



Weather Ready Pacific – A Decadal Program of Investment

April 2021

Executive Summary

The need for a Decadal Program of Investment

Pacific island countries are vulnerable to a wide range of weather, climate, hydrological, ocean and other related environmental extreme and high impact events, including tropical cyclones and typhoons, strong winds, high waves and seas, earthquakes, volcanic eruptions, drought, coastal inundation (including storm surges, waves, swell and tsunami) and flash floods. Already in the 2020-21 cyclone season, Fiji has been devastated by two severe tropical cyclones, causing loss of life and widespread damage, whilst Samoa was badly affected by flooding and landslides in December 2020. Economic losses from cyclones and flooding in the South Pacific region in 2020 were around \$1 billion with at least 71 lives lost.

Further, the risks posed by extreme events are increasing as the Pacific region is particularly vulnerable to climate change and it is likely that extreme events will become more intense and/or frequent in coming decades. Pacific Island countries will be significantly affected by sea level rise, which will greatly increase the risks posed by coastal inundation events. Climate change and disaster risks undermine the ability of the Pacific region to reach Sustainable Development Goals.

The forecasts and warnings provided by National Meteorological and Hydrological Services (NMHSs) are essential to the safety and well-being of Pacific people and communities, protection of property and contribute to sustainable development. During the past decade, there has been significant investment in weather, climate, hydrological and ocean related capacity and infrastructure in the Pacific region, which has resulted in improvement in the capacity and capabilities of NMHSs as outlined in the Pacific Islands Meteorological Strategy (2017-2026). However, critical gaps remain: governance arrangements, mandate, strategic plans and institutional support are lacking in some countries; the observation network is patchy and the ability to invest in and maintain modern observational infrastructure is limited; similarly, computational infrastructure and capacity is not up to global standards; forecasting systems in use are highly variable in approach and quality; there are insufficient qualified meteorological and technical staff to develop and deliver accurate, localised and impact-based forecasts and warnings. This creates challenges for NMHSs in providing the information needed by government, communities and industries (e.g. agriculture, fisheries, aviation, tourism) to better prepare for extreme events and manage the subsequent impacts on livelihoods and economies.

To address these critical gaps, a decadal response is needed urgently to enable Pacific island countries and territories to better anticipate and respond to high impact and extreme weather, hydrological, climate, oceanic and other related environmental events and their associated risks. In particular, empowering Pacific NMHSs to engage credibly with the communities, customers, partners and stakeholders contributes to more informed local and regional decision making, potentially saving lives and livelihoods. Further, enhancing capability builds a stronger platform for the region to manage the impacts of climate change and equipping countries with valuable information to inform adaptation and resilience strategies.

At its fifth biennial meeting in Apia, Samoa in August 2019, the Pacific Meteorological Council (PMC) recommended the Secretariat of the Pacific Regional Environment Programme (SPREP) commission a study to scope the feasibility for a Decadal Program of Investment to enable the Pacific Small Island Developing States to better anticipate, prepare for and respond to those risks. This report is the result of the scoping project and it provides a Decadal Program of Investment to underpin the ability of NMHSs to deliver effective and timely forecasts and warnings to Pacific communities and industries. It is also complementary to regional initiatives that aim to enhance resilience to climate change and disasters such as the Framework for Resilient Development in the Pacific: An Integrated Approach to Address Climate Change and Disaster Risk Management (FRDP).

Consultation Findings

To ensure the Decadal Program of Investment and its recommendations are based on a thorough understanding of current status, gaps and needs across Pacific island countries and territories, it was critical that there was engagement with the NMHSs in SPREP member countries and territories. In parallel, a thorough review was undertaken of previous assessments and reports and ongoing and planned projects related to strategy, infrastructure and capacity to gain insights and avoid duplication and repetition.

Key points to emerge from these consultations and document review were:

(a) Governance and coordination

- Many countries identified the need for more specific Meteorological Acts and/or strategic plans;
- A holistic approach to improving meteorological and hydrological services is needed. At present there is a major gap in that there are many modest scale initiatives from multiple agencies and donors, resulting in a fragmented patchwork of investments;
- Meteorological, hydrology and marine/coastal services need better integration to effectively deliver impact-based forecasts for extreme events such as tropical cyclones and typhoons, strong winds, high waves and seas, drought, heavy rainfall, riverine flash flooding, coastal inundation (including storm surges and coastal floods);
- There is generally good coordination with National Disaster Management Offices (NDMOs) and the ambition for stronger hazard and risk identification, detection and assessment, and integrate these into impact-based messaging in forecasts and warnings and improving the communication systems and messaging to communities;
- There is a need for leadership and management training for Directors and senior managers to help deliver better meteorological, hydrological, ocean services and other related environmental services.

(b) Forecast production and delivery

- The approach of cascading forecasts from Global Production Centres (GPC) to Regional Centres and then forecasts and warnings issued locally from NMHSs is potentially most effective. This is in part achieved through the WMO Severe Weather Forecasting Demonstration Project (SWFDP, now SWFP) that provides warning and general forecast information through MetConnect, implemented by MetService New Zealand, but it is under-resourced and no long-term sustainability plan is in place. The approach for cascading forecasts at the national level has shown to be effective via the WMO Coastal Inundation Forecasting Initiative (CIFI);
- Information, Communication and Technology (ICT) and national data systems need to be improved to better support weather, climate, water, ocean and other related environmental hazard and impact-based forecast and warning delivery systems with most NMHSs indicating a critical shortage of Information Technology (IT) staff. In many NMHSs, internet connectivity and bandwidth problems limit upload and download, and exchange of data;
- There is a need to better translate technical terms in forecasts and warnings into locally relevant risk, impact and response messages and incorporating traditional knowledge; for remote communities delivering forecasts and warnings in a timely way remains a challenge.

(c) Infrastructure and observations

- Observation equipment is acquired through multiple projects in an uncoordinated way, leading to a diversity of equipment types;
- Ongoing maintenance of equipment and having the required number of appropriately trained electronics technicians is a challenge for most NMHSs. Investment in new infrastructure should include in its budget provision for a long-term maintenance and operating schedule and a training program;
- Compared with surface observation equipment there is a lack of infrastructure investment in oceans (wave heights, tide gauges, salinity, sea surface temperature) and river gauging equipment (levels, flows, discharges);
- Few observations are provided to global observing networks and programmes such as the Global Climate Observing System (GCOS), the Global Ocean Observing System (GOOS), Global Basic Observing Network (GBON), WMO Integrated Observing System (WIGOS), Regional Basic Synoptic Network (RBSN), Regional Basic Climate Network (RBSN) though considerable data is now being captured in the Climate Data for Environment (CLiDE), a Climate Database Management System (CDMS) providing Pacific Island countries with a central database for climate data.

(d) Capacity and training

- Only a few of the NMHSs have forecasters trained to the level of the WMO Basic Instruction Package for Meteorologist (BIP-M) and there are also insufficient forecasters trained to the level of WMO Basic Instruction Package for Meteorological Technician (BIP-MT);
- To overcome constraints in travelling overseas for extended periods, new thinking is required around approaches to forecaster training, including hybrid models of online training coupled with more focused face to face intensive training modules. In addition to specific training, strengthening the capacity of NMHS with robust skills to deliver along the value chain from research to operations is critical.

Investment Framework

The proposed decadal program of investment seeks to cohesively and comprehensively respond to these findings, and deliver the following outcomes for the Pacific:

1. For all nations, assured access to localised, accurate and timely forecast and warning products:
 - derived utilising world-leading forecasting capability;
 - accessed via a Pacific Weather Exchange;
2. The ability to better communicate impacts – what the weather will do rather than what the weather will be;
3. Strengthened preparedness and response to severe weather events that provides improved safety for all communities in the region and travellers;
4. Increase in adaptive capacity of industries and communities to manage the impacts of climate change related weather, hydrological and ocean extreme events;
5. Reduced economic impacts of extreme events on key industries (agriculture, fisheries, aviation, tourism) and livelihoods of small businesses, farmers etc.;
6. For some nations, the generation of revenue derived from industry partnerships (e.g. energy, aviation, agriculture, tourism);
7. Pacific issues receive greater consideration in multilateral settings.

The resulting proposed Decadal Program of Investment takes into account:

- the depth, and breadth of the needs identified by NMHSs;

- variability of existing capability and training programs across Pacific island countries and territories;
- equipment maintenance and sustainability challenges;
- the critical interdependence between the individual components of an effective; meteorological service and the need for a comprehensive, regionally coordinated approach that draws on global products and services;
- related key projects and investments underway and planned across the region and the contribution NMHSs can make to broader regional resilience initiatives such as the Framework for Resilient Development in the Pacific (FRDP).

The Program focuses on five components:

1. **Strategy and Governance:** Supporting and strengthening governance and institutional arrangements, leadership, planning, and management of NMHSs and NDMOs and provide a key coordination function in partnership with the Pacific Meteorology Desk Partnership (PMDP) and the PMC.

Under this component the Program will:

- (i) Develop a Pacific Meteorological Leadership Program and deliver this to 60 NMHS leaders over the decade. Training will aspects of governance, strategic planning, financial management, communication;
- (ii) Put in place a Management and Advisor Team who will have responsibility for coordinating the implementation of the Decadal Program of Investment and work in partnership with the PMDP and with the PMC and its six technical panels and provide support in implementing strategic plans at the national level.

2. **Production of forecasts and warnings:** Strengthening regional and national severe weather forecasting and warning systems using impact-based approaches that better prepare communities and industries to deal with high impact and severe weather events, floods and coastal hazard impacts. The key rationale for this investment area is strengthening the cascading forecasting system that links World Meteorological Centres, Regional Centre(s), which include Regional Specialised Meteorological Centres (RSMC) and NMHSs. This approach, to some extent, is already in place through RSMCs in Fiji, Wellington and Darwin and the National Oceanic and Atmospheric Administration (NOAA) National Weather Service (NWS) Office in Guam, together with delivery mechanisms such as the SWFP. However, it needs strengthening in three areas: the integrating capability between global, regional and national forecasting processes that can deliver automated and consistent forecasts and warnings which will free up forecasters for higher priority tasks; improving the breadth and depth of forecasting services within NMHSs; and a well-supported delivery platform, the Pacific Weather Exchange. It will provide NMHSs with access to a greater suite of high quality NWP products.

Under this component the Program will:

- (i) Develop a comprehensive suite of automatically generated forecast and warning products for NMHSs, from post-processing of numerical weather prediction, including 7-day forecasts for as many individual locations as required by each NMHS which will include graphics as a way to avoid technical terms and translation issues as far as possible. This will also include hydrological products related to riverine flash flooding and sea level products that highlight areas at risk of coastal inundation;
- (ii) In combination with (i) above ensure that:
 - forecasts and warnings are more accurate, more localised and in some cases more timely;
 - forecasts and warnings are available to every pacific island nation regardless of national capacity challenges.
- (iii) Develop or enhance an existing data delivery system to contain and transmit these new products;
- (iv) Consolidate and strengthen the aviation weather forecasting hub in Fiji and build capacity of aviation forecasters in a small number of larger NMHSs;

3. **Communication and delivery of forecasts and warnings to end-users:** Enhance the ability of NMHSs and NDMOs to communicate impact-based forecasts and warnings in a timely manner and in a way that facilitates action responses from individuals, communities, government and industries.

Under this component the Program will improve the development and delivery of risk and impact-based messages through:

- (i) End-user workshops to identify types of messages that will lead to response actions;
- (ii) Training of NMHS and NDMO staff in development of impact-based messages including the use of traditional knowledge and how to reach groups disproportionately affected by extreme events, including women and people with disabilities;
- (iii) NMHS training workshops in the use of the WMO Common Alerting Protocol;
- (iv) Workshops between NMHSs and NDMOs to improve governance and delivery mechanisms so that pathways for forecasts and warnings are highly effective.

4. **Infrastructure:** Provide enhanced hydro-meteorological infrastructure networks and associated IT equipment that meets emerging and future needs and do this in a targeted and coordinated way to complement existing and planned initiatives.

Under this component the Program will:

- (i) Refurbish existing Automatic Weather Stations (AWSs) and river gauge networks and ensure they have connectivity with and deliver data to, WMO's Global Telecommunications System (GTS);
- (ii) Fill significant surface observations gaps with new equipment that become evident following the refurbishment listed above;
- (iii) Establish a network of automated upper air observations stations that will complement and "ground truth" remotely sensed data to improve input into NWP systems;
- (iv) Installation of weather watch radars around major population centres and international airports to improve safety;
- (v) Retrieval of meteorological data from selected commercial aircraft that operate through the region;
- (vi) Expand ocean observations networks to provide better coverage of waves and tides;
- (vii) Refurbish existing IT infrastructure and expand it where necessary to support the strengthened forecast and warning services being proposed above. This will also ensure that the much expanded observational data can be effectively and efficiently transmitted to global observing networks. The support for observation infrastructure and observations being delivered to global observing networks needs to complement the WMO Systematic Observations Financing Facility (SOFF) initiative.

5. **Capacity building:** Build the capacity of NMHS forecasters, hydrologists, oceanographers, observers, electronics technicians, and information and data technologists. In developing training and capacity building initiatives, care has been taken to ensure that they complement rather than replace existing initiatives such as WMO Regional Training Centres in the Asia-Pacific region, WMO and other provider training courses, and the programs provided by the Pacific International Training Desk in Hawaii.

Under this component the Program will provide:

- (i) A Secretariat to support a Regional Training Centre (RTC) in Fiji that focuses on accredited training for technicians and observers, and a hub for equipment servicing and calibration;
- (ii) Training for observers and technicians at the RTC;
- (iii) Training of WMO standard forecasters using a hybrid model of online courses complemented with an intensive face to face component;
- (iv) Training of hydrographers and hydrologists for staff in countries severely affected by flash floods;
- (v) Training of staff (especially meteorologists, oceanographers and hydrologists) in countries severely impacted by coastal inundation, including tsunamis;
- (vi) Professional development courses undertaken in the region drawing on external experts;
- (vii) Twinning program to provide mentoring from highly developed hydro-meteorological services.

A conceptual framework for how these investment areas come together to deliver an integrated package that improves NMHSs and the products they deliver is provided in Figure 1. Critical to this plan is the interaction with global and regional observing systems and centres that develop numerical weather prediction and satellite products, essential for the delivery of the proposed cascading forecast system.

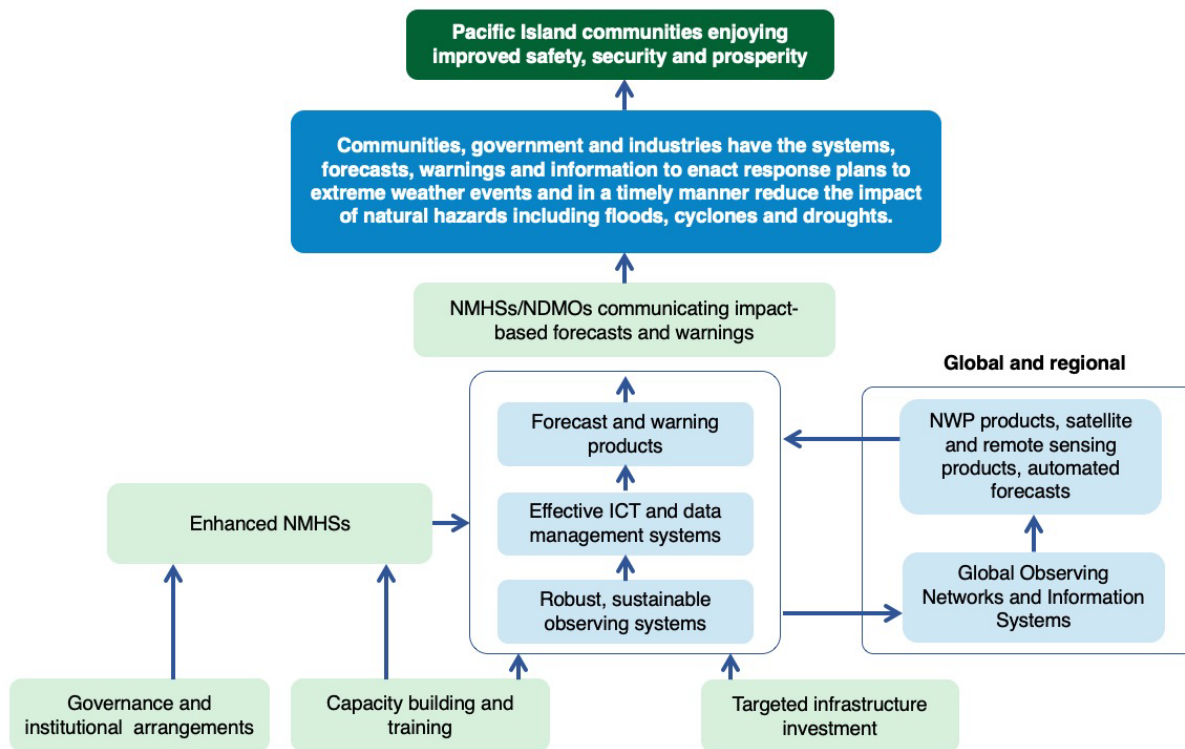


Figure 1: Conceptual representation of how the Decadal Program of Investment in the Pacific (light green boxes) needs to interact with regional and global observing networks and forecast centres (light blue box) to deliver desired community outcomes.

Summary of proposed investments

The investment required to provide a much enhanced, well-coordinated and sustainable NMHS network is significant. Table 1 provides a summary of the proposed investments over the decade. For the areas of governance, forecasts and warnings, and capacity and training it is envisioned that investment would commence in Year 1 and be sustained over decade. This is to ensure the capacity and systems are self-sustaining by the end of the decadal term of investment. There is a need to significantly uplift infrastructure capacity across the Pacific. This is not just in observational infrastructure but also in computers, servers, forecaster workstations etc. This requires both a large capital investment and, more importantly, the operating funding to ensure the equipment is maintained over the decadal timescale. It is envisioned that infrastructure will be deployed gradually over the first 5 years of the 10-year investment. This phasing in of infrastructure will allow for lessons learned with the first infrastructure deployments to be taken into account in subsequent infrastructure purchase and deployment. Consistent with this approach operating costs for infrastructure ramp up over the first three years of the decadal investment period. External reviews will be conducted after Years 3 and 6 to ensure the program is delivering and provide recommendations for program change and/or enhancement. The Year 6 Review will focus on enduring sustainability of the program beyond the decadal investment phase. Given the funding arrangements are still to be determined (single donor, multiple donors etc), the investment plan does not include any donor management and governance costs, which will ultimately need to be factored into the overall program.

Table 1: Operating and capital costs associated with the Decadal Program of Investment (USD millions).

	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Total
Governance	0.96	0.9	1.15	1.26	1.2	0.99	1.61	1.04	1.33	1.27	11.71
Forecasts production	2.99	3.48	3.15	3.67	3.77	3.83	3.86	3.86	3.86	3.91	36.37
Forecasts communication	0.35	0.17	0.18	0.36	0.19	0.21	0.39	0.2	0.21	0.21	2.47
Infrastructure - CAPEX	4.93	7.39	7.39	14.78	14.78						49.27
Infrastructure - OPEX	1.74	3.13	4.12	5.35	5.47	5.59	5.74	5.91	6.04	6.18	49.28
Capacity/training	1.98	1.32	1.37	1.38	1.55	2.14	1.57	1.47	1.71	1.63	16.13
Total	12.94	16.39	17.37	26.80	26.96	12.76	13.17	12.48	13.15	13.20	165.2

Whilst USD 165 million represents a significant investment, it is over a decade. Recent estimates of average annual losses in GDP in Pacific Island Countries due to natural disasters are in the order of USD 500 million or USD 5 billion over a decade. These estimates do not include losses of life or disruptions to livelihoods and social cohesion. If the improved services and delivery of forecasts and warnings from NMHSs could prevent just 5% of these losses (USD 250 million) that represents a positive return on investment. That superficial assessment of benefit is likely very conservative as other economic analyses of NMHS improvements to reduce disaster losses in developing countries show a Benefit-Cost Ratio of 4:1 to 36:1. Clearly, the human and financial cost of not acting is higher than the cost of acting through the investments proposed in this Decadal Program of Investment.