and regionally, the report examines these gaps in more detail, compares the unique and nuanced CIS-related challenges and ongoing projects in Samoa and Vanuatu, and proposes how these challenges might continue to be addressed. To build on these findings, future research could expand on the ways youth and all genders interact with CIS in Samoa, Vanuatu, and countries across the Pacific. CIS must become more inclusive, equitable, and intersectional to increase resilience to the impacts of climate change and natural disasters.

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Appendix A: Interview Questions

Interview Questions: CIS Producers

Introduction

- Could you tell us about the organization you are a part of and your role in the organization?
    - Could you tell us about the work you/your organization do(es) involving CIS and vulnerable communities (e.g., women and remote communities)

Understanding of Climate Information Services

- What climate information 'products' does your organization develop/use/disseminate?
- What are some of the climate information services or products your organization is involved with? What part of the process is it (production, translation, delivery, etc.) and who is the end user of these products or services?
    - Could you describe the process of sourcing and/or production of the data? Where does the information come from - is it internal or external?
    - (Depending upon the end user) - what is the format of the service/product? reports/warnings/EWS/Outlooks
- Do the products or services engage with the marginalized/vulnerable communities, such as youth, women, remote communities, etc. of the nation in any way?

Dissemination of CIS in the Community

- Production
    - What is the process of dissemination of the product/service out of your organization? What form does the information take?
- Dissemination
    - What are the channels/media used for dissemination?
    - To whom does your organization typically disseminate climate information?
    - (who are the end users? What form does the information take? What is the aim/end goal of the information?)
- How does the organization ensure effective dissemination, i.e. information is received by all end users?
- To the best of your knowledge, how do the local communities, especially women and remote communities typically receive information about current climate events?

- Would you say the process of production/dissemination has been effective/successful in the past?
    - Did the information reach in time?
    - Is there clarity in terms of
        - what the threat is (for example, its effect on the community, women / local economies)
        - how much time the community has to respond to the information given in [insert product name],
        - the probable duration of the hazard, and
        - what actions need to be taken to prepare/get themselves (and their crops/ livestock) to safety?
        - Are there any facilities or resources community members can turn to in case of emergency? (in terms of organizations seek out physical help such as shelter, transportation /monetary help / any other resources)
- What are some of the major barriers you/your organization has encountered with regard to the dissemination of climate information to vulnerable communities?
    - Information reaching them in a timely manner?
    - Understandable by the community?
    - Accessible by women in the community?

Vulnerable Communities and Climate Impacts + Engagement

- How would you say vulnerable communities are disproportionately harmed by climate change and disasters in your country/region?
- Although we spoke a little about their engagement in the process of (production/dissemination) of the product.service, could you describe some particular initiatives, projects, or programming focused on women/rural communities within your organization?
    - What is their role?
    - What initiatives do you believe have been successful, and why?
- What are some of the major challenges and/or biggest barriers you/your organization has encountered within these initiatives with regard to specifically the dissemination process- to vulnerable communities?
    - Information reaching them in a timely manner?
    - Understandable by them?
    - Accessible to them?

- If a person from these communities was to seek out climate information, would you say that they are generally able to access that information?
    - Are there any barriers that make it difficult for women to receive and access information from CIS?
- What kinds of climate information services are most useful for women? If women could access any climate information they wanted, what kind of information would they want? (Given the types of activities that they are involved in, their responsibilities, etc)

Community Engagement

- Does your organization engage with communities (directly or indirectly) to understand local climate information needs? If so, what does this engagement look like?
- To what extent are communities involved in the design and distribution of climate information like bulletins and outlooks?
- Are the climate information services you provide free to the public?
- Do you believe that [insert product name] is formatted/presented in a way that is easy for community members to understand?
- How involved are people from these communities in climate leadership and decision-making, at your institution and more broadly in your country region?
- Does your organization have any CIS-related initiatives that are community-led or women-led?
- While engaging communities in the production of climate information, does your organization utilize traditional knowledge when developing [insert product name]?
- To your knowledge, how are communities currently interacting and engaging with climate information from early warning systems?
    - Is there a way for your organization to measure how many people are interacting with or using the EWS? And who exactly they might be?

Recommendations

- If you had a magic wand and could change anything about the way CIS currently works in your country, what would you do?
- Do you believe that there is relevant information missing from [insert product name] that would be helpful in disaster preparedness and response for local communities?
    - For vulnerable communities (i.e., women and remote communities)?
- What do you think would be the ideal method of information dissemination to vulnerable communities? What do you think would be the best media for reaching the end users?
    - Radio
    - Text

    - Social Media
    - Community events
    - Etc
- Are there other changes, in both the dissemination system and [insert product name, that could benefit your organization and your community?
- What kinds of resources could make your production and dissemination of CIS/EWS report easier or more expansive? - software, money, processes, expertise...

Closing Questions

- Is there anything we didn't discuss that you would like to bring up about climate information services and how vulnerable communities use and engage with these reports/data?
- Do you happen to have any contacts in Samoa or Vanuatu that you think we should interview for this project?

Interview Questions: CIS Users

Introduction [NGO Representatives]

- Tell us about the organization you are a part of, your role in the organization, and the work you do involving CIS and/or women's issues
- What is your organization and what do they do? Can you give some history/background on your organization and explain how you got involved?
    - What is the size of your organization (staff numbers)?
- What is your role at your respective organization and how does it relate to climate information services and early warning systems? How did you end up in this role?

Understanding of CIS Involvement

- From our research we have seen that flooding, droughts, and heavy rainfalls have increased in the past years, have you also seen this change/impact?
    - Is [insert organization name here] involved in the production of climate data?
        - If so, how much is your organization involved?
        - Where does your organization get its climate data from? Is it internal or external?
        - Could you explain the production process a bit more?

Dissemination [NGO Representatives]

- What role does your organization play when it comes to disseminating climate information?
    - Could you take us through the whole process starting from where the information is produced, the channel with which it reaches you, and then the steps taken to distribute CIS reports to each person potentially affected?
    - Which organizations and/or government agencies relay CIS reports to you and your organization?
        - Do you have experience interacting or engaging with the Samoa Meteorological Service/Vanuatu National Meteorological and Geo-Hazards Department?
            - Do you follow their social media pages (ex. Facebook)?
- What role would you say your organization has with respect to the dissemination of climate information specifically to women in the community?
- How does the organization ensure effective dissemination, i.e. information is received by all end users?
- To the best of your knowledge, how do the local communities, especially women, typically receive information about current climate events?

    - Would you say the process of production/dissemination has been effective/successful in the past?
        - Did the information reach in time?
        - Is there clarity in terms of
            - what the threat is - its effect on the community, women / local economies (agriculture, fisheries, tourism)
            - how much time the community has,
            - the probable duration of the hazard, and
            - what actions need to be taken to prepare/get themselves (and their crops/ livestock) to safety?
            - Are there any resources community members can turn to in case of emergency?
- What are some of the major barriers you/your organization has encountered with regard to the dissemination of climate information to women and remote communities?
    - Information reaching them in a timely manner?
    - Understandable by the women in the community?
    - Does your organization have particular initiatives, projects, or programming focused on women? If so, what are examples?
    - How successful do you think these initiatives are?
    - What challenges have you experienced throughout these initiatives?
    - How are women disproportionately harmed by climate change and disasters in your country/region?
    - What kinds of CIS are most useful for women? If women could access any climate information they wanted, what kind of information would they want? (Given the types of activities that they are involved in, their responsibilities, etc)
    - How involved are women in climate leadership and decision-making, at your institution and more broadly in your country/ region?

Women and Climate Impacts + Engagement

- Does your organization have particular initiatives, projects, or programming focused on women? If so, what are examples?
    - How successful do you think these initiatives are?
    - What challenges have you experienced throughout these initiatives?
- How are women disproportionately harmed by climate change and disasters in your country/region?

- Are women who want information about climate or disaster warnings generally able to access that information?
- Are there any consistent socioeconomic factors that make it difficult for women to receive and access information from CIS?
- What kinds of climate information services are most useful for women? If women could access any climate information they wanted, what kind of information would they want? (Given the types of activities that they are involved in, their responsibilities, etc)
- How involved are women in climate leadership and decision-making, at your institution and more broadly in your country/ region?

Community Engagement

- Does your organization engage with communities (directly or indirectly) to understand local climate information needs? If so, what does this engagement look like?
- To what extent are communities involved in the design and distribution of climate information like bulletins and outlooks?
- Are the climate information services you provide free to the public?
- Are CIS reports formatted/presented in a way that is easy for community members to understand?
- Does your organization have any CIS-related initiatives that are community-led or women-led?
- How does your organization utilize traditional knowledge when developing EWS?
- To your knowledge, how are communities currently interacting and engaging with climate information from early warning systems?
    - What do you perceive as the biggest unmet needs of communities in relation to climate information? From your perspective, what unique challenges do women and girls face in accessing and using climate information?
    - Do you have or know of a way to measure how many people are interacting with or using the EWS?
        - Do you have a way to know who exactly is interacting with EWS?

Recommendations

- If you had a magic wand and could change anything about the way CIS currently works in your country, what would you do?
- What do you see as an ideal method of sharing climate information dissemination to ensure that those around you are safe?
- Do you notice relevant information missing from CIS/EWS reports that would be helpful in disaster preparedness and response for local communities, specific women in the communities?

- What do you think would be the ideal method of information dissemination to your community as well as other communities? What do you think would be the best method for reaching the end users?
    - Radio
    - Text
    - Social Media
    - Etc
- Are there other changes that could benefit your organization and your community?
- What resources could make your production and dissemination of CIS easier or more expansive?

Closing Questions

- Is there anything we didn't discuss that you would like to bring up about climate information services and how it's produced and disseminated to the community?

Appendix B: Comparing Country Statistics of Samoa and Vanuatu

	Samoa	Vanuatu
Region	Polynesia	Melanesia
Area (sq km)	2,842	12,189
Population	201,400 (2023)	315,700 (2022)
Islands	2 inhabited, several smaller uninhabited	80 Islands, 65 inhabited
Capital (Population)	Apia (36,000)	Port Vila (51,437)
Poverty Rate (<$5.50/day)	22.7%	15.9%
Rural Population	81%	74%
Official Language	Samoan (91.1%) and English	Bislama, English, and French
Internet Access/Coverage	78.2%	33.5%
Use of Social Media	65.7%	35.4%
Phone subscriptions	32 per 100 people	78 per 100 people
Climate Change Risks	Greater maximum air and ocean surface temperature, greater frequency in extreme daily rainfall events, sea level rise, increases in ocean acidification and coastal erosion, cyclones, and longer and more frequent droughts	Greater frequency in extreme daily rainfall events and heat waves, sea level rise, increases in ocean acidification, coral bleaching, and coastal erosion, floodings, cyclones, and longer and more frequent drought
Current Climate Policies	Samoa Climate Change Policy 2020-2030; Samoa: National Policy of Combating Climate Change	Vanuatu National Adaptation Program for Action; Vanuatu Climate Change and Disaster Risk Reduction Policy 2016 to 2030; Vanuatu National Sustainable Development Goals

Note. Data from this table are drawn from ADB, 2022, 2022; Britannica, n.d.-a, n.d.-b; DataReportal, 2021, 2022, 2023; DFAT, 2021; Government of Samoa, 2021; UNDP, 2023; World Bank, n.d., 2023

Appendix C: Van-KIRAP Outputs and Indicators

The highlighted sections in this table represent the Van-KIRAP outputs and indicators that are most relevant to the barriers outlined in our interview data.

Output	Indicator
Output 1.1. Strengthening Climate Information Services through data and interfaces	Climate data digitized, homogenized, and uploaded into the VMGD portals
	VMGD IT platform upgraded
	User interfaces have been strengthened to support CIS decision-making
Output 1.2. Research, modeling, and prediction to support CIS tools and uptake	Three observational networks established and operational
	Seasonal climate forecasts have improved utility and functionality
	Long-term projections developed
	Risk-based coastal and climate hazard mapping undertaken for Vanuatu
	Vulnerability mapping of the coastal zone in Vanuatu completed for target areas
	Agromet predictions for cropping systems developed
Output 2.1. CIS implemented within target sectors	Agricultural practices strengthened through the use of Climate Information Services to improve crop production
	Fisheries sector is strengthened through the use of CIS in MPA Management Plans
	Vanuatu infrastructure design strengthened utilizing climate data in the design and construction phases
	Improved water management and security in the Sarakata catchment
	Tourism sector is utilizing Climate Information Services in decision making

Output 2.2. CIS are incorporated into community practices	Communities are engaged and utilizing CIS at 12 sites
Output 2.3. Socioeconomic benefit analysis for Vanuatu utilizing the customized Pacific CIS cost-benefit framework is produced	A SEB on return on investment in Climate Information Services is utilized in decision-making
Output 3.1. TK is incorporated into Climate Information Services in Vanuatu	CIS tools and products incorporate TK and climate science and uptake by communities
Output 3.2. Developing CIS tools and information products for target end users	Decision support tools are developed and in use by Sectors and communities
Output 3.3. Implementing knowledge management, engagement, and outreach across sectors and communities	CIS tools and information is used to strengthen Sectors and communities to climate change impacts
Output 4.1. Institutional capacity to implement CIS across sectors strengthened	Sectors are using CIS in their decision-making
Output 4.2. Training of personnel leads to strengthening of institutional capacity	Capacity and knowledge of climate change and CIS are improved within VMGD and targeted Sectors