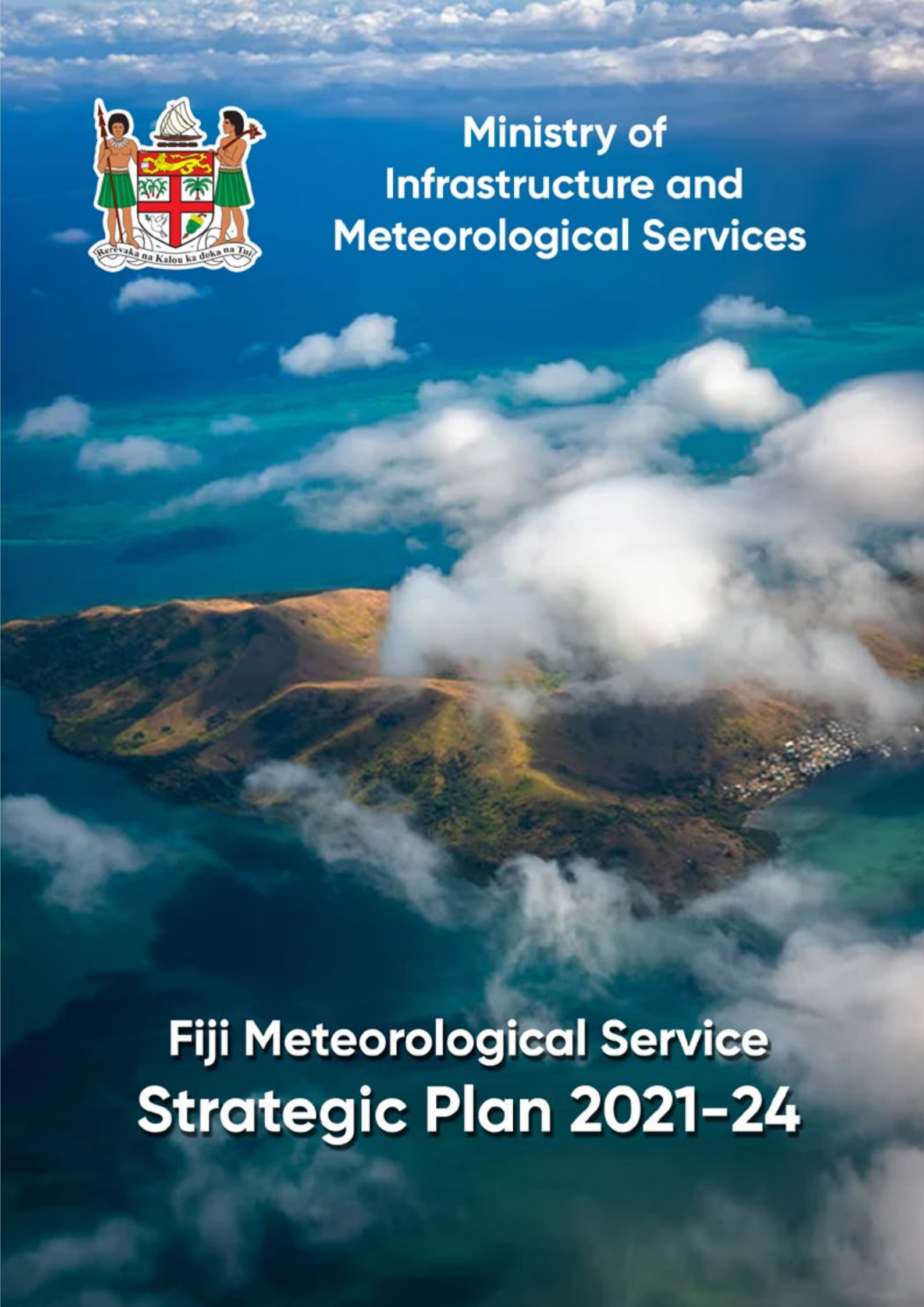

Ministry of
Infrastructure and
Meteorological Services

Fiji Meteorological Service
Strategic Plan 2021-24

Cover Photograph by: Janis Rozenfelds
Small trade wind cumulus clouds over Makogai Island, Fiji.
Source: https://unsplash.com/s/photos/fiji

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WORLD METEOROLOGICAL ORGANIZATION

CREWS CLIMATE RISK & EARLY WARNING SYSTEMS

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Environment and Climate Change Canada | Environnement et Changement climatique Canada

Minister's Foreword

Honorable Minister for Infrastructure and Meteorological Services.
Mr. Jone Usamate

As the Minister responsible for Fiji Meteorological Service, it is my pleasure to present the Fiji Meteorological Service Strategic Plan 2021-2024.

The Fiji Meteorological Service is Fiji's national weather, climate and hydrological information agency that, through actions taken under this Plan, will consistently improve the range and quality of services it provides to all Fijians by taking advantage of improving scientific understanding of weather, climate and water, and new technologies for observing the atmosphere and ocean, for supporting computer-based models and for communication data, forecasts and warnings.

The Fiji Meteorological Service has important regional responsibilities, including those for the provision of tropical cyclone warnings for a large part of the Southwest Pacific, supporting some of our close neighbors in the provision of basic weather services and the supply of international and domestic aviation operating over, and shipping in the oceans adjacent to Fiji with weather data, forecasts and other information. Under this Plan the Fiji Meteorological Service will find new efficiencies in meeting these responsibilities and put in place formal agreements with its stakeholders that establish mutual obligations that will be met in the future.

This Strategic Plan sets the strategic direction for the department and outlines its strategic priorities, goals, targeted indicators with set timelines. The strategy is accompanied by an Implementation Plan which sets out the processes and activities that will be undertaken by the Fiji Meteorological Service to achieve the goals set out in the Strategic Plan.

These are ambitious Plans that will serve all Fijians well.

I commend this Strategic Plan to all stakeholders and encourage that we all work together as we strive to transform Fiji Meteorological Service.

Permanent Secretary's Message

Permanent Secretary for Infrastructure and Meteorological Services.
Mr. Taitusi Vakadravuyaca

I am proud to present this Strategic Plan for the transformation of the Fiji Meteorological Service to better serve all Fijians as well and the residents of neighbouring countries.

The Plan has been built around five Objectives. Objective 1 focuses on improving FMS's contribution to the national multi-hazard early warning system, introducing impact-based forecasts and improving access of all Fijians to FMS's data and products.

Objective 2 describes the technology path to be taken in strengthening FMS's ability to improve its meteorological and hydrological observations, develop improved forecasts and distribute data, information, forecasts and warnings more efficiently.

Objective 3 provides a strategy for improved use of applied research with service users and cooperative research with local and international universities and laboratories to develop forecasts and warnings aimed at better meeting national and international needs.

Objective 4 challenges FMS's management to modernize systems and policies to improve the efficiency with which the FMS asset base is managed and to establish a robust framework for free basic services to be provided along with cost recovered and commercial services.

Objective 5 plans the process for supporting and strengthening the important international roles FMS plays within the World Meteorological Organization, the Pacific Meteorological Council and other relevant regional bodies.

It is a Strategic Plan for 2021-2024 but will establish an exciting path for FMS for many years beyond.

Finally, I must acknowledge World Meteorological Organization in guiding the preparation of this Plan, the many users of FMS's services who clearly expressed their ongoing needs for FMS's and so assisted the consultant in drafting the Strategic Plan and a number of supporting documents, including most importantly an Implementation Plan.

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Fiji Meteorological Service Strategic Plan:

A Strategy for the Ongoing Transformation of the Fiji Meteorological Service to Better Serve all Fijians

Seizing Opportunities

With this Strategy for the Fiji Meteorological Service, we are setting out how we will seize the opportunities inherent in scientific developments in meteorology and hydrology and technology developments in communications and computing to transform the organisation, creating new services for all Fijians and new opportunities for a range of economic sectors in Fiji.

Our Vision

FMS will be a people-focussed centre of excellence for weather, climate, hydrological and ocean services.

Fiji, along with the rest of the world, is facing an increasingly rapid digital transformation of trade, industry and society, which will affect most parts of our community. If we approach this development in the right way, FMS can utilize the opportunities to better protect lives, livelihoods and property during extreme weather events, improve wellbeing, assist in conserving the environment and create opportunities for savings in weather and climate sensitive industries.

Scientific and technological transformation bring with them great opportunities, but also challenges for FMS and for the users of our evolving services.

Automation of tasks now performed manually will result in speedier and higher quality data and information access but reduce the number of low-skilled jobs. New digital opportunities for visualizing meteorological and hydrological datasets and for combining these datasets with other non-hydrometeorological datasets, such as the distribution of vulnerable communities during disasters, will provide more effective warning services.

Economic sectors that are exposed to climate and weather-related risks will be able to integrate meteorological and hydrological data with business-related data, which will lead to the creation of new information, to the possibility of new business models, and to better products and service options for consumers. The integration of meteorological and hydrological data and information by companies can result in more efficient production and procedures, which can, in turn, improve productivity. Table 1 provides some examples of socio-economic benefit cost ratios arising from investment in meteorological and

hydrological services in developing and developed countries in a variety of sectors from households to agriculture, transport, oil drilling and hydro-power.

Table 1: *Illustrative economic assessments of the benefit cost ratio of investment in meteorological and hydrological services in developing and developed countries*[1].

Socio-Economic Benefits Study	Geographic Location	Sectors	Benefits Measures / Methods	Benefit Cost Ratio
Contingent valuation study of public weather service (Anaman et al., 1998)	Sydney, Australia	Households	Willingness to Pay (WTP) Survey	4:1
Economic value of weather forecasts in the US. (Lazo and Chestnut, 2002)	United States	Households	Willingness to Pay (WTP) Survey	4:1
Benefits to agriculture of ENSO early warning (Adams et al., 2003)	Five-state region in Mexico	Agriculture	Change in social welfare from drop in production	2:1 to 9:1
Value of hurricane forecasts to the oil industry (Considine et al., 2004)	Gulf of Mexico	Oil drilling	Value of avoided evacuation costs and lost drilling time	2:1 to 3:1
Benefits and costs of improving met-hydro services in developing countries (Hallegate, 2012)	Developing countries	Key economic sectors	Benefits-transfer approach considering asset losses, lives saved and total value added	4:1 to 36:1
Socio-economic benefits of enhanced weather services (Leviakangas and Hautala, 2009)	Nepal	Agriculture, transport and hydro-power	Statistical inference and expert judgement	10:1

While there have been many socio-economic studies showing the clear contributions to social welfare and positive public and private benefits from weather, climate and hydrological services, the concept that, using public financing to provide free meteorological, hydrological and oceanographic data and basic services increases economic value, has not always been recognised. Accompanying the free provision of

[1] Adapted from: "Valuing Weather and Climate: Economic Assessment of Meteorological and Hydrological Services" WMO Publication 1153, 2015.

basic meteorological services, experience shows that an open-data policy, meaning information is both technically accessible and legally licensed to permit commercial and non-commercial use and reuse without restrictions[2], tends to lead to a dramatic increase in the use of the data. It is anticipated that the next World Meteorological Conference will adopt a new Resolution further encouraging the exchange of weather, climate and hydrological data[3].

In the early 2000's, with the advent and growth of the Internet, the Australian Bureau of Meteorology's historical open data and information policy led to a substantial and rapid growth in use of its services (Figure 1) and increase in staff morale as the Bureau's website became, and remains the busiest Australian Government web site.

Figure 1 Growth in usage of the Australian Bureau of Meteorology's web services which are based on an open-data policy.

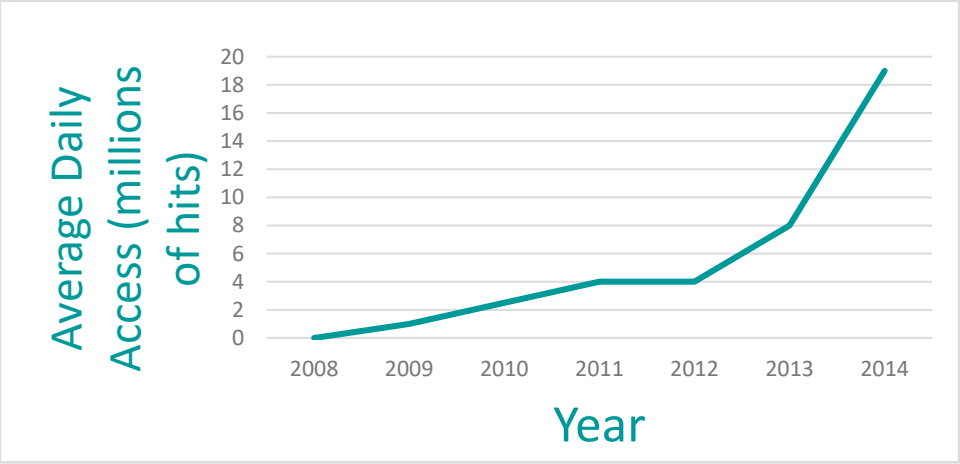
In 2006, the Norwegian Meteorological Institute decided to stop charging for weather and climate data to facilitate a broader use of its data and products. This policy has not

[2] World Bank, 2014: Open data essentials, http://data.worldbank.org/about/open-government-datatoolkit/knowledge-repository

[3] The proposed Resolution is Resolution 42 which will "update" the existing resolutions on weather data (Resolution 40), hydrology data (Resolution 25) and climate data (Resolution 60) to cover all Earth System Data. Information source: https://meetings.wmo.int/INFCOM-1-III/PublishingImages/SitePages/Update on WMO Data Policy/English WMO-Data-Policy-Brochure_en.pdf?Mobile=1

only led to exponential increases in the use of the Norwegian Meteorological Institute's data and products (Figure 2), but has contributed to the institute having the best public reputation of all Norwegian governmental institutions for nine years running (based on official annual polls), as well as high staff morale[4].

Figure 2 Growth in usage of the Norwegian Meteorological Institute's web services following adoption of open-data.



We must be ambitious and ready to take advantage of the opportunities to ensure that the FMS continues to provide the best possible weather, climate, hydrological and ocean services to the Fijian community.

With this strategy, we will be implementing a range of specific initiatives to enable Fiji and all weather- and climate-sensitive Fijian businesses to take advantage of the rapidly advancing meteorological and hydrological science and technology and the underlying digital transformation that will increasingly make new products and services available.

We are at a good starting point – but we must continue to take the long view of where we are going.

Meeting the Challenges

The scientific and technological developments also involve challenges that FMS and Fijian society, including the business sector, must deal with.

[4] Lyng, K., A. Sund and H. Futsaether, 2014: Open Data at the Norwegian Meteorological Institute. MET report commissioned for the World Bank Group. Oslo, Norwegian Meteorological Institute.

Individuals may feel insecure in regard to their ability to take advantage of new job opportunities – for example, new software systems can do parts of the tasks that are currently managed by people, such as data quality control and even the preparation of forecasts and warnings. Operation and maintenance of these new systems may not fit easily with old skills. These challenges place demands on the education system, organisational recruitment, training and retraining.

As automated systems increasingly become the core of our 24 hours a day, 7 days a week (24/7) forecast and warning system, computer security becomes of paramount concern. This means that data leaks and cyber-attacks can have major consequences for both FMS and society as a whole, requiring cyber security and privacy protection to be put in place on all FMS systems. Increased commercial use of data, and use of community vulnerability data in our impact-based warnings also demand an ethically sound approach to processing and storing information.

Objectives for FMS to Achieve its Vision

Stakeholder discussions, a review of Fiji Government's national policies and regional and global commitments and an FMS risk analyses have led to the establishment of five objectives to guide operations and organisational development in the coming years:

Objective 1 Better Serve Societal Needs for Weather-, Climate-, Hydrology- and Ocean-related Services.

To meet this objective; 'Better Serve Societal Needs', a community-based approach is needed. For example, FMS must implement severe weather, flood and drought risk management activities in collaboration with the NDMO, the Ministry of Waterways and Environment and other relevant Ministries. FMS and relevant Ministries will need to work with communities to identify hazard vulnerability and assess tools and strategies for mitigating risks to the extent possible. This work will involve community leaders and members, including women, the elderly, children, community civil defence volunteers, as well as officials from provincial and district governments.

Two strategic initiatives will be pursued that will contribute to achievement of this Objective:

1.1 FMS will continuously improve in its ability to protect lives, livelihoods and property through its active support for Fiji's Multi-hazard Early Warning System and the implementation of Impact-Based Forecasts (IBF) (including warnings[5]).

1.2 FMS will increase the range and quality of its services and streamline the processes for access to its data and information.

Objective 1 encompasses the upgrading of many aspects of FMS's services and is the most complex of the five Objectives. Table 2 shows the cascade from Objective 1 through the two Strategic Initiatives (SI 1.1 and SI 1.2) and the six Initiative Elements: Multi-Hazard Early Warning Systems (MHEWS) and Impact-Based Forecasts (IBF) which comprise SI 1.1 and Improved access to data, New and improved weather services, New and improved Climate Services and New and Improved hydrological services.

Table 2: Overview of the structure of Objective 1.

Objective	Strategic Initiative	Initiative Elements
1. Better Serve Societal Needs	S1.1 MHEWS and IBF	MHEWS
		IBF
	SI 1.2 Hydrometeorological Data and Services	Improved access to data
		New and improved Weather Services
		New and improved Climate Services
		New and improved Hyrological Services

Objective 2 Strengthening the Technical Foundation of the FMS for the Future.

Two strategic initiatives will be pursued that will contribute to achievement of this Objective:

[5] Warnings are a subset of forecasts, and arguably the most important type of forecast a meteorological service issues.

2.1 Enhance the FMS observation network and forecasting systems' underlying Information and Communications Technology (ICT); and,

2.2 Systematically eliminate "black spots" in Fiji's weather, climate, hydrological and ocean observing networks.

Objective 3 Promote Insight and Innovation within FMS

Two strategic initiatives will be pursued that will contribute to achievement of this Objective:

3.1 Collaborate with research partners in the university sector to bring the latest scientific developments in meteorology, hydrology and oceanography to Fiji and the region; and

3.2 Undertake applied research projects, in collaboration with Users of FMS's services, to better meet their needs.

Objective 4 Pursue the "Daunidraki Way" - Vibrant, Effective Corporate Support.

Four strategic initiatives will be pursued that will contribute to achievement of this Objective:

4.1 Resolve FMS's legal position as a service provider with the adoption of a Meteorology and Hydrology Act by Government;

4.2 Transform FMS's Corporate Systems;

4.3 Put in place Service Agreements with Key Clients; and,

4.4 Follow relevant international standards, including those of WMO, ICAO, IMO and ISO.

Objective 5 Serve the International Community.

Six strategic initiatives will be pursued that will contribute to achievement of this Objective:

5.1 Work towards the implementation of a WMO Regional Training Center (RTC) in the South Pacific;

5.2 Establish a WMO Regional Instrument Centre (RIC) within the FMS;

5.3 Continue to provide the full range of tropical cyclone-related services and information through the WMO Regional Specialized Meteorological Center (RSMC) – Nadi and as an ICAO Tropical Cyclone Advisory Centre (TCAC)[6];

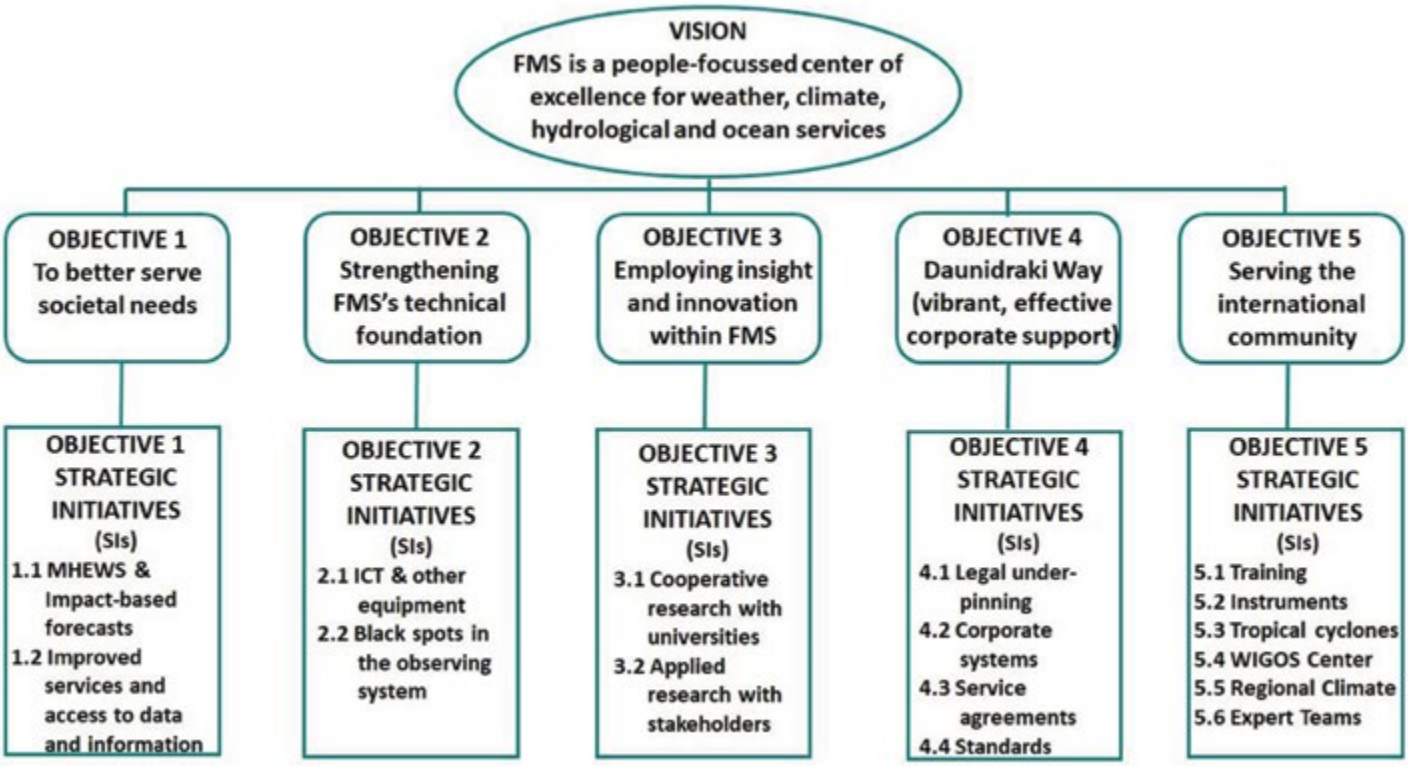
5.4 Establish a WMO Region V Regional WIGOS Center (RWC) within the FMS.

5.5 Establish a node of the WMO South Pacific Regional Climate Center (RCC) in FMS;

5.6 Continue to provide active support to a range of WMO Expert Task Teams.

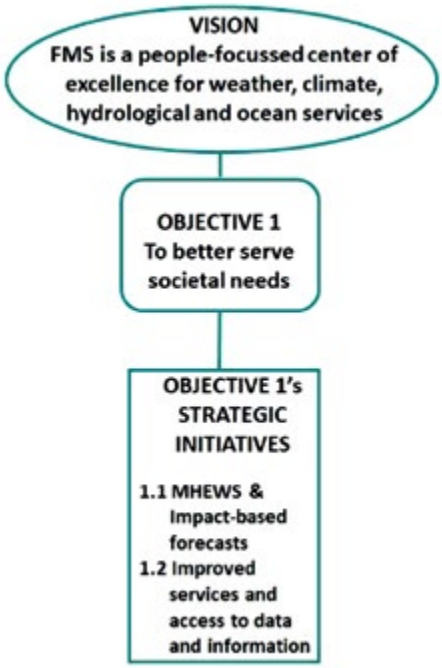
[6] See description at: https://www.icao.int/APAC/Documents/edocs/fasid/tmet3a.pdf

Figure 3: From the Vision follow the Objectives and from the Objectives flow the Strategic Initiatives



Objective 1 Strategic Initiatives (SIs)

SI 1.1 Support for Multi-Hazard Early Warning Systems (MHEWS) and Impact-Based Forecasts (IBF)



Support for MHEWS

Traditionally, many countries have been reactive to disasters experiencing significant losses in lives and livelihoods of their citizens. Adoption of the Hyogo Framework for Action (HFA) 2005–2015 by 168 countries has led to a paradigm shift in disaster risk management from emergency response to a comprehensive approach which also includes preparedness and preventive strategies to reduce risk.

Experience has shown that effective MHEWS comprise four components:

- Detection, monitoring and forecasting the hazards;
- Analyses of risks involved;
- Dissemination of timely warnings - which should carry the authority of government (including legislative backing);
- Activation of emergency plans to prepare and respond.

These four components need to be coordinated across many agencies at national to local levels for the system to function effectively. Failure in one component or lack of coordination across agencies and communities could lead to the failure of the whole system. The issuance of warnings is a national responsibility, a responsibility in which FMS has traditionally played a significant part. FMS's role in the Fijian MHEWS will be clarified, documented and underpinned by agreed Standard Operating Procedures.

Support for IBF

An impact-based hydro-meteorological forecast (and warning) has three distinct elements:

- A description of meteorological and/or hydrological conditions;
- A description of the generalized impacts of the meteorological and or hydrological conditions; and,

- A description of local opportunities and vulnerabilities arising from the meteorological and/or hydrological conditions, which entails involving a range of expertise not found in an NMHS.

In implementing IBF, all four components of Fiji's MHEWS will make important contributions. FMS will have a key role to play in the "detection, monitoring and forecasting" required to define hydro-meteorological hazards. Experts, including those of FMS, will work with NDMO and local communities to "analyse the risks" arising from extreme hydro-meteorological events and to disseminate timely IBFs to the last-mile users. Additionally, FMS will continue to provide forecast and warning support to those carrying out response to disasters.

The FMS will work with the US Weather Ready Nations (WRNs) project and other partners to advance the implementation of IBF in Fiji and in neighbouring countries that receive warnings and other forecasts originated by FMS.

Table 3 describes the significant Outputs, Outcomes, Key Performance Indicators (KPIs) and possible Other Targets that will be pursued by the FMS over the lifetime of this Plan.

Table 3: Overview of the structure of Strategic Initiative 1.1.

Strategic Initiative	Initiative Elements	Outputs	Outcomes	KPIs	Other Targets
S1.1 MHEWS and IBF	MHEWS	FMS contributes to Fiji's MHEWS for all hydro-meteological hazards	A consistent apprach to communicationg the risk associated with hydro-met hazards	MOU with NDMO to support collaborative work on enhancing FMS contribution to Fiji's MHEWS 2021	Number of collaborative projects underway and completed to both organisations' satisfaction
	IBF	Forecasts and warnings that meet IBF requirements	Forecast and warning recipients have products tailored to meet their needs.	Impact-based warnings by 2022	User satisfaction measure

SI 1.2 Increasing the Range and Quality of FMS's Services and Improving Access to Meteorological and Hydrological Data and Information

Improving Access to Meteorological and Hydrological Data

Stakeholder consultations made it clear that there was near universal demand for better access to FMS's data. Much of this demand is focused on demand for data in realtime, or at worst, in near realtime. Many stakeholders sought ways of using FMS realtime data with their own data to develop products tailored to their needs. Noting liability issues, the FMS considers it essential that data go through a quality control assessment and receive a fit-for-purpose rating before realtime exchange with external users.

Currently the FMS has an array of discrete databases and applications. While data for weather services (observations, radar and satellite imagery) are collected in realtime, climate data are often collected with significant delays of hours to one month. Hydrology data are generally collected automatically in real-time. There are separate databases for weather, climate and hydrology data. These databases hold data in different formats and are not set up for external access nor for sharing data via common applications because the databases reside in separate computing systems with different operating systems.

As a part of the FMS transformation, we will work to consolidate all incoming operational data (including climate and water observations, satellite and radar imagery) in a single quality-controlled database. If this database capability can be accommodated within the IBL framework that would be an excellent outcome, nevertheless current expectations that this database may have to be a "front-end" database that feeds the weather IBL software, the climate CLiDE software, the hydrology software package ultimately chosen by FMS and the Web-based, external client interface to those seeking realtime access to FMS data.

An overview of the Outputs, Outcomes, KPIs and Other Targets for the Access to data Element of SI 1.2 is provided in Table 4.

Increasing the Range and Quality of FMS's Services

Strategic Objective S1.1(above) deals with part of the highest priority function of the FMS – providing the best possible warnings and other information dealing with extreme hydro-meteorological events such as floods, storm surges, coastal inundation, forest and grass land fires, tropical cyclones and droughts. Strategic Initiative S1.2 deals with the other elements that comprise the highest priority function of FMS – maintaining a full range of

basic hydro-meteorological services 24/7 that meet the needs of all Fijians for access to weather, climate, hydrological and ocean forecasts, information and data.

Weather and Ocean Services

In the short-term we will continue to make the most effective use of overseas weather forecast model output, supplemented with national and regional observations, to serve as a basis for our weather and ocean services. In the longer-term the introduction and refinement of an FMS implemented weather forecast model will provide access to much more detailed forecasts and a greater range of more timely analyses and forecasts (see S2.1 for further discussion).

An overview of the Outputs, Outcomes, KPIs and Other Targets for the New and Improved Weather Services Element of SI 1.2 is provided in Table 4.

Table 4: Overview of the structure of Access to Data and New and Improved Weather Services Elements of Strategic Initiative 1.2.

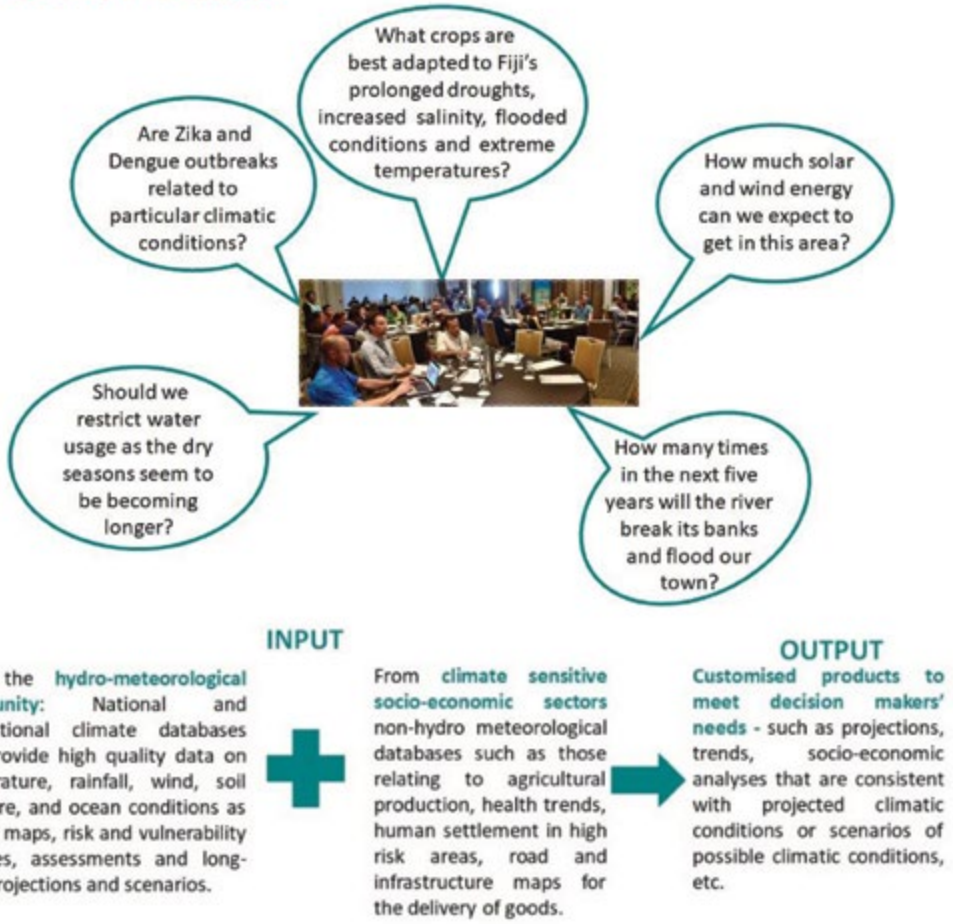
Strategic Initiative	Initiative Elements	Outputs	Outcomes	KPIs	Other Targets
SI 1.2 Hydro-met Data and Services	Access to data	Improved access to FMS's realtime and archived data and products	FMS's services users can make more informed weather, climate and water decisions	External access to data and products streamlined 2022	Level of access on an annual basis
	New and improved Weather Services	3-hour rainfall outlooks ans an adjunct to radar rainfall display	Improved flash flood warning	Implemented by end 2022	1.A measure of the level of public uptake. 2.A measure of user satisfaction. 3. The accuracy of the forecasts and warnings as computed using an objective (standard) measure.
		7-day forecasts	Extended outlook for Fiji's weather	Implemented by end 2021	
		Daily 24 hour digital (gridded) rainfall maps	better understanding of Fiji's rain climatology	Implemented by end- 2022	
		Weekly digital Sea Surface Temperature maps	Fishers, ecologists and others in the marine sector can monitor and use this key parameter in decision making	Implemented by mid- 2022	
		Daily wave height forecast maps (12, 24, 36 and 48hr ahead)	Mariners can better plan	Implemented by mid- 2022	
		All worded forecasts in "plain" language	Better community understanding of FMS products	Implemented by end 2021	

Climate Services

Under the auspices of the WMO initiated Global Framework for Climate Services (GFCS), we are working to increase the range and utility of the climate services we provide. The GFCS is a global initiative that is brings together climatologists and experts from climate sensitive sectors of the economy such as energy, agriculture, health, disaster management and water to apply expertise and data to solve pressing socio-economic problems (Figure 4). The GFCS Implementation Plan (WMO 2014b) describes in detail, among other things,

its vision, objectives, functional components and priority areas for action (these "priority areas" are described using "exemplars")[7].

Figure 4: GFCS, a global initiative to apply climate expertise and data to pressing socio-economic issues.



The FMS will work with key stakeholders in the GFCS priority areas of Health, Energy, Disaster Risk Reduction, Agriculture and Food Security, and Water to develop new services that best meet their needs. This work would be a part of the program undertaken in Strategic Initiative 3.2.

An overview of the Outputs, Outcomes, KPIs and Other Targets for the New and Improved Climate Services Element of SI 1.2 is provided in Table 5.

[7] The GFCS Implementation Plan and other supporting documentation may be found at: https://gfcs.wmo.int/implementation-plan

Table 5: Overview of the structure of New and Improved Climate Services Elements of Strategic Initiative 1.2.

Strategic Initiative	Initiative Elements	Outputs	Outcomes	KPIs	Other Targets
SI 1.2 Hydro-met Data and Services	New and improved Climate Services	Monthly and seasonal outlooks tailored to needs of key sectors (Health, Energy, Agriculture, Water Resources,etc.)	Improved use of hydro-met data in key sector decision making	Progressively implemented during Plan lifetime	1.Level of involvement of key sector organisations. 2.Number of products and user satisfaction. 3.Accuracy of outlooks
		Regular update of latest climate scenarios key hydro-meteorological parameters (rain, temperature and sea level) and implications for Fiji	Better support for integration of climate science into Fiji's climate change adaptation measures	Progressively implemented during Plan lifetime	Number of scenario studies for Fiji prepared by FM collaboratively with other scientists/ organisations.

Hydrological Services

FMS delivers a number of hydrological services, such as coastal inundation forecasts and flash flood forecasts[8] through its operational weather forecasting infrastructure. In addition to these services, we provide other elements of the Fiji Government, including the Waterways Department of the Ministry of Waterways and Environment, with river level and discharge data, riverine flood forecasts, drought forecasts and water resources assessment.

Currently the FMS hydrology group does not routinely provide services other than those from the operational weather forecasting area. It is planned to strategically increase the

[8] The FMS participates in the WMO's Flash Flood Guidance System in its developments of flash flood warnings and other advices (see http://www.wmo.int/pages/prog/hwrp/flood/ffgs/fijiffgs/fijiffgs.php)

capacity and role of FMS hydrology to provide a range of new services. These are detailed in Annex 2 to the Strategic Plan: "*Meeting Fiji's Requirements for Hydrological Services: A Strategic Sub-Plan*". It will mean the transformation of the hydrology group from essentially a support role to quasi-operational status. It will require further investment in staff and infrastructure – an investment that can only be specified after the preparation of an Operational/Business Plan for implementation of the new initiatives outlined in Annex 2.

Annex 2 also includes a preliminary list of new hydrological services that will be developed by FMS and made available directly to key service users and through the FMS Web. This list will be developed through further consultation with users. Table 6 shows the preliminary list of new hydrological services:

Table 6: Preliminary description of future, publicly available hydrological services and associated outputs (from Annex 2)

Service	Output
Flash Flood Watches	Routine watch messages 24 hours before possible flash flooding
Flash Flood Warnings	Warning messages 2 hours prior to flash flooding
Riverine and coastal Flood Watches	Routine watch messages 2 days before possible riverine and/or coastal flooding
Riverine Flood Warnings	Warning messages 12 hours prior to riverine and/or coastal flooding
River height data	Downloadable, quality-controlled data on FMS Web
Daily rainfall mapping	Downloadable, coloured, 24-hour daily rainfall map archive accessible on FMS Web
Monthly and seasonal outlooks for rainfall excess/deficit	Downloadable, coloured, monthly rainfall deficit/excess outlooks accessible on FMS Web
Monthly and seasonal outlooks for key stream flows	Streamflow outlooks (probabilistic products) accessible on FMS Web

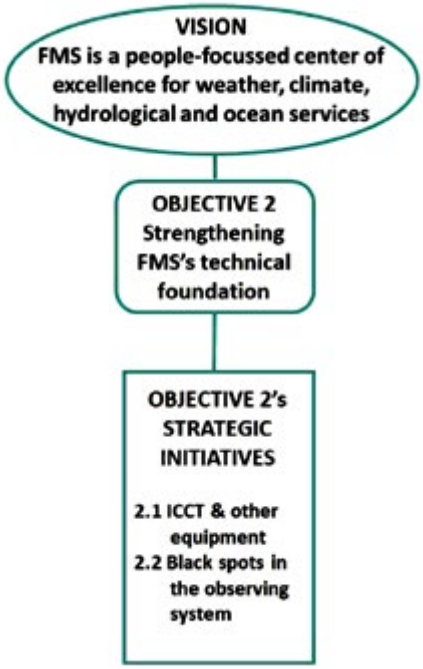
An overview of the Outputs, Outcomes, KPIs and Other Targets for the New and Improved Hydrological Services Element is provided in Table 7.

Table 7: Overview of the structure of New and Improved Hydrological Services Elements of Strategic Initiative 1.2.

Strategic Initiative	Initiative Elements	Outputs	Outcomes	KPIs	Other Targets
SI 1.2 Hydro-met Data and Services	New and improved Hydrological Services	Flash flood watches and warnings	Improved Fijian MHEWS, saved lives and reduced property loss	24 hr lead time watches and 2hr lead time warnings by end-2021	User Satisfaction. Accuracy of warnings and watches
		Riverine flood and coastal inundation watches and warnings	Improved Fijian MHEWS, saved lives and reduced property loss	2 day lead time watches and 12hr lead time warnings by end-2021	User Satisfaction. Accuracy of warnings and watches
		Daily river and stream height data	Improved realtime water management	Progressively implemented during Plan lifetime	Level of user uptake. Number of streams/rivers monitored in realtime.
		Monthly and seasonal river and stream flow outlooks	Improved national water management	implemented by end-2022	User Satisfaction. Accuracy of outlooks.

Objective 2 Strategic Initiatives

SI 2.1 Enhance the FMS observation network and forecasting systems' underlying Information Computing and Communication Technologies (ICCT)



A goal of FMS is to migrate all operation weather-related applications into a single, easily accessed environment. The chosen environment is the proprietary IBL one. IBL offers a broad range of functionality including Visual Weather. Visual Weather provides software for reception, processing, and graphical representation of meteorological data, monitoring of incoming messages and values, generation of textual products (TAFs, public forecasts and warnings, etc.) and graphical products (significant weather analyses, surface analyses, etc.), and includes tools for managing forecast roles and workflows, automatic generation of image products, and other functionalities for fulfilling the weather-related tasks of a meteorological service.

We will also strengthen FMS's overall capability by enhancing our observing networks, Information, Computing and Communications Technology (ICCT) infrastructure and staff expertise to collect, process, analyse, predict, visualise and disseminate data and information to users, employing "green" technologies where possible.

The enhancements needed for the weather observation network include:

- Standardisation of automatic weather stations such that all originate from a single manufacturer, so as to reduce costs of maintenance and simplify data management;
- Modernize access to the information made available through the WMO telecommunications network; and,
- Implement a weather, climate and hydrological modelling capability.

The enhancement most urgently needed for the climate network is the automation of the data collection so that the climate observers can enter the data on the traditional F10 paper form and also, at the time of each observation, into a mobile telephone App that feeds the data directly into FMS's WIGOS compliant data quality control system which

meets weather, climate and hydrology requirements and also into the data stream for access by all of FMS's authorised data and information users.

- **Discover Weather – WMO Information System.** Discover Weather is WMO Information System (WIS) software and is IBL's next generation solution to participating in the WMO's global data sharing programme. Its main features are that it provides:
  - WIS requirements without using GeoNetwork or SIMDAT as sidekick.
  - a unified solution for GISC, DCPC and NC.
  - synchronization with other WIS nodes.
  - optimized metadata search index for product discovery.
  - user friendly metadata editor to edit and create product descriptions.
  - a system built on top of reliable message switching and file distribution system to effectively deliver the discovered products.
  - ad hoc delivery as well as routine distribution of products.
  - access rights management to deal with non-public data.
  - integrated management of users and customers.
  - product package definition based on metadata identifiers to organize the products.
- **Aero Weather:** Aero Weather is an integrated system for reception, processing, and representation of meteorological data for purposes of providing reliable and high-quality weather information for aviation. It features an intuitive interface, instant access to OPMET data, forecasts and warnings and automated production of flight information bulletins.
- **Numeric Weather:** Numeric Weather is a complete solution for Numerical Weather Prediction system and is a combination of:
  - high performance computing with state-of-the-art local area numeric weather prediction (NWP) models:
    - COSMO – non-hydrostatic, resolution up to 2.8 km by DWD/COSMO Consortium.
    - WRF – non-hydrostatic Weather Research & Forecasting Model by NCAR, NCEP, FSL, AFWA, FAA.
    - WAMS – Wave model by GKSS.
    - WAVEWATCH III – Wave model by NOAA.
  - The complete solution also includes necessary training, customization and maintenance.

There are a number of other packages under the IBL framework and all those implemented by FMS would be fully supported by a service level agreement between IBL and FMS.

As we move into this new information technology environment, we will accompany the transition with staff training to increase the capability and productivity of our professionals and supporting technical officers.

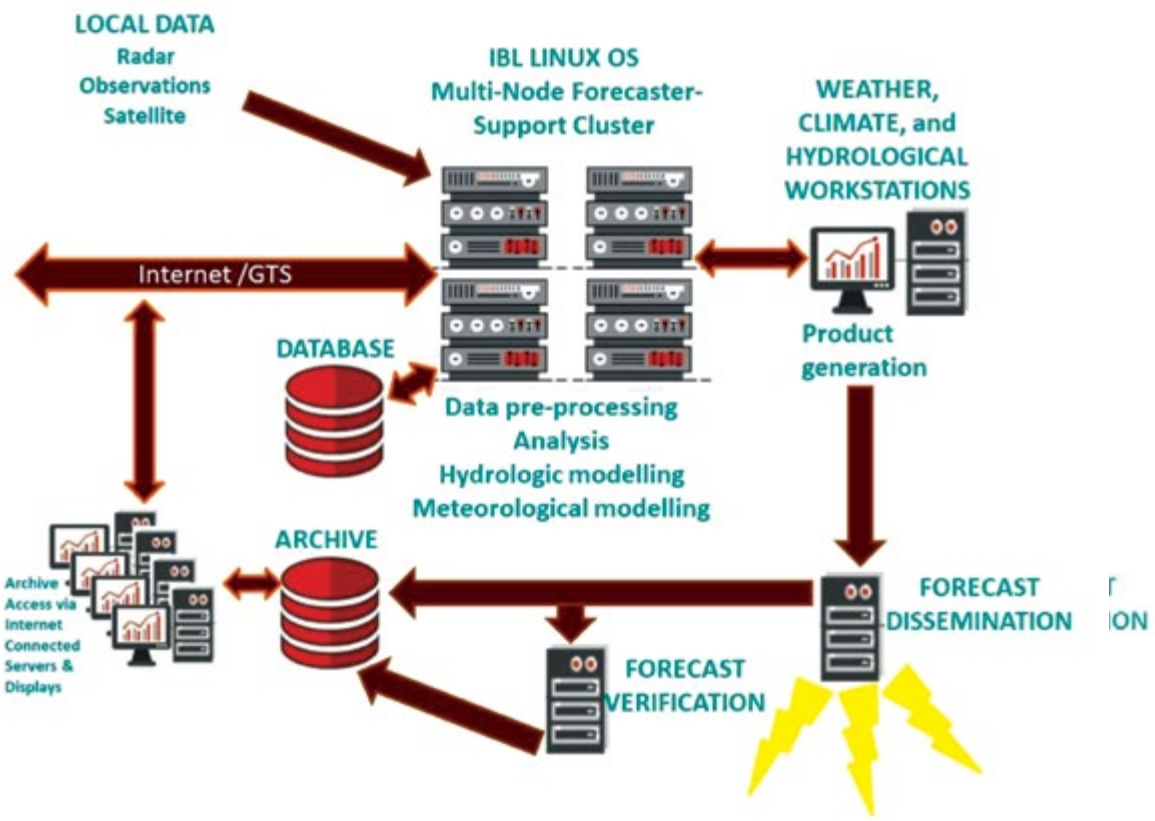
While FMS does not yet undertake any numerical weather prediction modelling, we are planning to further explore the option of implementing the open-source Weather Research and Forecasting (WRF) model from UCAR[9]. Many developing countries have implemented WRF in research mode or as an adjunct to operations. There is a large selection of literature identifying its strengths and weaknesses through verification of its forecasts in a range of applications. It is clear that the process of optimizing the WRF for Fiji would be a complex one, with the horizontal resolution chosen determining the physics package to be implemented. The overall capability of the available computing system would also be a consideration in the implementation strategy.

FMS plans to acquire a multi-node High Performance Computing Cluster (HPCC), by mid-2021 and WRF is currently expected to be FMS's first numerical weather prediction system[10]. A schematic of the likely configuration of a suitable HPCC, and its relationship to the IBL environment being developed is shown in Figure 5. The HPCC would likely support a backup version of the IBL multi-node forecaster support cluster.

[9] https://journals.ametsoc.org/bams/article/98/8/1717/216092/The-Weather-Research-and-Forecasting-Model

[10] An example of the issues related to modelling deep, moist convection in the tropics using WRF is given by Han J and Hong S (2018). Source: http://journals.ametsoc.org/pdf/10.1175WAF-D-18-0026.1

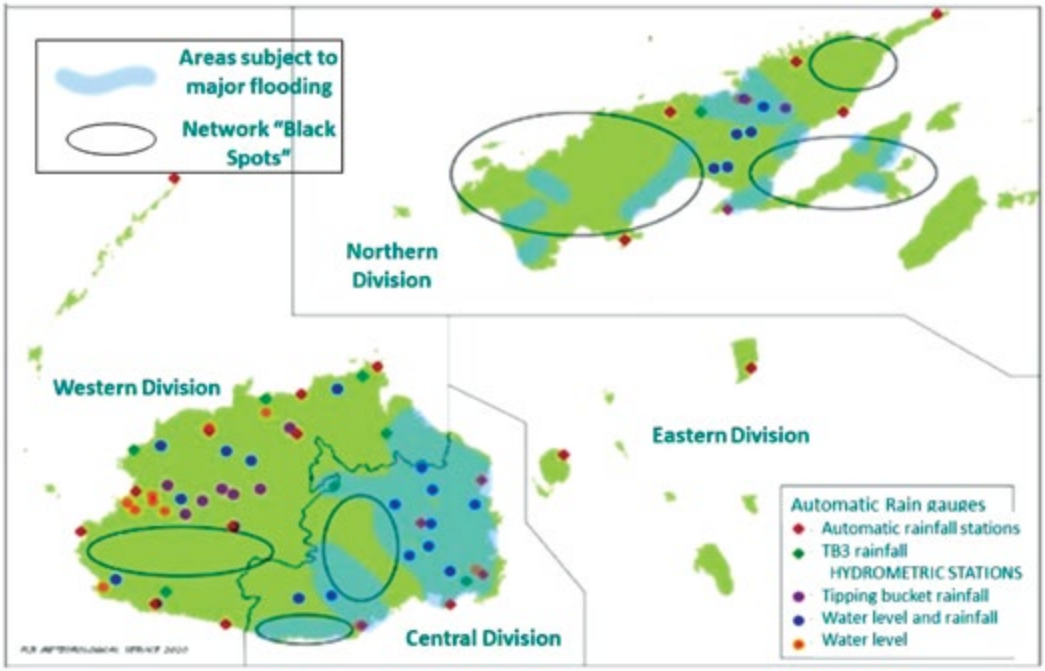
Figure 5 ***A schematic of the medium- to long-term weather forecasters' computational environment. All data, model generated analyses and forecasts, and information required by the forecaster are accessed through IBL software systems on an IBL workstation that supports smart product generation.***



SI 2.2 Systematically eliminate "black spots" in the weather, climate, hydrology and oceans observing networks.

The FMS operates a "composite" weather, climate, hydrological and oceans network of radars, automatic weather stations, high quality climate stations, river gauging systems and tide gauges. These national data are combined with observations from other countries and with remotely sensed observations from geostationary and orbiting satellites. Experience has shown that there are areas of Fiji not well covered by our three weather radars and by our in-situ stations (Figure 6). To better support our weather, climate, hydrological and ocean services, we have in place a program of increasing the catchments covered by river gauges and will continue this program through the lifetime of this Strategic Plan. We will also look to address black spots in other networks as opportunities to do so arise.

Figure 6: A map showing approximate major flood areas, hydrometric observing stations and observing black spots in Fiji.



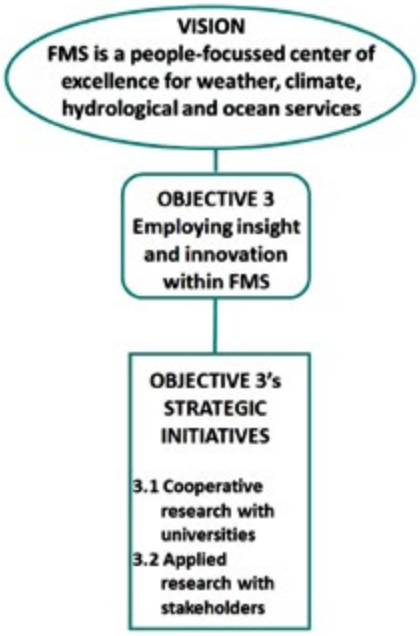
All the proposed black spot elimination hydrometric stations will be located within hydrometric observing system data voids (or "black spots" – Figure 6) in order for FMS to expand and improve its flood forecasting and water resources assessment services. To make these improvements FMS needs to:

- Receive near real time data from all major flood prone areas to support more accurate warnings in data sparse catchments; and,
- Improve the Fiji-wide Flash Flood Guidance System (Fiji-FFGS) by expanding the rainfall observation stations nation-wide and use the observations of rainfall amounts to calibrate radar and satellite derived rainfall estimates.
- The instrumentation that will be required includes:
  - Water level and equipment to measure the rainfall intensity in the upper catchments to provide an input into modelling of downstream water levels;
  - Soil moisture sensors;
  - Equipment (non-contact technology) to measure the velocity of the surface water during flood events; and,
  - Water level radar sensors on key bridges. This is also a non-contact technology that requires less maintenance than current technologies.

Table 8: Objective 2 and related Strategic Initiatives, Outputs, Outcomes and Key Performance Indicators.

OBJECTIVE	Strategic Initiative	Outputs	Outcomes	KPIs
2. Strengthen FMS's Technical Foundation	SI 2.1 ICCT and Observation equipment.	A reduction in the number of different systems being supported and an increase in automation.	Reduction in maintenance costs and an increase in efficiency.	IT Plan updated 2021. Further automation of forecasting environment 2023. Further automat ion of weather, climate and hydrology observation collection 2022.
	SI 2.2 Black spots.	Improved flood warnings and a more comprehensive national view of Fiji's hydrology	Lives and livelihoods better protected by more accurate and timely flood warnings and drought advices.	30 new hydro-met stations and 5 river basins mapped by 2022.

Objective 3 Strategic Initiatives



Weather, climate and hydrological forecasting has become increasingly complex and more accurate across all time and space scales as advances in computing, observation technologies have underpinned a range of scientific break-throughs. In response, this Strategic Plan sets the direction for FMS's engagement in research and development over the next decade through description of two research and development Strategic Initiatives.

SI 3.1 Collaborate with research partners in the university sector to bring the latest scientific developments in meteorology, hydrology and oceanography to Fiji and the region

In order to bring World-class scientific research in weather, climate, hydrology and oceanography to Fiji and to FMS, we will develop partnerships with the university community here in Fiji and with universities and research laboratories in Asia, Oceania, the US and Europe. We will look for opportunities to up-skill our staff in the latest developments in sensor and monitoring approaches, remote sensing, numerical analysis and prediction, seasonal forecasting and climate scenario down-scaling.

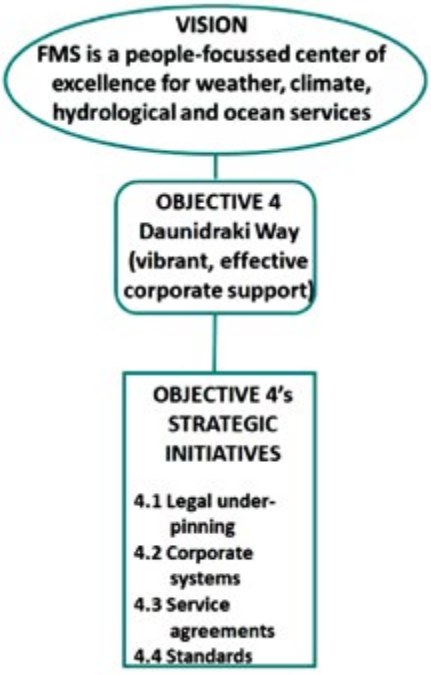
SI 3.2 Undertake applied research projects, in collaboration with users of FMS's services, to better meet their needs.

As a natural complement to increasing our access to the latest science, we will engage users of our services in Fiji to identify opportunities to improve their management of risks associated with extremes in weather, climate, hydrology and oceans through the development of improved, science-based forecast products. We expect that this would be a collaborative process, with the FMS bringing to the table data and scientific expertise in weather, climate, hydrology and oceanography and the users bringing to the table an understanding of how weather, climate and hydrological extremes drive their risk profile. In particular, we expect that service users can advise on thresholds at which crucial decisions for risk mitigation can be taken and give a commitment to work with FMS over time to continuously improve our services by providing informed feedback.

Table 9: Objective 3 and related Strategic Priorities, Outputs, Outcomes and Key Performance Indicators.

Objective	Strategic Initiative	Outputs	Outcomes	KPIs
3. Insight and Innovation	SI 3.1 Cooperative Research.	New insights into Fiji's weather, climate, hydrology and ocean systems.	FMS is better placed to take advantage of new science and technology.	Collaborative research projects with UCAR & USP by end of 2021.
	SI 3.2 Applied Research Collaboration with Users.	Innovative new weather, climate, hydrology and ocean services.	Service users gain new efficiencies and/or more effectively mitigate risks.	Collaborative projects with service users to develop innovative new products by the end of 2021.

Objective 4 Strategic Initiatives



SI 4.1 Resolving FMS's legal position as a service provider with the adoption of a Meteorology and Hydrology Act by the Government of Fiji

The public interests served by a National Meteorological and Hydrological Service (NMHS), such as FMS, are the:

- Protection of life, livelihoods and property;
- Promoting long-term observation and collection of meteorological, hydrological and climatological data, including related environmental data;
- Promotion of endogenous capacity-building;
- Safeguarding the environment;
- Contributing to sustainable development;
- Meeting international commitments; and,
- Contributing to international cooperation.

Over half the NMHSs operated by the WMO's 194 Members have formal legal instruments (such as a law, act or decree) covering their responsibilities, the establishment and operation of their facilities, government regulation and legal responsibility. The advantages of such a legal instrument for protecting these public interests are:

- The duties and areas of responsibility of the NMHS are defined for the benefit of both the NMHS and the governments;
- The NMHS is clearly designated as the national authority for the provision of information in support of disaster risk management (DRM) on weather- and hydrology-related hazards (in many cases, also for climate- and ocean-related hazards), to avoid public confusion and to facilitate inter-agency cooperation, particularly during disasters;
- Legal protection is provided for the field equipment and officers in the performance of their duties;
- Direct access to essential international communications is assured;
- Coordination of various weather, climate, hydrology, oceanography and related environmental activities in the country is provided; and,
- A basis for determining the level of funding needed to fulfil the agreed role is clarified, including provisions for retaining revenues earned by the NMHS to improve its operations.

Not only is the FMS transforming the way it uses developments in science and technology to undergo a transformation, it is also transforming its internal management processes and external liaison activities. The development of a Meteorology and Hydrology Bill that describes its roles, functions and other administrative arrangements in the meteorological and hydrological areas will likely set the scene for an administrative transformation of our organisation. Currently the operational model for the FMS is that of a Departmental Unit (Table 10) under the direct control of the Ministry of Infrastructure and Meteorological Services (MoIMS). With the passage of a Meteorology and Hydrology Bill through the Fiji Parliament, the FMS would move towards gaining its own legal identity while remaining as a public interest Service within a Ministry. Another transformation that is occurring within the organisation is a greater focus on revenue generation from both cost recovery and commercial activities (an issue addressed under Strategic Initiatives 4.2 and 4.3)

Table 10: A schematic summarising the operating models of National Meteorological and Hydrological Organisations around the World[11].

	Directly controlled	Indirectly controlled			
	Department unit	Contract Agency	Public body	State-owned enterprise	Privatised company
Type of task	Public service provision	Public service provision	Public service provision	Public service provision	Public service provision
Own legal personality	No	No	Partially or fully separate	Yes	Yes
Legal basis	Public law	Public law	Public law	Private law	Private law
Finances	State budget	State budget; own revenues possible	State budget and own revenues	Own revenues	Own revenues
Control mechanism	Direct political	Framework document	Statute law	Market intervention	Regulation
Ministerial responsibility	Yes	Yes	Partial	Type of task	No

4.2 Transforming Corporate Services

Enterprise Resources Planning (ERP)

A first step towards transforming FMS's Corporate Functions would be to assess the suitability of so-called Enterprise Resource Planning (ERP) system software. Such software typically provides inter-linked functionality covering: human resources, finances, book-keeping, payroll, assets, sales, and project management.

The range of capability and cost of such systems is large. Implementation of an ERP system, including training of all staff who will use the system is time consuming and the cost is highly dependent upon the complexity of the installation as well as the hardware employed and the various software licences that must be paid for annually. For a small but complex (and asset intensive) enterprise such as FMS, there is the added dimension

[11] Source: "Valuing Weather and Climate: Economic Assessment of Meteorological and Hydrological Services". WMO Publication 1153, 2015.

of the need for local support (both for training and maintenance). The FMS will explore the options for implementation of an ERP system, and if the benefit/cost ratio is favourable, develop a proposal for further consideration.

Assets Data Base

As noted, the operation of a modern national meteorological and hydrological services is capital-intensive. Modern observing systems employing radars, automatic weather and hydrological stations and remote field stations, and a central operational facility that manages high speed communications, advanced computing systems, satellite readout stations and a range of instrument calibration and equipment maintenance facilities are all expensive items with operational lifetimes ranging from as little as 2 to 3 years out to 10 or 15 years.

The Ministry of Economics has advised that in the short- to medium-term, Fiji will move from cash to accrual accounting. Regardless of this move, for purely operational reasons the FMS requires an accurate assessment of the value of its asset base, the rate at which it is depreciating and the annual outlay required to at least maintain current operational capability – information that should be consolidated in an Asset Data Base (ADB). When completed, the audited ADB should form the basis for the FMS's ongoing asset management, and a key plank in equipment maintenance and operational planning.

Evaluating the Cost of Services and Charging Policy

As the FMS moves towards establishing service agreements with cost recovery or commercial charging components, it will need to establish a charging model and operationalise, through a charging manual, staff determination of the cost of services. Underpinning the charges there needs to be a Government agreed charging policy which distinguishes between the "public goods", "mixed public-private goods" and "private goods" (Figure 7)[12].

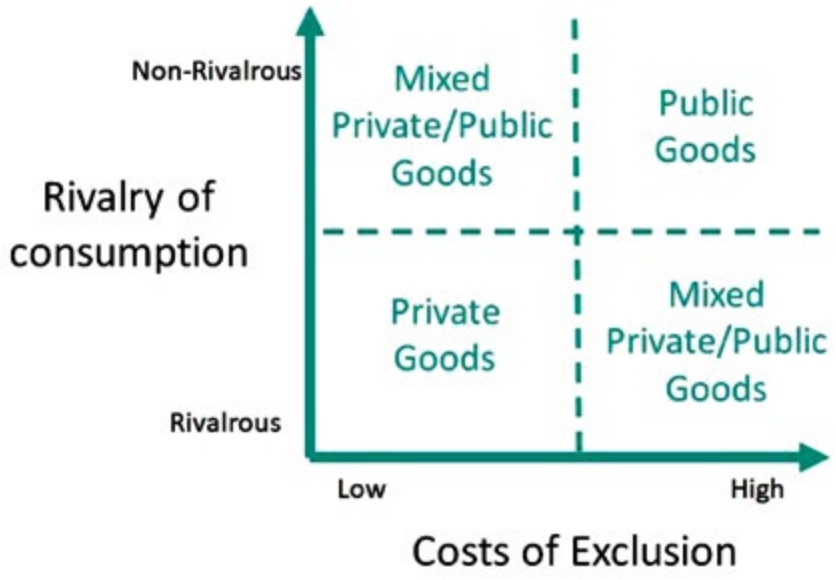
In essence, public goods are those for which it is hard to exclude access and the use by one person does not diminish the value to other (e.g. a tropical cyclone warning issued on television) – such goods are funded through taxation and are provided free of charge to all citizens.

[12] Adapted from J.W. Freebairn and J.W. Zillman 2002. "Funding Meteorological Services". Meteorol. Appl. 9, 45–54 (2002)

Private goods are those for which it is easy to exclude access and the provision of the good means that someone else is disadvantaged (e.g. a member of the public speaks to a forecaster taking her away from her public forecasting duties so that she can provide the member of the public with a private benefit). Such goods should be provided in a commercial way, with market forces establishing the price of the service.

Mixed public/private goods include aviation weather services which could be considered as rivalrous, because they could be used to convey an advantage to one user over another, but the cost of not giving access to all could be disastrous if airlines were to fly without forecasts, and so the cost would be high. The agreed international practice, managed by ICAO, is that each signatory to the Chicago Convention provides an agreed range of meteorological services and recovers the cost of this provision from the airlines at cost recovery, not commercial rates. Another type of mixed Public/Private Good held by all National Meteorological and Hydrological Services is the weather, hydrological and climate data they collect using government funds. There are two threads to the argument for them being mixed Public/Public Goods: Firstly, the cost of exclusion is high because the national economic interest is best served if every citizen and organisation that needs weather, climate and water data for risk management should have access and furthermore the public, through taxation, has already paid for the data. Secondly, because those accessing these national data gain private benefit, they should pay the cost of accessing the data (where cost of access exceeds the cost of recovering the associated revenue).

Figure 7 The factors that can be used to determine the economic classification of FMS's services.



As the Government establishes a charging policy for FMS a range of challenges will be met, including:

- Drawing the boundary lines between public good, private good and mixed private/public good services.[13] Private sector meteorologists already operating in Fiji will have a considerable stake in where these boundaries are drawn and will likely feel that they should be consulted concerning FMS's charging policy as it is developed and as it evolves over time once established;
- Determining the true cost of a particular service. In the case of mixed public/private goods this determination will need to be transparent, and in the case of services to aviation, will be the subject of annual consultation as technologies and requirements evolve;
- Structuring the FMS's internal operations such that funds allocated for public good services do not underpin the production of private goods, or vice versa; and,
- Managing the culture change necessary as FMS moves from a purely public good service provider to a service provider that also has commercial and cost recovery objectives.

[13] A "service", in this context, is the combination of the product and its delivery mechanism. As technologies evolve the incremental cost of delivery of a product can vary substantially depending on the mode of delivery. For example, the incremental cost of delivering an image of a tropical cyclone to all citizens via public television is substantially less than sending every citizen an SMS "blast" message.

SI 4.3 Service Agreements with Key Clients

There are two situations in which the FMS provides significant services without an MoU or service agreement in place:

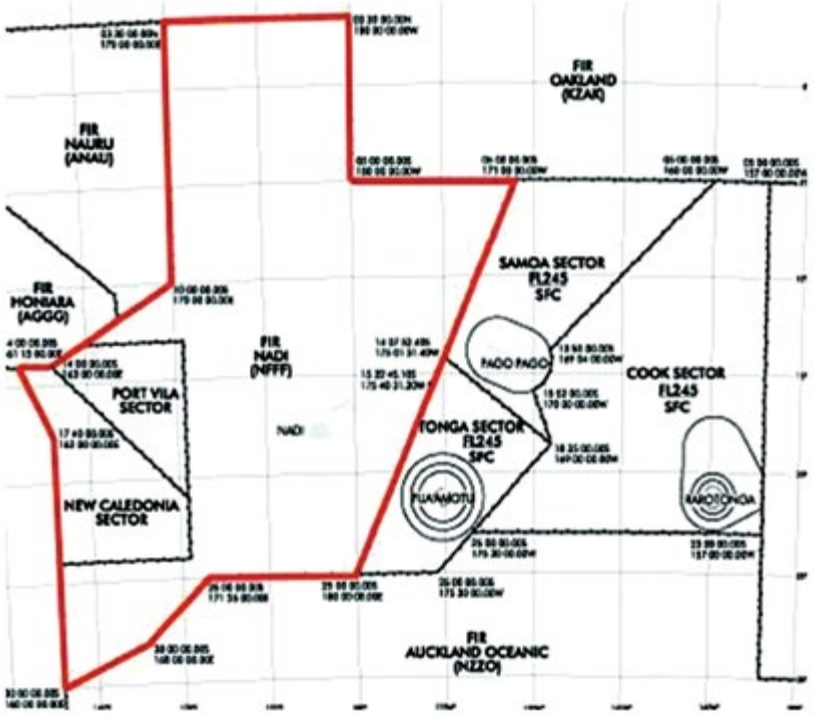
- Provision of public and marine forecasts and warnings to Niue, Cook Islands, Tuvalu, Tokelau, Nauru and Kiribati.
- Provision of aviation services to aircraft operating in Fiji's Flight Information Region (FIR) (see Figure 8).
- Provision of aviation weather services and forecast especially Terminal Aerodrome Forecast (TAF) to aerodromes outside of Fiji's FIR – Rarotonga and Aitutaki (Cook Islands); Bonriki and Cassidy (Kiribati); Nauru (Nauru); Alofi (Niue); Faleolo (Samoa); Fumotu, Hapai and Vavaú (Tonga).

Stakeholder discussions stressed the need to clearly distinguish RSMC-Nadi services (tropical cyclone related information, advices, watches and warnings for the RSMC area of responsibility) from public good information forecasts and warnings (as supplied on the FMS web to six[14] neighbouring countries). Furthermore, they encouraged FMS to underpin the public good services with agreements (Memoranda of Understanding or Service Level Agreements) to ensure that legal liability for the users of those services rested with the national NMS that agreed to the provision of these services by FMS.

FMS will work to establish service agreements in those situations where it provides public good meteorological services to neighbouring countries. The emphasis of these agreements will not be focused on the cost of the service but rather on its quality, reliability and fitness for purpose. As a first step, the FMS will endeavour to establish MoU with these countries that outline areas of cooperation – observations and other information provided by the neighbouring countries and services provided by FMS. A second stage would be a move towards service agreements that describe in more detail the service standards FMS aims to meet and place responsibilities on the recipients to provide routine feedback on how well FMS meets these standards. This feedback will become a part of the overall feedback we are seeking to base our continuous improvement upon. Given the international nature of these service agreements, it is likely that they would be a technical annex to a more general MoU between Fiji and the other Pacific nations they are working with.

[14] The Cook Islands, Kiribati, Nauru, Niue, Tokelau, Tuvalu

Figure 8 Flight Information Region (FIR Nadi) of Fiji, and those of nearby countries.



We will use the Pacific Meteorological Council to discuss and achieve these agreements between the FMS and the respective beneficiary National Meteorological Services.

SI 4.4 Following relevant international standards, including those of WMO, ICAO and ISO

The WMO has established a range of technical standards that are promulgated through its Technical Regulations[15] which are followed by FMS in its operations. The benefits that flow from these regulations include standardisation of observing practices that makes it possible to confidently use all data collected and distributed by WMO, similarly forecasts and warnings meet agreed standards and training of staff achieves agreed levels of competency.

The International Civil Aviation Authority (ICAO), through the Chicago convention has put in place a regulatory framework for the provision of meteorological services to aviation

[15] The WMO's Technical Regulations are contained in three volumes - Vol 1: https://library.wmo.int/doc_num.php?explnum_id=10113 Vol II https://www.wmo.int/aemp/node/183 and Vol III: https://library.wmo.int/doc_num.php?explnum_id=4564

that flies internationally[16]. The FMS provides meteorological services for its FIR following these standards which enable international airlines to be confident that FMS's services are compatible with those received all around the World.

The benefits of, and process for implementing a Quality Management System (QMS) and achieving certification of compliance with ISO 9001 are fully described in WMO Publication No. 1100. Some of the key benefits that flow from having a mature QMS in place include:

- Customer needs identified, met and monitored within a consistent management framework;
- Improved management control and reporting;
- Continuous improvement and enhanced quality culture embedded in the organization;
- Clear processes in place to address poor-quality/non-conforming services;
- Significantly improved documentation processes and procedures that, in turn, enhance the capture of corporate knowledge; and,
- Competencies are identified, gained and maintained through appropriate training.

The FMS will implement a QMS that encompasses its weather, climate, hydrology and ocean services.

[16] Relevant documents include: Source: "ICAO Manual of Aeronautical Meteorological Practice (Doc 8896)", https://www.skybrary.aero/bookshelf/books/2506.pdf and the "ICAO Manual on Air Navigation Services Economics (Doc 9161)". https://www.icao.int/publications/Documents/9161_en.pdf

Table 11: Objective 4 and related Strategic Initiatives, Outputs, Outcomes and Key Performance Indicators.

Objective	Strategic Initiative	Outputs	Outcomes	KPIs
4. Daunidraki Way – Vibrant, Efficient Corporate Services	SI 4.1 Legal basis.	A Bill for Fiji's Parliament that sets out the legal basis for FMS's activities.	All FMS's stakeholders have a clear understanding of FMS's function and role.	National Meteorology and Hydrology Bill by end-2021.
	SI 4.2 Corporate systems.	Energetic and innovative corporate support.	Improved overall efficiency of FMS.	ERP evaluation 2021 Assets register and ADB 2022. Charging policy 2021 and manual 2022.
	SI 4.3 Service agreements.	Service Agreements or equivalents with key stakeholders and overseas NMSs.	FMS's stakeholders and staff reach a clear understanding of the services FMS will provide.	MoU or equivalents with key stakeholders and overseas NMSs 2021 SLAs or equivalents by the end of 2023.
	SI 4.4 Meeting international standards.	FMS's data, products and services follow international standards.	The underlying metadata of FMS's data, services and products are available to all their users.	FMS follows relevant WMO, ISO, IMO, ICAO and other nationally and internationally relevant standards.

Objective 5 Strategic Initiatives

SI 5.1 Working towards the implementation of a WMO Regional Training Center (RTC) in the Pacific

For many years, the shortage of well trained and appropriately qualified meteorologists, hydrologists and support technicians in the FMS has been of considerable concern, not only to its Director but also to the Government and to those who rely on meteorological, hydrological and ocean services in their day-to-day decision making, including; aviators, ship operators, builders, tourists, tourism operators, defence forces and many others.

The shortage has come about for a variety of reasons including; the lack of a training facility in the South Pacific, the high cost of training meteorologists, hydrologists, oceanographers and support technicians in the (relatively) nearby countries of Australia and New Zealand, the high costs of accessing training facilities in Indonesia, the Philippines and Hawaii, the cultural and meteorological differences between these locations and the Pacific, and the loss of many (expensively) trained staff to other countries and careers shortly after they return to the Pacific (see UNDP Study[17] : "Feasibility Study for a Pacific-based WMO Regional Training Center").

A meteorological and hydrological Regional Training Facility (RTC) in the Pacific SIDS has not been established in the past because no single nation has seen the level of demand for meteorological and hydrological training sufficient to justify such an institution, or none of the 15 Pacific SIDS National Meteorological and Hydrological Services has had the resources necessary to establish an RTC.

The FMS will continue to collaborate with a number of parties that collectively would be able to work together to put in place a Centre that could meet WMO requirements for designation as a Regional Training Centre for hydro-meteorological professionals and technical officers in the South Pacific with a campus in Fiji.

[17] The UNDP Study can be found at: "Feasibility Study for a Pacific-based WMO Regional Training Center" https://www.pacific.undp.org/content/dam/fiji/docs/feasibility-study-pacific-based-wmo-regional-training-centre.pdf

SI 5.2 Establish a WMO Regional Instrument Centre (RIC) within the FMS

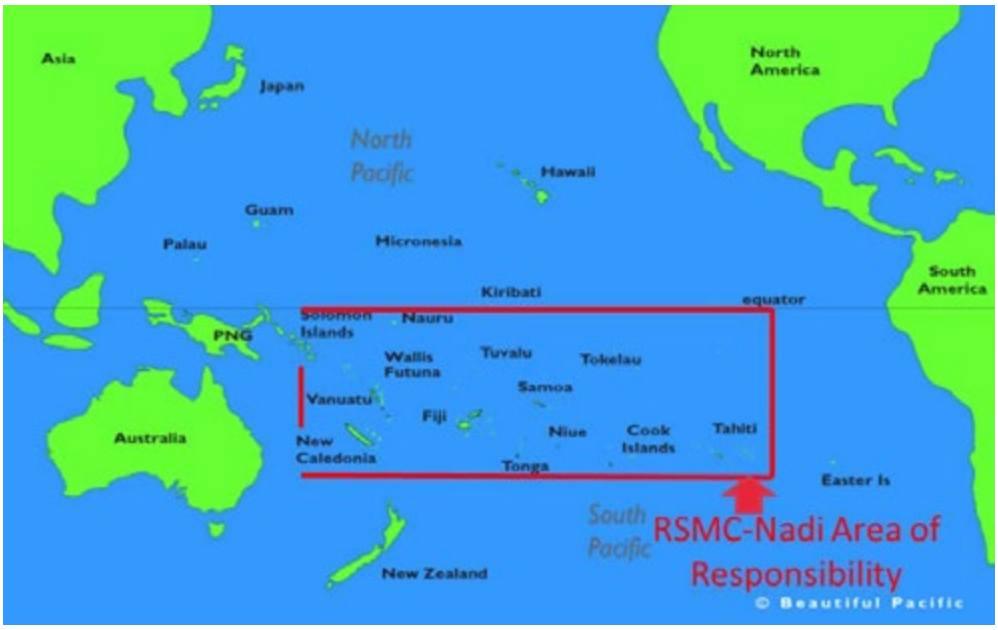
Regional Instrument Centres (RICs) play a key role in maintaining relevant calibration standards and assisting National Meteorological and Hydrological Services in calibrating their national meteorological and related environmental standards and monitoring instruments. The WMO Region V RICs are in Melbourne, Australia and Manilla, Philippines, both expensive locations for Pacific SIDS to access for calibration support.

To better support our own instrumentation, and to offer a cost-effective calibration option to neighbouring countries FMS will work, with the support of donor expertise from Japan to implement a WMO-designated RIC.

SI 5.3 Continue to provide the full range of tropical cyclone-related services and information through the WMO Regional Specialized Meteorological Center (RSMC) – Nadi

In fulfilment of its role as a World Meteorological Organization (WMO) Regional Specialized Meteorological Centre (RSMC) for Tropical Cyclone Forecasting, the FMS through its Nadi office contributes to the safety of life, property and livelihoods of communities living in the Southwest Pacific between longitudes 160°E and 120°W from the equator to 25°S (see Figure 9) through the provision of warnings and other information relating to tropical cyclones.

Figure 9 The geographical extent of the area of responsibility of RSMC-Nadi



SI 5.4 Establish a WMO Region V Regional WIGOS[18] Center (RWC) within the FMS

The WMO, at its 68th Executive Council Session (15-24 June, 2016)[19] decided to proceed with the creation of Regional WIGOS Centers, initially carrying out certain mandatory functions and being able to elect to undertake other optional functions.

The mandatory functions are directly linked with two of the priority areas of the WIGOS Pre-operational Phase (2016-2019):

1. Regional WIGOS metadata management (work with data providers to facilitate collecting, updating and providing quality control of WIGOS metadata in OSCAR/Surface); and,
2. Regional WIGOS performance monitoring and incident management (WIGOS Data Quality Monitoring System) and follow-up with data providers in case of data availability or data quality issues.

Depending on available resources and regional needs, one or more optional functions may be adopted, for example:

(a) Assistance with the coordination of regional/sub-regional and national WIGOS projects;
(b) Assistance with regional and national observing network management; and,
(c) Support for regional capacity development activities.

FMS has submitted a proposal to the President of WMO Region V and if accepted, would provide mandatory and, after discussion with WMO Members in the South Pacific also provide optional RWC functionality to the South Pacific region of WMO Regional Association V.

SI 5.5 Establish a node of the WMO Pacific Regional Climate Center (RCC) in FMS

The WMO RA-V Pacific Regional Climate Centre (RCC) Network, currently in "demonstration phase", is a virtual Centre of Excellence that assists National Meteorological and Hydrological Services (NMHSs) in the Pacific Islands region to deliver better climate services and products and to strengthen their capacity to meet national climate information and service delivery needs. Many of FMS's stakeholders are looking to make better use of our climate services through closer collaborative work.

[18] WMO Integrated Global Observing System (WIGOS)
[19] Executive Council, Sixty-eighth session, Geneva, 15–24 June 2016. "Abridged final report with resolutions and decisions". WMO Publication No 1168. Source: https://library.wmo.int/doc_num.php?explnum_id=3166

The RCC is currently supported by the University of Papua New Guinea (UPNG), National Institute of Water and Atmospheric Research (NIWA) New Zealand, Australian Bureau of Meteorology (BoM), US National Oceanic and Atmospheric Administration (NOAA), South Pacific Regional Environment Programme (SPREP) and Australian Commonwealth Scientific and Industrial Research Organisation (CSIRO), Meteo-France, University of Hawaii, and Pacific Community (SPC).

The RCC is a hub for up-to-date regional long-range climate forecasts, climate monitoring products, climate change projections, climate data services, and information on regional training activities. The RCC[20] consists of five nodes. Each node is led or co-led by a lead institution(s) together with a consortium of support members (Table 8).

Table 12: The structure of the WMO Region V Regional Climate Centre Network

Node Title	Lead Agency/Co-Lead	Consortium Members
Node on Long-Range Forecasting	NIWA & BoM	Meteo-France, NOAA, University of Hawaii, SPREP & SPC
Node on Climate Monitoring	NOAA & University of Hawaii	BoM, SPC, SPREP & NIWA
Node on Climate Change Projections	CSIRO	USGCRP, BoM & SPREP
Node of Operational Data Services	BoM	NOAA, University of Hawaii, SPC & NIWA
Training Function	SPREP	NOAA, University of PNG, BoM, NIWA, SPC & CSIRO

FMS has submitted a proposal to the President of WMO Region V to participate in the node and if its proposal and after discussion with WMO Members in the South Pacific it would clarify the nature of its participation.

[20] A description of the WMO Region V Regional Climate Centre (RCC) can be found at: https://www.pacificmet.net/rcc

SI 5.6 Provide active support to a range of International Expert Task Teams

The WMO has two Technical Commissions:

- Commission for Observation, Infrastructure and Information System; and,
- Commission for Weather, Climate, Water and Related Environmental Services and Applications.

Each Technical Commission has standing committees for normative work and study groups and expert teams. There is clear delineation between the intergovernmental work of Technical Commissions and that of the experts working in the committees and groups. The non-intergovernmental expert teams and study groups are open to experts from national meteorological services, academia and the private sector.

The FMS has a long history of engaging in the work of the WMO. Expert teams provide an opportunity for the unique problems of SIDS to be addressed in the technical fora of the WMO and create linkages at a professional level between experts from FMS and meteorological centres around the globe, including, for example, centres in the Caribbean that face similar problems to Fiji and Centres in the US, Asia and Europe where many of the scientific advances in meteorology, hydrology and related-technologies originate. Finally, through FMSs expert involvement in WMO teams, we are able to share our experiences with other National Meteorological and Hydrological Services in the region. WMO noted in stakeholder consultations that WMO Region V is reviewing its expert working team structures to re-align them with the new WMO Secretariat structure and considered it important that FMS continue to play an important role in whatever structures emerged.

The Pacific Meteorological Council has five Expert Panels. Stakeholders have indicated that FMS is very active in all the PMC Expert Panels and felt that in its Strategic Planning there should be strong support for a continuation of the support FMS gives to all five Panels[21]. With regard to the work of the PICI, SPREP noted that the region needs to work more closely with donors on standardization of equipment. Put simply, the cost of maintaining different AWS, radar and computing systems across many small NMS is very high. Furthermore, there needs to be some sort of regional pooling of spare parts to minimize the time that key infrastructure is off-line, particularly during the tropical cyclone season.

[21] The five PMC Expert Panels are: PIMOS – Pacific Island Marine and Ocean Services, PICS - Pacific Island Climate Services, PIETR- Pacific Island Education, Training and Research, PIAWS- Pacific Island Aviation Weather Services, and PICI- Pacific Island Communications and Infrastructure.

Table 13: Objective 5 and related Strategic Initiatives, Outputs, Outcomes and Key Performance Indicators.

Objective	Strategic Initiative	Outputs	Outcomes	KPIs
5. Serve the International Community	SI 5.1 Become a node of the WMO RA V Pacific Regional Climate Center.	Contribute to nodes of the RA V Pacific RCC.	Improved climate-related products and services for Fiji and the Pacific.	Be endorsed as a consortium member of the Long-Range Forecasting, Operational Data Services and Training nodes of the RA V Pacific RCC in 2022.
	SI 5.2 Participate in a Consortium that comprises a WMO Region V Regional Training Center.	A Center in the South Pacific supplying training for hydro-meteorological technicians and professional officers.	Lower training costs and improved hydro-meteorological capacity in the South Pacific.	MOU or equivalents with NCAR & USP 2020 Syllabus developed 2021. Faculty assembled 2024. Fully functional 2025.
	SI 5.3 Establish a WMO Region V Regional Instrument Center.	Provide a calibration and maintenance facility for hydro-meteorological instrumentation.	Lower maintenance costs and improved hydro-meteorological instrumentation in the Pacific.	ISO certification by 2021. Application approval 2022. Fully functional 2023.
	SI 5.4 Regional Specialized Meteorological Center – Nadi.	Tropical cyclone warnings, advices and other related information.	Lives and livelihoods better protected by accurate and timely tropical cyclone warnings and related information.	A high-level of user satisfaction with RSMC-Nadi services. Error statistics for tropical cyclone forecasts (24 hours and 48 hours lead time, position and maximum wind speed forecasts errors that are comparable with international norms).
	SI 5.5 WMO Region V WIGOS Center.	Improved quality control of data.	Improved services using regional data.	"Front-end" realtime quality control monitoring in place by 2023.
	SI 5.6 International Expert Teams.	Engagement in designing and implementing WMO compliant systems and procedures.	FMS technical capacity increased and it better supports regional forecasting and warning.	The number of experts from FMS engaged in the WMO's Commissions and its Research Board. Participation in Region V Association Working Groups and PMC Panels.

Annex 1 List of Acronyms

ACP	Africa Caribbean Pacific Organization
ADB	Asian Development Bank also (in a different context) Asset Data Base
AIFS	Australian Integrated Forecast System
AMDAR	Aircraft Meteorological Data Relay
APEC	Asia Pacific Economic Cooperation
APFM	Associated Programme on Flood Management (joint WMO / Global Water Partnership initiative)
AWS	Automatic Weather Station
BoM	Australian Bureau of Meteorology
CC	Commerce Commission
CCCPIR	Coping with Climate Change in the Pacific Island Region programme
CliDE	Climate Data for the Environment
CROP	Council of Regional Organizations in the Pacific
CSIRO	Commonwealth Scientific and Industrial Research Organisation (of Australia)
DCPC	Data Collection or Production Center
DoE	Department of Energy
DFI	Development Finance Institution
DRM	Disaster Risk Management
DWD	Deustcher WetterDienst
EC	European Commission
EEZs	Exclusive Economic Zones
EE	Energy Efficiency
EIB	European Investment Bank
ERP	Enterprise Resources Planning
EU	European Union
EDF	European Development Fund
ENSO	El Niño-Southern Oscillation
FAA	USA Federal Aviation Administration
FDI	Foreign Direct Investment
FEA	Fiji Electricity Authority
FFGS	Flash Flood Guidance System
FIR	Flight Information Region (under the ICAO arrangements)
FMS	Fiji Meteorological Service
FJD	Fiji Dollar

FRDP	Framework for Resilient Development in the Pacific 2017-2030
FREPP	Fiji Renewable Energy Power Project (GEF funded)
FSL	Forecast Systems Laboratory (now part of Earth System Research Laboratory)
GFCS	Global Framework for Climate Services (a WMO initiative)
GDPC	Global Disaster Prepareness Center
GDP	Gross Domestic Product (in $US unless otherwise noted)
GEF	Global Environmental Facility
GIZ	German Agency for International Cooperation
GISC	Global Information System Center (a WMO initiative)
GIS	Geographical Information System
HFA	Hyogo Framework of Actions
HPCC	High Performance Computer Clusters
IBF	Impact-Based Forecasts
IBL	Slovakia based software engineering including capabilities such as; message/data switching system called “moving weather”, a visual software called “visual weather”, and pilot briefing software called “aero weather”
ICAO	International Civil Aviation Organization
ICCT	Information, Computing and Communication Technologies
ICT	Information and Computing Technologies
IT	Information Technology
IMO	International Maritime Organization
IPP	Independent Power Producer (private single purpose investor)
ISO	International Organization for Standardization
KPI	Key Performance Indicator
NCAR	National Center for Atmospheric Research (of USA)
NCEP	National Center for Environment Prediction (of USA)
NDMO	National Disaster Management Office (in Fiji) or more generally National Disaster Management Organisation
NDP	National Development Plan2017-2036
NEP	National Energy Policy
NEF	National Energy Forum
NHS	National Hydrological Service
NIWA	New Zealand National Institute of Water and Atmospheric Research
NMHS	National Meteorological and Hydrological Service
NMS	National Meteorological Service
NOAA	USA National Oceanic and Atmospheric Administration

NWP	Numerical Weather Prediction
MDGs	Millenium Development Goals
MHEWS	Multi-Hazard Early Warning System
MoIMS	Ministry of Infrastructure and Meteorological Services (of Fiji)
MoU	Memorandum of Understanding
MWA	Meteorological Watch Area (under the WMO arrangements)
OPMET	OPerational METeorological data (under ICAO)
OSCAR	Observation System Capability, Analysis and Review (a part of WIGOS)
PIAWS	Pacific Island Aviation and Weather Services (PMC Expert Panel)
PCCPP	Peoples Charter for Change, Peace and Progress
PCCSP	Pacific Climate Change Science Program
PIC	Pacific Island Country
PICS	Pacific Island Climate Service (PMC Expert Panel)
PICI	Pacific Island Communications and Infrastructure (PMC Expert Panel)
PICTs	Pacific Island Countries and Territories
PIETR	Pacific Island Education, Training and Research (PMC Expert Panel)
PIMS	Pacific Island Meteorological Strategy
PMC	Pacific Meteorological Council
PMDP	Pacific Meteorological Desk Partnership
PNG	Papua New Guinea
PPA	Pacific Power Association, Power Purchase Agreement
PPI	Private Participation in Infrastructure
PPP	Public Private Partnership
PSD	Private Sector Development
QMS	Quality Management Systems
RA V	WMO Regional Association 5 (South-West Pacific)
RBF	Reserve Bank of Fiji RE Renewable Energy
RCC	Regional Climate Centre (under the WMO arrangements)
RESCO	Renewable Energy Service Company
RDSSED	Roadmap for Democracy and Sustainable Socio - Economic Development
RIC	Regional Instrument Centre (under the WMO arrangements)
RSMC	Regional Specialized Meteorological Centre (under the WMO arrangements)
RTC	Regional Training Centre (under the WMO arrangements)
RWC	Regional WIGOS Center (under WMO arrangements)
SAIDI	System Average Outage Duration
SAIFI	System Average Interruption Frequency Index

SE4ALL	Sustainable Energy for ALL (UN Initiative)
SDGs	Sustainable Development Goals
SI	Strategic Initiative
SIDS	Small Island Developing State
SIMDAT	Simulated Data
SMS	Short Message Service
SOE	State Owned Enterprise
SOLAS	Safety Of Life At Sea (Convention)
SPREP	Secretariat of the Pacific Regional Environment Programme
SPC	Secretariat of the Pacific Community
TA	Technical Assistance
TCAC	Tropical Cyclone Advisory Center (under ICAO arrangement)
TAF	Terminal Aerodrome Forecasts (under ICAO arrangement)
UCAR	University Corporation for Atmospheric Research (in Boulder, Colorado, USA)
USP	University of the South Pacific
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
USGCRP	United States Global Change Research Program
UPNG	University of Papua New Guinea
WAF	Water Authority of Fiji
WB	World Bank
WIGOS	WMO Integrated Global Observing System
WIS	WMO Information System (under WMO arragement)
WRF	Weather Research and Forecasting Model
WRN	USA Weather Ready Nations
WTP	Willingness-To-Pay
WMO	World Meteorological Organization

Annex 2 Meeting Fiji's Requirements for Hydrological Services: A Strategic Sub-Plan

Introduction

The FMS hydrology staff are 12 in number. The leader of the team has an advanced degree, two further staff have BSc degrees and the remaining nine staff are qualified technical staff. Their principal focus is managing a river monitoring network, quality controlling and otherwise providing the necessary data management for the hydrological data, training and supporting operational meteorologists in the issuance of flood forecasts, and liaising with users of FMS's hydrological services.

Essentially the hydrology services of FMS have no presence on the FMS web page. Over the next decade, the contribution of FMS to all Fijians through new and improved hydrological services will be significant.

The strategies to be adopted

♦ The hydrology team will be user focused. An Hydro-meteorological Services User Group (HSUG) will be established and the FMS hydrologists will support its activities through including the hydrological community of Fiji in its program of work. It will be comprised of participants from government, the community, academia and industries and activities that are severely affected by floods and droughts and lack of, or improper, water resources management. Basic "public good" hydrological services will remain a priority for FMS and there will be scope for tailored services to meet government, community and industry needs. The HSUG will assist in identifying areas where new or reinforced services are required, and where necessary and appropriate, work collaboratively with HSUG representatives from government, community, industry and academia in service development. It may be convenient to have HSUG operate as a component of FMS's GFCS User Interface. The FMS hydrology staff will implement formal and regular feedback mechanisms (e.g., satisfaction surveys, face-to-face discussions, etc.,), incorporating follow-up mechanisms as appropriate.

♦ Hydrology will be integrated closely with FMS's other service deliver activities. Just as the hydrology staff now work closely with operational weather forecasters in the development and delivery of flash flood forecasts, they will work closely with the climate staff in the development of hydrological (as distinct from meteorological) drought[22] outlooks and associated stream flow outlooks. As new hydrological services are developed, they will be assessed to ensure that they possess the essential characteristics of an effective service (WMO 2014a), that is that they are, and will be seen by the service users as:

[22] Meteorological drought happens when dry weather patterns dominate an area. Hydrological drought occurs when low water supply becomes evident, especially in streams, reservoirs, and groundwater levels, usually after many months of meteorological drought.

- Credible;
- Timely, dependable and reliable;
- Responsive and flexible to meet changing user needs and to take advantage of new technologies; and,
- Useable and useful.

FMS will develop and support all relevant hydrological services on the FMS Web Page. Among these services will be;

- Coastal inundations, flash and riverine flood watches and warnings;
- Data – including reports from automated sensors after passing through a quality control process, a daily map of the preceding day's 24-hour rainfall accumulation across the major islands of Fiji (likely to be a composite of manual observations, radar data and/or information from the US operated Microwave-adjusted Global Hydrological Estimator);
- Outlooks – a map-based product issued monthly that identifies probable rainfall excess/deficit from the monthly normal, streamflow outlooks for major rivers for the month ahead.

The Hydrology staff will use internationally sourced data and products wherever possible in their initial development of new services. All services will only be introduced operationally after a demonstration period during which the product is objectively verified and validated using standard techniques and subjectively assessed by potential users against fit-for-purpose criteria.

♦ Hydrology staff will operate and maintain fit-for-purpose infrastructure. For FMS's hydrological services to be reliable and sustainable the supporting infrastructure must be fit-for-purpose (i.e., reliable, scaled to meet operational requirements and properly maintained). There are two broad areas of infrastructure to be considered:

- Equipment deployed "in the field" (e.g., stream gauges and associated communications). The FMS will need to implement, and regularly re-visit the design and optimization of the hydrological network to meet its service requirements. It will pursue collaborations that bring external capital investment to rehabilitate and/or modernize monitoring networks that meet the service needs of key partners. FMS will seek and adopt innovative and robust technologies that can provide sustainable solutions to hydrological monitoring (e.g., downward looking contactless systems mounted on bridges to measure river height and surface water velocity). River discharge rate can then be continuously monitored through empirical calibration or theoretical modelling using the river cross-section, recorded and made available to those that need the information.

- Infrastructure within Head Office: computers, software the intranet and Internet. Hydrology will work closely with the Weather and Climate programs to move towards a lower-cost, more flexible computing environment. Included in this effort will be using common data processing applications that reduce repeated re-transmission of

the same data sets across the FMS intranet. FMS will aim to employ modern, user-friendly, flexible interoperable and low-cost (open source) data management systems and deploy numerical models of river catchments, rain radar data processing software, etc., that have been proven within the global hydrological community.

♦ Hydrology Operational/Business Plan.

Hydrology staff will further define the services that will be delivered to meet stakeholder needs. While there has been no polling of Fijian stakeholders at this level of detail needed for this sub-plan, experience from within Fiji and from other countries shows that flood warnings, hydrological data and hydrological outlooks are all sought from national hydrological services. At the generic level these are all basic services. The ability to meet the national "basic service" requirement provides the foundation for the development and provision of tailored services – which might be provided on a cost recovery basis or commercial basis (see the discussion under Section 4.2 of the Strategic Plan "*Evaluating the Cost of Services and Charging Policy*"). In future, the Hydrology Operational/Business Plan should be strongly stakeholder driven.

The Business/Operational Plan will identify in detail the service development Objectives to be met, the Outputs to be produced to meet the Objectives, the Outcomes sought from delivery of the service and the Key Performance Indicators (KPIs) that will be monitored to determine whether the desired Outcomes have been achieved. The Hydrology Service Matrix will be along the lines of the simple example matrix shown in Table 2.1. As these services are currently under development and will be driven by user requirements, timelines for implementation and other details will be agreed with key service users.

The Hydrology Operational/Business Plan will also commence a preliminary identification of the key physical assets that underpin the hydrological services. Where these key assets are located, their original value, their age, the rate at which each asset is depreciating (i.e., its expected operational lifetime) and the annual outlay required to at least maintain their current operational capability.

The Hydrology Operational/Business Plan will also describe the staffing needed to maintain the services it is committing to reliably supply to the Fijian community, and at least for the cost recovered and commercial services, have an assessment of the cost of providing that service based upon the agreed FMS Charging Policy.

♦ Legislative Basis. Section 4.1 of this FMS Strategic Plan 2021-24 notes that the public interest is served by a National Meteorological and Hydrological Service (NMHS), such as FMS, and include:

- Protecting life, livelihoods and property;

- Promoting long-term observation and collection of meteorological, hydrological and climatological data, including related environmental data;
- Promoting endogenous capacity-building;
- Safeguarding the environment;
- Contributing to sustainable development;
- Meeting international commitments; and,
- Contributing to international and domestic/national cooperation.

The Legislation that describes the functions of the FMS should include such functions as:

- The issue of warnings of weather conditions likely to give rise to flash floods and riverine and coastal flooding;
- The provision of hydrological data and information to the general public and to specialist users within government, the community and the private sector;

With such functions defined in legislation, the FMS will have a firm basis on which to invest in the development of services, to build a network of collaborators in service development and win broad support in the community for its hydrological services.

Table 2.1: Hydrology Services Matrix: Service, Outputs, Outcomes and KPIs

Service	Output	Outcome	Key Performance Indicators
Flash Flood Watches	Routine watch messages 24 hours before possible flash flooding	Communities, NDMO and relevant Ministries fully alerted to flash flood potential one day ahead	Objective verification: level of skill. Subjective verification: level of use of the service, is user feedback positive
Flash Flood Warnings	Warning messages 2 hours prior to flash flooding	Communities, NDMO and relevant Ministries fully alerted to high likelihood of flash floods prior to flooding	Objective verification: level of skill. Subjective verification: level of use of the service, is user feedback positive
Riverine and coastal Flood Watches	Routine watch messages 2 days before possible riverine and/or coastal flooding	Communities, NDMO and relevant Ministries fully alerted to riverine/coastal flood potential two days ahead	Objective verification: level of skill. Subjective verification: level of use of the service, is user feedback positive
Riverine Flood Warnings	Warning messages 12 hours prior to riverine and/or coastal flooding	Communities, NDMO and relevant Ministries fully alerted to high likelihood of riverine and/or coastal floods 12 hrs prior to flooding	Objective verification: level of skill. Subjective verification: level of use of the service, is user feedback positive
River height data	Downloadable, quality-controlled data on FMS Web	Public and hydrology specialists can see and use some of the data underlying FMS services	Subjective verification: level of use of the service, is user feedback positive

Daily rainfall mapping	Downloadable, coloured, 24 hour daily rainfall map archive accessible on FMS Web	Public, hydrology and meteorology specialists can see and use some of the data underlying FMS hydrology services	Subjective verification: level of use of the service, is user feedback positive
Monthly and seasonal outlook rainfall excess/deficit	Downloadable, coloured rainfall deficit/excess outlooks accessible on FMS Web	Provide the public and specialists with a record of Fiji's rainfall climatology	Objective verification: level of skill. Subjective verification: level of use of the service, is user feedback positive
Monthly and seasonal outlook for key stream flows	Streamflow outlook (a probabilistic product) accessible on FMS Web	Public and key users can know the likelihood of water levels likely to have an impact on their activities	Objective verification: level of skill. Subjective verification: level of use of the service, is user feedback positive

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Ministry of
Infrastructure and
Meteorological Services

Fiji Meteorological Service

Implementation Plan
for the
FMS Strategic Plan 2021-24

Cover Photograph by: Janis Rozenfelds
Small trade wind cumulus clouds over Makogai Island, Fiji.
Source: https://unsplash.com/s/photos/fiji

The Director's Message

This Implementation Plan is an internal working document for all staff of FMS. It provides a template for delivering the Outputs and Outcomes described in the FMS Strategic Plan 2021-24. The Strategic Plan calls for a transformation of the FMS from a high performing technical organization to one that will listen more carefully to its stakeholders in Government, in the community, in the private sector and beyond Fiji in the international community so as to be able to continuously upgrade its weather, climate and hydrology services in accordance with expressed stakeholder needs.

It will also be a transformation from an organization that works through five long-established Divisions to one that sees cross-cutting teams working to achieve the five Objectives described in the Strategic Plan.

In many ways these five Objectives are not new. Everyone will recognize them as already underpinning how we work. The new Strategic Plan recognizes that each part of the FMS has a role to play in achieving each of the Objectives and this Implementation Plan creates a mechanism for getting the work done.

What everyone needs to recognize is that these new arrangements will cause friction – change is difficult. The rewards are better outcomes from our work for all Fijians. It must be recognized that all Objectives cannot be achieved at once. Resources are limited and priorities will need to be in place.

The establishment of priorities will be done through our normal management processes, but two clear priorities have emerged from the process of preparing the Strategic Plan. Firstly, from the Permanent Secretary, it is clear that we must improve the range and quality of our hydrological services. Secondly, from stakeholder consultations, it is clear that we need to improve our external communications and provide better access to the hydro-meteorological observations we collect.

I look forward to the cooperation and assistance from all staff as we move forward – continuing to meet our day-to-day operational challenges while also laying the foundations for a stronger and more capable national meteorological and hydrological service.

Thank you all for your support in this important work.

Terry Atalifo
Acting Director of Meteorology
July 2021

Strategic Plan 2021-24

Implementation Plan

Table of Contents

1. Brief Background to the Implementation Plan

The Fiji Meteorological Service has recently reviewed and updated its strategic thinking. The material outcome of this process has been the development of the FMS Strategic Plan 2021-24. The Strategic Plan describes the need for organizational transformation and the directions to be taken as the FMS transforms from a high performing, technically focused, data collecting and product preparation organization into one that is outward looking, client focused and that delivers continuously improving services to meet Government, community and other stakeholder needs.

1.1 Purpose

The purpose of this Implementation Plan is to take the considerations and conclusions developed in the Strategic Plan into a coherent set of actions. The outcome from these actions will be the achievement of the range of Key Performance Indicators (KPIs) listed in the Strategic Plan and other milestones indicative of progress in the overall organizational transformation.

1.2 Changing Roles and Responsibilities

The Strategic Plan describes five Objectives (Figure 1). These are, by their very nature interactive, with each contributing to all others. Supporting these five Objectives are 15 Strategic Initiatives with associated Outputs, Outcomes and KPIs. While senior staff will continue to manage their well-defined areas of responsibility, they will also play a vital part in participating in the "FMS Transformation Management Team" – a cross-cutting team that will be responsible for meeting the KPIs and milestones laid out in this Implementation Plan.

Figure 1: The overlapping, mutually supporting Objectives

Table 1: The Implementation Plan Transformation Management Team. The Chair of the Team is …..

FMS TRANSFORMATION MANAGEMENT TEAM			
NAME	**TITLE**	**SIGNATURE**	**DATE**
Leader Objective 1 Team Members	Heads of Weather, Climate & Hydrology		
Leader Objective 2 Team Members	Head of Technical Systems		
Leader Objective 3 Team Members	The Head from the weather, climate and hydrology services area and the Head of IT		
Leader Objective 4 Team Members	Head of Corporate		
Leader Objective 5 Team Members	Director		

2. Overview

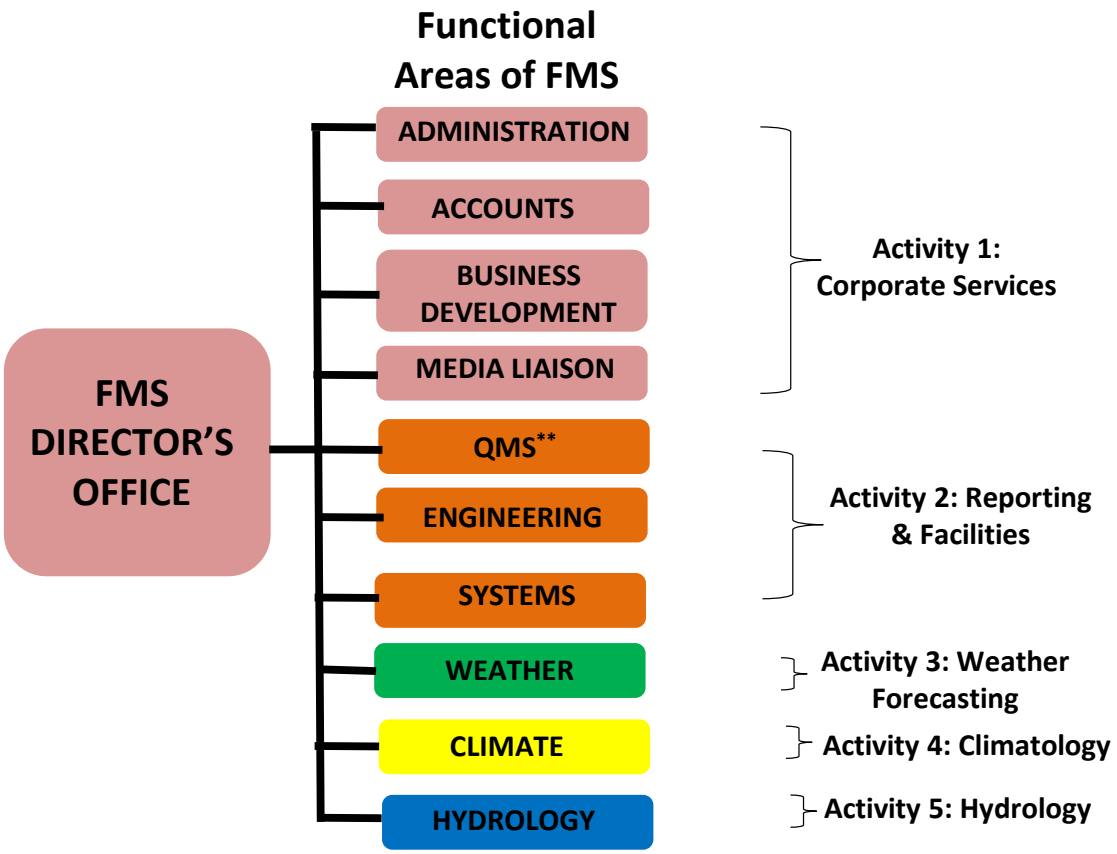
This Section of the plan briefly outlines the current state of FMS and a vision of the FMS sometime in the future, possibly beyond the forward planning period considered in the 2021 – 24 Strategic Plan, but nevertheless consistent with overall Strategic Plan direction.

2.1 Current State

Management Structure

The FMS has a flat structure with its approximately 124 staff distributed across five Activity areas reporting to the Director (Figure 2).

Figure 2: A schematic of the historic staffing and management structure of the FMS.



Observing Systems

Automatic Weather Stations (AWS) are a heterogeneous mix of manufacturers, sensor types and characteristics leading to higher maintenance than if it were a homogeneous system. Not all data from the climate observing system are available to the weather forecasting team in realtime, are subject to their own quality control processes and are ultimately held in a database remote from the realtime system. The hydrology observing system has "black spots" in key catchments.

The radar system is again heterogeneous, with three older radars of different technical capabilities, none of which is a dual polarized doppler radar. Again, maintenance is more costly than with a homogeneous network and it lacks dual polarization/doppler capability.

Computing (data-processing and -display) Systems

The computing system is heterogenous, with machines from different manufacturers, a range of operating systems and stand-alone legacy applications using a variety of programming languages. Again, maintenance is more costly than it needs to be (including in terms of the human resources needed to "keep the system running" on a day-to-day basis), and developing new applications and new services that integrate across data types is difficult because of the multiplicity of databases. Furthermore, many of the display systems use differing applications to display the same data, which leads to the intranet becoming, at times, heavily loaded with duplicate data.

Output Focus

The output of the weather forecasting area is focused on products that describe the weather phenomena affecting Fiji and the countries within the Nadi-Flight Information Region (FIR) and RSMC Nadi area of responsibility. The products are generally static, text-based and stakeholders in the public-sector domain find that they use jargon that is not easily understood by their intended recipients.

The climate area provides access to climate data, climate products and has in place a project to digitize paper records so that older data can be used in climate studies and the like.

Currently the hydrology area primarily provides hydrology data and advice to the Waterway Department of the Ministry of Environment and Water and to FMSs' weather forecasters.

Client Relations

Stakeholders have been unanimous in their view that they enjoy good working relationships with the FMS. In virtually all instances, stakeholders noted that the services they receive from the FMS are based on unwritten agreements reached over time between FMS's Director and senior staff of their organisations. There was a minority view that these arrangements made stakeholder operations simple, and a more widespread view that service arrangements should be supported by written agreements (Memoranda of Understanding (MOU) or Service Level Agreements (SLAs)).

A number of stakeholders saw the value of a Meteorology and Hydrology Act underpinning service agreements. There was some concern that FMS forecasts and warnings are not written in plain language, were too technical and contained jargon not understood by users. An FMS communications plan is required to properly prioritise communications efforts and to target measure improving understanding of, and support for FMS amongst key stakeholders.

Cost Accounting

The FMS recovers costs from the provision of climate data to meet client requests but otherwise all services are provided free of charge to meet the Fiji Government's public service obligations in the meteorology and hydrology areas. With the growing interest in SLA's there is an emerging requirement to be able to determine the cost of the services being provided. For FMS there are usually three cost components of service provision; cost of consumables, cost of human resources and the cost of infrastructure being used. There needs to be an accounting of these costs for services provided by FMS.

Currently the financial management of the Fiji public sector is cash-based, though the Ministry of Economy advises that a transition to accrual-based accounting is expected over the next few years. Noting that FMS's services are heavily dependent upon infrastructure such as observing stations, radars, satellite readout stations, computers and communication systems, the infrastructure component of the cost of particular services is difficult to quantify in a cash accounting environment which does not account properly for the depreciation of assets over their lifetime of usage.

2.2 Future State

Through the transformation process the FMS will adopt something that resembles a matrix structure with the traditional functional areas on one axis and the transformation team on the other (Figure 3).

Figure 3: A schematic of the transformational management structure of the FMS.

FMS TRANSFORMATION MATRIX	1. Societal Needs	2. Technical Foundation	3. Innnovation & Insight	4. Daunidraki Way	5. International Community
1. Corporate Services					
2. Reporting & Facilities					
3. Weather, Climate & Hydrology Services					

Observing Systems

Automation will increase in the observing system with a planned and managed evolution towards homogeneity of equipment supplier and type (weather, climate and hydrology), standardisation of data quality control, and systematic movement of data through the realtime system to a meteorological and hydrological database and then to an archive.

The hydrological and meteorological observing systems have "black spots" where no local data are collected. Addressing these "black spots" must be prioritized according to stakeholder requirements and then systematically addressed as resources become available. River monitoring in key catchments, as required in the National Development Plan, will remain a priority.

While the current radar system is adequate for basic severe weather tracking a cost – benefit analysis of upgrading to a homogeneous, modern network will be undertaken.

Computing (data-processing and -display) Systems

The computing system supporting weather forecasting is evolving to a homogeneous, IBL-based[1] infrastructure of hardware and software with outsourced technical support. Planning to implement efficient, built-for-purpose interfaces between the weather, climate and hydrology systems will be a priority if IBL infrastructure cannot accommodate the required functionality. The planning will be based on end-to-end cost/functionality comparisons that take account of; capital cost, operating and maintenance costs and functionality trade-offs.

[1] IBL is a meteorological software provider with around 40 years industry experience World-wide. Its web home page may be found at: https://www.iblsoft.com/

Output Focus

The output of the weather forecasting area will be focused on service provision and service user requirements and satisfaction. Key stakeholders in the public weather sector (the media and the community in the RSMC Nadi area of responsibility) and in the aviation sector (Civil Aviation Authority of Fiji, Fiji Airport Limited and neighbouring country National Meteorological Services (NMSs) in the Nadi FIR) will routinely be surveyed for both their requirements for services and their satisfaction with current services.

The services FMS provides will increasingly be image-based and text will be simple and in plain language.

In support of the WMO's Global Framework for Climate Services (GFCS), the range and utility of the climate services we provide will be extended by bringing climatologists together with experts from climate sensitive sectors of the economy such as energy, agriculture, health, disaster management and water to apply expertise and data to solve pressing climate-related problems and develop operational climate services based on this collaborative work.

The climate areas priorities will transition to become (in priority order); (1) seasonal climate outlook services; (2) climate data quality control and provision to users; (3) climate change science advice – with a focus on downscaled climate change scenarios that relate to Fiji; and (4) the rescue of paper-based data records.

Hydrology Division will continue to provide hydrology data and advice to the Waterway Department of the Ministry of Environment and Water and to the FMSs' weather forecasters. The focus on training of forecasters in basic hydrology and in flash flood forecasting will increase. There will be a hydrology section on the FMS web enables access to observations and forecasts of river levels, current forecasts of riverine and flash flooding and provides information describing Fiji's of surface water resources – including those relating to meteorological drought and areas of inundation. Groundwater resources assessment is an issue to be addressed collaboratively with relevant Ministries at a future time.

Client Relations

Routine surveys, annual or bi-annual, of stakeholder requirements and satisfaction with existing services will be conducted and outcomes monitored against performance indicators as a part of the FMS Communications Plan (Annex 3).

MOUs and, where appropriate, SLAs will be put in place. A Meteorology and Hydrology Bill will be prepared for the Government's consideration which enables stakeholders understand the roles and responsibilities of FMS.

Cost Accounting and Charging Policy

In preparation of a Fiji Government transition from cash- to accrual-accounting the FMS will begin building a comprehensive asset register that includes all infrastructure used in operations. The register will include, among other things; A unique IDentification Number (FMS ID) with an ID bar or QR code on the piece of equipment, Description, Brand, Model Number, Serial Number, Purchase Date, Purchase Price, Expected Lifetime (depreciation Rate), Current Value, Physical Location.

The FMS will develop a charging policy and cost accounting policy that underpins the MoUs and SLAs (Annex 2). In brief, Annex 1 addresses cost recovery for aviation weather and other services, provision of services for commercial purposes that meet national needs (mixed private/public benefits) and for purely commercial purpose (private benefit of recipient) and draws on a proposed cost accounting model for the FMS.

3. Communication

3.1 Developing a Communications Plan

Currently the FMS does not have a communications plan in place. The FMS requires an outward looking Communications Plan that examines whether we are meeting the needs of our current and prospective service stakeholders. In addition to identifying user needs, putting the Communications Plan into action will also make clear to staff how we value clients and how collectively we will meet their requirement for our services. Annex 3 describes an implementation strategy for the FMS Communications Plan.

In essence the FMS Communication Plan aims to:

- Assist the FMS in increasing the number and range of users of its services in the coming years.
- Enable our staff to measure whether we're meeting FMS communication-related objectives; and,
- Enable our staff to continually improve the FMS communication strategy.

Communications Strategy Overview

- **"Drilling Down" on the Objectives.** FMS's communication objectives need to address key elements of the FMS's services. These will include: aiming for annual growth of Internet-based service users, promoting weather, climate, hydrological and ocean services, creating an awareness of the role of the business unit, and increasing the aviation industry's overall confidence level in FMS Aviation Services.

- **Positioning Statement.** The Plan will, in plain language, describe the FMS and our unique capabilities. It will describe what makes the FMS different from the other providers of meteorological services and provide a strategy that will reinforce this difference in all messaging.

- **Target Audiences.** The Plan will describe who are we trying to reach. The Plan will identify both primary target audiences and the people who influence them, also known as secondary or tertiary target audiences (e.g., friends of recipients of FMS services, or users of weather-, climate-, hydrological- and/or related services).

- **Desired Action.** The Plan will identify its target audiences. It will include those we want to immediately respond appropriately to FMS's warnings, along with secondary and tertiary audiences who are likely to seek further "confirmatory" information from FMS or other

authoritative organisations such as the NDMO. It will also identify the audiences that take an active interest in the daily forecast, read more about climate change and its likely impacts in the southwest Pacific, and perhaps spread the word about FMS services (possibly school students and volunteer weather observers).

Communication Platforms

The Plan will list and describe communication platforms and how they are used:

- List which platforms FMS is using;
- List who is FMS trying to reach through each one; and,
- Monitor how frequently FMS is messaging through each platform.

3.2 Communication with Stakeholders

The stakeholders with whom the FMS must constantly communicate include (Table 1):

- Fiji Ministries and agencies that are sensitive to extremes in the weather, climate and hydrology of Fiji and of the oceans around Fiji;
- The community at large, and in particular vulnerable people and businesses exposed to extremes in Fiji's weather, climate and hydrology.
- Research facilities undertaking research into the natural systems of weather, climate, hydrology and the ocean or into applied research into how best to adapt to, or take advantage of, current and future weather, climatic and hydrologic events;
- Donors who provide assistance to Fiji in building capacity and resilience.

The stakeholder listed in Table 2, except those representing neighbouring country National Meteorological Services, were consulted during the preparation of the FMS Strategic Plan, 2021-2024.

A stakeholder workshop and a series of stakeholder teleconferences (described in Annex 4) made clear that there is a near universal requirement for better access to meteorological and hydrological data and information. The degree of interaction between the stakeholders and FMS varied quite substantially - the aviation sector had possibly the closest working arrangements with FMS while the FBC tended to interact most closely with FMS at times of severe weather. The aviation sector considers adhering to ICAO standards essential and would like to see Service Level Agreements (SLAs) underpinning their work with FMS.

The media (represented by FBC) sought forecasts with less technical jargon while the NDMO indicated that it considers one of its roles is to "translate" the technical information in FMS's

warnings into something the average person could understand. This feedback from FBC, NDMO and others seems to indicate that FMS needs to implement as an element of its communications plan a move away from technical jargon in its public forecast products.

Donor agencies (represented by JICA and UNDP) both envisaged continuing support for developing countries but possibly at a reduced level until the economic impacts of the covid-19 pandemic had receded. Every stakeholder reported good working relations with FMS. An extended summary of the stakeholder consultations undertaken as a part of the preparation of the FMS Strategic Plan 2021-24 is provided at Annex 4.

Table 2: Key stakeholders, the Objectives of the Strategic Plan that affect them or the services they receive, the Area of the Impact (by Objective) and the Extent of the Impact (by service area or type).

STAKEHOLDER REVIEW		
Stakeholder	**Area of Impact**	**Extent of Impact**
Min H&MS	All Objectives	Weather and climate related diseases
Min of Env' & Water	Objectives 1, 2, 4 and 5	Department of Waterways
F Hotel &Tourism A	Objectives 1, 2 and 5	Disaster impacts on tourism
Univ South Pac	Objectives 1, 2, 3, and 5	Regional training for Met and Hydro
Fj Roads Auth'	Objectives 1, 2 and 5	Forecasts, data and observations
Min of Agric'	Objectives 1, 2 and 5	Data, forecasts, outlooks, applied research
Sugar Research Inst F	Objectives 1, 2 and 3	Data, forecasts, outlooks, applied research
Energy Fiji Ltd	Objectives 1, 2, 3 and 5	Data, forecasts, outlooks, applied research
Marine Safety Auth'y	Objectives 1, 4 and 5	Data, forecasts, warnings, regional cooperation
F Ports Co Ltd	Objectives 1, 2, 4 and 5	Data, forecasts, warnings
Fiji Navy	Objectives 1, 2, 4 and 5	Data, forecasts, warnings
Fiji Broadcasting Com'	Objectives 1, 2, 3, 4 and 5	All FMSs services and their impacts
Min of Economics	Objectives 1 and 2	Continuity of services. Nat Dis Plan Objectives
NDMO	Objectives 1, 2, 3 and 5	Data, warnings, message coordination
UNDP	Objectives 1, 4 and 5	Strengthening capability
JICA	Objectives 1, 3, 4 and 5	Strengthening capability
SPREP	Objectives 1,2,3,4 and 5	Involved in all FMS activities
WMO	Objectives 1,2,3,4 and 5	Involved in all FMS activities
Civ Av Auth Fiji	Objectives 1, 2 and 5	Continuity, quality of aviation weather services
Fiji Airports Ltd	Objectives 1, 2 and 5	Continuity, quality of aviation weather services
NMSs:		
Cook Is.	Objectives 1 and 2	Continuity, quality of FMS forecasts and warnings
Kiribati	Objectives 1 and 2	Continuity, quality of FMS forecasts and warnings
Nauru	Objectives 1 and 2	Continuity, quality of FMS forecasts and warnings
Nuie	Objectives 1 and 2	Continuity, quality of FMS forecasts and warnings
Tokelau	Objectives 1 and 2	Continuity, quality of FMS forecasts and warnings
Tuvalu	Objectives 1 and 2	Continuity, quality of FMS forecasts and warnings

4. Implementation Plan and Objectives

4.1 Implementation Overview

The approach to implementing the transformation outlined in the Strategic Plan is to integrate achievement of Objectives 1 through 5 into the organizational structure of FMS by identifying the alignment of existing functional responsibilities with new transformational responsibilities as illustrated schematically in Figure 4.

The next step, which is described in this Section of the Implementation Plan is to identify the implementation actions to be carried out and milestones to be achieved.

In the Strategic Plan the Strategic Initiatives were grouped under longer term Objectives as follows:

Objective 1: Better Serve Societal Needs for Weather-, Climate- and Water-related services.

Strategic Initiative 1.1 FMS will continuously improve in its ability to protect lives, livelihoods and property through its active support for Fiji's Multi-hazard Early Warning System and the implementation of Impact-Based Forecasts and Warnings.

Strategic Initiative 1.2 FMS will increase the range and quality of its services and streamline the processes for access to its data and information.

Strategic Initiative 1.2 is the largest and most complex of the Strategic Initiatives as it addresses data access along with all of FMS's services; weather, climate and hydrology. For ease of management these Elements that collectively comprise the Strategic Initiative have been broken out as depicted in Table 3.

Table 3: Overview of the structure of Objective 1 and its Strategic Initiatives

Objective	Strategic Initiative	Initiative Elements
1. Better Serve Societal Needs	S1.1 MHEWS and IBFW	MHEWS
		IBF
	SI 1.2 Hydro-met Data and Services	Access to data
		New and Improved Weather Services
		New and Improved Climate Services
		New and Improved Hydrological Services

Objective 2: Strengthening the Technical Foundation of the FMS for the Future.

Strategic Initiative 2.1 Enhance the FMS observation network and forecasting systems' underlying Information and Communications Technology (ICT).

Strategic Initiative 2.2 Systematically eliminate "black spots" in the weather, climate and water observing networks.

Objective 3: Promote Insight and Innovation within FMS.

Strategic Initiative 3.1 Collaborate with research partners in the university sector to bring the latest scientific developments in meteorology and hydrology to Fiji and the region.

Strategic Initiative 3.2 Undertake applied research projects, in collaboration with Users of FMS's services, to better meet their needs.

Objective 4: Pursue the "Daunidraki Way" - Vibrant, Effective Corporate Support.

Strategic Initiative 4.1 Resolve FMS's legal position as a service provider with the adoption of a Meteorology and Hydrology Act by Government.

Strategic Initiative 4.2 Transform FMS's Corporate Systems.

Strategic Initiative 4.3 Put in place MoU and Service Agreements with Key Clients.

Strategic Initiative 4.4 Follow relevant international standards, including those of WMO, ICAO and ISO.

Objective 5: Serve the International Community.

Strategic Initiative 5.1 Work towards the implementation of a WMO Regional Training Centre (RTC) in the South Pacific.

Strategic Initiative 5.2 Establish a WMO Regional Instrument Centre (RIC) within the FMS.

Strategic Initiative 5.3 Continue to provide the full range of tropical cyclone-related services and information through the WMO Regional Specialized Meteorological Centre (RSMC) – Nadi.

Strategic Initiative 5.4 Establish a WMO Regional WIGOS Centre (RWC) within the FSM.

Strategic Initiative 5.5 Establish a node of the WMO South Pacific Regional Climate Center (RCC) in FMS. Strategic Initiatives

Strategic Initiative 5.6 Provide active support to a range of WMO, PMC and other international organisations' Expert Task Teams.

4.2 Objective 1: Better Serve Societal Needs

Strategic Initiative 1.1: Contribute to Fiji's Multi-Hazard Early Warning System (MHEWS) and implement Impact-Based Forecasting (IBF) by the FMS.

Multi-Hazard Early Warning Systems (MHEWS)

There are four components to a MHEWS[2]:

- *Disaster Risk Knowledge*

Risks is a combination of the exposure of people and assets to the hazards and their vulnerability to that hazard. Assessments of these risks require systematic collection and analysis of data over time. These data include the historic impacts of hazards on communities. These analyses must be made in the knowledge that to some extent all disasters are unique and community vulnerabilities are constantly evolving.

- *Detection, Monitoring, Analysis & Forecasting of Hazards and Possible Consequences*

Continuous monitoring of hazard parameters and particularly precursor events if they are known is essential to generate accurate information, forecasts and warnings in a timely fashion for the hazard. The systems used for detection and monitoring which can be automated should be, to allow for a rapid response when the time available for effective response is limited.

- *Warning Dissemination and Communication*

Information, forecasts and warnings relating to the hazard must reach those at risk. Trust is an important component of effective risk communication. If the information source cannot be trusted, those at risk may not respond proactively to the advice they receive.

- *Preparedness and Response Capabilities*

It is essential that people know how to react to the information, forecasts and warning messages in the lead up to, and during a disaster. Education and preparedness activities play a key role. It is also essential that disaster management plans include evacuation strategies that are well practiced and tested. People should be well informed on options for safe behaviour to reduce risks and protect their health, know available evacuation routes and safe areas and know how best to avoid damage to and loss of property.

[2] See for example; https://public.wmo.int/en/resources/world-meteorological-day/wmd-2018/multi-hazard

Impact-Based Information, Forecasts and Warnings are directed at communities with the aim of encouraging and enabling the most appropriate community response to a developing potential disaster, and in doing so mitigating its impacts.

Impact-Based Forecasts (IBF)

The elements of an Impact-Based Forecast or Warning are:

- A description of the hazard;
- A description of its likely-impacts at a threatened community-level in terms that can easily be understood by the community, and, most importantly; and,
- Information that will assist those who are threatened make the best decisions to protect their lives, livelihoods and property.

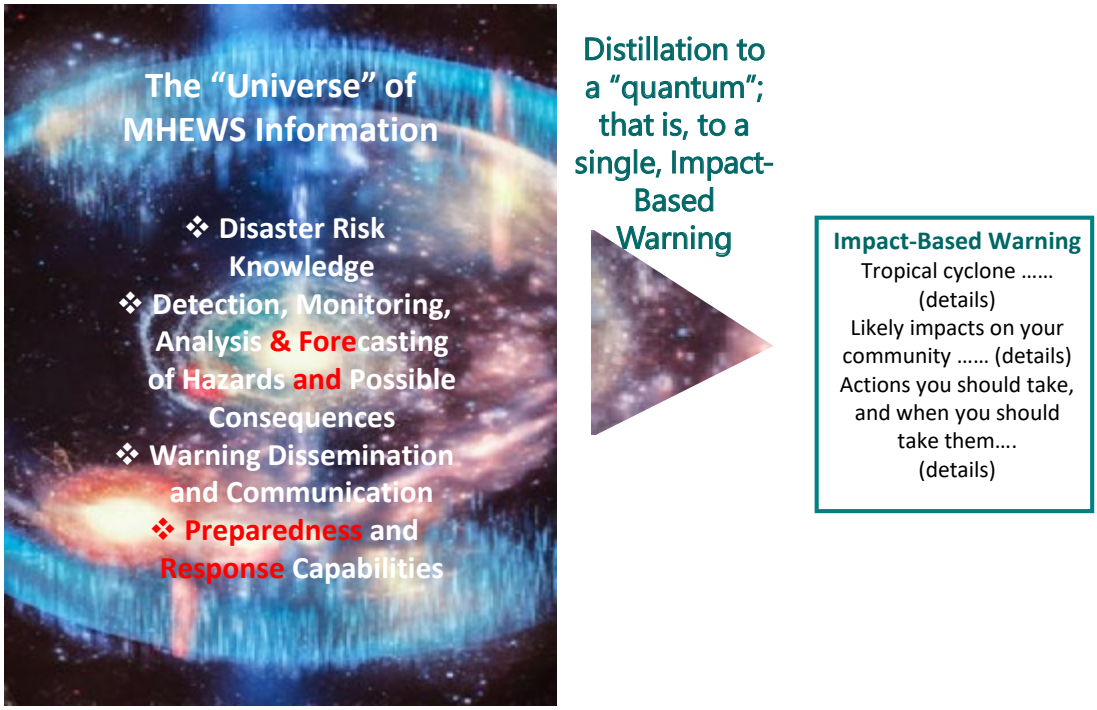
To prepare effective Impact-based products those generating them need to have some involvement in all phases of the MHEWS. They need to understand the dynamics of the developing extreme event, be familiar with the history of past extreme events of the same type on the threatened communities, understand the vulnerabilities of the affected communities, the appropriate communication channels to get information, forecasts and warnings the "last mile", and finally have an understanding of the preparedness of the threatened communities and the options for action available to them.

At the large-scale every country needs to maximise the efficiency of its investment in early warning systems (EWS) and the best way to do this is to invest in a single system that addresses the range of hazards most likely to impact the country. This strategy is particularly important when two or more hazards affect a country at the one time: for example - a tropical cyclone and Covid 19; drought, cholera, grass and forest fires; or flooding, malaria outbreaks and food shortages. In these circumstances a single, multi-hazard, early warning system that is alert to all hazards and is responsible for generating a coordinated response is the most efficient, cost effective national response.

At the micro-level the authorities responsible for community safety and welfare require that the information, forecasts and warnings going to the nation during a hazardous event will generate the most appropriate responses at the level of the threatened individual, be it a single mother or a business person with a family, hundreds of employees and threatened assets worth millions of dollars. Impact-based forecasts and warnings are being designed to generate the appropriate response at the individual level by all those at risk during an extreme hydro-meteorological event.

One way of thinking about the concepts of MHEWS and IBF is that combine together a little like macroeconomics and micro economics or general relativity and quantum mechanics. At the national scale there is MHEWS which aims to treat, hazards holistically, while at the scale of the individual there is IBF, which endeavours to meet each persons' particular needs for hazard information (Figure 4),

Figure 4: A schematic of the distillation of the "universe" of knowledge gained from the MHEWS processes being distilled to the essence necessary for an actionable Impact-Based Forecast or Warning for Individual Communities.



No single expert is likely to have command of all the information required to generate an effective impact-based forecast. Generating impact-based products will require a range of specialists work together as a team. For a hydro-meteorological event (for example a flood, hurricane, drought) the hydrologists and meteorologists will need to work with disaster mangers and community leaders (including social workers). This teamwork will need to commence with analysis of past disasters, continue in coordination of activities that monitor the hydro-meteorological event, include assessment and implementation of communication systems, move to preparedness and response exercises and culminate in smooth team work that generates warnings and other advice for mitigating impacts, to targeted communities, during extreme events.

Implementation Activities MHEWS and IBF

The FMS recognizes that the final element of an IBF - the actions that warning recipients can and should take to mitigate impacts of a hazard are the province of the NDMO in consultation with communities and in accordance with preparedness activities. Nevertheless, during hydro-meteorological hazards FMS has a role to play in supplying a range of hydro-meteorological information.

As a MHEWS and IBF "pilot" project the FMS will work towards providing the hydro-meteorological support component for IBFs for coastal inundation for all of Fiji's coastline.

Current FMS Coastal Inundation Forecasting Capability (and its limitations)

The FMS is currently able to run operationally a coastal inundation forecasting system that has been developed to provide predictions of inundation caused by tropical cyclones of realistic intensities and structure affecting many of the islands in the area of responsibility of RSMC-Nadi (Figure 5), including all of Fiji (Figure 6) – which shows an example post-event ("hindcast") forecast of the coastal inundation associate with a tropical cyclone.

Figure 5: The domains that the FMS coastal inundation forecast model operates over.

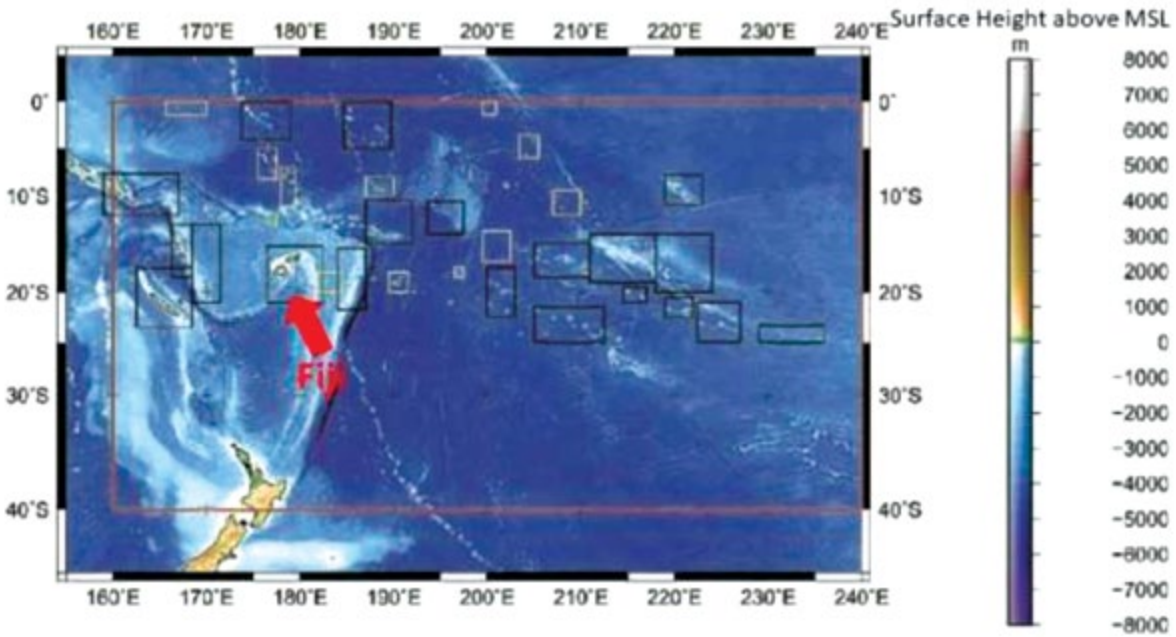
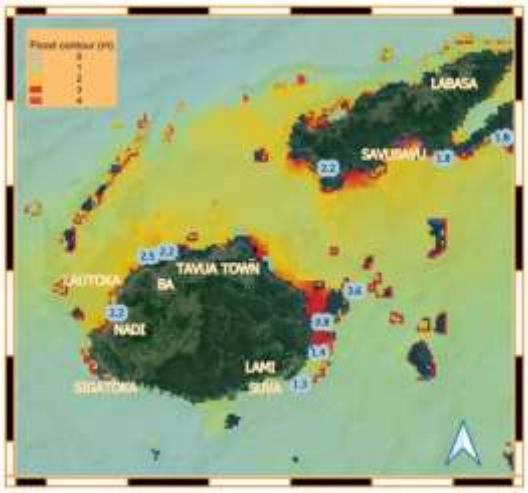


Figure 6: A "hindcast" inundation forecast for a tropical cyclone affecting Fiji. Surge heights at key locations are given in metres above MSL.



The FMS inundation forecast system was built collaboratively with scientists from the Japan Meteorological Agency (JMA) and provides an accurate assessment of the accumulation of water on the low-lying contours by wind driven surges, breaking wave setup and the effects of near shore natural features, such as reefs, that contribute to the total water level envelope. The system is built on one-way coupled architecture, and automated to run tidal prediction, surge, wave height in sequence, so as to construct the total water level.

The system was initially developed and tested for the Fiji domain, the domains covering other South Pacific islands in the remainder of the RSMC area were added later. There has been no systematic study of forecasts outside the Fijian islands. The ocean model does not resolve fine coastal features, for example small bays that may "amplify" surges, and the land topography uses (SRTM) digital elevation model topography that is on a 30 metre grid[3], which means it will not resolve flooding affected by features smaller than about 60m. The model does not include inundation from inland sources, such as flooding rivers and streams entering the zone of ocean-sourced surge. Generally, this would be a small contribution to coastal flooding in the Pacific islands, though in Fiji, for example in the Rewa River delta, it is possible there could be a substantial inland contribution to coastal flooding.

Implementing MHEWS and IBF via the Coastal Inundation "Pilot"

Step 1: Establish a Hydro-meteorological Services User Group (HSUG) or similar, to include Government (NDMO, Waterways Department), private sector (SRI, FPL, FH&TA) and Academia (USP). The objective is to work closely with a group of stakeholders who are weather-sensitive and

[3] The SRTM data. Source: https://about.agrible.com/agnews/2014/11/7/global-30-meter-srtm-elevation-data-release.

obtain valuable feedback to be used for building a better, more responsive coastal inundation service. The HWLC should be chaired by someone other than an FMS staff member, the secretariat for the group should be supplied by FMS and it should meet twice a year, immediately prior to, and after, the rainy season.

Step 2: Collaborate with NDMO, Waterways and FPL to set up community monitoring of surge levels. Possibly new, surveyed surge level markers in key localities with designated observers. The sub-steps in this process could be:

(1) Reach agreement with NDMO to increase local involvement in surge-level monitoring.
(2) Agree a plan to establish a volunteer surge level monitoring community.
(3) Install surveyed markers.
(4) Set up a mechanism for submission of reports after surge events.

Step 3: Education material on the hazards of coastal inundation developed and distributed via schools and observing offices in the immediate pre-rainy season period

Step 4: Analyse surge reports against model forecasts, provide reports to HWLC as to the capability of the system. Provide summaries of the analyses to those who provide the data upon which they are based.

Step 5: Work with USP, UCAR and other academics (as appropriate) to continuously improve the system and put in place and the outcome of step-wise improvements monitored and documented.

Strategic Initiative 1.2: Initiative Element - Improved access to hydrometeorological data and information.

Stakeholder consultations made it clear that there was near universal demand for better access to FMS's data. As a part of the FMS transformation, we will work to consolidate of all incoming operational data (including weather, climate and water observations, and satellite and radar imagery) in a single quality-controlled, database. This will either be a "stand alone" front-end database that feeds the weather IBL software, the climate CLiDE software, the hydrology software package ultimately chosen by FMS, and the web interface for external client access to FMS realtime data or an integral part of the IBL software suite – in which case it must hold climate and hydrological data but possibly not support climate and hydrology applications.

Implementing a comprehensive, quality controlled realtime database

Step1: Document the quality control standards and algorithms for each data type planned to be held in the database. Develop an access policy for external clients according to the usage they will put the data (eg research, teaching, public education, commercial revenue generation, cost recovery meeting a mixed public- private-interest, etc.) and security and management procedures to properly meet the needs of internal and external user access.

Step 2: Develop a tender for the development of a database that, included among its specifications are:

- Interfaces to all realtime streams and datatypes in the weather-, climate- and -hydrology domains;
- Interfaces to the realtime radar and satellite data streams;
- Ability to populate a relational database with all FMS realtime data streams, along with quality control flags and links to relevant metadata;
- Web-interface search routines for internal and external clients with security controls depending on levels of access the user has authorization for; and,
- An on-line duplicate, back-up version of the database for development, testing and substitution for the operational version when maintenance is required.

Step 3: Let the tender, monitor software development. Include a testing phase in the tender to ensure the database is stable, meets requirements and is robust to the challenges of supporting a 7x24 realtime, operational system.

Step 4: Operationally implement a robust, secure realtime database the meets the WMO WIGOS quality control requirements[4] as well as the FMS requirements.

Strategic Initiative 1.2: Initiative Element – New and Improved Weather Services.

The proposed new and improved weather services fall into three categories:

1. Short-term 3-hourly radar predictions of rainfall. Such predictions are a feature of a number of weather radar displays publicly available overseas and there will need to a significant development effort to implement this feature in Fiji;
2. Four items; 7-day forecasts, 24-hr rainfall totals on a 15km resolution grid across Fiji, SST's wave heights in the ocean around Fiji are all available from high-quality numerical weather prediction models routinely available to FMS; and,
3. Plan language forecasts and warnings will require considerable planning, development and 'market testing' prior to operational implementation.

Implementing a range of new and improved Weather Services

Step 1: Establish a new weather products Group. The Group's task to be to review internally the priority to be attached to developing each of these new and improved services, the resources required and the process to be adopted to take the development of the services through to operational implementation.

Step 2: Systematically work through the priority list. With each new product development activity will build into the process an automated verification of the forecast product against a verifying

[4] See Implementation Strategy for Strategic Initiative 5.4.

analysis and/or observational data and, to the extent possible, also 'market test' the product with a sample of likely product users.

Step 3: Operationally implement each new product using standard communication protocols specified in the FMS Communications Plan.

Strategic Initiative 1.2: Initiative Element – New and Improved Climate Services.

The new and improved Climate Services element has two quite different parts:

1. The first part involves the collaborative development of monthly and seasonal outlooks that meet the needs of specific sectors (health, energy, agriculture, etc. This will entail collaborative applied research with key players in the sectors; and,
2. A new, deeper involvement by FMS in the review of climate change scenarios and analysis of climate change scenarios from long-run climate simulation models. This work should be carried out in collaboration with scientists in Fiji Universities to the extent that they are doing such work and with the IPCC and WMO scientists who are deeply engaged in this effort.

Implementing a range of new and improved sector specific outlooks

Step 1: Work with the key sectors to build a consortium of interested parties in key economic sectors of Fiji. An exemplar of a consortium of climate sensitive sectors is the EWISACTS Consortium in the Caribbean[5]. The agreement between consortium members should cover such aspects as exchange of data and information and the commitment to work collaboratively on agreed projects.

Step 2: Agree a range of climate sensitive elements of the Consortium partners activities that would benefit from improved climate services.

Step 3: Set priorities consistent with available resources and the overall public benefit from improved decision making based on climate services.

Step 4: Establish agreed communication protocols around the activities of the Consortium that meet agreed needs.

Step 5: Systematically develop, test and operationalize new products that best meet Consortium needs.

[5] Details of the EWISACTS Consortium can be found at: https://rcc.cimh.edu.bb/ewisacts/
Since 2015, the Caribbean Institute for Meteorology and Hydrology (CIMH) in collaboration with its network of National Meteorological and Hydrological Services (NMHSs) and its Consortium of Sectoral Early Warning Information Systems Across Climate Timescales (EWISACTs). Consortium partners have been working together to increase the range of sector-specific climate products, as well as integrated decision-support processes and tools that support evidence-based and risk informed decisions in key sectors in the Caribbean.

Implementing a new capability to review, participate in, and provide advice on climate change science

Step 1: Systematically explore the opportunities for deeper involvement of FMS in the ongoing development of climate change modelling relevant to Fiji which relates to emissions scenarios and the skill of the models to capture key processes that influence outlooks in the tropics such the ENSO, air-sea interaction, etc. These deeper involvements could come from regional activities, and more global activities of the WMO and IPCC.

Step 2: Encourage young, scientifically accomplished FMS staff to participate in the work of key groups.

Step 3: Build working relationships with any academics in Fiji who are also engaged in climate change science research.

Step 4: Over time build a national and international reputation for competence in the areas of review and provision of advice on the utility of climate change scenarios for Fiji and surrounding countries.

Strategic Initiative 1.2: Initiative Element – New and Improved Hydrological Services.

The implementation of a range of publicly accessible hydrology services is, in large part a new initiative for FMS. Initial implementation is likely to be delayed by the lack of resources, including the lack of skilled staff at the professional and technical levels and lack of finances for new equipment, travel and training. Nevertheless, progress can be made within existing resources. Annex 2 to the Strategic Plan lays out an ambitious plan for building these new services. The first step is to put in place a Hydrological Services User Group (HSUG) that can serve as an advisory group as this element of Strategic Initiative 1.2 is implemented.

In essence the key features of the Hydrological Services initiative are:

- The hydrology team will be user focused.
- Hydrology will be integrated closely with FMS's other service delivery activities.
- Hydrology staff will operate and maintain fit-for-purpose infrastructure.
- A detailed Hydrology Operational/Business Plan will be developed.
- The legislative basis for the FMS Hydrology Services will be addressed in the Meteorology and Hydrology Bill

Implementing a range of new Hydrological Services

Step 1: Establish the HSUG including agreeing role, functions, mode of operation, chairing and secretariat arrangement with initial participants.

Step 2: Undertake work internal within the FMS to build capability to routinely deliver to the public flash flood, riverine flood and coastal inundation watches and warnings.

Step 3: Commence a process of building the capability to make available on-line, in near realtime river and stream monitoring data. This will include on-line quality control and incorporation of the data in an on-line database that includes weather and climate data.

Responsibilities of Transformation Management Team for Objective 1

The Transformation Management Team for Objective 1 (TMTO-1) is responsible for:

- The five-step process to implementing MHEWS and IBF using the coastal inundation forecast system as a "Pilot";
- The four-step process for implementing a comprehensive, quality controlled realtime database;
- The three-step process for implementing new and improved weather services;
- The five-step process for new, sector specific climate services and four-step process for new capabilities in contributing to climate change analysis and prediction;
- The three-step process for implementing new hydrological services; and,
- Achieving the KPIs and collecting information relevant to the "other targets" given in Table 3 (below-extracted from Table 2 of the Strategic Plan).

Table 3 (a) Key Performance Indicators and "other targets" for Objective 1, Strategic Initiative 1.1 (from Table 3 in the FMS Strategic Plan)

Strategic Initiative	Initiative Elements	Outputs	Outcomes	KPIs	Other Targets
S1.1 MHEWS and IBF	MHEWS	FMS contributes to Fiji's MHEWS for all hydro-meteological hazards	A consistent apprach to communicationg the risk associated with hydro-met hazards	MOU with NDMO to support collaborative work on enhancing FMS contribution to Fiji's MHEWS 2021	Number of collaborative projects underway and completed to both organisations' satisfaction
	IBF	Forecasts and warnings that meet IBF requirements	Forecast and warning recipients have products tailored to meet their needs.	Impact-based warnings by 2022	User satisfaction measure

Table 3 (b) Key Performance Indicators and "other targets" for Objective 1, Strategic Initiative 1.2, Initiative Elements Access to Data and New and Improved Weather Services. (From Table 4 in the Strategic Plan)

Strategic Initiative	Initiative Elements	Outputs	Outcomes	KPIs	Other Targets
SI 1.2 Hydro-met Data and Services	Access to data	Improved access to FMS's realtime and archived data and products	FMS's services users can make more informed weather, climate and water decisions	External access to data and products streamlined 2022	Level of access on an annual basis
	New and improved Weather Services	3-hour rainfall outlooks ans an adjunct to radar rainfall display	Improved flash flood warning	Implemented by end 2022	1.A measure of the level of public uptake. 2.A measure of user satisfaction. 3. The accuracy of the forecasts and warnings as computed using an objective (standard) measure.
		7-day forecasts	Extended outlook for Fiji's weather	Implemented by end 2021	
		Daily 24 hour digital (gridded) rainfall maps	better understanding of Fiji's rain climatology	Implemented by end- 2022	
		Weekly digital Sea Surface Temperature maps	Fishers, ecologists and others in the marine sector can monitor and use this key parameter in decision making	Implemented by mid- 2022	
		Daily wave height forecast maps (12, 24, 36 and 48hr ahead)	Mariners can better plan	Implemented by mid- 2022	
		All worded forecasts in "plain" language	Better community understanding of FMS products	Implemented by end 2021	

Table 3 (c) Key Performance Indicators and "other targets" for Objective 1, Strategic Initiative 1.2 Climate Services Element. (From Table 5 in the Strategic Plan)

Strategic Initiative	Initiative Elements	Outputs	Outcomes	KPIs	Other Targets
SI 1.2 Hydro-met Data and Services	New and improved Climate Services	Monthly and seasonal outlooks tailored to needs of key sectors (Health, Energy, Agriculture, Water Resources,etc.)	Improved use of hydro-met data in key sector decision making	Progressively implemented during Plan lifetime	1.Level of involvement of key sector organisations. 2.Number of products and user satisfaction. 3.Accuracy of outlooks
		Regular update of latest climate scenarios key hydro-meteorological parameters (rain, temperature and sea level) and implications for Fiji	Better support for integration of climate science into Fiji's climate change adaptation measures	Progressively implemented during Plan lifetime	Number of scenario studies for Fiji prepared by FM collaboratively with other scientists/ organisations.

Table 3 (d) Key Performance Indicators and "other targets" for Objective 1, Strategic Initiative 1.2 Hydrology Element. (From Table 7 in the Strategic Plan)

Strategic Initiative	Initiative Elements	Outputs	Outcomes	KPIs	Other Targets
SI 1.2 Hydro-met Data and Services	New and improved Hydrological Services	Flash flood watches and warnings	Improved Fijian MHEWS, saved lives and reduced property loss	24 hr lead time watches and 2hr lead time warnings by end-2021	User Satisfaction. Accuracy of warnings and watches
		Riverine flood and coastal inundation watches and warnings	Improved Fijian MHEWS, saved lives and reduced property loss	2 day lead time watches and 12hr lead time warnings by end-2021	User Satisfaction. Accuracy of warnings and watches
		Daily river and stream height data	Improved realtime water management	Progressively implemented during Plan lifetime	Level of user uptake. Number of streams/rivers monitored in realtime.
		Monthly and seasonal river and stream flow outlooks	Improved national water management	implemented by end-2022	User Satisfaction. Accuracy of outlooks.

4.3 Objective 2: Strengthening the Technical Foundation of FMS

Strategic Initiative 2.1 Enhance the FMS observation network and forecasting systems' underlying Information and Communications Technology (ICT).

Observing Networks

The transformations needed for the weather observation network include:

- Standardisation of automatic weather stations such that all hardware originates from a single manufacturer, so as to reduce costs of maintenance and simplify data management;
- Modernize the radar network by progressively (as opportunities arise) replacing the existing three radars with dual polarized, doppler radars network with all hardware and software originating from the one manufacturer; and,
- Enhance data collection from all FMS observing stations (weather, climate and water) such that all data are received in real time.

For the climate network automation of the data collection automation is required so that the climate observers can enter the data on the traditional F10 paper form and also, at the time of each observation, into a mobile telephone App that feeds the data directly into FSM's WIGOS compliant data quality control system which meets weather climate and water requirements and subsequently into a database for access by all of FSM's authorised data and information users.

Implementation Actions – Observation Infrastructure

Step 1: Review the effectiveness of the AWS network. What is the importance to operations and cost of operating each AWS (maintenance, communications costs, cost of carrying spares, AWS reliability, perceived importance to forecasters and other users of realtime observational data).

Step 2: Determine the AWS functionality required and review the suppliers.

Step 3: Draw up a tender document describing the specifications of the AWS FMS requires and the likely numbers over the next five years. Installation at existing AWS sites (as replacement) should minimize financial outlays.

The FMS's 28 AWSs and 4 automated weather observing systems (AWOS) for aviation are installed from four different manufacturers: NIWA, VAISALA, SUTRON and JICA. Below is the breakdown of the stations from different suppliers. Each AWS has associated with it a data logger sourced from the AWS supplier:

- NIWA: 22 AWS
- SUTRON: 5 AWS
- VAISALA: 4 AWOSs
- JICA: 1 AWS

Step 4: Assess the funding options. If funding is limited priority should be given to replacing the NIWA AWS.
Step 5: Let tender when resources are available and implement the replacement process. Monitor the implementation process and report on its completion.

Computing Systems

A goal of FMS is to migrate all operation weather-related applications into a single, easily accessed environment. The chosen environment is the proprietary IBL one. IBL offers a broad range of functionality including Visual Weather. Visual Weather provides software for reception, processing, and graphical representation of meteorological data, monitoring of incoming messages and values, generation of textual products (TAF s, public forecasts and warnings, etc.) and graphical products (significant weather analyses, surface analyses, etc.), and includes tools for managing forecast roles and workflows, automatic generation of image products, and other functionalities for fulfilling the weather-related tasks of a meteorological service.

We will also strengthen FMS's overall capability by enhancing our observing networks, ICT infrastructure and staff expertise to collect, process, analyse, predict, visualise and disseminate data and information to users, employing "green" technologies where possible.

Implementation Actions – Computing Infrastructure

Step 1: Review the existing FMS Computing Plan in light of this Strategic Plan. Initiate a search for a software package that meets the needs of the growing hydrological services of FMS (flood warning and water resources assessment). Incorporate the outcomes of this search in the next Computing Plan.
Step 2: Continue the IBL implementation.
Step 3: Review how realtime data are ingested into the operational environment, assess whether climate, hydrology and image data (radar and satellite) can be accommodated in IBL. Review how a quality Control front-end process can be implemented so as to ensure the realtime data stream is acceptable for distribution to external users that have the appropriate authorities.
Step 4: Implement quality control and database for the entire incoming, realtime data stream.
Step 5: Monitor implementation. Regularly update senior management on progress.

Strategic Initiative 2.2: Systematically eliminate "black spots" in Fiji's weather, climate and water observing networks.

Experience has shown that there are areas of Fiji not well covered by our three weather radars and by our in-situ weather, climate and river monitoring stations. To better support our weather, climate and hydrological services we have in place a program of increasing the catchments covered by river gauges and will continue this program through the lifetime of this Strategic Plan. We will

also look to address black spots in the weather and climate networks as opportunities to do so arise.

All the proposed black spot elimination hydrometric stations will be located within hydrometric observing system data voids (or "black spots"). To expand its network in the black spot areas and improve its flood forecasting and water resources assessment services FMS needs to undertake a number of implementation actions.

Implementation Actions to Eliminate Black Spots

Step 1: Continue to install new stations hydro-meteorological stations in black spot areas to meet National Development Plan objectives

Step 2: Work to improve the Fiji-wide Flash Flood Guidance System (Fiji-FFGS) by expanding the rainfall observation stations nation-wide and use the observations of rainfall amounts to calibrate radar and satellite derived rainfall estimates. The new instrumentation this work will require includes:

- Water level and equipment to measure the rainfall intensity in the upper catchments to provide an input into modelling of downstream water levels;
- Soil moisture sensors; and,
- Equipment (non-contact technology) to continuously measure river height and surface water velocity; and,

Step 3: Explore options for acquiring the new instrumentation and implement as circumstances allow.

Responsibilities of Transformation Management Team for Objective 2

TMTO-2 is responsible for:

- The five-step process for transforming the observing infrastructure;
- The five-step process for transform the FMS computing infrastructure;
- The three-step process for implementing actions to eliminate Black Spots; and
- Achieving the KPIs and collecting information relevant to the "other targets" given in Table 4 (below-extracted from Table 3 of the Strategic Plan).

Table 4 Key Performance Indicators and “other targets” for Objective 2

OBJECTIVE	Strategic Initiative	Outputs	Outcomes	KPIs
2. Strengthen FMS’s Technical Foundation	SI 2.1 ICCT and Observation equipment.	A reduction in the number of different systems being supported and an increase in automation.	Reduction in maintenance costs and an increase in efficiency.	IT Plan updated 2021. Further automation of forecasting environment 2023. Further automat ion of weather, climate and hydrology observation collection 2022.
	SI 2.2 Black spots.	Improved flood warnings and a more comprehensive national view of Fiji's hydrology	Lives and livelihoods better protected by more accurate and timely flood warnings and drought advices.	30 new hydro-met stations and 5 river basins mapped by 2022.

4.4 Objective 3: Promote Insight and Innovation within FMS

Strategic Initiative 3.1: Collaborate with research partners in the university sector to bring the latest scientific developments in meteorology and hydrology to Fiji and the region.

In order to bring World-class scientific research in weather, climate and water to Fiji and to FMS we will develop partnerships with the university community here in Fiji and with universities and research laboratories in Asia, Oceania, the US and Europe. We will look for opportunities to up-skill our staff in the latest developments in remote sensing, numerical analysis and prediction, seasonal forecasting and climate scenario down-scaling.

Implementation Actions for Research-Driven Insight and Innovation

Step 1: Consider the need for a Chief Scientist on the staff of FMS to foster and coordinate research activities. Continue discussions with USP and other tertiary institutions as appropriate concerning joint research activities.

Step 2: Encourage young professional staff to undertake masters and doctorate degree level studies in the areas of weather, climate and hydrological modelling.

Step 3: If possible, build linkages with the UCAR WRF research group

Strategic Initiative 3.2: Undertake applied research projects, in collaboration with Users of FMS's services, to better meet their needs.

As a natural complement to increasing our access to the latest science we will engage users of our services in Fiji to identify opportunities to improve their management of risks associated with extremes in weather and climate through the development of improved, science-based forecast and warning products. We expect that this would be a collaborative process, with the FMS bringing to the table data and scientific expertise in weather climate and hydrology and the users bringing to the table an understanding of how weather and climate extremes drive their risk profile. In particular, we expect that service users can advise on thresholds at which crucial decisions for risk mitigation can be taken and give a commitment to work with FMS over time to continuously improve our services by providing informed feedback.

The most effective way for FMS to advance applied research would be for FMS to promote a consortium of weather and climate sensitive users to form a consortium to develop weather and climate products that address particular sensitive economic sectors. Included in the consortium would be scientific representatives from agriculture, fisheries, health, tourism, transport. FMS could look to immediately provider starter products in many areas to encourage sharing data and problems for solution.

Implementation Actions for User Driven Insight and Innovation

Step 1: Using the Caribbean EWISACTS[6] Consortium as an example, develop a collaboration between weather-, climate- and hydrology-service users to jointly undertake applied research to improve the services FMS provides.

Step 2: Encourage junior staff to become involvement in the analysis of service challenges and in developing innovative solutions.

Step 3: recognize and reward staff who make positive contributions to this work.

Responsibilities of Transformation Management Team for Objective 3

TMTO-3 is responsible for:

- The three-step process for implementing actions to support research-driven insight and innovation;
- The three-step process for implementing actions to promote user driven insight and innovation; and
- Achieving the KPIs and collecting information relevant to the "other targets" given in Table 5 (below-extracted from Table 4 of the Strategic Plan).

Table 5 Key Performance Indicators and "other targets" for Objective 3

Objective	Strategic Initiative	Outputs	Outcomes	KPIs
3. Insight and Innovation	SI 3.1 Cooperative Research.	New insights into Fiji's weather, climate, hydrology and ocean systems.	FMS is better placed to take advantage of new science and technology.	Collaborative research projects with UCAR & USP by end of 2021.
	SI 3.2 Applied Research Collaboration with Users.	Innovative new weather, climate, hydrology and ocean services.	Service users gain new efficiencies and/or more effectively mitigate risks.	Collaborative projects with service users to develop innovative new products by the end of 2021.

[6] EWISACTS is a consortium for climate services. FMS could broaden a consortium to address weather, climate and hydrology issues. Further information on EWISACTS can be found at: https://rcc.cimh.edu.bb/cimh-ewisacts-consortium-the-caribbeans-champions-for-climate-services-info/

4.5 Objective 4: Pursue the "Daunidraki Way" - Vibrant, Effective Corporate Support.

Strategic Initiative 4.1: Resolve FMS's legal position as a service provider with the adoption of a Meteorology and Hydrology Act by Government

The development of a Meteorology and Hydrology Bill that describes FMS's roles, functions and other administrative arrangements in the meteorological and hydrological areas will likely set the scene for an administrative transformation of our organisation. Currently the operational model for the FMS is that of a Departmental Unit (Table 5) under the direct control of the Ministry of Infrastructure and Meteorological Services (I&MS). With the passage of a Meteorology and Hydrology Bill through the Fiji Parliament the FMS would move towards gaining its own legal identity while remaining as a public interest service within a Ministry. Another transformation that is occurring within the organisation is a greater focus on revenue generation from both cost recovery and commercial activities (an issue addressed under Strategic Initiative 4.2)

Implementation Actions to put into Legislation a clear statement of FMS's Roles and Functions

Step 1: Continue development of a Meteorology and Hydrology Bill.

Step 2: Informally circulate drafts among legal and policy advisers with a knowledge of the role and functions of FMS and of Fiji public administration. Revise and further consult until an acceptable draft emerges.

Step 3: Passage of the Bill and assent by Government.

Strategic Initiative 4.2: Transform FMS's Corporate Services.

Enterprise Resource Planning

A first step towards transforming FMS's Corporate Functions would be to assess the suitability of so-called Enterprise Resource Planning (ERP) system software. Such software typically provides inter-linked functionality covering: human resources, finances, book-keeping, payroll, assets, sales, and project management.

The range of capability and cost of such systems is large. Implementation of an ERP system, including training of all staff who will use the system is time consuming and the cost highly dependent upon the complexity of the installation as well as the hardware employed and the various software licences that must be paid for annually. For a small but complex (and asset intensive) enterprise such as FMS, there is the added dimension of the need for local support (both for training and maintenance).

Within the Government sector there may be other agencies of FMS's size that have reviewed the ERP system market and possibly have experience in implementing products suitable for Fiji. As a

first step the FMS should assemble a small team from the IT and corporate support areas of FMS to explore the Fiji Government sector and the Fiji market for recent experiences in ERP systems. The output of the team's work should be an assessment of the three most suitable systems along with an estimated up-front cost, ongoing annual cost and the benefits that will accrue from the system.

Assessing whether to move to Implement an ERP System

Step 1: Establish a small team of IT and corporate support to assess options for an ERP system, including:

- The three most suitable systems.
- The estimated up-front cost.
- The ongoing annual cost.
- The benefits that will accrue from the system.

Implementing an Asset Data Base

As noted, the operation of a modern national meteorological services is a capital-intensive operation. The Ministry of Economy has advised that in the short- to medium-term Fiji will move from cash to accrual accounting. Regardless of this move, for purely operational reasons the FMS requires an to build an Asset Data Base (ADB) to hold an accurate assessment of the value of its asset base, the rate at which it is depreciating and the annual outlay required to at least maintain current operational capability. Such an ADB should form the basis for the FMS ongoing asset management, and become a key plank in equipment maintenance and operational planning.

Implementation of the ADB

Step 1: Design the ADB. Identify where the management of the ADB will reside.

Step 2: Train a small group of staff to move systematically throughout FMS collecting and recording in a database, descriptions of assets by characteristics such as: serial number, location, age, expected operational lifetime, purchase price, current condition, current value, other. Each asset to be bar coded at the time it is entered into the database, and that unique bar code identification to be used to identify the asset until it is de-commissioned.

Step 3: Train all staff who commission, maintain and de-commission assets in use of the ADB.

Evaluating the Cost of Services and Charging Policy

As the FMS moves towards establishing service agreements with cost recovery or commercial charging components the FMS will need to establish a charging model and operationalise, through a charging manual, staff determination of the cost of services. Underpinning the charges there needs to be a Government agreed charging policy which distinguishes between the "public goods", "mixed public-private goods" and "private goods".

With the charging policy settled the services the FMS provides need to be listed and assigned categories based on the policy and for those products that not supplied as free, basic services charges assessed according to the procedures laid down in the FMS Charging Manual (which will be an on-line, web enabled document).

Implementation of the Charging Policy

Step 1: Build an on-line catalogue of all services (product description, category of product (free, basic / Mixed public- private- good / commercial) frequency of issue, recipients, time spent manually generating the product, communication mechanism, cost of communication).

Step 2: Review charging policies and practices of NMS that have charging structures in place (eg Metservice - NZ, Met Office – UK, BoM – Australia, etc.) and literature surrounding charging practice for meteorological services from WMO and ICAO.

Step 3: In consultation with stakeholders develop a succinct statement of FMS's Charging Policy.

Step 4: In consultation with stakeholders develop an on-line Charging Manual that sets out the processes for charging for the different categories of services provide by the FMS Charging Policy. Develop cost tables for inclusion in the Charging Manual, including those for:

- Overheads (power, accommodation, computing and communication services, training, etc.).
- Direct staff hours.
- Consumables.
- Other.

Step 5: Put in place annual review mechanisms, ongoing consultation mechanisms for the charging activities of FMS.

Strategic Initiative 4.3: Put in place Service Agreements with Key Clients.

There are many users of FMS's services that have in place long-standing understandings of just what will be provided and the timetable for the provision of these routine services. This group of important stakeholders includes the aviation sector, a number of neighbouring countries and Ministries within Government. The services include data, forecasts and warnings.

Before putting service agreements in place with these stakeholders it would be appropriate to develop MoU with them. The MoU to establish shared interests, the type of services they require from FMS and reciprocal interests the FMS might have. Service level agreements would follow when both parties had a good understanding of each other capabilities and responsibilities in the mutually useful transactions. Noting that relationships develop and change over time the MoU and service agreements would most likely be have times for review/update built into them.

Implementation Actions to Establish Understandings and Agreements on FMS's Service Provision Roles and Responsibilities

Step 1: Continue to actively pursue the ongoing initiative to put in place MoU with many of FMS's key stakeholders. Develop an online register of MoU that are "in force".

Step 2: Use the Pacific Meteorological Council to discuss establishing MoU between the FMS and the National Meteorological Services for which FMS provides public weather and warning services.

Step 3: Work with key clients that would see advantages in moving to service agreements (for example the aviation sector) to commence the process of defining precisely the services that would be covered by such an agreement. In the case of the aviation sector, noting the ICAO advice that cost recovery mechanisms be put in place with this sector, FMS should commence the task of building a costing model that could be applied to the aviation meteorological service.

Step 4: Annually review and report on the MoU and service agreements that are in place and under development.

Strategic Initiative 4.4: Follow to relevant international standards, including those of WMO, ICAO and ISO.

The WMO has established a range of technical standards that are promulgated through its Technical Regulations that are followed by FMS in its operations. The benefits that flow from these regulations include standardisation of observing practices that makes it possible to confidently use all data collected and distributed by WMO, similarly forecasts and warnings must meet agreed standards and training of staff must achieve agreed levels of competency.

The International Civil Aviation Authority (ICAO), through the Chicago convention has put in place a regulatory framework for the provision of meteorological services to aviation. The FMS provides meteorological services for its flight information region following these standards which enable international airlines to be confident that FMS's services are compatible with those received all around the Globe.

The FMS has implemented a Quality Management System (QMS) and achieved certification of compliance with ISO 9001 for this System for its weather and climate services.

Implementation Actions for Following International Standard

Step 1: Keep under review the WMO, ICAO, ISO, National Public Sector Accounting, etc., that apply to the operations of FMS.

Step 2: As standards evolve make every effort to "keep up", noting that modification of operational systems to meet changing standards takes time (and costs money and staff time).

Step 3: To the extent possible, annually report on any areas where standards have moved faster than FMS has been able to respond, including a timetable for remedial action.

Responsibilities of Transformation Management Team for Objective 4

TMTO-4 is responsible for:

- The three-step process for implementing actions to put into Legislation a clear statement of FMS's roles and functions;
- Three distinct actions for transforming corporate systems:
  - A one-step process for evaluating Enterprise Resource Planning systems
  - A three-step process for implementing an Asset Data Base
  - A five-step process for implementing Charging Policy.
- The four-step process for implementing actions to establish understandings and agreements on FMS's service provision roles and responsibilities;
- The three-step process for implementing actions to implement actions for following international standards; and,
- Achieving the KPIs and collecting information relevant to the "other targets" given in Table 6 (below-extracted from Table 5 of the Strategic Plan).

Table 6 Key Performance Indicators and “other targets” for Objective 4

Objective	Strategic Initiative	Outputs	Outcomes	KPIs
4. Daunidraki Way – Vibrant, Efficient Corporate Services	SI 4.1 Legal basis.	A Bill for Fiji's Parliament that sets out the legal basis for FMS's activities.	All FMS's stakeholders have a clear understanding of FMS's function and role.	National Meteorology and Hydrology Bill by end-2021.
	SI 4.2 Corporate systems.	Energetic and innovative corporate support.	Improved overall efficiency of FMS.	ERP evaluation 2021 Assets register and ADB 2022. Charging policy 2021 and manual 2022.
	SI 4.3 Service agreements.	Service Agreements or equivalents with key stakeholders and overseas NMSs.	FMS's stakeholders and staff reach a clear understanding of the services FMS will provide.	MoU or equivalents with key stakeholders and overseas NMSs 2021 SLAs or equivalents by the end of 2023.
	SI 4.4 Meeting international standards.	FMS's data, products and services follow international standards.	The underlying metadata of FMS's data, services and products are available to all their users.	FMS follows relevant WMO, ISO, IMO, ICAO and other nationally and internationally relevant standards.

4.6 Objective 5: Serve the International Community

Stakeholders noted that FMS plays an important role in south-south cooperation in the South Pacific through a broad range of technical activities including provision of tropical cyclone related by RSMC-Nadi, aviation forecasts public weather to neighbouring countries through the FMS weather centre, very active participation in the Pacific Meteorological Council's Expert Panels and through the WMO's RA V and Technical Commissions' Expert Task Teams.

In turn agencies such as SPREP and the WMO find working with the FMS greatly assists in the delivery of their regional programs. One key request they make of FMS engagement in their programs is that it comes with a sustainable financial underpinning from the Fiji Government. In general, this is not an issue though the current Global Covid-19 pandemic has put severe stress on Fiji Government financial resources which may put stress on FMS's participation in international programs – but at time of drafting this Implementation Plan the six Strategic Initiatives listed below fall within FMS's available resource budget.

Strategic Initiative 5.1: Work towards the implementation of a WMO Regional Training Center (RTC) in the South Pacific.

A meteorological and hydrological Regional Training Facility (RTC) in the Pacific SIDS has not been established in the past because no single nation has seen the level of demand for meteorological and hydrological training sufficient to justify such an institution, or none of the 15 Pacific SIDS National Meteorological and Hydrological Services has had the resources necessary to establish an RTC.

Implementation Actions for Improved Technical and Professional Hydro-Meteorology Training in the South Pacific

Step 1: The FMS will continue to collaborate with a number of parties that collectively would be able to work together to put in place a Centre that could meet WMO requirements for designation as a Regional Training Centre for hydro-meteorological professionals and technical officers in the South Pacific with a campus in Fiji.

Step 2: FMS to give support to USP's proposed:

- Course to provide the WMO approved Basic Instruction Package for Meteorologists (BIP-M) and for Meteorological Technicians (BIP-MT).
- Workshop on data sharing.
- Implementation of an Automatic Weather Station (AWS) at USP as a part of the FMS's AWS network.
- The use of the USP's Moodle system for FMS staff on-line learning activities.
- The USP installation of the CLiDE climate database and software environment.

Step 3: Implement an MoU with USP to support provision of data to USP and cooperative training and research activities.

Strategic Initiative 5.2: Establish a WMO Regional Instrument Centre (RIC) within the FMS.

To better support our own instrumentation, and to offer a cost-effective calibration option to neighbouring countries FMS will work, with the support of donor expertise from Japan to implement a WMO-designated RIC.

Implementation Actions for an FMS-based Regional Implementation Centre

Step 1: Continue to work with JICA in developing the FMS's capabilities in meteorology.
Step 2: Explore opportunities for working with other RICs in the WMO V Region, including those in Australia and the USA.
Step 3: Build links to instrument makers through involvement in HMEI[7]

Strategic Initiative 5.3: Continue to provide the full range of tropical cyclone-related services and information through the WMO Regional Specialized Meteorological Center (RSMC) – Nadi.

In fulfilment of its role as a World Meteorological Organization (WMO) Regional Specialized Meteorological Centre (RSMC) for Tropical Cyclone Forecasting, the FMS through its Nadi office contributes to the safety of life, property and livelihoods of communities living in the Southwest Pacific between longitudes 160°E and 120°W from the equator to 25°S through the provision of warnings and other information relating to tropical cyclones.

Implementation Actions to Provide Ongoing Support for RSMC-Nadi

Step 1: Continue to meet all operational obligations as a Regional Specialized Center (RSMC) for tropical cyclone warning in the South Pacific.
Step 2: Promote the extension of the Coastal Inundation Forecast (CIF) capability to encompass all countries in the RSMC area of responsibility (see Section 4.2, Initiative 1.1). Develop a process for feedback of surge information after tropical cyclone impacts for system verification and improvement.
Step 3: With the implementation of IBL, the WIS communication system and impact-based warning (Initiative 1.1) upgrade the quality and effectiveness of tropical cyclone warnings.

[7] Further information at: https://www.hmei.org/about-us/

Strategic Initiative 5.4: Establish a WMO Region V Regional WIGOS Center (RWC) within the FMS.

The WMO, at its 68th Executive Council Session (15-24 June, 2016) decided to proceed with the creation of Regional WIGOS Centers, initially carrying out certain mandatory functions and being able to elect to undertake other optional functions.

The mandatory functions are directly linked with two of the priority areas of the WIGOS Pre-operational Phase (2016-2019):

1. Regional WIGOS metadata management (work with data providers to facilitate collecting, updating and providing quality control of WIGOS metadata in OSCAR/Surface);
2. Regional WIGOS performance monitoring and incident management (WIGOS Data Quality Monitoring System) and follow-up with data providers in case of data availability or data quality issues.

Implementation Actions

Step 1: Develop a quality control capability on the "front end" of the FMS IBL realtime data processing system that meets WIGOS requirements.

Step 2: Promote the exchange of data that meet OSCAR requirements.

Step 3: Establish a system to feedback to data providers issues of data quality and assist in addressing these issues.

Strategic Initiative 5.5: Establish a node of the WMO South Pacific Regional Climate Center (RCC) in FMS.

The WMO RA-V Pacific Regional Climate Centre (RCC) Network is a virtual Centre of Excellence that assists National Meteorological and Hydrological Services (NMHSs) in the Pacific Islands region to deliver better climate services and products and to strengthen their capacity to meet national climate information and service delivery needs. Many of FMS's stakeholders are looking to make better use of our climate services through closer collaborative work.

Implementation Actions

Step 1: Continue to maintain and build the Fiji National Climate Database and to provide access to, and guidance on, the use of the data held in that database.

Step 2: Work to enhance ease of access to Fiji's Climate data, and to provide additional seasonal climate services to address the specific needs of climate sensitive users (agriculture, water, health, etc.).

Step 3: Contribute as a Node of the WMO RA V (distributed) Regional Climate.

Step 4: Increase FMS's contributions in the climate change adaptation and impact areas.

Step 5: Develop expertise and capabilities in the climate model downscaling area.

Strategic Initiative 5.6: Continue to provide active support to a range of WMO Expert Task Teams and PMC Expert Panels.

The FMS has a long history of engaging in the work of the WMO. Expert teams provide an opportunity for the unique problems of SIDS to be addressed in the technical fora of the WMO and create linkages at a professional level between experts from FMS and meteorological centres around the globe, including, for example, centres in the Caribbean that face similar problems to Fiji and centres in the US, Asia and Europe where many of the scientific advances in meteorology and related-technologies originate. Finally, through FMSs expert involvement in WMO teams we are able to share our experiences with other National Meteorological and Hydrological Services in the region.

Implementation Actions for

Step 1: Review the range of WMO Expert Task Teams of Commission and Region V to undertake work relevant to FMS's operations at the completion of the review of task teams consequent to the re-structure of the WMO Secretariat.

Step 2: Review staff expertise available and, as opportunities become available, promote younger, well qualified staff to expert teams. Support these staff in their expert roles over extensive periods – it is staff that contribute to the work of Teams over five years or more that make the most impact. Monitor the efforts of those that participate in Expert Teams and reward staff who succeed in contributing to the work of Expert Teams, replace those that do not.

Step 3: Distribute to the other WMO Members in the South Pacific information on the work and outcomes of the Expert Teams that FMS contributes to.

Step 4: Continue active participation in the PMC Expert Panels.

Responsibilities of Transformation Management Team for Objective 5

TMTO-5 is responsible for:

- The three-step process for collaboratively participating in the establishment of a WMO Regional Training Centre in the South Pacific;
- A three-step process for implementing a WMO Regional Instrument Center in the South Pacific.
- A three-step process for providing ongoing support for WMO RSMC-Nadi.
- A three-step process for implementing a WMO Regional WIGOS Center in FMS.
- A five-step process for future participation by FMS in the WMO RA v Regional Climate Center.
- A four-step process for continuing support for WMO and PMC technical Expert Teams and Panels in the South Pacific.
- Achieving the KPIs and collecting information relevant to the "other targets" given in Table 7 (below-extracted from Table 6 of the Strategic Plan).

Table 7 Key Performance Indicators and “other targets” for Objective 5

Objective	Strategic Initiative	Outputs	Outcomes	KPIs
5. Serve the International Community	SI 5.1 Become a node of the WMO RA V Pacific Regional Climate Center.	Contribute to nodes of the RA V Pacific RCC.	Improved climate-related products and services for Fiji and the Pacific.	Be endorsed as a consortium member of the Long-Range Forecasting, Operational Data Services and Training nodes of the RA V Pacific RCC in 2022.
	SI 5.2 Participate in a Consortium that comprises a WMO Region V Regional Training Center.	A Center in the South Pacific supplying training for hydro-meteorological technicians and professional officers.	Lower training costs and improved hydro-meteorological capacity in the South Pacific.	MOU or equivalents with NCAR & USP 2020 Syllabus developed 2021. Faculty assembled 2024. Fully functional 2025.
	SI 5.3 Establish a WMO Region V Regional Instrument Center.	Provide a calibration and maintenance facility for hydro-meteorological instrumentation.	Lower maintenance costs and improved hydro-meteorological instrumentation in the Pacific.	ISO certification by 2021. Application approval 2022. Fully functional 2023.
	SI 5.4 Regional Specialized Meteorological Center – Nadi.	Tropical cyclone warnings, advices and other related information.	Lives and livelihoods better protected by accurate and timely tropical cyclone warnings and related information.	A high-level of user satisfaction with RSMC-Nadi services. Error statistics for tropical cyclone forecasts (24 hours and 48 hours lead time, position and maximum wind speed forecasts errors that are comparable with international norms).
	SI 5.5 WMO Region V WIGOS Center.	Improved quality control of data.	Improved services using regional data.	“Front-end” realtime quality control monitoring in place by 2023.
	SI 5.6 International Expert Teams.	Engagement in designing and implementing WMO compliant systems and procedures.	FMS technical capacity increased and it better supports regional forecasting and warning.	The number of experts from FMS engaged in the WMO's Commissions and its Research Board. Participation in Region V Association Working Groups and PMC Panels.

Table 8 The Schedule of Actions described in the Implementation Plan

ACTIVITY ID	ACTION DESCRIPTION	RESPONSIBLE MANAGER
Objective 1	TMTO-1 is responsible for: ♦ The five-step process to implementing MHEWS and IBF using the coastal inundation forecast system as a "Pilot"; ♦ The four-step process for implementing a comprehensive, quality controlled realtime database; ♦ Achieving the KPIs given in Table 3 (below-extracted from Table 2 of the Strategic Plan.	
Objective 2	TMTO-2 is responsible for: ♦ The five-step process for transforming the observing infrastructure; ♦ The five-step process for transform the FMS computing infrastructure; ♦ The three-step process for implementing actions to eliminate Black Spots; ♦ Achieving the KPIs given in Table 4 (below-extracted from Table 3 of the Strategic Plan).	
Objective 3	TMTO-3 is responsible for: ♦ The three-step process for implementing actions to support research-driven insight and innovation; ♦ The three-step process for implementing actions to promote user driven insight and innovation; and ♦ Achieving the KPIs given in Table 5 (below-extracted from Table 4 of the Strategic Plan).	
Objective 4	TMTO-4 is responsible for: ♦ The three-step process for implementing actions to put into Legislation a clear statement of FMS's roles and functions; ♦ Three distinct actions for transforming corporate systems: o A one-step process for evaluating Enterprise Resource Planning systems o A three-step process for implementing an Asset Data Base o A five-step process for implementing Charging Policy. ♦ The four-step process for implementing actions to establish understandings and agreements on FMS's service provision roles and responsibilities; ♦ The three-step process for implementing actions to implement actions for following international standards; and, ♦ Achieving the KPIs given in Table 6 (below-extracted from Table 5 of the Strategic Plan).	

Table 8 continued:-

ACTIVITY ID	ACTION DESCRIPTION	RESPONSIBLE MANAGER
Objective 5	TMTO-5 is responsible for: ♦ The three-step process for collaboratively participating in the establishment of a WMO Regional Training Centre in the South Pacific; ♦ A three-step process for implementing a WMO Regional Instrument Center in the South Pacific. ♦ A three-step process to provide ongoing support for WMO RSMC-Nadi. ♦ A three-step process for implementing a WMO Regional WIGOS Center in FMS. ♦ A five-step process for future participation by FMS in the WMO RA V Regional Climate Center. ♦ A four-step process for continuing support for WMO and PMC technical Expert Teams and Panels in the South Pacific. ♦ Achieving the KPIs given in Table 7 (below-extracted from Table 6 of the Strategic Plan).	

5. Monitoring, Evaluation and Post-Implementation Plan

Monitoring the implementation process and evaluation of the monitoring process to determine whether the Strategic Plan is being implemented effectively and achieving the desired outcomes is crucial. Furthermore, it is inevitable that the monitoring process will detect problems of one sort or another, the key is to address the issues, resolve blockages and adapt the Strategic Plan if necessary, to respond to changing circumstances.

In this Implementation Plan the focus has been on minimizing administrative overheads. Keeping documentation to a minimum, having technical expertise at the heart of the implementation and breaking down barriers between different parts of the FMS organization to enable the Transformation Management Team exploit new synergies.

5.1 Monitoring and Evaluation Process

The principal component of the monitoring and evaluation process is the preparation and circulation of quarterly reports from each of the five Transformation Management Teams. A Quarterly Report will:

- Describe progress in completing implementation tasks, which are step-wise processes listed against each Strategic Initiative.
- Compile, and review, monthly data for KPIs (as necessary- found in Implementation Plan Tables 2, 3, 4, 5 and 6) and describe progress in developing and compiling statistics that will be internal measures (the so-called "other targets") of how effective the transformation process is in achieving the outcome described in the Strategic Plan Tables 2, 3, 4, 7 and 9.

5.2 Post-Implementation Activities

The ultimate success of the transformation of the FMS will require a complex set of value judgements that include:

- Has the range of services the FMS provides to its stakeholders increased in range and effectiveness?
- Is the "return on investment" by the Fiji Government and international donors in the FMS increasing over time?

- Is staff morale high, is the overall capacity of the FMS increasing as new science and technologies are integrated into its operations?
- Does FMS continue to be seen as an exemplar in south-south cooperation in multi-hazard early warning, aviation and public weather services?

As a part of the post-implementation activities The FMS will endeavour to prepare a "Snapshot Report" in 2025 of progress against criteria such as those listed above, of the success of the transformation path taken by FMS in the Strategic Planning period 2021-2024.

6. Approval

This Implementation Plan is one of three documents commissioned by the World Meteorological Organization to assist the Fiji Meteorological Service in the development of its Planning processes.

The three documents are:

- Stakeholder Assessment
- Strategic Plan 2021-24
- Implementation Plan

Each of the three documents was drafted by Dr Geoff Love, an independent consultant, under guidance from the Acting Director, FMS, Mr Terry Atalifo and with assistance from staff of the WMO.

Review and approval of the documents was undertaken by Mr Atalifo, other FMS senior staff and representatives of the WMO.

Annex 1: List of Acronyms

ACP	Africa Caribbean Pacific Organization
ADB	Asian Development Bank also (in a different context) Asset Data Base
AIFS	Australian Integrated Forecast System
AMDAR	Aircraft Meteorological Data Relay
APEC	Asia Pacific Economic Cooperation
APFM	Associated Programme on Flood Management (joint WMO / Global Water Partnership initiative)
AWS	Automatic Weather Station
BoM	Australian Bureau of Meteorology
CC	Commerce Commission
CCCPIR	Coping with Climate Change in the Pacific Island Region programme
CliDE	Climate Data for the Environment
CROP	Council of Regional Organizations in the Pacific
CSIRO	Commonwealth Scientific and Industrial Research Organisation (of Australia)
DCPC	Data Collection or Production Center
DoE	Department of Energy
DFI	Development Finance Institution
DRM	Disaster Risk Management
DWD	Deustcher WetterDienst
EC	European Commission
EEZs	Exclusive Economic Zones
EE	Energy Efficiency
EIB	European Investment Bank
ERP	Enterprise Resources Planning
EU	European Union
EDF	European Development Fund
ENSO	El Niño-Southern Oscillation
FAA	USA Federal Aviation Administration
FDI	Foreign Direct Investment
FEA	Fiji Electricity Authority
FFGS	Flash Flood Guidance System
FIR	Flight Information Region (under the ICAO arrangements)
FMS	Fiji Meteorological Service

FJD	Fiji Dollar
FRDP	Framework for Resilient Development in the Pacific 2017-2030
FREPP	Fiji Renewable Energy Power Project (GEF funded)
FSL	Forecast Systems Laboratory (now part of Earth System Research Laboratory)
GFCS	Global Framework for Climate Services (a WMO initiative)
GDPC	Global Disaster Prepareness Center
GDP	Gross Domestic Product (in $US unless otherwise noted)
GEF	Global Environmental Facility
GIZ	German Agency for International Cooperation
GISC	Global Information System Center (a WMO initiative)
GIS	Geographical Information System
HFA	Hyogo Framework of Actions
HPCC	High Performance Computer Clusters
IBF	Impact-Based Forecasts
IBL	Slovakia based software engineering including capabilities such as; message/data switching system called "moving weather", a visual software called "visual weather", and pilot briefing software called "aero weather"
ICAO	International Civil Aviation Organization
ICCT	Information, Computing and Communication Technologies
ICT	Information and Computing Technologies
IT	Information Technology
IMO	International Maritime Organization
IPP	Independent Power Producer (private single purpose investor)
ISO	International Organization for Standardization
KPI	Key Performance Indicator
NCAR	National Center for Atmospheric Research (of USA)
NCEP	National Center for Environment Prediction (of USA)
NDMO	National Disaster Management Office (in Fiji) or more generally National Disaster Management Organisation
NDP	National Development Plan2017-2036
NEP	National Energy Policy
NEF	National Energy Forum
NHS	National Hydrological Service
NIWA	New Zealand National Institute of Water and Atmospheric Research
NMHS	National Meteorological and Hydrological Service
NMS	National Meteorological Service
NOAA	USA National Oceanic and Atmospheric Administration

NWP	Numerical Weather Prediction
MDGs	Millenium Development Goals
MHEWS	Multi-Hazard Early Warning System
MoIMS	Ministry of Infrastructure and Meteorological Services (of Fiji)
MoU	Memorandum of Understanding
MWA	Meteorological Watch Area (under the WMO arrangements)
OPMET	OPerational METeorological data (under ICAO)
OSCAR	Observation System Capability, Analysis and Review (a part of WIGOS)
PIAWS	Pacific Island Aviation and Weather Services (PMC Expert Panel)
PCCPP	Peoples Charter for Change, Peace and Progress
PCCSP	Pacific Climate Change Science Program
PIC	Pacific Island Country
PICS	Pacific Island Climate Service (PMC Expert Panel)
PICI	Pacific Island Communications and Infrastructure (PMC Expert Panel)
PICTs	Pacific Island Countries and Territories
PIETR	Pacific Island Education, Training and Research (PMC Expert Panel)
PIMS	Pacific Island Meteorological Strategy
PMC	Pacific Meteorological Council
PMDP	Pacific Meteorological Desk Partnership
PNG	Papua New Guinea
PPA	Pacific Power Association, Power Purchase Agreement
PPI	Private Participation in Infrastructure
PPP	Public Private Partnership
PSD	Private Sector Development
QMS	Quality Management Systems
RA V	WMO Regional Association 5 (South-West Pacific)
RBF	Reserve Bank of Fiji RE Renewable Energy
RCC	Regional Climate Centre (under the WMO arrangements)
RESCO	Renewable Energy Service Company
RDSSED	Roadmap for Democracy and Sustainable Socio - Economic Development
RIC	Regional Instrument Centre (under the WMO arrangements)
RSMC	Regional Specialized Meteorological Centre (under the WMO arrangements)
RTC	Regional Training Centre (under the WMO arrangements)
RWC	Regional WIGOS Center (under WMO arrangements)
SAIDI	System Average Outage Duration
SAIFI	System Average Interruption Frequency Index
SE4ALL	Sustainable Energy for ALL (UN Initiative)

SDGs	Sustainable Development Goals
SI	Strategic Initiative
SIDS	Small Island Developing State
SIMDAT	Simulated Data
SMS	Short Message Service
SOE	State Owned Enterprise
SOLAS	Safety Of Life At Sea (Convention)
SPREP	Secretariat of the Pacific Regional Environment Programme
SPC	Secretariat of the Pacific Community
TA	Technical Assistance
TCAC	Tropical Cyclone Advisory Center (under ICAO arrangement)
TAF	Terminal Aerodrome Forecasts (under ICAO arrangement)
UCAR	University Corporation for Atmospheric Research (in Boulder, Colorado, USA)
USP	University of the South Pacific
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
USGCRP	United States Global Change Research Program
UPNG	University of Papua New Guinea
WAF	Water Authority of Fiji
WB	World Bank
WIGOS	WMO Integrated Global Observing System
WIS	WMO Information System (under WMO arragement)
WRF	Weather Research and Forecasting Model
WRN	USA Weather Ready Nations
WTP	Willingness-To-Pay
WMO	World Meteorological Organization

ANNEX 2: FMS Charging and Costing Frameworks

Background to Charging by National Meteorological Services

The successful provision of modern, science-based meteorological services requires access to data and information that are exchanged globally under arrangements coordinated by the WMO. The free exchange of meteorological data and information that are *essential* for the provision of services relating to the safety of life, property and livelihoods was reasserted through Resolution 40[8] of the 1995 Twelfth World Meteorological Congress. Fiji is a signatory to the WMO Convention under which these arrangements were unanimously agreed, and through the FMS is a major beneficiary of them. Resolution 40 also sets out how commercial activities in meteorology may be carried out between WMO members and how data not considered *essential* may be exchanged using the WMO coordinated communication infrastructure.

Underlying the Resolution 40 concept of *essential* data is the notion that these are the data required for meteorological services that are provided for the safety of life, property and livelihoods which are, in economic terms, a public good[9]. Such public good services include general forecasts of the day-to-day weather along with warnings of severe weather and are usually made available to the public through free-to-air radio, television and the newspapers. More recently we have begun to see national meteorological services and other meteorological service providers using social media for quick updating of forecasts and warnings during extreme and noteworthy events. Other meteorological services may be a considered to be mixed public and private goods (for example, forecasts for major yacht races) for which cost recovery arrangement may be put in place and others purely private goods (for example, high temporal resolution forecasts of temperature for energy management purposes) for which commercial charging arrangements are made.

An important outcome from the global free exchange of *essential* data is that no signatory to the WMO Convention can expect to make monopoly profits from the sale of its meteorological data for either weather- or climate-related purposes. If a WMO Member, through either the Member's NMS or through some private organization, wishes to commercialise some aspect of meteorology it cannot be

[8] Source: http://www.wmo.int/pages/prog/www/ois/Operational_Information/Publications/Congress/Cg_XII/res40_en.html

[9] A public good is a product that one individual can consume without reducing its availability to another individual, and from which no one is excluded. Economists refer to public goods as "nonrivalrous" and "nonexcludable."
Nonrivalry denotes any product or service that does not reduce in availability as people consume it. Nonexcludability refers to any product or service that is impossible to provide without it being available for many people to enjoy. Therefore, a public good must be available for everyone and not be limited in quantity.
National defense, sewer systems, public parks and other basic societal goods can all be considered public goods.
Source: http://www.investopedia.com

through the provision of basic data because that is already in the public domain, so it has to be by selling value-added services that meet targeted private needs.

A number of NMSs already undertake commercial activities including MetService (NZ), the Bureau of Meteorology (Australia), MeteoFrance and the UK Meteorological Office. In addition, there are many private organisations providing commercial meteorological services including NaDraki (Fiji), Weathernews International (Japan) and Accuweather (US). Should FMS create a commercial unit, local players such as NaDraki would expect to compete on a level playing field while other international players might represent possible competitors and/or partners. Another consideration is that WMO Members would expect Fiji to continue to abide by the arrangements set out in Resolution 40 of the 12th World Meteorological Congress (or the proposed replacement, Resolution 42, if adopted at the next World Meteorological Conference).

The Charging Framework

The transition of FMS from a purely public good service provider to one that also operates in the commercial space would seem to require that it make clear to Government, the public, potential partners and potential competitors the precise nature of the FMS charging policy.

The following three charging regimes will be adopted by the FMS:

(1) Free Public Good Services

Within the policy framework outlined above, the FMS provides meteorological services to the community at large through (and in a close partnership arrangement with) the mass media and via the Internet. The FMS does not attempt to charge the public for the universally available public services and it neither charges the mass media for the information it provides nor pays the media for delivery of the service.

(2) Cost Recovered Services

The FMS will recover costs for those services that are deemed to be in the public interest, but for which it is not appropriate for the taxpayer to meet the full cost of provision.

Cost recovery charges will occur under the following two categories:

(a) Services which are themselves provided free of charge but for which the user is required to meet the cost involved in accessing them either by phone, fax or the Internet. Examples might include:

- numerical model output which is used as internal guidance for its forecasters in the preparation of the public forecasts and warnings;

- high resolution radar and satellite imagery;
- climate data; and,
- consultancies that are mixed private/public goods.

(b) Services which are developed for a special sector or user group such as aviation and defence for which the FMS is, through Government policy, a "monopoly" provider and so, for which the incremental costs that the FMS must incur in producing them should only be recovered from those for whom they are provided. Examples include:

- Aviation Weather Services;
- Defence Weather Services;
- Other specialised services including: design rainfall information, climate services and products for community planning purposes; forecasts for public entertainment events (eg yacht races, golf tournaments, etc.).

(3) Commercially Charged Services

Commercial services provided by the FMS Unit in competition with the private sector subject to whatever competitive neutrality requirements the Fiji Government requires with the profit returned to Government under arrangements agreed at the time the FMS commercial unit is established.

The Costing Framework

The Charging Framework outlined above assumes that it is possible to determine the cost of providing a particular service. Furthermore, the provision of meteorological services to international aviation in accordance with the cost recovery principles of Annex 3 of the ICAO Convention, also requires that the cost of providing that service by the FMS can, and has been, determined.

A number of practical issues will arise in the costing of individual FMS services, deriving, primarily, from the inherent subjectivity in locating the boundary, in any particular case, within the grey area between purely public good services, on the one hand, and purely private good services on the other. For example, where a forecaster contributes to both public weather forecasting and forecasting for an international yacht race on a single shift how is the time to be charged?

In determining the cost of a product or service in a cost recovery environment, one area that requires closer inspection is that of how an overhead is determined and applied, especially when the service has been seen as being incremental to a public good service. The overhead cost borne by the FMS administration in support of provision of aviation weather services is an important issue to resolve. Similarly, commercial competitors with the FMS commercial unit would like to see the FMS overhead support for the unit fully costed and incorporated in its commercial charging arrangements.

The inclusion of capital costs in the cost recovery environment may also be difficult when the equipment being used was donor funded. Furthermore, capital costs would be treated quite differently in an accrual as compared to a cash accounting environment.

Establishing the FMS Commercial Unit

As outlined above the successful establishment of the FMS commercial unit will require that the FMS develop a charging policy that is compatible with relevant Fiji Government policies on commercial activities within its Departments. This policy will also need to be consistent with the WMO Resolution 40 and should look to achieving compliance with the ICAO Convention, Annex 3 cost recovery principles.

With a charging policy in place the FMS would then need to develop a comprehensive description of: (a) the free, public good; (b) the cost recovered; and, (c) the commercial services it would provide under the new arrangements.

The FMS would then need to develop its costing model which takes account of: (a) the direct costs; (b) the overhead (support) costs; and, (c) capital (equipment outlay or depreciation) costs appropriate for each cost recovered and commercial service.

The FMS will establish a "standing committee" to review the charging and costing policies from time-to-time and advise FMS staff on how any proposed new services should be categorised for charging policy and costing purposes.

Noting the relatively small size of the FMS, the new unit should take responsibility for managing both cost recovered and commercial services.

Revenues from cost recovered services should be retained by the FMS (presumably through arrangements with the Fiji Department of Finance) to meet its costs of operations. The costs of operating the commercial unit should be removed from its revenues and the profits returned to Government. The FMS should agree profit targets for the commercial unit with the Department of Finance on an annual basis. In the first years of its commercial operation the commercial unit is likely to require a loan from the FMS to support its operations

Experience within the meteorological community indicates that the culture of a group providing services to meet a financial "bottom line" is somewhat different to the more traditional public service culture and that these differences will need to be managed.

Mode of Establishment of the FMS Commercial Unit

As outlined above, the first steps towards establishing the commercial unit would be to settle charging and costing models and establishing the committee to operationalize these.

The unit should initially deal only with cost recovered services, taking responsibility for promoting and recovering revenues from mixed public/private goods. This should not compete with private sector commercial providers nor would it run the risk of contravening WMO Resolution 40, but would assist in moving towards being able to achieve the cost recovery actions recommended by ICAO. With experience in dealing with paying clients of FMS's services and in managing the finances of a small (albeit) not-for-profit business the staff of the unit would be well placed after a year (or so) of such operations to initiate commercial services in both the climate and weather arenas. At this second stage of its operations, it may need a loan from the FMS and agree profit (or loss) targets with the Fiji Department of Finance.

It is suggested that initially two staff, one a meteorologist and one with a financial background be recruited. Both staff members should have strong IT skills and be capable of liaising with external clients of FMS services. The transition to commercial operations may see the need for an increase in staffing that is in line with its profit projections.

Annex 3: Implementing a Communications Plan

1. Establish a Planning Team

The Team will consist of representatives from the Weather, Climate and Hydrology elements of the combined Service Division and be chaired by the media liaison officer. This Team will be responsible for preparing a detailed Communications Plan and then oversighting its implementation.

2. Aims

The aims of the Plan will be to:

- Assist the FMS in increasing the number and range of users of its services in the coming years.
- Enable our staff to measure whether we're meeting FMS objectives; and,
- Enable our staff to continually improve the FMS communication strategy.

3. Key Contents of the Plan

- **Objectives.** The Plan will include a list of FMS's communications objectives in order of priority.
- **Positioning Statement.** The Plan will, in plain language describe the FMS and our unique capabilities.
- **Target Audiences.** The Plan will describe who are we trying to reach.
- **Desired Actions.** The Plan will describe the activities that will enable implementation.

Implementation Activities

4. Messaging

Each Division will develop:

- **Article Topics.** Create a list of topics to generate articles for your website and Twitter Feed. These topics should appeal to specific target audiences and somehow contribute to your overall positioning.
- **Daily / Weekly Message Themes.** Themes to help guide the FMS staff in their daily messaging. Include the proportion of messages for each theme. For example: 60% forecast or event related (climate, weather, hydrology); 20% school-focused educational campaigns; 15% fun, quirky but informative stuff; 5% inspirational quotes. Involve all staff and all areas in developing the themes and then prepare an annual list with the responsibility for the weeks spread across the FMS.

5. Key Dates

FMS as an entity and each services output Division has key dates that recur each year. Whether it's World Meteorological Day, a regional meeting, the start of the cyclone season, etc. These are to be listed so the communication team knows when they are coming. Each Division will take responsibility for planning and carrying out the events promoting FMS and reporting back to the Communications Team when they are over.

6. Campaigns

Campaigns are critical for harnessing all the time the FMS will invest in the communication strategy. People don't take action on an issue unless they are motivated them through an educational campaign.

The Communications Team will schedule its campaigns in advance whenever possible, and attempt to launch one at least every quarter. The more campaigns the FMS launches, the better FMS staff will understand its users and stakeholder communities, enabling it to improve its communications over time.

7. Benchmarks for Success

This is one of the most important parts of the communication plan. Here is where the FMS measures the impact of its communication efforts, both in terms of **intermediary benchmarks** (such as the size of your Facebook following or email list) and **organizational objectives** (like responses to warnings, feedback from users).

This Communications Team will establish:

- A baseline (where are we starting in terms of your social media community size, website traffic volume, total donors, total members, etc.)
- Intermediary goals (every three months, what type of growth would we like to see?)
- End goals (where will we be in 12 or 18 months)
- Metrics for each platform FMS is using.

The FMS will use its web site statistics for reviewing and updating the majority of the communications benchmarks each quarter.

8. Strategy Review Meetings

The Communications Team will schedule a strategy review meeting each quarter. This will enable FMS to determine what's working and what isn't, such as:

- Which benchmarks has the FMS met or exceeded?
- Which benchmarks are elusive?
- What can we do to give the weaker areas a boost?
- What were the FMS's biggest successes? Why?
- Do we need to adjust and update the Plan?

From time-to-time, as needed, the Communications Team will recommend to the Director updates for the Communications Plan.

Annex 4: Summary of Stakeholder Consultations

1. Introduction

This stakeholder consultation summary is based, in part, upon the outcomes of the UNEP sponsored, Pearl Resort FMS Stakeholders Workshop (1-17 July, 2020), that included representatives from 11 stakeholder organizations:

- Ministry Health and & Medical Services (MoH&MS)
- Ministry of Water (MoW)
- Fiji Hotel and Tourism Association (FH&TA)
- University of the South Pacific (USP)
- Fiji Roads Authority (FRA)
- Ministry of Agriculture (MoAg)
- Sugar Research Institute of Fiji (SRIF)
- Energy Fiji Limited (EFL)
- Marine Safety Authority (MSA)
- Fiji Ports Company Limited (FPCL)
- Fiji Navy

In addition to the Pearl Resort Workshop teleconferences were held with the following nine stakeholders in September 2020:

- University of the South Pacific (8 September)
- United Nations Development Program (UNDP) (23 September)
- Japan International Cooperation Agency (JICA) (23 September)
- Ministry of Water and Energy (Waterways Department) (24 September)
- Ministry of Economy (MoE) (17 September)
- National Disaster Management Office (NDMO) (22 September)
- Fiji Broadcasting Commission (FBC) (24 September)
- Fiji Airports Limited (FAL) (14 September)
- Civil Aviation Authority of Fiji (CAAF) (8 September)
- South Pacific Regional Environment Programme (SPREP and the World Meteorological Organization (WMO) (19 October)

2. Outcomes Pearl Resort Workshop and Teleconferences

Introduction

Discussions from the Pearl Resort Workshop highlighted that all participants valued the services provided by FMS while also identifying ways that the expertise and capabilities of FMS could be enhanced to assist the stakeholders in better meeting their organizational responsibilities. A theme of the UNDP sponsored workshop was to promote the establishment of Memoranda of Understanding (MoU) between FMS and its key stakeholders. Stakeholder presentations emphasized closer collaboration with FMS in a number of different ways, including by; establishing and maintaining hydro-meteorological observing stations, improving exchange of data and information, and carrying out joint research and development work (as appropriate) to improve user-relevant information, forecasts and warnings.

The teleconferences reinforced the near universal requirement for better access to meteorological and hydrological data and information. The degree of interaction between the stakeholders and FMS varied quite substantially - the aviation sector had possibly the closest working arrangements with FMS while the FBC tended to interact most closely with FMS at times of severe weather. The aviation sector considers adhering to ICAO standards essential and would like to see Service Level Agreements (SLAs) underpinning their work with FMS.

The media (represented by FBC) sought forecasts with less technical jargon while the NDMO indicated that one of its roles was to "translate" the technical information in FMS's warnings into something the average person could understand. This feedback from FBC and NDMO seems to indicate that FMS needs to implement a communications strategy by way of the implementation of an FM Communications Plan as soon as possible.

Donor and supporting UN and regional agencies (represented by JICA, UNDP, WMO and SPREP) envisaged continuing support for developing countries but possibly at a reduced level until the economic impacts of the covid-19 pandemic had receded. JICA felt that an increased role in providing advice on the science of climate change and possible impact on Fiji is a role FMS could contribute more. WMO and SPREP saw FMS as an organization that benefited from their programs and had a role to play in assisting them in delivering their programs to other countries in the South Pacific.

Every stakeholder reported good working relations with FMS.

Linking Strategic Initiatives to Objectives

Reviewing the 15 Strategic Initiatives that have been identified through stakeholder and staff consultations they can be grouped under five broader, Objectives. The first two stakeholder-driven Strategic Initiatives are:

1.1 Contribute to Fiji's Multi-Hazard Early Warning System (MHEWS) and implement Impact-Based Forecasting (IBF) by the FMS; and,

1.2 Improve the efficiency of the collection, storage and access to hydrometeorological data and information.

These Strategic Initiatives contribute to the achievement of Objective 1: Better Serve Societal Needs for Weather-, Climate- and Water-related services.

The second two stakeholder-driven Strategic Initiatives are:

2.1 Enhance the FMS observation network and forecasting systems' underlying Information and Communications Technology (ICT); and,

2.2 Systematically eliminate "black spots" in the weather, climate and water observing networks.

These Strategic Initiatives contribute to the achievement of Objective 2: Strengthen the Technical Foundation of the FMS for the future.

Table 1: The distribution of stakeholder requirements for Strategic Initiatives 1.1, 1.2, 2.1, and 2.2

Objectives	1. Better Serve Societal Needs		2. FMS's Technical Foundation	
Stakeholders	1.1 MHEWS and IBF	1.2 Hydromet Data and Information	2.1 Observations and ICCT	2.2 "Black Spots"
Min H&MS				
Min of Water				
FHTA				
USP				
Fj Roads Auth'				
Min of Agric'				
SRIF				
EFL				
MSA				
FPCL				
Fiji Navy				
Media				
Min of Eco				
NDMO				
Fiji Airports Ltd				

LEGEND	
Stakeholder requirement	
Supports stakeholder requirement	
Not a stakeholder requirement	

Objectives	1. Better serve societal needs		2. FMS's Technical Foundation	
Stakeholders	1.1 MHEWS and IBF	1.2 Hydromet Data and Information	2.1 Observations and ICCT	2.2 "Black Spots"
CAAF				
SPREP				
WMO				
NMSs:				
Cook Is.				
Kiribati				
Nauru				
Nuie				
Tokelau				
Tuvalu				

The third pair of stakeholder-driven Strategic Initiatives are:

3.1 Collaborate with research partners in the university sector to bring the latest scientific developments in meteorology and hydrology to Fiji and the region; and

3.2 Undertake applied research projects, in collaboration with Users of FMS's services, to better meet their needs.

These Strategic Initiatives contribute to the achievement of Objective 3: Promote Insight and Innovation within FMS.

The fourth stakeholder-driven Strategic Initiatives are:

4.1 Resolving FMS's legal position as a service provider with the adoption of a Meteorology Act by Government;

4.2 Transform corporate services;

4.3 Put in place Service Agreements with Key Clients; and,

4.4 Follow to relevant international standards, including those of WMO, ICAO and ISO.

These Strategic Initiatives contribute to the achievement of Objective 4: Pursue the **"Daunidraki Way"** so as to generate vibrant corporate support system.

The final six stakeholder-driven Strategic Initiatives are:

5.1 Working towards the implementation of a WMO Regional Training Center (RTC) in the South Pacific;

5.2 Establish a WMO Regional Instrument Centre (RIC) within the FMS;

5.3 Continue to provide the full range of tropical cyclone-related services and information through the WMO Regional Specialized Meteorological Center (RSMC) – Nadi;

5.4 Establish a WMO Regional Water Center (RWC) within the FSM

5.5 Establish a node of the WMO South Pacific Regional Climate Center (RCC) in FMS;

5.6 Provide active support to a range of WMO, PMC and other international organisations' Expert Task Teams.

These Strategic Initiatives contribute to the achievement of Objective 5: **Serve the International Community**.

Table 2: The distribution of stakeholder requirements for Strategic Initiatives 3.1, 3.2, 4.1, 4.2 and 4.3.

Objectives	**3. Insight and Innovation**		**4. Daunidraki Way**			
Stakeholders	3.1 Advancing science	3.2 Applied Research	4.1 Legal status	4.2 Corporate Systems	4.3 Service Agreements	4.4 Standards
Min H&MS		■	▫	▫	■	
Min of Water			▫	▫		
FHTA			▫	▫	▫	■
USP	■	■	▫	▫		
Fj Roads Auth'			▫	▫		
Min of Agric'		■	▫	▫		
SRIF		■	▫	▫		
EFL		■	▫	▫		
MSA			▫	▫	■	■
FPCL			▫	▫	■	
Fiji Navy			▫	▫	■	
Media						
Min of Eco						
NDMO						
Fiji Airports Ltd		■	■	■		
CAAF		■	■	■	■	■
SPREP			■		■	
WMO	■		■		■	■
NMSs:						
Cook Is.					▫	▫
Kiribati					▫	▫
Nauru					▫	▫
Nuie					▫	▫
Tokelau					▫	▫
Tuvalu					▫	▫

LEGEND	
Stakeholder requirement	■
Addresses stakeholder needs	▫
Not a stakeholder requirement	

Table 3: The distribution of stakeholder requirements for Strategic Initiatives 5.1, 5.2, 5.3, 5.4 and 5.6.

Objective	**Serving the International Community**					
Stakeholders	5.1 RTC	5.2 RIC	5.3 RSMC	5.4 RWC	5.5 RCC	5.6 ET's & EP's
Min H&MS	■	■	▫	▫	■	
Min of Water	■		■	▫	▫	
FHTA		■	▫		▫	
USP	■		▫	▫		■
Fj Roads Auth'	■		▫	▫	▫	
Min of Agric'	■		▫	▫	■	
SRIF			▫		■	
EFL	■		▫		■	
MSA			■		▫	■
FPCL			■		▫	
Fiji Navy			■	▫	▫	
Media						
Min of Eco						
NDMO						
Fiji Airports Ltd	■	■	■	■	■	■
CAAF	■	■	■	■	■	■
SPREP	■	■	■		■	■
WMO	■	■	■	■		■
NMSs:						
Cook Is.	▫	▫	▫	▫	▫	▫
Kiribati	▫	▫	▫	▫	▫	▫
Nauru	▫	▫	▫	▫	▫	▫
Nuie	▫	▫	▫	▫	▫	▫
Tokelau	▫	▫	▫	▫	▫	▫
Tuvalu	▫	▫	▫	▫	▫	▫

LEGEND	
Stakeholder requirement	■
Addresses stakeholder needs	▫
Not a stakeholder requirement	