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Advancing Flood Early Warning in Selected Pacific Island Countries: A Roadmap

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Advancing Flood Early Warning in Selected Pacific Island Countries: A Roadmap

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The *Advancing Flood Early Warning in Selected Pacific Island Countries: A Roadmap* developed under the *Hydrology support for flood early warning systems in the Pacific* project, supported by the Australian Water Partnership (AWP).

This roadmap was developed in consultation with Fiji Meteorological and Hydrological Service, Samoa Ministry of Natural Resources and Environment (Water Resources Division), Solomon Islands Water Resources Management Division and, Vanuatu Department of Water Resources, is subject to further review by Pacific countries in 2024.

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A gorge in the upper Navua Catchment, Fiji,
© Pacific Community (SPC) photo credit Alluvium International

1. FOREWORD

The Pacific is one of the most natural disaster-prone regions in the world. Approximately 69% of disasters are related to hydro-meteorological hazards (e.g. storms, flooding and drought), and every year flooding in the Pacific is responsible for loss of life, infrastructure damage and disruption to business and communities. On average, economic impacts total USD 157 million annually.[1] Between 2010 and 2021, floods in the Pacific resulted in the displacement of over 210,000 people.[2] The impacts are often felt disproportionally—women, children, people with disabilities, vulnerable and intersectional groups experience natural disasters, like flooding, differently.[3]

According to the United Nations Office for Disaster Risk Reduction (UNDRR), "of all risk reduction and climate change adaptation measures, early warning and early action stand as one of the best-proven and cost-effective methods for reducing disaster deaths and losses."[4] Early Warning Systems (EWS) are designed to reduce the impact of natural hazards upon communities and organisations by giving them more time to prepare.

Hydrological data is central to creating an effective flood EWS. This data informs forecasts of location, timing and magnitude of flood events. However, the limited availability of real-time data, hydrological observation systems and appropriate hydrological data management and analysis is a significant gap across Pacific Island countries (PICs). Increased capacity to collect, manage and analyse hydrological data will support the enhanced performance of flood early warning systems.

The roadmap has been developed in collaboration with National Hydrological Services (NHSs) from Fiji, Samoa, Solomon Islands and Vanuatu. The development of this roadmap draws upon the understanding and experience of situations current at time of writing in these countries. These countries experience a range of types of flood events and water-related challenges that are common across other PICs.

This roadmap is also a step towards understanding and addressing the unique challenges facing hydrological services in PICs. Hydrological data is critical across ten of the Sustainable Development Goals (SDGs) and supports many sectors, including water; food and energy security; disaster risk management; and the design of climate resilient infrastructure. There are often multiple agencies involved in the collection and analysis of hydrological data, including NHSs, National Meteorological Services (NMSs); Land and Mineral Resources/Geology Departments; water utilities, water supply services and public health departments. As such, a suite of complementary and coordinated strategies, informed by broader consultation across other PICs may be required to address the range of hydrological challenges facing the region.

1. Australian Aid 2021. Pacific Risk Profile: Pacific Region. Available at: ↗ https://wrd.unwomen.org/sites/default/files/2022-01/PACIFIC%20RISK%20PROFILE_Pacific%20Region.pdf (accessed 28 May 2024).

2. Internal Displacement Monitoring Centre (IDMC) n.d. Disaster Displacement in Asia and the Pacific. Available at: ↗ https://api.internal-displacement.org/sites/default/files/publications/documents/220919_IDMC_Disaster-Displacement-in-Asia-and-the-Pacific.pdf (accessed 28 May 2024).

3. The term 'intersectionality' is used to recognise that individuals hold many social and cultural identities that can impact on their experience of and response to natural disasters. These differences are those that exist within traditional social and cultural groups such as diverse gender identities *fa'afafine, fakaleiti, fakafifine, akava'ine and qauri.*

4. United Nations Office for Disaster Risk Reduction (UNDRR) n.d. Early Warning For All (EW4All). Available at ↗ https://www.undrr.org/implementing-sendai-framework/sendai-framework-action/early-warnings-for-all (accessed 29 May 2024).

2. PURPOSE OF THE ROADMAP

VISION: *To increase climate resilience and strengthen Disaster Risk Reduction systems in Pacific Island countries through increased hydrological capacity and enhanced performance of flood early warning systems.*

Teouma River, Efate, Vanuatu

Participants during the roadmap development workshop in Rakiraki, Fiji, February 2024 © Pacific Community (SPC) / Credit: SPC

This roadmap aims to assist countries, regional organisations and development partners to effectively support the capacity of NHSs. These services exist in many forms with many capacities across the Pacific, but they all play an important role in supporting national goals for development and climate resilience, including flood early warning. This roadmap captures the goals and outcomes articulated by NHSs that will enable them to reach their full potential.

Support to hydrological services can provide benefits across multiple sectors. For example, investing in improved hydrological services can strengthen flood early warning, while also benefiting other sectors relying on hydrological data, such as infrastructure services, water utilities and national planning. Targeted support to NHSs can be an effective way for countries to meet their national climate and adaptation goals. There are many entry points to supporting hydrological services (e.g. NHSs, NMSs, Water Utilities), and this roadmap helps to identify effective pathways in which that support can be most effective.

This roadmap is intended to assist countries with strategic programming as well as potential action and investment for improving hydrological services to enhance flood early warning within their respective countries. It is also intended to assist development partners and regional organisations in the design of initiatives to support hydrology and flood early warning that are reflective of the goals and outcomes identified by NHSs.

There are limited funds and resources available to implement initiatives in the roadmap. In pursuing efficient and effective implementation of the roadmap, it will be important to build and maintain cooperation, coordination and consistency of approach within national government agencies and between regional and international bodies, civil society organisations and donors.

This will avoid duplication, while maximising opportunities to build on existing programs and work.

Development of the roadmap

This roadmap is informed by experiences and outputs from the *Hydrology Support to enhance Flood Early Warning* project (see next page), undertaken by SPC over a period of two years (2022–2024). The collaborative process of developing the roadmap included nearly 200 stakeholder and community consultations and the implementation of two pilot studies (in Fiji and Vanuatu). The project culminated in a roadmap development workshop in Rakiraki, Fiji, in February 2024, attended by representatives of NHSs from each of the four project countries: Fiji, Samoa, Solomon Islands and Vanuatu.

The findings and recommendations of the *Pacific Countries and Territories Hydrological Capacity Assessment and Needs*[5] *Report* also contributed to the development of the roadmap. The report canvassed the hydrological capacities and needs in 11 PICs.

The development and provisioning of flood early warning requires strong linkages between the agencies responsible for hydrological services, weather forecast services and disaster management. In light of this, the project consulted with and sought expert advice from each of these stakeholder groups, which played a major role in the development of the roadmap.

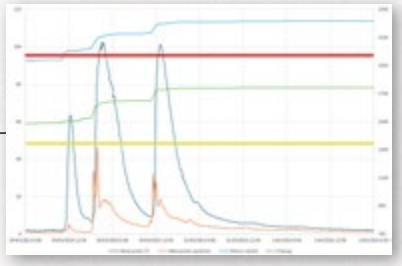
5. Catchlove R., Stewart B, and Hankinson A., 2019. Pacific Countries and Territories Hydrological Capacity Assessment and Needs. A report for Pacific Hydrological Services Panel and SPREP.

Participants during the roadmap development workshop in Rakiraki, Fiji, February 2024 © Pacific Community (SPC) / Credit: SPC

The **Hydrology support to enhance flood early warning** project undertook a range of activities across Fiji, Vanuatu, Samoa and Solomon Islands over a period of 2 years, including:

Field assessment

Data analysis



Rainfall/runoff (hydrological) modeling

Flood (Hydraulic) modelling

Field maintenance & planning

Data synthesis

Hydrometric station installation

Stakeholder consultation

Impact based forecasting

Funding support from Australian Water Partnership

Australian Aid
THE AUSTRALIAN WATER PARTNERSHIP

Transporting hydrometric monitoring equipment down the Teouma River, Vanuatu

3. WHY WE NEED A ROADMAP

PICs are home to resilient communities who maintain strong connections to their land and thus hold critical traditional and local community knowledge related to water and flooding. Floods are natural and common occurrences in PICs that impact these communities. However, their ability to prepare for and respond to flooding is changing due to increasing rainfall intensity coupled with urbanisation in flood-prone areas. Furthermore, the impacts of flooding are not felt equally and typically compounds the vulnerability of women, children, people with disabilities and vulnerable and intersectional groups.

Hydrological services play a critical role in understanding and communicating the risks of flooding and water-related disasters, including forecasting and warning of impending flood events. This role will only become more critical as rainfall events are expected to become more intense as the impacts of climate change become more pronounced. Currently, hydrological services across the region do not have the capacity or capability to fulfil the suite of hydrological services that are required for effective flood early warning. There are a range of political, economic, social and technological factors that influence this capability, which have resulted in significant challenges to the role of hydrological services (See annex 1 for further details).

Whilst flooding cannot be prevented, supporting the collection, management and analysis of hydrological data will enhance the ability of communities and other stakeholders to make evidence-based decisions, helping to preserve their resilience to flooding and reduce the socio-economic costs from flooding experienced by PICs annually.

To date, investment and support for hydrology has been ad hoc and in many cases has not involved the national hydrological services. For example, a recent study identified 46 projects within the region where high quality hydrological services were fundamental to the success of the projects. However, NHSs appear to have been directly engaged in only four of these projects. This ad-hoc investment has resulted in the failure of approximately 200 of the over 250 river level monitoring stations installed in the region and challenges to capacity in NHSs, which in many cases impacts the ability of NHSs to provide effective flood forecasting and warning.

There is a need for a regional strategic approach, which can be scaled to the national situation for a structured approach to support hydrological services in PICs. Through the development and implementation of this roadmap, the hydrological services community can enhance coordination and leverage funding at both the national and regional scales. This will further support and resource PIC's work towards a defining a regional strategy for hydrological services.

"There is a need for a regional strategy on flood early warning systems because Pacific Island Countries which are vulnerable to flood events have similar needs, similar gaps and similar challenges, being able to come together and have this discussion."

Ms Emarosa Romeo, Principal Hydrology Officer, Ministry of Natural Resources and Environment, Samoa

Types of flooding

There are five main types of flooding that affect PICs: riverine flooding, flash flooding, urban/pluvial flooding, groundwater flooding and coastal flooding. Almost all PICs experience urban/pluvial flooding and coastal flooding, whilst riverine flooding and flash flooding is restricted to high volcanic islands with short steep catchments, such as Fiji, Samoa, Solomon Islands, Vanuatu, New Caledonia, Papua New Guinea and Cook Islands. Groundwater flooding, due to rising water levels in low-lying areas, has been identified in parts of Vanuatu.

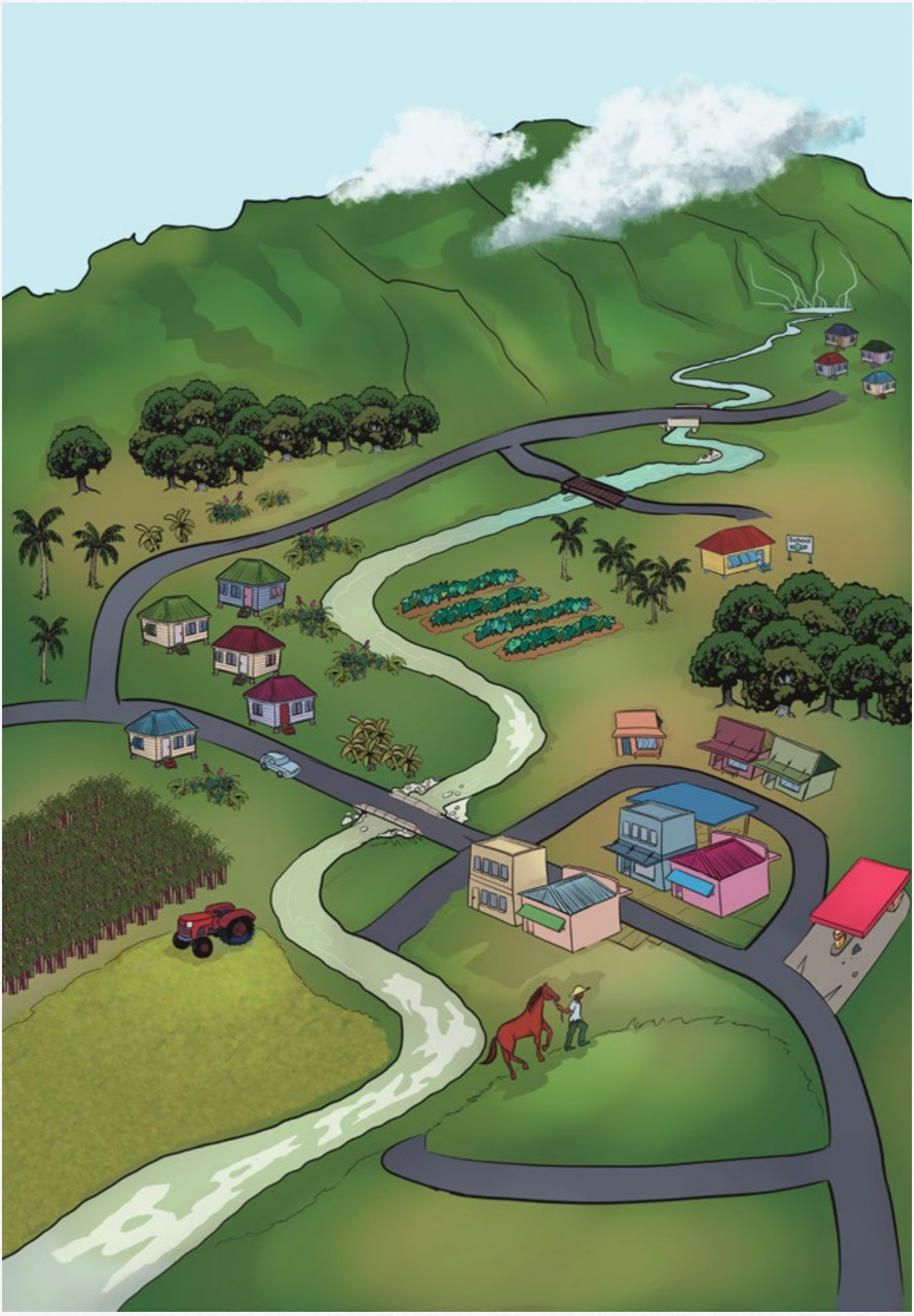
Impacts of flooding

The impacts of flooding can be variable and wide ranging. Major flooding can result in significant loss of life and nationally-significant economic impacts, for example, the 2014 floods in Honiara, Solomon Islands, where 24 people died and loss and damage equated to ~ 9.2 % of GDP (USD 90 million).[6] Another example is the 2009 floods in western Fiji, where seven people died and loss and damage equated to ~ 7 % of GDP (USD 190 million).[7] However, the accumulated impacts of more frequent minor and moderate flooding could exceed that of the single large flood events. For example, in the 39 years between 1980 and 2019 in Fiji, 127 flood events were recorded, which resulted in over 200 deaths and significant economic and social impacts upon communities.[7] Typical impacts from flooding can be both immediate and long-term. They include:

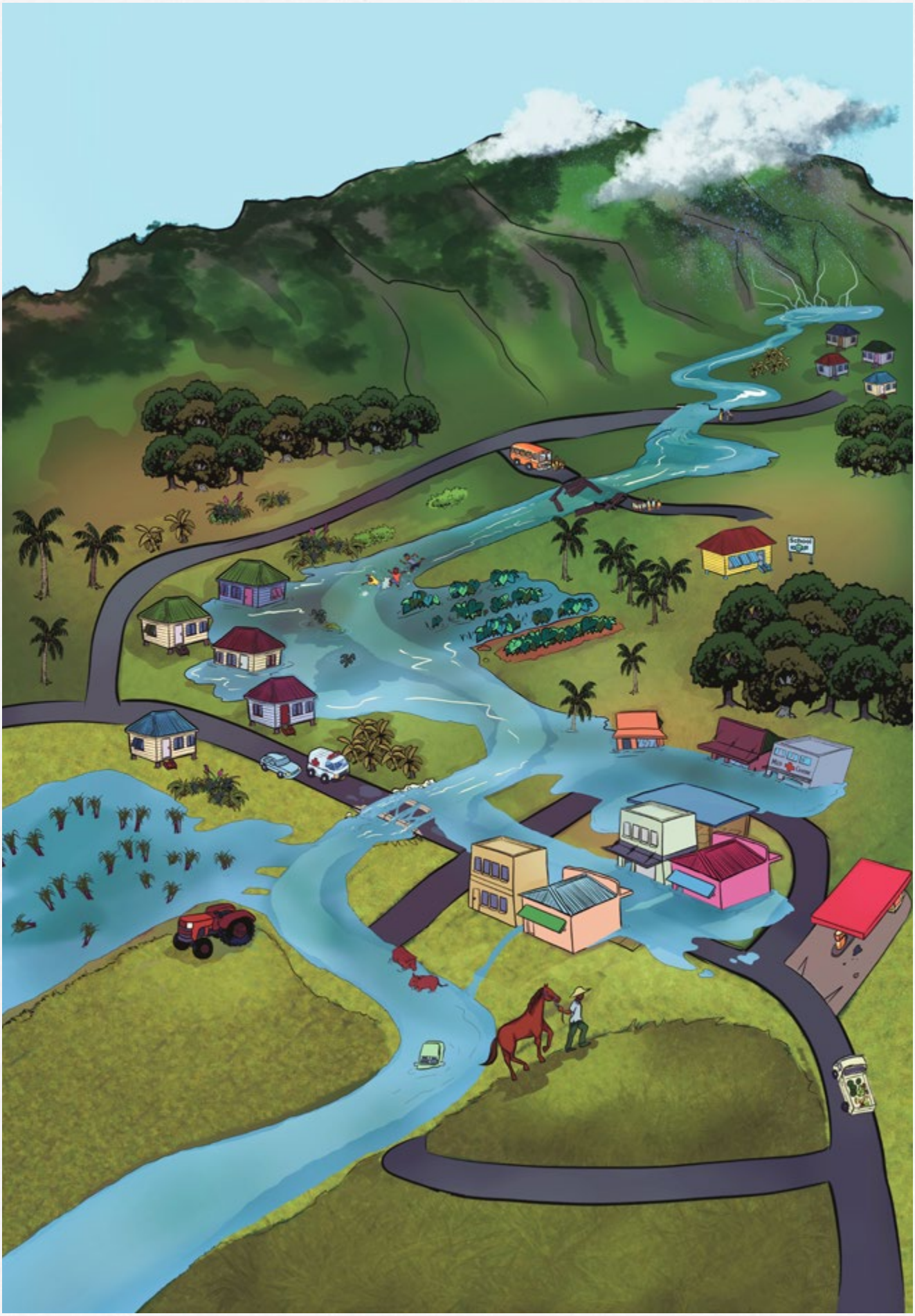
- Loss of life
  - ⟶ Often in PICs these deaths occur whilst trying to cross flooding rivers
- Damage to and inundation of properties
- Impacts upon water quality
- Damage to infrastructure
  - ⟶ For example, bridges, water supply pipes, roads, communication networks
- Road and river crossing closures
  - ⟶ Disruption to transport networks
  - ⟶ Isolated communities
- Damage to agricultural enterprises—damage to crops and loss and displacement of livestock, which can affect food security

6. Yeo S., Esler S.L., Taaffe F.P., Jordy D.J.-J. and Bonte-Grapentin M. 2017. Urban flood risk management in the Pacific: Tracking progress and setting priorities (English). UFCOP knowledge notes Washington, D.C.: World Bank Group. Available at ↗ http://documents.worldbank.org/curated/en/421071516106649769/Urban-flood-risk-management-in-the-Pacific-tracking-progress-and-setting-priorities (accessed 29/05/2024).

7. Fiji Meteorological Service, 2022, List of floods occurring in the Fiji Islands between 1840 and 2019, FMS Information Sheet 125.



Barriers and enablers to hydrology and flood early warning in the Pacific



Gender equality, disability and social inclusion

Weather, water and climate-related hazards pose significant challenges on a global scale, affecting communities worldwide. However, these impacts are not evenly distributed, with certain groups bearing a disproportionate burden. Women, children, youth, people with disabilities, and other vulnerable and intersectional groups face unique vulnerabilities because their specific needs often go unheard or are inadequately considered in critical decision-making processes. Consequently, these groups are more severely impacted by hazards, exacerbating existing inequalities. These groups experience stigma, discrimination and lack of protection. For intersectional vulnerabilities such as in the case of traditional gender diverse individuals, including *Fa'afafine*, *fakaleitī, fakafifine, akava'ine, qauri*, adolescent girls with disability and pregnant women for example, the impacts are multiplied exponentially. These groups often experience higher mortality, loss of livelihoods, risks of gender-based violence, or are at the risk of being excluded from evacuation and relocation activities due to lack of representation in consultations and in decision making structures.

These groups also possess unique capabilities that are invaluable for DRM. Women often serve as primary caregivers and formal and informal community leaders and bring valuable insights into local dynamics, resource management, and risk perception. Their knowledge of traditional coping mechanisms and community networks enhances resilience and facilitates effective disaster response. Similarly, youth are often at the forefront of innovative solutions and technology adoption, playing a crucial role in community mobilisation, awareness raising and advocacy for inclusive DRM policies. Additionally, people with disabilities offer invaluable perspectives on accessibility, inclusive communication and adaptive strategies essential for ensuring the resilience of all members of society to natural hazards. Harnessing the capabilities of women, youth, people with disabilities and other vulnerable and intersectional groups in DRM efforts not only strengthens community resilience but also fosters greater social cohesion and empowerment.

The *Sendai Framework for Disaster Risk Reduction 2015-2030* emphasises the importance of engaging women in building disaster resilience programmes. Recommendations include considering gender, age, disability and cultural perspectives across all disaster risk reduction (DRR) policies and practices.

"Women's participation is critical for effectively managing disaster risk and designing, resourcing and implementing gender-sensitive disaster risk reduction policies, plans and programmes; and adequate capacity building measures need to be taken to empower women for preparedness as well as build their capacity for alternate livelihood means in post-disaster situations."

(UNDP 2018) [8]

8. United Nations Development Programme. 2018. Five approaches to building functional early warning systems. Available at ↗ https://www.adaptation-undp.org/sites/default/files/resources/undp_brochure_early_warning_systems.pdf (accessed on 29/05/2024).

The *Sendai Framework* identifies responsibilities and actions that need to be taken from national government level through to local government and community levels. It stresses the roles of non-government and civil society organisations in disseminating disaster information (UN nd).[9]

Flood warnings need to have a human-centric approach and be tailored to suit local communities' interests, needs and values to be effective. Local communities often have a complex knowledge of local disasters and have an inherent capacity to respond to these. Involving communities in DRR, emergency management planning and including local languages and existing knowledge of indicators of floods can improve responsive actions. The incorporation of GEDSI into the messaging is crucial to ensure vulnerable members of society do not get left behind. An example of GEDSI in initiatives by hydrological services is provided in Annex 2, along with common GEDSI issues in disaster risk management and potential solutions that address these issues.

9. United Nations, n.d. Sendai Framework for Disaster Risk Reduction 2015 – 2030, available at ↗ Sendai Framework for Disaster Risk Reduction 2015 - 2030 (undrr.org) (accessed on 29/05/2024).

Mapping of flood extents and flood behaviour during a community meeting in Vatukacevaceva, Fiji, April, 2023 © Pacific Community (SPC) / Credit: SPC

4. FLOOD EARLY WARNING FRAMEWORK

The geography and climate of many PICs render them vulnerable to impacts from extreme flooding. Volcanic islands with short and steep catchments combined with intense tropical weather events such as cyclones can lead to the rapid onset of extreme flooding known as flash floods. The short timeframe between rainfall and flash flooding poses significant challenges for early flood warning. This timeframe can be shorter than the time required for decision making and emergency response. As such, the interlinkages between NMSs, NHSs and disaster management organisations (DMOs) are essential to effective end-to-end flood warning.

To reflect the integrated nature of end-to-end flood warning, a Flood Early Warning Framework was developed through the project, *Technical Support in Hydrology to enhance Flood Early Warning in the Pacific*. The framework was developed as an extension to the United Nations office for Disaster Risk Reduction (UNDRR) Multi-Hazard Early Warning Framework (MHEWF) to be specific to flood early warning. The UNDRR MHEWF includes four pillars. These are described in Table 1 (below), which also lists the types of PIC agencies involved in each pillar.

The flood early warning framework guides the understanding of the status of end-to-end flood early warning systems in PICs. Development of the framework was informed by inputs gathered through consultation with lead hydrology, meteorology, disaster and emergency response agencies from PICs

Table 1.
Pillars of the Multi-Hazard Early Warning Framework

	Pillar	Description	Agencies involved
1	**RISK/IMPACT**	***Understanding and mapping the hazard*** **– understanding the potential likelihood and consequence of flooding. It refers to the awareness of the spatial scale, temporal scale and magnitude of flooding combined with the vulnerabilities of communities.**	**DMOs*, NMSs, NHSs**
2	**MONITORING AND WARNING SERVICES**	***Monitoring and forecasting impending*** **– monitoring and forecasting meteorological events; forecasting, predicting and monitoring catchment responses to rainfall; and determining and disseminating flood warnings.**	**NMSs*, NHSs***
3	**DISSEMINATION AND COMMUNICATION**	***Processing and disseminating understandable warnings to political authorities and the population*** **– what message needs to be communicated to warn people of impending flooding and getting that message to the people and organisations that are going to be affected by flooding.**	**NMSs*, DMOs, NHSs**
4	**RESPONSE CAPABILITY**	***Undertaking appropriate and timely actions in response to the warnings*** **– the capability of communities and agencies impacted by flooding to respond to the flood warnings**	**DMOs***

* Denotes the typical lead agency for the pillar

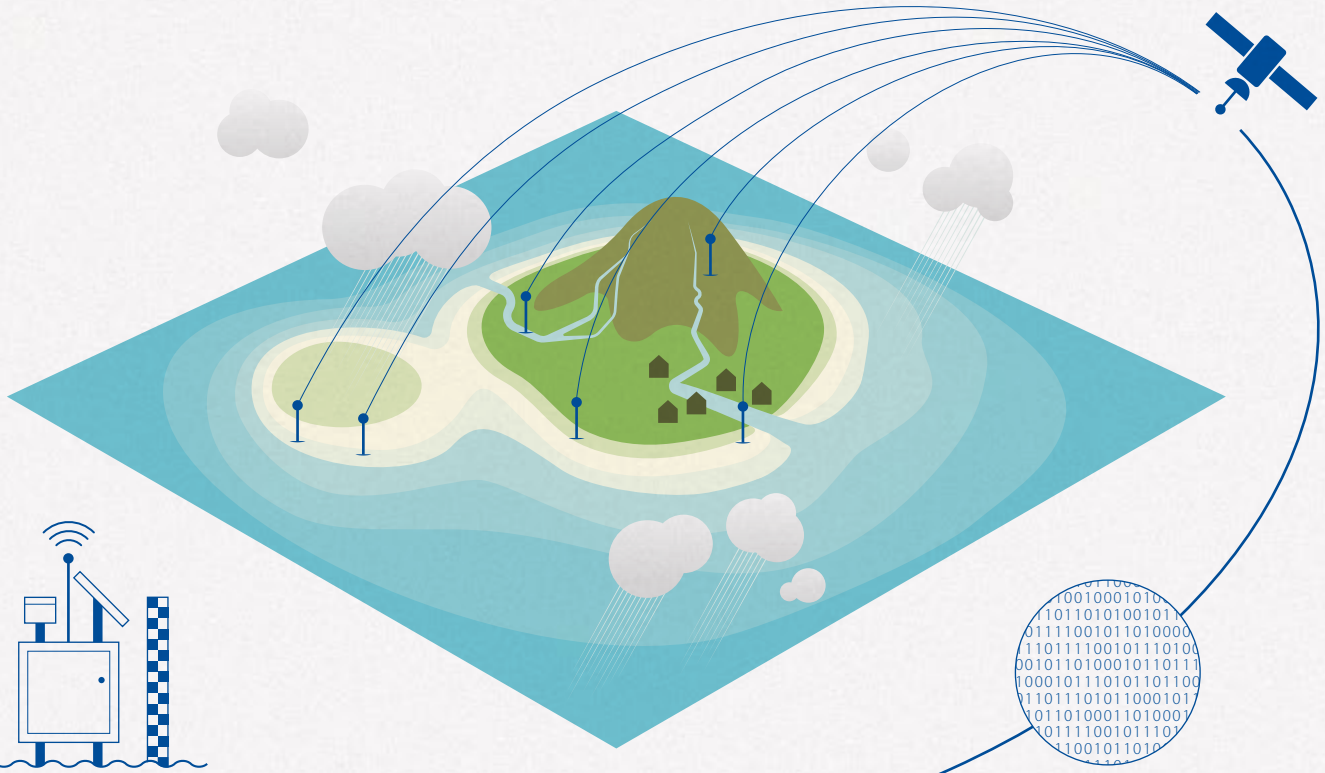
Flood early warning framework

and regional agencies. The framework is specific to riverine flooding and does not extend to an assessment of systems and infrastructure relating to tidal, coastal or marine inundation.

The framework maintains the four pillars of the UNDRR multi-hazard early warning framework at its core but breaks these into components specific to flood early warning under each pillar. These components are broken down further to elements that support each component. The framework supports the development and implementation of this roadmap by detailing the specific requirements that encompass an effective flood early warning system. The approach extends across the full value chain of flood early warning systems and disaster risk reduction, which helps to identify the role in which hydrology plays.

Role of hydrology in flood early warning

HYDROLOGICAL DATA IS A FOUNDATIONAL PART
OF AN EFFECTIVE FLOOD EARLY WARNING SYSTEM



1

Telemetered hydrological observational networks
Measurement of rainfall volumes, water level and streamflow.

2

Hydrometric data
Managing data: including data processing, quality assurance and control, archiving and data sharing.

3

Analysis of data
Understanding the relationship between rainfall, runoff, river water level response.

4

Flood modelling
Understanding the extent and impacts of flood events.

5

Flood forecasting
Predicting the location, timing and magnitude of flood events.

6

FLOOD EARLY WARNING
Impact based forecasting

Hydrology plays a crucial role in flood early warning through understanding, predicting, and preparing for flooding. By studying and understanding factors such as rainfall patterns, topography, soil moisture, land use, and river flow dynamics, hydrologists can assess the location, likelihood, timing, and severity of flooding.

1. **Telemetered hydrological observation networks collect near-real time measurements of rainfall volumes, river water levels and in some cases, flow volumes. The ongoing maintenance and validation of hydrometric equipment to ensure data quality is a key part of an effective hydrological and meteorological observation network and is critical to its ongoing operation and sustainability.**

2. **Hydrometric data management includes data processing, quality assurance and control, archiving and data sharing. The quality and quantity of hydrological data, namely rainfall, water levels and streamflow, is critical to the ability to accurately forecast flooding.**

3. **Analysis of hydrological data helps hydrologists understand the relationship between rainfall, runoff, river water level response, and the likelihood of flooding. Hydrologists use this information to model hydrological responses under a range of scenarios which are then used to improve flood warning through an increased understanding of the timing and magnitude of flood events.**

4. **Flood models predict and simulate where water might flow, which can be used to determine impacts of flooding. The accuracy of flood modelling and mapping is dependent on the quality and quantity of the input data. Poorly calibrated flood models are more likely to over or underestimate the risk of flooding and provide less accuracy around the movement of floodwaters.**

5. **Flood forecasters use real time data, coupled with an understanding of the relationship between rainfall and river water level response, to predict which rivers might be about to flood, at what time and at what height flood waters will peak.**

6. **There are many ways to undertake flood forecasting and there are many different flood early warning systems available. The type of methodology used to undertake flood forecasting is dependent on its applicability (suitability) for the system and the availability of resources.**

   The common theme between the methods is the quality of the hydrometric data that underpins forecasting and decision making, i.e. it doesn't matter if the systems are the most expensive or complex, if poor quality or inaccurate data is used to 'feed' or support these systems then it is unlikely they will yield the anticipated benefits.

RESILIENT FUTURE

Hydrological services support many sectors, including water, food and energy security; disaster risk management; and the design of climate resilient infrastructure.

5. CONTRIBUTION OF THIS ROADMAP TO NATIONAL, REGIONAL AND GLOBAL RESILIENCE GOALS

The Sustainable Development Goals and the *Sendai Framework for Disaster Risk Reduction 2015–2030* set global goals for sustainable development, and for preventing and reducing disaster risk and losses. Similarly, the *2050 Strategy for the Blue Pacific Continent* and the *Framework for Resilient Development in the Pacific 2017–2030* provide guidance on the implementation of the global goals at the regional level. Many of the goals outlined in the global and regional frameworks are reliant on effective hydrological services. This roadmap is designed to support PICs to achieve their national development and resilience goals through enhancing the capacities of NHSs. The goals and outcomes provide pathways, as identified by NHSs, in which hydrological services can be strengthened across PICs.

There are a range of initiatives across the Pacific to support DRR and sustainable development, including the Pacific regional Weather Ready Pacific Programme of Investment and the global Early Warning for All initiative. These initiatives operate at different levels and incorporate a range of hazards and thematic areas. This roadmap highlights the role that hydrological services play in supporting these initiatives and recognises the importance of close collaborations and partnerships, in particular with other government departments/agencies and regional organisations.

National priorities

In many PICs, NMSs, NHSs and DMOs sit within different divisions and/or ministries, but all have responsibilities across the flood early warning value chain, and collaboration between agencies is essential to an effective flood EWS. A range of national legislation, strategies, policies and agencies already exist to guide the various responsibilities of flood early warning within PICs. The capacity and capability of national hydrological services throughout PICs continue to be supported by national government initiatives, bilateral support from development partners and regional initiatives.

This roadmap seeks to leverage and build upon existing capacities and initiatives with a focus on supporting each of the agencies responsible for flood EWS through strengthening the capacity and capability of hydrological services.

Regional initiatives

A range of forums and initiatives are already supporting hydrology and flood early warning within the region. For example, the Pacific Hydrological Services Panel supports NMSs through providing strategic advice to

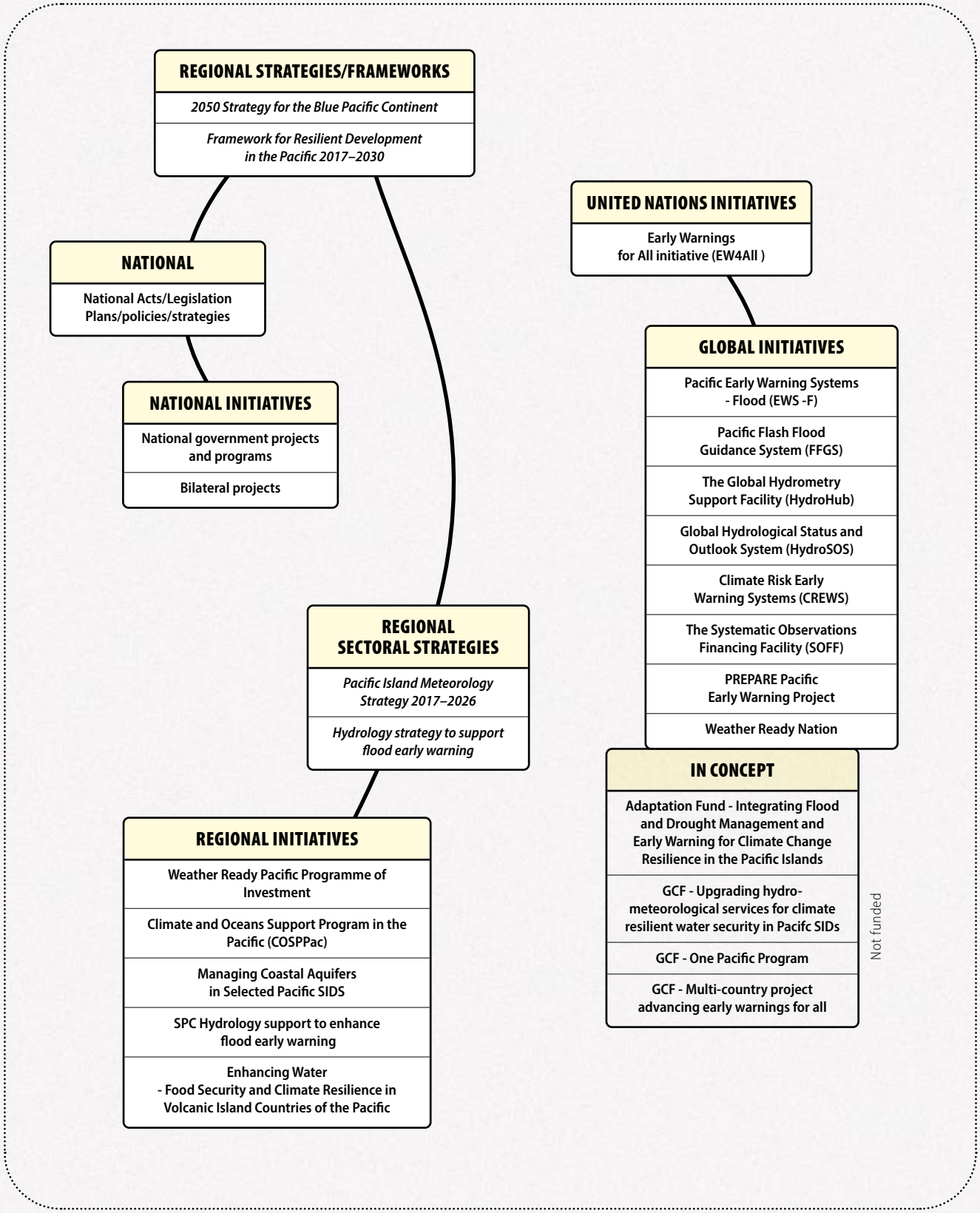
the Pacific Meteorological Council (PMC). Additionally, the Regional Association V (RAV) Hydrology Working Group are responsible for the coordination of meteorological, hydrological and related activities within the Southwest Pacific Region. This roadmap seeks to support these efforts through the articulation of goals, outcomes and potential action pathways that have been identified by the hydrological services community.

Regional agencies play a significant role in supporting national hydrological services and flood early warning, including SPC, the South Pacific Regional Environmental Program (SPREP) and the Pacific Islands Forum Secretariat (PIFS). These agencies are members of the Council of Regional Organisations of the Pacific (CROP) who are mandated to support member countries to achieve their resilience and development goals. Continued collaboration between CROP agencies and with PICs is essential to delivering hydrological advancements in flood early warning.

By defining the shared strategic direction of the national hydrology services, this roadmap aims to build and maintain cooperation, coordination and consistency of approach in leveraging funding to support the role of hydrological services in flood early warning. Hydrological services would benefit from developing a regional community of practice and forum to better communicate hydrological issues, challenges and linkages across sectors, as well as tapping into existing national and regional forums, and funding sources to drive each of the four goals. Key initiatives include SPC's project support for hydrology to enhance flood early warning, the Weather Ready Pacific and global initiatives such as EW4All and the regional flash flood guidance system (FFGS).

Flooding on the Queens Highway, Fiji © Pacific Community (SPC) / Credit: Alluvium International

Strategies, frameworks and initiatives related to hydrological services and flood early warning



INTERNATIONAL FRAMEWORKS

Sendai Framework for Disaster Risk Reduction 2015–2030

Sustainable Development Agenda 2015–2030

Maintenance of monitoring equipment by Vanuatu Department of Water Resources, 2023 © Pacific Community (SPC) / Credit: SPC

Field assessment by Fiji Meteorological Service, Viti Levu, Fiji, 2022 © Pacific Community (SPC) / Credit: SPC

Simplified flood early warning system equipment, Mataniko River, Solomon Islands © Pacific Community (SPC) / Credit: SPC

6. GOALS AND OUTCOMES TO SUPPORT THE VISION

This roadmap has four goals which address the key challenges identified in the region. Each goal is underpinned by more specific outcomes and actions. The four goals outline the opportunities to support the vision for hydrology to strengthen the technical foundations of flood early warning and to integrate hydrology more widely across sectors. Together, the goals, the outcomes and the actions establish clear priorities.

GOAL 1 To enhance **awareness** and foster **engagement** regarding the critical role of hydrological services in supporting effective disaster risk management.

GOAL 2 To improve the availability and reliability of **hydrometric data** to strengthen flood early warning systems, vital to safeguard lives and livelihoods.

GOAL 3 To ensure hydrometric observation data is incorporated into **impact-based flood forecasting** for informing mitigation and preparedness actions.

GOAL 4 To establish multiple **training pathways** to promote a sustainable pool of diverse skilled staff, ensuring *continual improvement* of hydrological services to manage the current and emerging needs of relevant sectors.

Stream gauging by Fiji Meteorological Service, Fiji, 2022 © Pacific Community (SPC) / Credit: SPC

GOAL 1

*To enhance **awareness** and foster **engagement** at all levels regarding the critical role of hydrological services in supporting effective disaster risk management.*

Context

There is a general lack of awareness of the integral role that hydrological services play in preparing for climate resilient communities. As a result, support for national hydrological services, including Flood EWS, has historically not been provided in a systematic or standardised way across the region. This has led to reduced hydrological capacity for monitoring and analysis, limiting the ability to provide effective flood warnings to support the safety and resilience of PIC communities. Increased engagement between national hydrological and meteorological services, and disaster management organisations is critical for effective flood early warning.

Outcomes

A) Increased awareness: Raise awareness among stakeholders and the communities about the essential role of hydrological services in DRM, highlighting their significance in mitigating and responding to water-related disasters.

B) Strengthened engagement: Foster collaboration and dialogue among government agencies, regional organisations, civil society organisations, academia and communities to promote understanding and utilisation of hydrological services in DRM planning and decision-making processes.

C) Policy integration: Advocate for the integration of hydrological services into national and regional meteorological, DRM and climate change policies, frameworks and strategies, ensuring their inclusion as a fundamental component of disaster preparedness and response efforts.

D) Increased and sustainable investments: Advocate for increased financial support and resource allocation towards hydrological services and operational capabilities, enabling them to better support effective DRM and climate change adaptation efforts at all levels.

Action pathways

- Effective communication, knowledge sharing and inclusive engagement to bridge the gap between technical expertise and local perspectives, enhancing accessibility of hydrological information.
- Raise awareness of the value of hydrological services, leveraging existing forums and relationships and identify new opportunities.
- Develop communications products to support the awareness of hydrology and foster engagements.
- Strengthen interagency relationships at a national level regarding hydrology and flood early warning.
- Review of the integration of hydrological services into national and regional meteorological, DRM and climate change dialogues, policies, frameworks and strategies.
- Establish the effectiveness of investment in hydrology services through the development of a business case for investment in hydrological services through cost-benefit analyses.
- Identification of potential funding mechanisms to support sustainable, programmatic approaches to hydrological support.
- Establish baseline mapping of existing stakeholders and their interconnectedness.
- Mainstream GEDSI principles throughout design, implementation and monitoring, evaluation, reporting and learning (MERL).

Participants at the Fiji National Flood Early Warning Workshop, Suva, August 2022
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Hazard mapping with members of the hydrological services, weather forecast services and disaster management in Samoa
© Pacific Community (SPC) / Credit: SPC

Hydrometric monitoring station Vaturu Dam, Fiji © Pacific Community (SPC) / Credit: SPC

GOAL 2

*To improve the availability and reliability of **hydrometric data** to strengthen flood early warning systems, vital to safeguard lives and livelihoods.*

Context

Hydrometric observation data is the foundation of effective flood early warning. Telemetered hydrological observational networks are a critical tool in flood forecasting. Telemetered data networks allow flood forecasters to collect and access near real time information to help identify where rainfall is occurring, how the catchment is responding (i.e. how the river water level is changing), and when and where it is likely to result in flooding. The ongoing maintenance and validation of hydrometric equipment to ensure data quality is a key part of an effective hydrological and meteorological observation network and is critical to its ongoing operation and sustainability.

Outcomes

A) Timely and reliable data access: Consistent, long-term functionality of hydrometric monitoring equipment enabling near-real time telemetered hydrometric data.

B) Optimised coverage: Increase the coverage of hydrometric data through the expansion and modernisation of monitoring networks, ensuring risk-informed and need-based coverage of flood prone areas.

C) Robust and centralised data management: Establish national centralised data archives for hydrometric data, facilitating easy access, quality assurance, standardised data formats and comprehensive data storage, ensuring single window, long-term data preservation and accessibility.

Action pathways

- Standardisation of equipment and maintenance procedures at a national level.
- Improved standard operating procedures and systems to support hydrometric data collection and management.
- Engagement with communities to increase awareness around the purpose and value of protecting observation equipment to ensure data integrity and long-term datasets.
- Development and refinement of streamflow rating tables for all water level monitoring locations, supported by improved streamflow gaugings with a focus on medium to high flows to support flood early warning.
- Optimisation of observation networks to support well informed forecasting with increased spatial and temporal resolution.
- Identification and implementation of innovative, tailored solutions and technological advancements where appropriate to a Pacific Island setting and in line with national priorities.
- Identifying and adopting a modern, fit-for-purpose database for the management, storage and sharing of hydrological data.
- Improved data sharing policies and practices.

Water level monitoring station in the Teouma River, Vanuatu
© Pacific Community (SPC) / Credit: SPC

Water Authority Fiji and SPC undertaking a river cross-section survey of Penang River, Fiji
© Pacific Community (SPC) / Credit: SPC

Members of the Greenhill Community assisting with the installation of a hydrometric monitoring station in the Teouma River, Vanuatu © Pacific Community (SPC) / Credit: SPC

GOAL 3

*To ensure hydrometric observation data is incorporated into **impact-based flood forecasting**, for informing mitigation and preparedness actions.*

Context

For effective and actionable warnings, communities need to understand where and when a flood is likely to occur, how big that flood might be and what the impacts could be. An understanding of flood risk and the interpretation of observed data (in conjunction with rainfall forecasts) provides flood forecasters with the information to understand the potential timing, magnitude and impact of flooding, which in turn supports impact-based forecasting. Communities play a critical role in the understanding of risk. PICs are home to resilient communities that maintain strong connections to their landscapes and hold important historical, traditional and community knowledge related to hydrology and flooding.

The analysis of quality hydrometric observation data, validated by community knowledge, is fundamental to the understanding of flood risk, and flood forecasting and monitoring, which in turn is dependent on the tools, capacity and capability of NHSs.

Outcomes

A) **Data driven flood modelling:** Flood risk modelling and mapping is informed by and calibrated/validated with relevant hydrological observation data and traditional and community knowledge.

B) **Actionable and data informed flood warnings**: Flood warnings are informed by hydrometric data and community knowledge, and include potential flood location, timing, magnitude and impact, making them actionable by communities and relevant authorities for enhancing response effectiveness and reducing vulnerability to flood-related hazards.

Action pathways

- Develop flood models and maps using quality assured hydrological data validated by traditional and community knowledge.
- Incorporate near real-time hydrometric observation data into operational flood forecasting to enable impact-based flood forecasting.
- Investigate and apply up-to-date flood early warning systems and technologies.
- Harness community historical and traditional knowledge to ensure impact-based forecasting is accessible, inclusive and human centric, and is reflective of the local communities' interests, needs and values.
- Mainstream GEDSI approaches throughout stakeholder engagement.
- Identify and enhance necessary capacities across communities and other stakeholders to develop and improve understanding of hydrological messaging.

Data analysis by Fiji Meteorological Service Hydrology division staff © Pacific Community (SPC) / Credit: SPC

Mapping of flood extents and flood behaviour during a community meeting in Rakiraki, Fiji, April, 2023 © Pacific Community (SPC) / Credit: SPC

Field inspection of a flood prone community in Tamboko, Solomon Islands © Pacific Community (SPC) / Credit: SPC

GOAL 4

*To establish multiple **training pathways** to promote a sustainable pool of diverse skilled staff, ensuring continual improvement of hydrological services to manage the current and emerging needs of relevant sectors.*

Context

Diverse skilled technical staff are at the core of hydrological services and flood forecasting. However, PIC NHSs generally have very limited numbers of trained hydrological specialists, particularly women, and there are limited formal hydrological training pathways. Enhancing staff capacity to meet the current and future challenges of building, operating and utilising critical hydrological infrastructure and undertaking flood forecasting are essential to an effective flood early warning system. This can only be achieved through a co-design/co-development approach with NHSs to develop clear training pathways informed by identified country needs and to ensure the retention of skills and knowledge within institutions. A commitment to the *Revitalised Pacific Leaders Gender Equality Declaration* (2023) will support diversity in employment.

Outcomes

A) Multiple training pathways: Establish a range of training programs tailored to various skill levels and career stages in hydrological services, fostering inclusivity and diversity while equipping individuals with the necessary expertise to meet the evolving demands of the sector and meet industry standards.

B) Sustainable skilled workforce: Cultivate a sustainable pool of diverse skilled professionals in hydrological services and associated sectors through comprehensive and multiple training initiatives, ensuring the continuity and resilience of services amidst emerging needs of the sector(s).

C) Continuous professional development: Create new and leverage existing opportunities for professional growth and development within hydrological services.

Action pathways

- Develop a programmatic approach to training with clear training pathways informed by identified needs and align with industry standards.
- Strengthen the Pacific Region Communities of Practice for Hydrology.
- Support institutional development and retention of skills through succession planning, clearly defined roles and responsibilities, and increased accountability.
- Support diverse participation in hydrological services through the commitment to the *Revitalised Pacific Leaders Gender Equality Declaration* (2023).

Fiji Meteorological Service field hydrology training © Pacific Community (SPC) / Credit: SPC

Installation of equipment by hydrology staff from Fiji Meteorological Service and Vanuatu Department of Water Resources © Pacific Community (SPC) / Credit: SPC

Review of hydrological data with Solomon Islands Water Resources Management Division and SPC © Pacific Community (SPC) / Credit: SPC

Water treatment plant in Samoa© Pacific Community (SPC) / Credit: SPC

7. OPPORTUNITIES

There has been a sustained increase in funding to projects related to climate resilience and disaster risk reduction in the Pacific region. Several national and regional projects and initiatives are in progress that address some of the gaps and challenges. However, these are largely ad hoc, uncoordinated or insufficient to address the challenges hydrological services experience in full. Additionally, in many circumstances, projects undertaken to address these gaps do not always involve the NHSs. For example, many projects focused on flood early warning are executed by NMSs or DMOs with minimal engagement with NHSs. This amplifies the problem of sustainability of projects post completion.

By defining the shared strategic direction of the national hydrology services, this roadmap aims to build and maintain cooperation, coordination and consistency of approach in leveraging funding to support the role of hydrological services in flood early warning. Hydrological services would benefit from developing a regional community of practice and forum to better communicate hydrological issues, challenges and linkages across sectors, as well as tapping into existing national and regional forums, and funding sources to drive the each of four goals. The target donor partners and programs to link in with include Australian DFAT, AWP, New Zealand MFAT, WMO and USAID, in addition to regional partners and programs including SPREP and Weather Ready Pacific.

This framework has utility across other PICs that have surface water resources; however, a regional approach informed by broader consultation across other PICs is recommended to address the range of hydrological challenges facing the region.

Key initiatives include SPC's project support for hydrology to enhance flood early warning, the Weather Ready Pacific and global initiatives such as EW4All and the regional FFGS.

8. IMPLEMENTATION

This roadmap outlines the overarching vision and goals to enhance hydrological services across the Pacific region and strengthen the role and significance of hydrology to support flood early warning systems. Detailed and collaborative planning is imperative to translate this strategic vision into tangible on-ground actions – a process referred to as IMPLEMENTATION PLANNING.

Members of the Greenhill Community carting equipment for the installation of a hydrometric monitoring station © Pacific Community (SPC) / Credit: SPC

It is intended that this roadmap document will facilitate the formulation of implementation plans at the national level and highlight the importance of coordinating efforts to enhance hydrological services to strengthen national-level flood early warning systems. The implementation plan, crafted collaboratively by local stakeholders, should follow the framework developed by this roadmap to identify the outcomes and actions that are relevant at the national level and identify specific activities to be undertaken for implementation of the roadmap. They should be consistent with, and supported by, other regional and international policies and plans, particularly those mentioned in Section 4. The implementation plans should include:

- Identification of tasks and activities
- Development of timelines in which milestones should be achieved
- Determination of resources available and required
- Assignment of accountability at national and sub-national levels
- Identification and engagement with stakeholder communities
- Identification of and mitigation strategies for risks and threats
- Development of MERL plans

Regional and international agencies are also pivotal in driving the implementation of this roadmap. Challenges such as increasing awareness of hydrology, identifying and supporting hydrological databases and establishing regional programmatic training pathways can be effectively addressed through a coordinated regional approach.

It is intended that SPC will support monitoring, evaluating and reporting on the progress of the implementation of the roadmap and in consultation with PICs, regularly review progress and amend the roadmap as required.

MERL

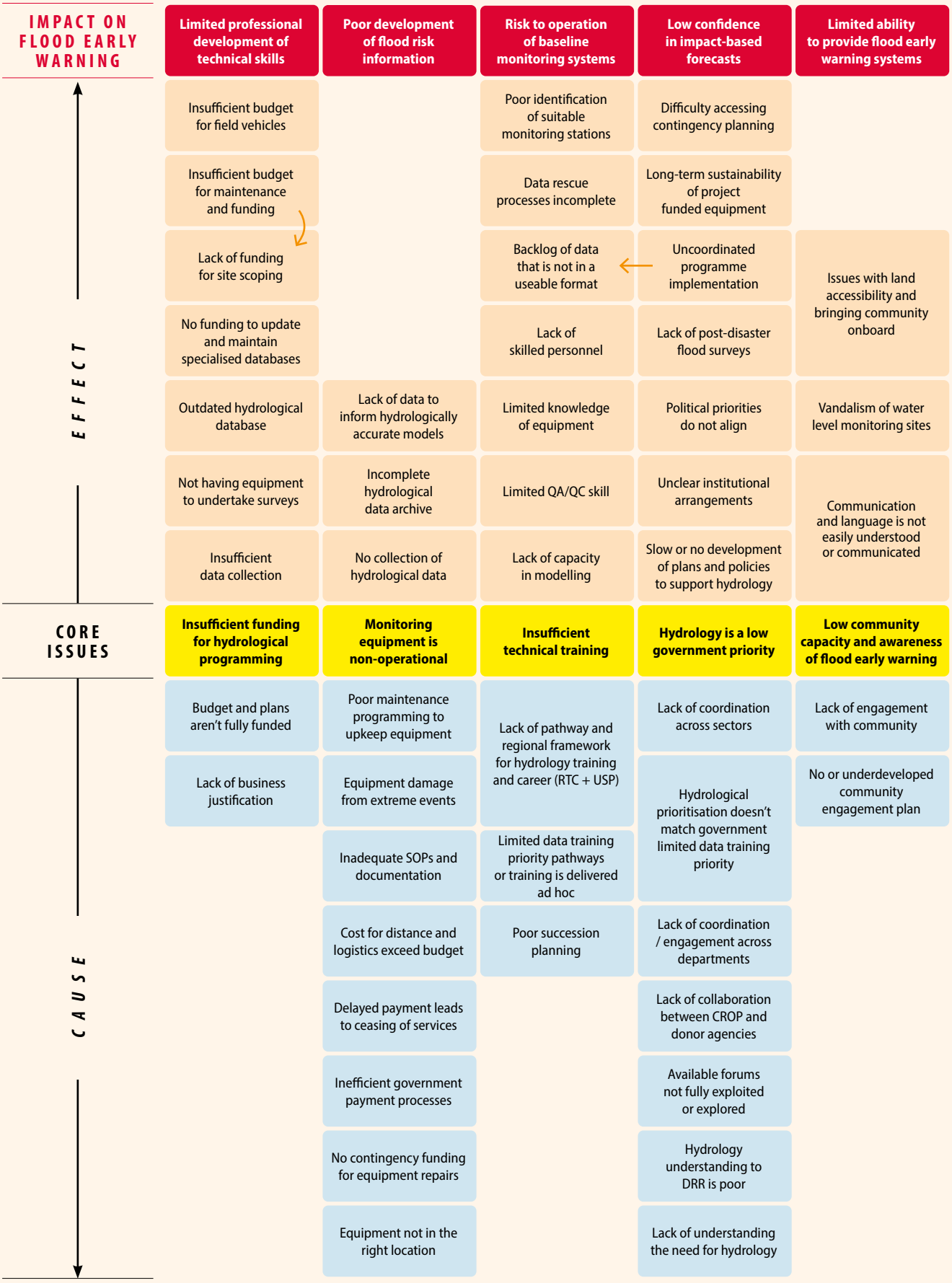
To ensure strategic alignment and maximise effectiveness, MERL plans should be integrated with implementation plans at the national level. These plans serve as indispensable tools for monitoring progress towards the overarching vision, goals, and outcomes outlined in the roadmap, while also offering a platform for ongoing learning and contextualised application of the roadmap. The MERL plans should be guided by the key principles outlined in **Annex 3**.

Further, targeted and insightful evaluation activities that maximize learning value act as a crucial component of MERL plans. These activities are advised to be structured around a set of key evaluation questions (KEQs). These questions have been designed to align with various evaluation criteria, based on global evaluation standards and prescribed by the Organization of Economic Development and Cooperation's Development Assistance committee (OECD-DAC), including relevance, coherence, effectiveness, efficiency, impact and sustainability. These KEQs also outlined in **Annex 3.**

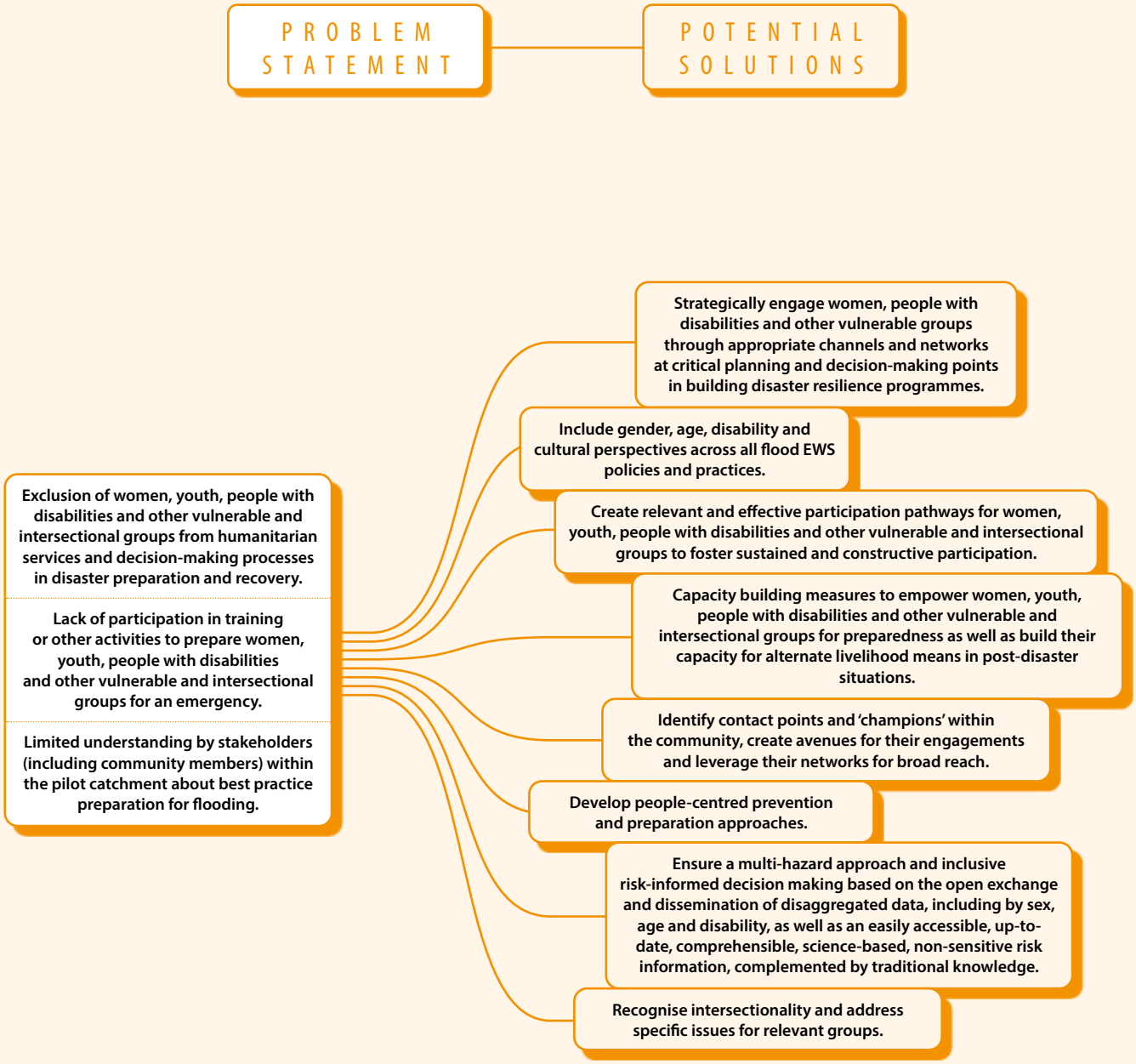
9. ANNEX 1 – CHALLENGES AND IMPACTS TO HYDROLOGY AND FLOOD EARLY WARNING IN THE PACIFIC

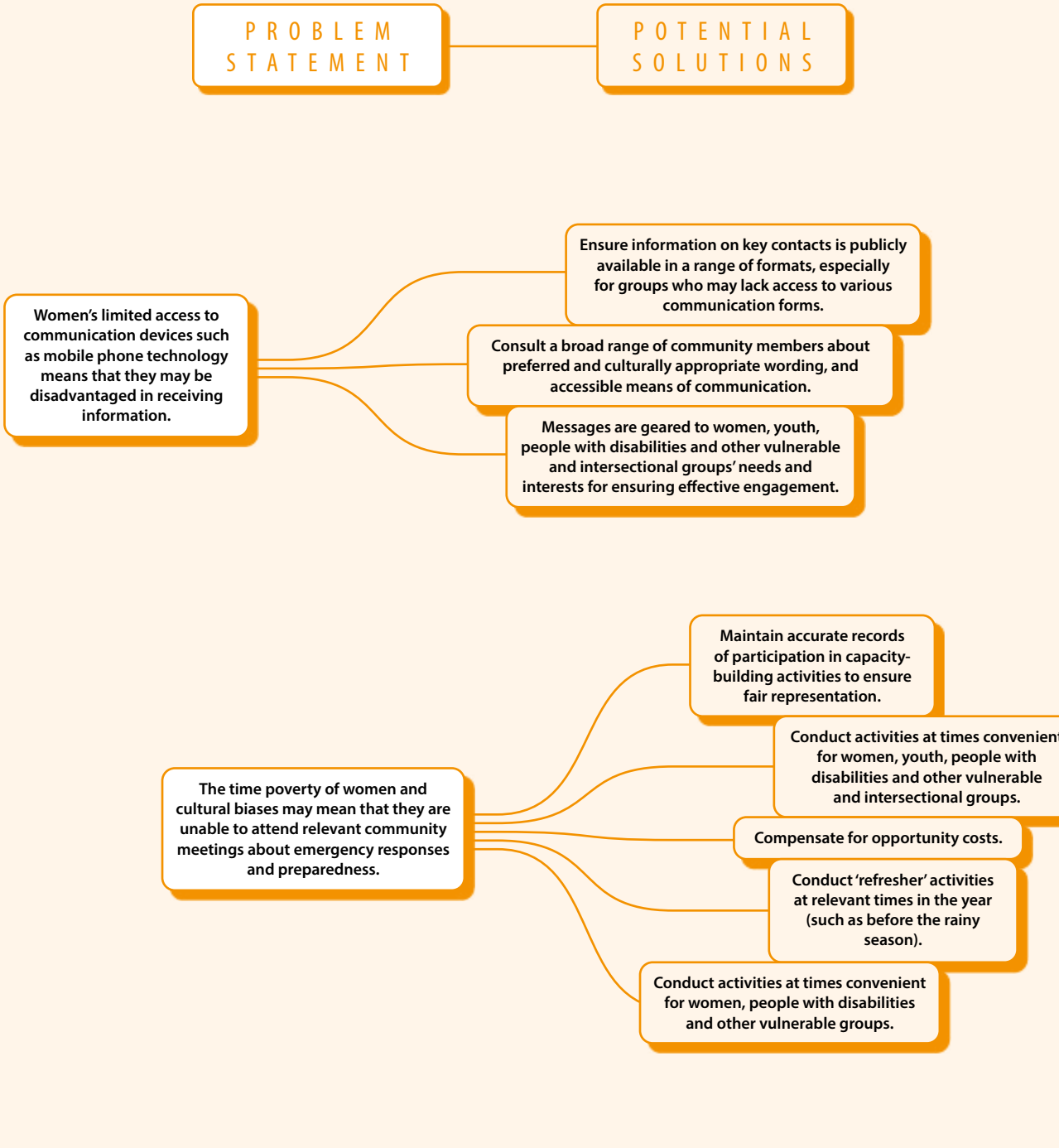
Flooded river crossing in Ba Province, Fiji © Pacific Community (SPC) / Credit: SPC

Challenges and impacts to hydrology and flood early warning in the Pacific



10. ANNEX 2 – GEDSI INTEGRATION




PROBLEM STATEMENT
POTENTIAL SOLUTIONS
Women's limited access to communication devices such as mobile phone technology means that they may be disadvantaged in receiving information.
Ensure information on key contacts is publicly available in a range of formats, especially for groups who may lack access to various communication forms.
Consult a broad range of community members about preferred and culturally appropriate wording, and accessible means of communication.
Messages are geared to women, youth, people with disabilities and other vulnerable and intersectional groups' needs and interests for ensuring effective engagement.
The time poverty of women and cultural biases may mean that they are unable to attend relevant community meetings about emergency responses and preparedness.
Maintain accurate records of participation in capacity-building activities to ensure fair representation.
Conduct activities at times convenient for women, youth, people with disabilities and other vulnerable and intersectional groups.
Compensate for opportunity costs.
Conduct 'refresher' activities at relevant times in the year (such as before the rainy season).
Conduct activities at times convenient for women, people with disabilities and other vulnerable groups.
Suboptimal collaboration between official organisations and community groups.
Include diverse community members (or representatives) as stakeholders in key decision-making groups.
Ensure official staff are allocated with responsibility to maintain community-based FF EWS responses.
Effective collaboration between all stakeholders.
Continue to sustainably resource local and provincial planning for FF EWS.
Ensure mechanisms for community feedback to inform official processes and subsequent incorporation into course correction.

Rakiraki community engagement

As part of the pilot project, community consultation was undertaken in the Rakiraki catchment on the 18–19 April 2023 in two communities: Vatukacevaceva village and the Rakiraki Town. The community workshops were cohosted with the Fiji Meteorological Service (FMS). A local civil society organisation (CSO), FemLINK Pacific, was engaged to assist with the logistics and design of the community engagement workshops. FemLINK Pacific is an organisation with existing links to FMS and experience in disaster risk reduction through strengthening coordination and relationship efforts between vulnerable communities and authorities.

The engagement of a local CSO was an important part of ensuring that the community stakeholder consultation process was designed to reflect GEDSI principles, and GEDSI was mainstreamed throughout the engagement process. Further to this, the role of the CSO was to:

- Ensure any information provided at the workshops was culturally appropriate and accessible to those with low literacy and other differences.
- Coordinate a stakeholder consultation that involved a diversity of stakeholders and to ensure that women, youth, people with disabilities and other vulnerable and intersectional groups were represented and included in consultations and workshops, and that sex and disability disaggregated data was collected, reported and analysed for all activities.
- Structure workshop activities at times and locations convenient for community members, including women, youth, people with disabilities and other vulnerable and intersectional groups.
- Provide translation in local vernacular.

Workshop activities were designed to gather local and traditional knowledge about flood extents, community behaviour and actions during severe weather events, and to gather an understanding of how information and messaging is received and passed on at a community level. It was also an opportunity for FMS to share with the communities the existing flood warning products available.

Community participation during a community flood early warning workshop, Vatukacevaceva, Fiji © Pacific Community (SPC) / Credit: SPC

11. ANNEX 3 – MERL KEY PRINCIPLES AND KEY EVALUATION QUESTIONS

MERL key principles:

FIT FOR PURPOSE:
Tailor to the vision, goals and outcomes of the roadmap and enable hydrology practitioners to evaluate their effectiveness and efficiency in meeting objectives and outcomes set out in the implementation plan.

CREDIBLE AND COHERENT:
Pay close attention to existing science (environmental, social/cultural and economic) and use methods that are appropriate and robust.

CLEAR AND ACCESSIBLE:
Ensure clarity and accessibility for all stakeholders, making the MERL plan straightforward and comprehensible without imposing undue complexity or implementation burdens.

COST-EFFICIENT:
Prioritise cost-effectiveness by ensuring that the benefits of monitoring, evaluation and reporting surpass the associated costs. Where feasible, leverage existing systems, programs, and data to optimise resources and minimise expenditure.

PROMOTE CONTINUOUS IMPROVEMENT:
Foster a seamless flow of information to empower management decisions, particularly those aimed at enhancing or adapting management strategies as needed.

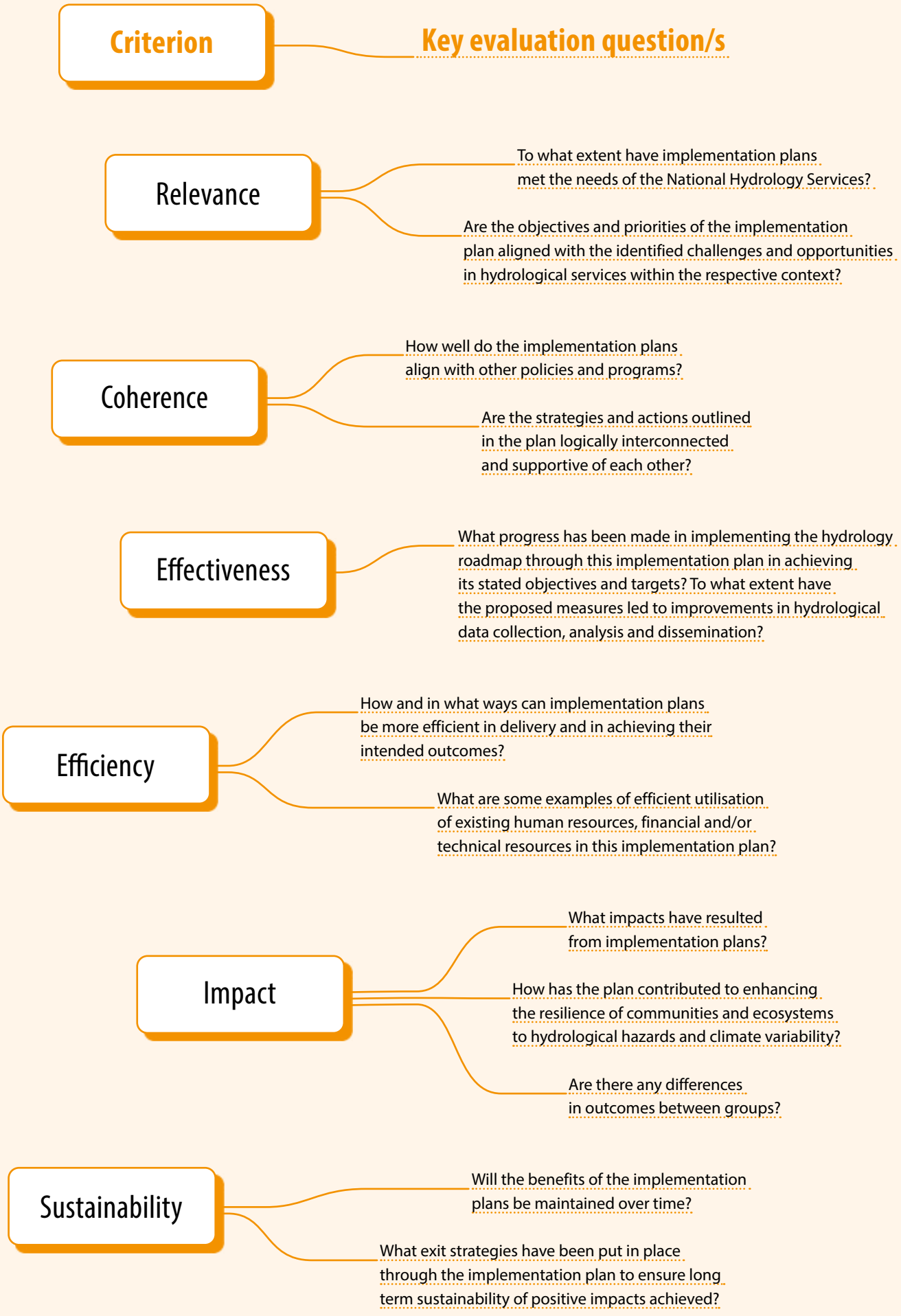
FOSTERING ACCOUNTABILITY:
Establish clear mechanisms for accountability by delineating roles, responsibilities and performance indicators to track progress and ensure accountability at every level of implementation.

PROMOTE ADAPTABILITY:
Embrace a flexible and adaptive approach to MERL, allowing for timely adjustments in response to emerging challenges, opportunities and evolving stakeholder needs.

FACILITATE STAKEHOLDER ENGAGEMENT:
Promote active engagement of stakeholders including women, youth, people with disabilities and other vulnerable and intersectional groups throughout the MERL process for fostering ownership, participation and collaboration, thereby enriching the quality and relevance of evaluation findings and learning outcomes.

SUPPORT EVIDENCE-BASED DECISION MAKING:
Empower decision-makers with timely and actionable insights derived from MERL activities, facilitating informed decision making and resource allocation to optimise programme outcomes.

CULTIVATE ONGOING LEARNING:
Ensure the roadmap remains pertinent and user-centric by fostering a culture of continuous learning and adaptation.


Criterion
Key evaluation question/s
Relevance
To what extent have implementation plans met the needs of the National Hydrology Services?
Are the objectives and priorities of the implementation plan aligned with the identified challenges and opportunities in hydrological services within the respective context?
Coherence
How well do the implementation plans align with other policies and programs?
Are the strategies and actions outlined in the plan logically interconnected and supportive of each other?
Effectiveness
What progress has been made in implementing the hydrology roadmap through this implementation plan in achieving its stated objectives and targets? To what extent have the proposed measures led to improvements in hydrological data collection, analysis and dissemination?
Efficiency
How and in what ways can implementation plans be more efficient in delivery and in achieving their intended outcomes?
What are some examples of efficient utilisation of existing human resources, financial and/or technical resources in this implementation plan?
Impact
What impacts have resulted from implementation plans?
How has the plan contributed to enhancing the resilience of communities and ecosystems to hydrological hazards and climate variability?
Are there any differences in outcomes between groups?
Sustainability
Will the benefits of the implementation plans be maintained over time?
What exit strategies have been put in place through the implementation plan to ensure long term sustainability of positive impacts achieved?

12. ANNEX 4 – NATIONAL SUMMARIES OF THE CURRENT FLOOD EARLY WARNING CAPABILITIES

Water level monitoring equipment in the Waidina River, Nabukaluka, Fiji © Pacific Community (SPC) / Credit: SPC

FIJI

ROLES AND RESPONSIBILITIES

Flood risk planning
National Disaster Management Office, Fiji Meteorological Service

Hydrometric monitoring (rainfall and surface water)
Fiji Meteorological Service, Water Authority of Fiji

Flood forecasting
Fiji Meteorological Service

Flood warning
Fiji Meteorological Service, National Disaster Management Office

Flood response
National Disaster Management Office

POLICIES AND STRATEGIES INFLUENCING FLOOD EARLY WARNING

- Natural Disaster Management Act 1998
- Meteorological and Hydrological Services Bill (in draft)
- National Disaster Risk Management Bill (in draft)
- Fiji National Disaster Management Plan
- National Disaster Risk Reduction Policy 2018–2030
- Fiji Meteorological Service Strategic Plan 2021–2024
- Ministry of Waterways and Environment Republic of Fiji – Strategic Plan 2020–2024

CURRENT STATUS

Telemetered hydrometric network

Water level monitoring stations:	**38**
Automatic rainfall stations:	**58**
Radar:	**3 operational**

The hydrometric monitoring network covers most flood prone catchments; however, current capacity, equipment and database limitations are constraining full utilisation of the system.

Flood warning system
Several flood warning systems are in place for flood forecasting and warning, including:

- Fiji Flash Flood Guidance System (FFGS)
- Riverine threshold warning levels
- Nadi Coastal Inundation Alert Support System (CIASS)
- Ba flood warning system (Ba FEWS)

Flood hazard mapping
High-resolution flood hazard maps have been developed for Nadi; however, awareness of these products amongst institutions is low. Low-resolution flood extent maps using a range of methods have been produced in other population centres; however, the resolution of these limits the applicability for impact-based forecasting.

Flood warnings issued
Catchment specific flood and flash flood warnings are typically issued however, current forecasting capabilities limit the ability to forecast the timing and scale of flooding, prohibiting impact-based forecasting, particularly during localised rainfall events. A lack of impact-based forecasting makes disaster warning messaging for vulnerable communities challenging.

PRIORITY FOR HYDROLOGICAL SERVICES

Staff and training
Targeted technical specialised training for staff is required to enhance capability and capacity of field programs, data analysis and technical leadership.

Data management and analysis
Improved standard operating procedures for field data collection and a fit-for-purpose hydrological database with quality control functionality will assist data management and analysis.

Warning
Improved timeliness of warnings and the inclusion of impact-based forecasting will increase the ability of communities to prepare for and respond to flooding.

Flood modelling and mapping
High resolution flood mapping is required in most flood prone populated regions to support risk knowledge, impact-based forecasting and flood response. A lack of high-resolution elevation data such as LiDAR is a major limitation to this.

Cross-agency integration
Clearer articulation of roles and responsibilities in flood warning is required to ensure agencies effectively work together to deliver consistent flood messaging.

VANUATU

ROLES AND RESPONSIBILITIES

Flood risk planning
National Disaster Management Office, Department of Water Resources, Vanuatu Meteorology and Geo-Hazard Department

Hydrometric monitoring (rainfall and surface water)
Department of Water Resources, Vanuatu Meteorology and Geo-Hazard Department Flood forecasting

Flood forecasting
Department of Water Resources, Vanuatu Meteorology and Geo-Hazard Department Flood forecasting

Flood warning
Department of Water Resources, Vanuatu Meteorology and Geo-Hazard Department Flood forecasting

Flood response
National Disaster Management Office, Department of Water Resources, Vanuatu Mobile Force (VMF)

POLICIES AND STRATEGIES INFLUENCING FLOOD EARLY WARNING

NATIONAL LEGISLATION:

- Water Resources Management Act 2002
- National Disaster Act 2019
- Meteorology, Geological Hazards, and Climate Change Act 2016
- Vanuatu National Water Strategy 2018–2030

CURRENT STATUS

Telemetered hydrometric network

Water level monitoring stations:	**3**
Automatic rainfall stations:	**10**
Radar:	**0**

The hydrometric monitoring network does not cover all flood prone catchments, and improvement is needed in standard operating procedures and staff training for data collection and management.

Flood warning system
No end-to-end flood warning system is in place in Vanuatu. Generalised heavy rain alerts are issued by the Vanuatu Meteorology and Geo-Hazard Department.

Flood hazard mapping
Flood hazard maps have been developed for the two main population centres, Port Vila and Luganville; however, awareness of these products amongst institutions is low.

Flood warnings issued
Flood forecasts are limited to issuing generalised heavy rain alerts.

PRIORITY FOR HYDROLOGICAL SERVICES

Staff and training
Increased training for staff is required to enhance capability and capacity of technical work and leadership.

Data collection
Increased coverage of hydrometric monitoring stations and enhanced planning and maintenance for existing systems will support the timeliness and reliability of data to inform flood forecasting.

Data management and analysis
Development of fit-for-purpose standard operating procedures for field data collection, data management and analysis will improve accuracy of baseline flood information.

Flood forecasting and warning
Development of a flood forecasting system that incorporates real-time data and nowcasting to increase resolution of flood forecasts.

Cross-agency integration
Clearer articulation of roles and responsibilities in flood warning is required to ensure agencies effectively work together to deliver consistent flood messaging.

SAMOA

ROLES AND RESPONSIBILITIES

Flood risk planning
Water Resources Division, Disaster Management Office

Hydrometric monitoring (rainfall and surface water)
Water Resources Division, Samoa Meteorological Division

Flood forecasting
Water Resources Division, Samoa Meteorological Division

Flood warning
Samoa Meteorological Division

Flood response
Disaster Management Office

POLICIES AND STRATEGIES INFLUENCING FLOOD EARLY WARNING

NATIONAL LEGISLATION:

- Water Resources Management Act 2008
- Disaster Management Act 2007
- Meteorology, Geoscience and Ozone Services Act, 2021
- Planning and Urban Management Act 2024
- Samoa National Action Plan for DRM 2017–2021
- Samoa National Disaster Management plan 2017–2020
- Multi-hazard Early Warning Systems Policy 2022

CURRENT STATUS

Hydrometric network

Water level monitoring stations:	**16**
Automatic rainfall stations:	**18**
Radar:	**0**

The hydrometric monitoring network covers most flood prone catchments; however, staff, equipment and database constraints limit full functioning capacity of stations.

Flood warning system

- The end-to-end Vaisigano Flood Decision Support System, operated by the Water Resources Division, provides flood warning information in the Vaisigano catchment (Apia).
- Generalised heavy rain alerts are issued by the SMD for all other regions.

Flood hazard mapping
Flood hazard maps have been developed for several catchments in the main population centre, Apia. Limited mapping of flood hazard in other areas is limiting effective flood early warning capabilities that include impact-based forecasting.

Flood warnings issued
Flood forecasts are limited to issuing generalised heavy rain alerts.

PRIORITY FOR HYDROLOGICAL SERVICES

Flood risk mapping
Improved mapping of flood hazard in areas outside of Apia will improve effective flood early warning capabilities.

Data management and analysis
Improved standard operating procedures for field data collection and a fit-for-purpose hydrological database with quality control functionality will assist data management and analysis.

Warning
Improved timeliness and resolution of warnings and the inclusion of impact-based forecasting will increase the ability of communities to prepare for and respond to flooding.

SOLOMON ISLANDS

ROLES AND RESPONSIBILITIES

Flood risk planning
National Disaster Management Office, Water Resources Management Division, Climate Change Division

Hydrometric monitoring (rainfall and surface water)
Water Resources Management Division, Solomon Islands Meteorological Service

Flood forecasting
Water Resources Management Division, Solomon Islands Meteorological Service

Flood warning
Solomon Islands Meteorological Service

Flood response
National Disaster Management Office

POLICIES AND STRATEGIES INFLUENCING FLOOD EARLY WARNING

- Rivers Water Act 1996
- Environment Act 1998
- Environment Regulation 2008
- Meteorology Act 1985
- National Disaster Council Act 1989 (under review)
- Water Resources Bill – in development to replace the Rivers Water Act 1996
- Solomon Islands National Disaster Management Plan 2018
- Solomon Islands National Climate Change Policy (NCCP) 2023–2032
- Framework for Resilient Development in the Pacific
- SIMS National Strategy and Framework for Weather, Climate, and Ocean (2023–2028)
- National Meteorology Policy
- National Development Strategy 2016–2035
- National Disaster Risk Management Plan 2010

CURRENT STATUS

Telemetered hydrometric network

Water level monitoring stations:	**0**
Automatic rainfall stations:	**13**
Radar:	**0**

There is no telemetered riverine monitoring network, therefore no water level observation data to inform flood early warning. Current network is not telemetered and is primarily for mini-hydroelectric schemes.

Flood warning system
No end-to-end flood warning system is in place in the Solomon Islands.

Flood hazard mapping
Flood hazard maps have been developed for the main population centre, Honiara; however, the awareness of these products amongst institutions is low. Limited mapping of flood hazard in other areas is limiting effective flood early warning capabilities that include impact-based forecasting.

Flood warnings issued
Flood forecasts are limited to issuing generalised heavy rain alerts at the provincial level.

PRIORITY FOR HYDROLOGICAL SERVICES

Data collection
Establishment of telemetered hydrometric monitoring sites at locations suitable for providing early warning information in priority flood prone catchments

Flood forecasting and warning
Development of a flood forecasting system that incorporates real-time hydrological and meteorological data to increase resolution of flood forecasts and ability to nowcast events.

Data management and analysis
Fit-for-purpose standard operating procedures for field data collection, data management and analysis to improve accuracy of baseline hydrological information

Staff and training
Targeted technical training for staff is required to enhance capability and capacity of field programs, data analysis and technical leadership.

Aerial view of the team transporting hydrometric monitoring equipment down the Teouma River, Vanuatu

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