COUNTRY HYDROMET DIAGNOSTICS

Informing policy and investment decisions for high-quality weather forecasts, early warning systems, and climate information in developing countries.

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Jamaica Meteorological Service Peer Review Report

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WORLD METEOROLOGICAL ORGANIZATION

Alliance for Hydromet Development

IDB Inter-American Development Bank

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METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

SOFF Systematic Observations Financing Facility

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The findings, interpretations and conclusions expressed are those of the named authors alone and do not necessarily reflect those of the agencies involved.

Authorisation for release of this report has been received from the Peer Reviewing Agency and the Country NMHS as of November 2024.

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Abbreviations

BReTCAT	Building Resilience Through Climate Adaptation Technologies
CAA	Civil Aviation Authority
CCADRRP	Climate Change Adaptation and Disaster Risk Reduction Project
CHD	Country Hydromet Diagnostics
CIMH	Caribbean Institute of Meteorology and Hydrology
CMO	Caribbean Meteorological Organization
GBON	Global Basic Observation Network
FMI	Finnish Meteorological Institute
IDB	Inter-American Development Bank
MSJ	Meteorological Services of Jamaica
NEOC	National Emergency Operational Centre
NEPA	National Environmental and Planning Agency
NOAA	National Oceanic and Atmospheric Administration
ODPEM	Office of Disaster Preparedness and Emergency Management
PPCR	Pilot Programme for Climate Resilience
QA/QC	Quality Assurance / Quality Control
RADA	Rural Agricultural Development Authority
SOFF	Systematic Observations Financing Facility
WMO	World Meteorological Organization
WRA	Water Resources Authority

Executive Summary

Element	Maturity level score
1. Governance and institutional setting	2
2. Effective partnerships to improve service delivery	3
3. Observational infrastructure	2
4. Data and product sharing and policies	3
5. Numerical weather prediction model and forecasting tool application	3
6. Warning and advisory services	4
7. Contribution to climate services	2
8. Contribution to hydrology	4
9. Product dissemination and outreach	3
10. Use and national value of products and services	2

Based on the analysis of the Country Hydromet Diagnostics, the following critical gaps in the MSJ current capabilities have been identified:

- There is currently no legislation for meteorological services to stipulate MSJ's mandate and responsibilities. The development of national legislation to grant the MSJ the status of an Authority is essential. It is recommended that cost-recovery mechanisms be incorporated into the bill to enhance the MSJ's capacity for sustainable budget development. Once its status is strengthened, the MSJ should formalize key relationships with national stakeholders.
- The MSJ has identified a staff shortage and is encouraged to continue pinpointing key positions—such as those in climate services, quality management, and communications—that are either absent from the staff roster or require additional

dedicated personnel. Initiating the recruitment process to fill these roles is strongly recommended.

- Operation and maintenance plans, including life-cycle plans, annual maintenance and calibration SOPs need to be developed or updated to support the sustainable operation of observing systems. In case the Regional Calibration Centre's capabilities are not improved, the MSJ will need to establish service relations with other laboratories. These plans need to be reflected in its annual budget.
- Currently no Quality Management System is consistently followed by the MSJ. The MSJ is recommended to train staff in QMS implementation, expand QMS from aviation services to cover all MSJ services, and to integrate and operationalize it into all areas of the Meteorological Service.
- The MSJ is encouraged to maintain close and regular engagement with stakeholders, fostering coordinated discussions on needs and co-design of new services. Significant potential exists to enhance collaboration with academia and the CIMH in areas such as research, model development, and the sharing of model data.
- The MSJ is recommended to strengthen their human capability in utilizing automatic product dissemination, model editing and post-processing, introducing AI based methods and initiating forecast verification, as well as improving capabilities in impact-based forecasting and QMS.
- Significant gaps exist in the observation system, including the need to upgrade manual GBON observation stations to automated ones and the urgent repair of the malfunctioning weather radar. Furthermore, there is a clear requirement for a lightning observation network and a marine observation network, both of which would benefit from regional support and solutions. Additionally, the absence of an integrated data management system presents a major challenge. Such a system is needed to store and process all observation data in a unified platform, enabling automated data processing, quality assurance/quality control (QA/QC), and modern methods of data dissemination.
- The MSJ is encouraged to continue developing its mobile app and website based on user feedback, while also working to enhance public awareness of these tools. Improving the MSJ's overall communication presence, including on social media platforms, is also recommended.

Chapter 1: General information

Introduction

Jamaica is the largest and most populated island in the English-speaking Caribbean. Jamaica is vulnerable to natural disasters such as hurricanes and flooding that occur annually and is severely affected by the climate change, especially along its coasts. The expected impacts of climate change include a warming and drying trend, causing more frequent droughts and bush fires, as well as intense rainfalls and sea level rise[1]. These effects will have a huge impact on the national food and water security, as well as and the country's society and economy. Jamaica has significant agricultural, tourism and maritime sectors, which are all susceptible to severe weather and climate events. As a country, Jamaica has suffered both the loss of human life and financial income resulting from weather and climate events. Effective weather and climate services have a large potential to mitigate the impacts.

The Meteorological Service of Jamaica (MSJ) is a branch of the Ministry Economic Growth and Job Creation of the Government of Jamaica with the responsibility for monitoring and tracking weather and climate in Jamaica.

The MSJ is successfully providing weather warnings, as well as versatile weather services and climate services to the public and local stakeholders, and has an important role in disaster risk reduction and emergency operations in Jamaica. Besides its national collaborations, the MSJ is actively partaking in the regional and international meteorological community. The MSJ has been continuously developing its capabilities to produce and disseminate services effectively and to serve specific stakeholder needs, as well as increasing public awareness and knowledge of weather and climate topics.

CHD methodology

The work to create this Country Hydromet Diagnostics (CHD) report was done as an output for the Systematic Observations Financing Facility (SOFF) project in Jamaica. The work was preceded by the preparation of the National GBON Gap Analysis and National Contribution Plan.

During the SOFF project's Readiness Phase the following activities were organized:

- Remote workshop for the kick-off for the SOFF work.
- A fact-finding mission to Jamaica focusing on the observation network gap analysis, network status and plans. The mission focused primarily on information to support the Gap Analysis report and the National Contribution Plan documents.
    - Both GBON nominated surface weather stations in Kingston and Montego Bay and the sounding station in Kingston was visited. The site-survey to Montego Bay also included visit to the observation office and meeting the airport management operator.
- A mission focusing on the Country Hydromet Diagnostics. The mission included workshopping with the MSJ to assess and evaluate all line-items on the CHD template and a half day key stakeholder engagement to collect input from the user and stakeholder groups. Invitees included representatives from the following agencies and institutes:

[1] World Bank Climate Knowledge Portal

    - Office of Disaster Preparedness and Emergency Management (ODPEM)
    - Water Resources Authority (WRA)
    - National Water Commission
    - Civil Aviation Authority
    - National Fisheries Authority
    - Jamaica Public Service
    - Ports Authority of Jamaica
    - Airports Authority of Jamaica
    - PAC Kingston Airport Limited (PACKAL)
    - University of West Indies
    - Rural Agricultural Development Authority
    - Jamaica Defence Force Coast Guard
    - Media
    - Maritime Authority of Jamaica
    - Food for the Poor

- Consultation with the US National Oceanic and Atmospheric Administration National Weather Service Office of Observations regarding the Cooperative Hurricane Upper Air Stations program.
- Two visits to the Caribbean Meteorological and Hydrological Institute (CIMH) to discuss regional network support and plans and the capacity of the regional calibration centre.
- Several remote meeting to prepare and comment on the findings and documents.

Chapter 2: Country Hydromet Diagnostics

Element 1: Governance and institutional setting

1.1 Existence of Act or Policy describing the NMHS legal mandate and its scope

No Act or Policy exists that describes the MSJ's legal mandate and its scope. Although no formal mandate exists, the MSJ is widely recognized by the Government of Jamaica, stakeholders and the public as the meteorological and climatological service provider in Jamaica, with responsibility for public, aviation and marine weather services. The MSJ is operated as a branch of the Ministry Economic Growth and Job Creation in the division of Climate Change, National Spatial Data Management and Meteorological Services.

The Principal Director of the MSJ reports to the Division Director General that reports to the Permanent Representative of the Ministry, who reports to the Minister. The Prime Minister has the authority to reassign divisions to different Ministries. The MSJ is primarily funded by the Government of Jamaica and operates to provide public weather services and other services to the state and the public, without operating any commercial services.

The MSJ is divided into three distinct Sections: support services, weather services and climate services, that the Principal Director of Meteorological Services oversees. The MSJ is responsible for providing meteorological and climatological services and warnings in Jamaica, including services for aviation and marine meteorology. The MSJ is supporting national air quality monitoring by providing observations and forecasts on meteorological conditions such as haze and dust (mainly originating from Sahara) and can share simple and generic advisories for the population related to these phenomena. Further responsibilities for air quality services are shared between the Ministry of Health and the National Environmental and Planning Agency (NEPA). Hydrological responsibilities are shared with the Water Resources Authority (WRA), with a formalized agreement (MoU) between the two entities for sharing of related data. The MSJ has also formalized its relationship with the Civil Aviation Authority (MoU and LoA) and Maritime Authority (MoU) that stipulate their duties and shared responsibilities. The Ministry of Agriculture and the Rural Agricultural Development Authority are leading the provision of agrometeorological services, which the MSJ is closely supporting with seasonal outlooks, as well as other climate services and public weather services.

A draft for the meteorological bill and regulator policy for Jamaica was drafted in 2021 with the assistance of the Caribbean Meteorological Organization (CMO). The draft is not fully compliant with the national legislative standards and thus will need to be adjusted before submission to the Ministry for approval. The draft should clearly define the MSJ's mandate and authority and grant it the role of an independent authority, with its own fiscal capabilities and possibilities of cost-recovery services. There is a pressing need to develop and finalize this legislation, which benefits form the strong support from all key stakeholders consulted. The MSJ is recommended to be granted support from the Ministry to finalize the necessary adjustments to the bill.

The MSJ staff is governed by the Staff Orders for Public Services of the Civil Service Act. The MSJ has been named as a branch of the Ministry in the Minister Order and the amount and pay category of its staff is assigned in the Order. It includes no mention of MSJ's mandate or services. The Jamaican Disaster Risk Management Act incorporates some elements for meteorology, but it does not specifically state the MSJ's responsibilities.

Jamaica has been a Member State of the WMO from its Independence in 1962, and is bound by with the responsibilities set by the WMO Convention and regulations. The MSJ Principal Director is appointed as the WMO Permanent Representative.

1.2 Existence of Strategic, Operational and Risk Management plans and their reporting as part of oversight and management.

No separate strategy has been yet established for the MSJ.

The MSJ has developed a national five-year strategy plan based on the regional strategy plan for meteorological services in the Caribbean. The plan has not yet been endorsed by the government and thus has not been made public yet.

The MSJ is annually contributing to the development of the strategic plan for the Ministry Economic Growth and Job Creation. The Ministry's plan covers a five-year period that is revised annually. The MSJ introduces and incorporates strategic objectives from the regional strategy plan to the Ministry's plan. This is crucial in securing budget funding for strategic development priorities.

During the revision period of the strategic plan, meetings occur regularly and follow-up meetings can be arranged when needed. Reporting on this plan is only done on an ad-hoc basis and no public report exists.

The national plan for Jamaica mentions the MSJ[2] under the national goal "Jamaica has a healthy natural environment" in the outcome "Hazard Risk Reduction and Adaptation to Climate Change". The MSJ services are also closely linked to the water sector's and health sector's development plan and in the national environmental vision goals.

No risk management plan exists. It is recommended for the MSJ to include the development of risk management plans in its Quality Management System development when it is started.

1.3 Government budget allocation consistently covers the needs of the NMHS in terms of its national, regional, and global responsibilities and based, among others, on cost-benefit analysis of the service. Evidence of sufficient staffing to cover core functions

Ministry has a dedicated account for the MSJ. The MSJ budget is divided into an administrative and directorate budget, and a dedicated budget for the weather and climate sectors. The annual budget for MSJ in 2024/2025 was 322,4 million Jamaican Dollars (equivalent to approx. 2M USD). The administrative and support services budget covers items such as facility rents and vehicles, whereas the weather and climate budget cover the expert staff costs as well as the operation and maintenance budget of the systems. From this second budget, 80% was allocated to staff costs. The annual budgets have been quite stable, with a slow increase that mainly covers the inflation. New investments are primarily done thru external project funding. The year 2024 had no investment budget. Project funding is mainly provided by different international donors and the size of this funding has a sizable annual variation. Currently, there is no income from commercial services.

International meteorological membership fees to WMO, CMO or CIMH are covered from the Ministry's budget, not from the MSJ's.

"A business plan for the production of meteorological and climate information services and dissemination to end users" was developed as part of the Pilot Program for Climate Resilience in 2018. The plan sets out the objective to improve the funding of the MSJ by introducing cost recovery for aeronautical meteorological service provision following ICAO recommendations, by establishing the baseline services expected by the Government of Jamaica through legislation concerning the MSJ and by exploring potential customer

[2] Vision 2030 for Jamaica

segments for added value services. The MSJ is recommended to review this plan and to consider its findings in developing its strategy going forward, esp. once the meteorological bill has been approved.

1.4 Proportion of staff (availability of in-house, seconded, contracted- out) with adequate training in relevant disciplines, including scientific, technical, and information and communication technologies (ICT). Institutional and policy arrangements in-country to support training needs of NMHS.

The number of permanent staff in the MSJ is currently 69. All of the posts including the pay grade are defined and classified according to the Civil Service Establishment[3] Act.

Table 1 Number of positions and different posts in MSJ.

Post	Amount
Principal Director	1
Meteorologist 4	2
Meteorologist 3	3
Meteorologist 2	3
Meteorologist 1	4
Meteorological Systems Specialist	1
Meteorological Instruments & Equipment Specialist	1
Manager Support Services	1
Senior Meteorological Technician	10
Meteorological Technician 2	11
Meteorological Technician 1	18
Executive Secretary 1	1
Accounting Technician 2	1
Accounting Technician 1	1
Accounting Clerk 2	2
Secretary 2	1
Secretary 1	1
Telephone Operator/Receptionist	1
Driver	2
Attendant	2
Caretaker/Watchman	1
Messenger	1
Total:	**69**

As seen from the table above the majority (57%) of MSJ workforce are Meteorological Technicians. The management consists of four people: the principal director and the section heads.

There are no climatological positions, although currently four staff members work on providing climate services. This is due to the fact that climatological services are not the primary task for any of the staff. Of the four staff members, three work primarily as meteorologists and one as management.

The male to female ratio for the MSJ staff is 19:11. Equal participation is well represented at the management tiers of the MSJ.

[3] The Civil Service Establishment Act

The MSJ has implemented competency assessments for technicians and forecasters during the QMS implementation for the aviation services, but there is no overall competency assessment framework in place.

Staff levels and requirements are based on the job functions. The Ministry holds the power to nominate all recruitments and the MSJ's role has been set as the technical expert in the selection panel. All human resources and procurement functions are seated in the Ministry, which assists the MSJ on a requirement basis. The MSJ is governed by the Ministry's training policy and therefore the MSJ does not have an internal one. The MSJ proposes needed trainings with a yearly training plan to the Ministry for acceptance.

The education and training level of the MSJ staff is very good overall. Most meteorologists have been studying in the University of West Indies' and Caribbean Institute for Meteorology and Hydrology's (CIMH) joint meteorological programmes. The MSJ is a member of CIMH and can utilize the offered specific training courses and request additional assistance in training in topics such as observation system maintenance. The MSJ staff also participates in other training opportunities such as training at the NWS tropical desk in US. Technical staff have attended meteorology specific sensor maintenance and operation training courses for the different acquired technologies and systems, typically offered by the systems manufacturers.

The current gaps regarding the human resources at the MSJ is the shortage of staff to perform all duties in case of any absence and to dedicate resources for new service development or research duties. Key staff capabilities and responsibilities such as Quality Management, project management, communications and customer relations are lacking from the MSJ's staff complement.

1.5 Experience and track record in implementing internationally funded hydromet projects as well as research and development projects in general.

The MSJ has a long history of successfully implementing projects funded with different international funding instruments.

Recent projects are:

- Climate Services and Related Applications Programme (ClimSA) funded by the European Union (on-going)
    - The main objective with the program is to strengthen the capacity of the region in building resilience to climate change, mitigating its effects and adapting at national and regional levels. Activities in the MSJ are focused on improving the climate services value chain with attention targeted on water which is the pilot sector for Jamaica for this project.
- Building Resilience Through Climate Adaptation Technologies (BReTCAT) funded by the Inter-American Development Bank and World Meteorological Organization (WMO) and Caribbean Development Bank. (Ended in 2023)
    - The project aims to strengthen the early warning and data management systems to provide enhanced weather and climate communication to vulnerable populations and their communities in Jamaica.
    - Activities included co-creation of weather products, public awareness campaign, launching of the MSJ weather app and involving a large number of users from the public and stakeholders and businesses throughout all steps.

- Climate Change Adaptation and Disaster Risk Reduction Project (CCADRRP) funded by the European Union, United Nations Environment Programme (UNEP) and Government of Jamaica.
    - Project target is to collaboratively reduce degradation and to restore terrestrial, coastal and marine ecosystems and ensuring greater resilience to climate change impacts.
- Jamaica's Bush Fire Warning Index – Predicting, Detecting and Mitigating Disaster funded by European Union and Caribbean Development Bank.
    - The project aim is to develop a comprehensive Jamaican Bush Fire Warning Index to determine critical thresholds for bush fire outbreaks under different conditions for effective bush fire management.
- Weather Ready Nations funded by NOAA
    - Introduction of impact-based forecasting including training in risk maps and impact statements. Included joint activities for the MSJ, office of Disaster Risk Preparedness and Water Authority.
- Water sheds project funded by Inter-American Development Bank.
    - Developing integrated management for Yallahs river and Hope river watersheds. Automatic surface weather stations were installed in the watershed area.
- Enhancing Climate Resilience in CariForum Countries by Caribbean Community Climate Change Centre
    - The MSJ received three automatic surface weather stations (two of which have been installed to date) in the project.
- Hills to ocean project
    - Focuses on watershed management and agricultural products. The MSJ contributed by helping to select sites for agriculture stations and in return receives the data from these.

Summary score and recommendations for Element 1

The summary score for the element is 2 "Effort ongoing to formalize mandate, introduce improved governance, management processes and address resource challenges".

It is recommended to support the development of national legislation for meteorological services - this will require assistance from the Ministry to tailor the existing draft bill into accepted format. The legislation should clearly define the MSJ's mandate and grant it the status of an Authority for meteorological warnings. Methods for cost-recovery should be addressed in the legislation to support the MSJ's budget development towards increased sustainability.

It is recommended to formalize the relationship with the Office of Disaster Preparedness and Emergency Management (ODPEM). In the stakeholder engagement workshop, it was **suggested to develop a similar status as for the Water Resources Authority for the MSJ**.

The MSJ is recommended to establish a Quality Management System including risk management plans.

To improve the sustainability of project benefits it **is recommended to improve the operation and management, and life-cycle budget planning and reflect this in the annual budget plan.**

The MSJ is **recommended to identify key positions that they are currently lacking from the staff complement,** such as staff dedicated to quality management, project management, communications or customer relations **and to start filling these positions**. This entails increasing the number of staff positions that make up the structure of the MSJ.

Element 2: Effective partnerships to improve service delivery

2.1. Effective partnerships for service delivery in place with other government institutions.

The MSJ is very well known and valued by all relevant national stakeholders. Most of these relationships are informal and engagement mostly ad-hoc.

The MSJ has existing formal partnerships with some of its key governmental stakeholders. Memorandum of Understandings exist with the Water Resources Authority (WRA), with whom the MSJ shares responsibilities related to hydrology, as well as with Maritime Authority, which the MSJ is supporting by providing meteorological safety services for sea areas, and with the Civil Aviation Authority (CAA), with whom the MSJ also has a Letter of Agreement that stipulates the way the cooperation is governed.

Additionally, the MSJ is supporting national air quality monitoring by providing observations and forecasts on meteorological conditions such as haze and dust (mainly originating from the Sahara) with the Ministry of Health and the National Environmental and Planning Agency (NEPA). The MSJ is also supporting the Ministry of Agriculture and the Rural Agricultural Development Authority with seasonal outlooks, as well as other climate and public weather services needed for agricultural services.

The partnership between the MSJ and WRA is very strong, and it includes free and open data sharing for precipitation information from observation systems between the two entities.

A multi-sectoral platform is called upon by the Office for Disaster Preparedness and Emergency Management (ODPEM) in case of a disaster event. The mission of ODPEM is to lead the process of reducing the impact of the disaster on Jamaica through comprehensive disaster management. Its mandate is to coordinate roles in the execution of emergency response and relief operations in major disaster events. The platform works with both public and private entities including different ministries e.g. Ministries of Transport and Works, Energy and Mining, Economic Growth and Job Creation Agriculture and Fisheries, Local Government and Community Development, Labour and Social Services, National Security, Foreign Affairs and Trade, Finance and Planning, Education, Tourism, Health and Wellness and the office of Prime Minister, and divisions and entities such as: the National Water Commission, Caribbean Disaster Emergency Management Agency, National Works Agency, MSJ, Jamaica Private Sector Organization, Adventist Development and Relief Agency, Airports Authority, Red Cross, Customs Agency, Port Authority, Social Investment Fund, University of West Indies, University of Technology, Council of Persons with Disabilities, Jamaica Defence Coast Guard, Defence Headquarters, Constabulary Force, Digicel, Flow, Forestry, Social Development Commission, Planning Institute, Public Service Company, National Solid Waste Management Authority, Spatial Data Management Division, Climate Change Division, Jamaica Fire Brigade, Land Information Council, Mine

& Geology Division, National Hurricane Centre, WRA, NEPA, Earthquake Unit, Jamaica Information Services.

The MSJ has hosted stakeholder events to discuss needs and introduce new services. The events have been highly appreciated by the participants. Key stakeholders to be invited to such events include: ODPEM, WRA, National Water Commission, CAA, National Fisheries Authority, Jamaica Public Services, Ports Authority, Airports Authority, University of West Indies, RADA, Defence Force Coastal Guard, media, Maritime Authority and nonprofit organizations such as Food for the Poor. The stakeholders have expressed an interest for more frequent engagement with the MSJ.

2.2. Effective partnerships in place at the national and international level with the private sector, research centres and academia, including joint research and innovation projects.

The MSJ is actively collaborating with the private company that manages the airport operation in Norman Manley International Airport and the Montego Bay International Airport. Both airports are operated by the Grupo Aeroportuario del Pacifico. The collaboration includes discussion on observation site maintenance, access to the sites and works made in the near vicinity of the sites that may affect observation quality. The MSJ also has service contracts with private sector suppliers for new equipment.

Jamaica is part of the Cooperative Hurricane Upper Air Stations (CHUAS) network that is supported by the US National Weather Service (NWS). The cooperation is based on a Memorandum of Understanding that stipulates NWS's responsibility to provide needed equipment and consumables for sounding operations and the MSJ's responsibility to provide the facility and to operate the soundings.

The MSJ is actively participating in regional collaboration with the Caribbean Meteorological Organization (CMO) and the Caribbean Institute of Meteorology and Hydrology (CIMH) through the WMO Region IV activities.

The MSJ has collaborated with the University of West Indies in climate studies. The collaboration has mainly been to assist the University to access climatological data. There is interest to increase the collaboration between the University and the climate service division in climate research. Currently this is hindered by staff shortage.

Collaboration between the MSJ and the University of Technology has been initiated , with a primary focus on developing emission inventories and supporting human capacity building.

In a recent project named Building Resilience Through Climate Adaptation Technologies (BReTCAT), the MSJ partnered with the Caribbean Climate Innovation Center (CCIC). CCIC is a joint venture between the Scientific Research Council and the Caribbean Industrial Research Institute. It focuses on empowering developing countries to proactively and profitably adapt, develop and deploy climate smart technologies and business models.

2.3. Effective partnerships in place with international climate and development finance partners.

The MSJ has been active in many internationally-funded projects and has proactively been seeking opportunities for new projects. Thanks to this active approach, the MSJ has been the pilot for many regional projects. Despite this activity however, the MSJ has very little direct partnerships with the financing partners. The MSJ typically works with regional organizations such as CMO and CIMH or within projects such as CREWS that lead the engagement with financing partners.

2.4. New or enhanced products, services or dissemination techniques or new uses or applications of existing products and services that culminated from these relationships.

The MSJ has been able to do modifications to their products and services based on the input they have received from the stakeholders as ad-hoc or from the MSJ led engagement.

In a recent project Building Resilience Through Climate Adaptation Technologies (BReTCAT) a large effort was made to harvest input from product users and stakeholders for co-designing new products, increasing public awareness with a campaign and implementing a new dissemination channel: the MSJ weather app.

Summary score, recommendations, and comments for Element 2

The summary score for the element is 3 "Moderately effective partnerships but generally regarded as the weaker partner in such relationships, having little say in relevant financing initiatives".

In order to improve MSJ's partnerships with national organizations and the private sector it **is recommended to grant the status of an Authority and finalize the legal status for the MSJ.** A stronger status and possibility of cost-recovery would promote the MSJ as an equal partner with the other governmental authorities. In addition to the legislative status, **key partnerships should be formalized, and stakeholder engagement should be made regular**. A need for sector level stakeholder engagement e.g. agriculture or marine, was expressed in the stakeholder inputs. To support such activities, it is **recommended to improve the MSJ partnership management by human capacity building and nominating focal points for the different sectoral user groups.**

The MSJ and academia have many promising collaboration initiatives ongoing. The MSJ is **recommended to increase such joint research and development activities**. In the long run it is **recommended to invest in having time for staff to participate in research and development activities** from both the weather and climate divisions.

Element 3: Observational infrastructure

3.1. Average horizontal resolution in km of both synoptic surface and upper-air observations, including compliance with the Global Basic Observing Network (GBON) regulations.

There are two synoptic surface weather stations in the GBON network in Jamaica. The stations are located in Montego Bay international airport and Kingston international airport with less than 150km distance between them. Both stations are operated manually and are recommended to be updated to automatic ones. The coverage is well in line with the WMO GBON criteria.

Besides the land area, Jamaica has a large marine area. The marine area, especially to the south of Jamaica, is lacking observations. The need is to receive sea surface observations from buoy-based stations or by utilizing other technologies e.g. unmanned surface vessels. It is recommended to offer support to increase the marine area observations in Jamaica, and overall in the Caribbean region.

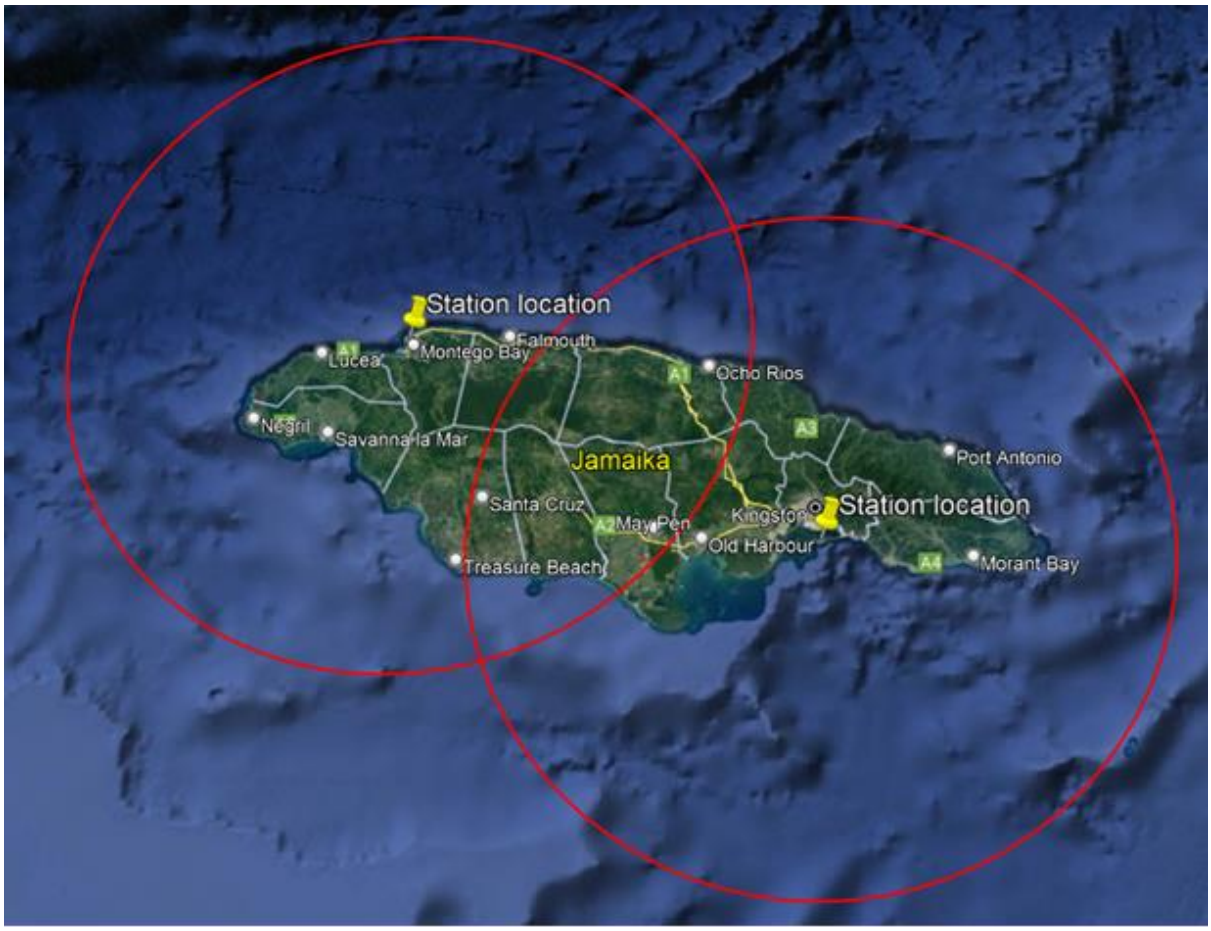

Figure 1 GBON surface weather stations in Kingston international airport and Montego Bay international airport. Indicated circles have a 100km radius.

In addition to the GBON stations, the MSJ has a network of six synoptic surface weather stations with WMO standard wind measurement on 10m height, approximately 35 automatic weather stations with wind measurements on 2m height, and a network of complementary low-cost surface stations (the MSJ does not own all of the stations but is in charge of the operation) used mainly for agricultural data and climate services. The MSJ also operates weather stations on the airport, that are owned by the Civil Aviation Authority. Additionally, there is a network of manual rain gauges. MSJ's strategy for the

surface weather network is to have at least one synoptic weather station in each parish (14 parishes in total) that are complemented with the denser network of smaller stations. All in all, the network consists of over a hundred automatic weather stations.

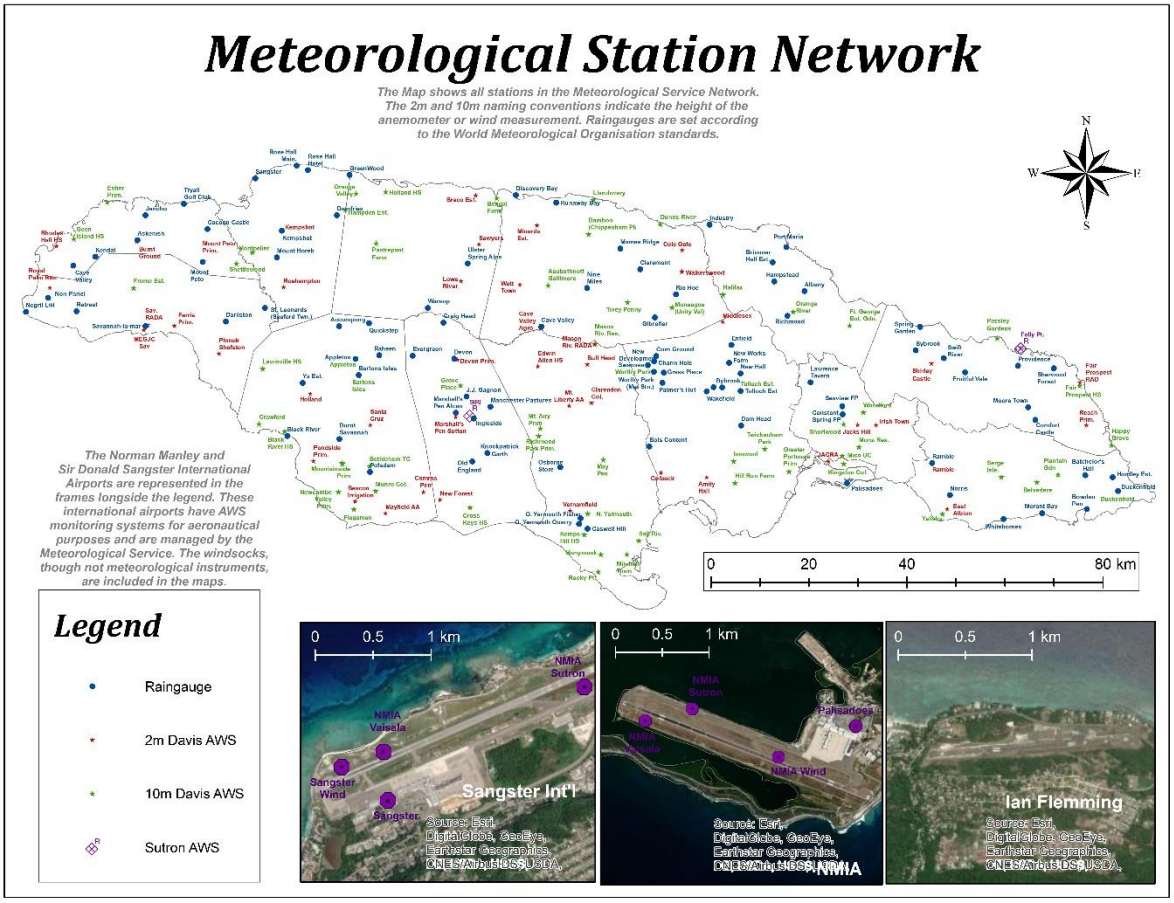

Figure 2 Meteorological Station Network of the MSJ.

There is a lack of a centralized network monitoring system or database with up-to-date information on all of the systems and sensors on their status, metadata and maintenance. A solution for this is recommended to be developed as the network consists of a large variety of different types of systems with different sensors and site setup, different manufacturers and models, from different times and projects, and in some cases with different ownership.

The station network consists of many different types of stations from different manufacturers (Vaisala, Campbell, Suttron, Davis) which poses difficulty in maintenance and calibration processes and keeping a spare part stock. This multitude of vendors is mainly a result of project-based investments, as the MSJ does not necessarily have a say in selecting the systems if the project lead is in charge of procurement, as well as MSJ's long operation history.

The MSJ operates one upper-air sounding station at the Kingston international airport, which is adequate according to the GBON regulation for spatial resolution. The station is part of the Cooperative Hurricane Upper Air Station network and therefore supported by US National Weather Service (NWS). NWS has provided the sounding equipment including hydrogen generator and continues to provide the consumables for twice daily sounding and maintenance of the system. MSJ provides housing and human resources for its

operation. The station is operational and delivers soundings reliably twice a day, or more during the hurricane season depending on NWS's wishes.

The importance of the sounding station in Jamaica is highlighted by the sparsity of observations from the neighboring countries. The closest sounding stations reporting frequently to the GBON WDQMS data portal are in San Andreas and Key West.

3.2. Additional observations used for nowcasting and specialized purposes.

The MSJ has one S-band weather radar. The weather radar has been malfunctioning since 2021 due to a failure in the radar mechanics. The MSJ is still waiting for support from the supplier to reestablish operation. This has highlighted the need for redundancy as the critical observations are operated on a single point of failure approach. The complementary network of small weather stations and rain gauges has been critical to support rain measurements during the downtime of the radar.

Currently there is no lightning observations network in Jamaica, only one single point sensor located at the upper-air sounding station. A network-based solution (nation or region wide) would be a very valuable addition to monitor the approach and evolution of high-impact storm and hurricane events.

The aviation meteorological services have access to the low-level wind shear detection system owned by and located at the airport.

3.3. Standard Operating Practices in place for the deployment, maintenance, calibrations and quality assurance of the observational network.

The MSJ has SOPs and maintenance plans in place for many of its systems. However, it is recommended to review and update relevant SOPs when new investments are made to the network and when introducing new technologies or methods.

The MSJ is operating a maintenance unit with well trained staff that can take care of basic maintenance needs for most of the observation systems. Maintenance work is driven by maintenance plans with scheduled monthly maintenance duties and maintenance of new and unexpected system failures. Duties include cleaning sensors from salt and dust, cleaning the observation site, comparison of sensor values with field calibration kits and potential repair work for the site.

Currently, the largest shortcomings are the lack of budget for spare parts or the difficulty in procuring spares for the variety of different manufacturers' stations, and the lack of staff for the maintenance operations. Utilizing a multitude of surface weather system providers poses difficulties not only to the spare part stock but also to the variations in calibration and maintenance practices.

The maintenance of the upper-air sounding system is done based on maintenance manual recommendations from the system supplier. NOAA provides the comparison standard for pressure once a year for the use of upper-air sounding calibration.

Two staff members have been trained for calibration activities with certification from CIMH, but routine activities in this sector have not yet been started. At the moment sensors can be calibrated case-by-case by using external calibration services or during maintenance work with field calibration kits for some of the sensor types (temperature and humidity). The MSJ has previously been utilizing the WMO regional calibration laboratory services provided by the CIMH, but in recent years this has not been utilized due to the lowered capacity of CIMH to calibrate standard parameters (at the time of writing, the CIMH can only provide calibration of pressure sensors). In case CIMH's capabilities are not significantly improved, the MSJ is recommended to establish service contracts with other

calibration facilities. Such service contracts need to be included in the annual budget. The MSJ is also recommended to upgrade its field calibration kits and continue the comparison of observations during the maintenance calls to monitor sensor drift and needs of calibration. Synoptic WMO standard station sensors are recommended to be calibrated annually.

A limited Quality Management System (QMS) is currently only applied for aviation services and only to some extent. Previously the QMS covered aviation services, but due to staff changes the skills have diluted and the processes are not consistently followed. The MSJ is planning to expand the QMS to cover its other services and to obtain a ISO9001:2015 certification.

3.4 Implementation of sustainable newer approaches to observations.

The MSJ is utilizing a network of non-WMO compliant small automatic weather stations to complement the sparser network of synoptic stations. These stations provide valuable information especially on rainfall, which has a high local variability and impact - this value has been notably highlighted during the downtime of the weather radar. Many of the stations have been located so as to serve local agricultural purposes, which brings added local value but compromises the site representativeness. Although there are some issues with the site representativeness, data quality and access to the data (via the manufacturers portal), the MSJ feels that the network brings a lot of added value especially on local weather and climate conditions.

3.5. Percentage of the surface observations that depend on automatic techniques.

From the total amount of 118 stations (including synoptic scale stations and substandard stations) approximately 30 have the capability to transmit information in real-time from which approximately half in a reliable fashion. Many of the manually recording stations require manual pick-up of the data.

Summary score, recommendations, and comments for Element 3

The summary score for element 3 is 2 "basic network, large gaps, mostly manual observations with severe challenges and data quality issues".

Key recommendations are to **improve the calibration practices** by strengthening staff capabilities in onsite calibration and the use of calibration kits, **improving the regional WMO calibration laboratory's capabilities or to seek contracts with other calibration facilities**. The cost of shipping sensors and having a sufficient spare part stock for the calibration cycle needs to be included in the annual budget, as well as the service fees if the calibrations are outsourced to a calibration service provider.

The largest gaps in the observation network are the **malfunctioning of the weather radar which is recommended to be fixed as soon as possible**, **lack of lightning detection network** (national or regional solution needed) and the **lack of observations from the vast marine areas**. Marine areas are mostly under observed in the entire Caribbean region and a regional approach in developing the sea surface observation network and complementing systems e.g. with unmanned surface vessels, would benefit the entire area and potentially improve the sustainability of the investments.

The MSJ is lacking an automatic data collection system with tools for quality control. Currently quality of the data is checked manually at the manual stations or manually when entering the data to the climate database. The automatic data collection system would also require improving the real-time data access from the sites. Improving the data transmission will also decrease the need for site visits solely focused on retrieving

the data. The database should support metadata collection and support the OSCAR/surface data requirements.

Element 4: Data and product sharing and policies

4.1. Percentage of GBON compliance – for how many prescribed surface and upper-air stations are observations exchanged internationally. Usage of regional WIGOS centres.

The MSJ is sharing successfully data from both GBON surface weather stations and the GBON upper-air sounding systems which is supported by the CHUAS. Data from the upper-air station is shared fully (twice a day), but the data from the surface weather stations has not been shared hourly as GBON requires (based on the WDQMS database results).

The MSJ has been working on achieving the WIS2.0 compliancy by installing the wis2box solution with the support form the CMO and the Meteorological Service of Trinidad and Tobago. The migration to the new protocol is not yet fully complete, as it will need to be updated to support new automatic weather stations with automatic data dissemination and the dissemination of upper-air soundings. Currently supper-air soundings are transferred to the WMO dissemination is done by the NOAA.

4.2. A formal policy and practice for the free and open sharing of observational data.

There is no formal policy in place, but the MSJ has practices of sharing observations freely with main stakeholders i.e. Civil Aviation Authority (MoU and LoA), Maritime Authority (MoU) and ODPEN nationally, and WMO and CMO internationally. Other national stakeholders can receive data also free of charge based on requests. Such engagement happens ad-hoc.

4.3. Main data and products received from external sources in a national, regional and global context, such as model and satellite data.

The MSJ is utilizing freely available satellite and model data from the internet for its forecasting work. The main satellite products used are from the GOES satellite and the main models are GFS and ECWMF. Satellite information is utilized to monitor the approach of hurricane and storm events and complemented with the trajectories and model input from the Hurricane Centre as well as available models and data, including the Caribbean weather radar composite (hosted by the Barbados Meteorological Service). A gap the MSJ has identified is the need to improve human skills on the use of lightning products from satellite data.

The MSJ does not yet have experience in utilizing drought products from satellite data and would need training for the staff to start this work. Currently, a reginal drought model output information is received from CIMH CariCOF climate centre via seasonal outlooks. It is recommended to provide the regional model output also for the MSJ to use.

Summary score, recommendations, and comments for Element 4

Summary score for element 4 is 3 "Partial GBON data sharing compliance with regards to either surface or upper-air data. A data policy or practices in place that promote the free and open use of data for research, as well as the in-house use of external data".

The MSJ is recommended to consider their data policy once the meteorological legislation has been passed. The MSJ is recommended to continue the free

sharing of the data with the main stakeholders and improve ways to share data to more stakeholders without increasing the manual workload for the MSJ.

The MSJ is recommended to improve data sharing by fully completing the WIS2.0 transition and by improving the hourly data sharing from surface stations. Upgrading the manual GBON stations to automatic ones will be essential in achieving this. To support automatic data transfer, **updating the data management system is recommended**, with automatic quality control and assurance, metadata management, support of OSCAR/surface requirements and sharing of the data with national stakeholders via a direct interface.

Element 5: Numerical model and forecasting tool application

5.1. Model and remote sensed products form the primary source for products across the different forecasting timescales.

The main numerical models the MSJ is utilizing are the ECMWF model (model spatial resolution of 9 km), GFS (spatial resolution of 25 km), NAM (spatial resolution of 12 km) and GDPS (spatial resolution of 16.7km). The MSJ produces up to 3-day forecasts for the general public based on these. Model data is utilized as ready products such as text and charts, but also as gridded data input to the forecasting workstation. The MSJ is utilizing models, forecasts and outlook products from the Regional Specialized Meteorological Centres (RSMC) mainly from the Hurricane Center, Tsunami Warning Center and for volcanic warnings. Additionally, the MSJ is utilizing the regional climate model outputs in the form of seasonal outlooks provided by CIMH CariCOF Climate Centre. The CIMH is also running a WRF model for the Caribbean area, but the model data is currently not available for the members to be ingested to their own forecasting workstations and processes.

Model data is ingested in gridded format and shown in the forecast workstations where it can be edited by the forecaster. The same forecaster workstations enable simple post-processing of parameters.

Other products are used in table, picture and outlook formats (especially the products from the RSMCs). The MSJ also utilizes available satellite images via the internet. The main satellite covering the area and used by the MSJ is GOES.

5.2. a) Models run internally (and sustainably), b) Data assimilation and verification performed, c) appropriateness of horizontal and vertical resolution.

MSJ does not run any models internally nor does it perform any data assimilation.

5.3. Probabilistic forecasts produced and, if so, based on ensemble predictions.

Forecasters use readily available probabilistic forecast products in the analysis work as support. Other than this use, the MSJ does not use or produce any probabilistic forecasts or ensemble predictions, nor are such products available for the public.

Summary score, recommendations, and comments for Element 5

The summary score for element 5 is 3 "prediction based mostly on model guidance from external and limited internal sources (without data assimilation) and remote sensed products in the form of maps, figures and digital data and cover nowcasting, short and medium forecast time ranges".

The regional WRF model data hosted by CIMH and the regional climate model data from the CariCOF are recommended to be shared with the members as a data input to their forecasting workstations and processes.

The MSJ is recommended to have additional capacity building on how to most effectively utilize model editing and post-processing tools as well as how to develop model parametrization and localization with their current forecaster workstation. Furthermore, it is recommended to have **training in how to introduce AI based methods for the forecasting process.**

As a next step, the MSJ is recommended to establish forecast verification processes to guide operational work and to start utilizing automatic forecast verification tools.

To improve the overall capabilities of utilizing and potentially running models the MSJ is recommended to build partnerships with the academia e.g. the University of Wes Indies to consider running a limited area weather model (WRF) for the Jamaican region, as both parties could utilize the output for their benefit.

Element 6: Warning and advisory services

6.1. Warning and alert service cover 24/7.

The MSJ operates warning and alert services 24/7.

In Jamaica, the National Disaster Risk Reduction Council is chaired by the Prime Minister and meets annually. The Council has several subcommittees that meet more regularly. The main collaboration platform nationally in the field of warnings and alerts is hosted by the Office of Disaster Preparedness and Emergency Management (ODPEM)[4]. The ODPEM has the responsibility to activate the National Emergency Operational Centre (NEOC) when the threat of a hazard is high. The Principal Director represents the MSJ in the Centre. The work is guided by the National Disaster Risk Management plans and relevant SOPs (ODPEM have SOPs to govern the community level actions, no specific SOP concerning the MSJ). The national MHEWS has participants from all government sectors, emergency operators, major institutes and service agencies, private operators from the telecom and power sector, NGOs etc. The MSJ is currently a member in three subcommittees.

The MSJ and ODPEM have regular communication even outside of the committee work. The collaboration between the institutes is governed by the Severe Weather Orders. The ODPEM has the unique role of being the only government agency to provide disaster management functions in Jamaica. Its operations are designed to:

- develop and implement policies and programmes for the purpose of achieving and maintaining an appropriate state of national preparedness for natural disasters and other emergency events,
- encourage and support disaster preparedness and mitigation measures in all parishes,
- provide early warnings, emergency response, relief and cover operations in emergency situations,
- advocate and support risk reduction measures,
- provide training in all areas of disaster management,
- promote a greater national awareness for disaster management issues through public education and awareness,

[4] ODPEM website

- conduct hazard identification and risk assessments,
- conduct research in social behaviour in relation to disaster mitigation and response, and
- establish and maintain mutual assistance and co-operation among partners.

ODPEM organizes hurricane simulations annually to test the cooperation and readiness of operations. Many of the ODPEM activities and responsibilities are directly dependent on support from the MSJ.

The MSJ issues warnings for bush fires, aerodrome warnings, drought, flash floods, high surf, hurricane, seasonal rainfall, temperature, severe weather, small craft warnings, storm surge, thunderstorm, tropical storm, tsunami and high wind. Warnings are delivered in CAP format and visualized using a four-step colour code: minor threat, potentially dangerous, dangerous and very dangerous.

Figure 3 Four-step colour code for warning indications used on the MSJ website and mobile app.

Warnings and alerts are shared via MSJ's website and mobile phone app, TV and radio and all channels ODPEM has available (including community level engagement). The reach of the messages is estimated to be very good as over 90% of the population has access to smartphones and internet.

All warnings the MSJ issues will stay on the forecasting server and the MSJ operates a separate manual archive collecting annual data for the forecasting office. Previously the MSJ did spot based forecast verification with comparison to weather radar, surface weather and satellite images, but after the weather radar went out in 2021 the operation has been on pause.

The MSJ has several fail-safe systems in place such as staff on several sites (forecasting office at the airport and central office in the city), on-call personnel, power backup for the forecasting office, internet backup for the forecasting office and operation plans in case of failure.

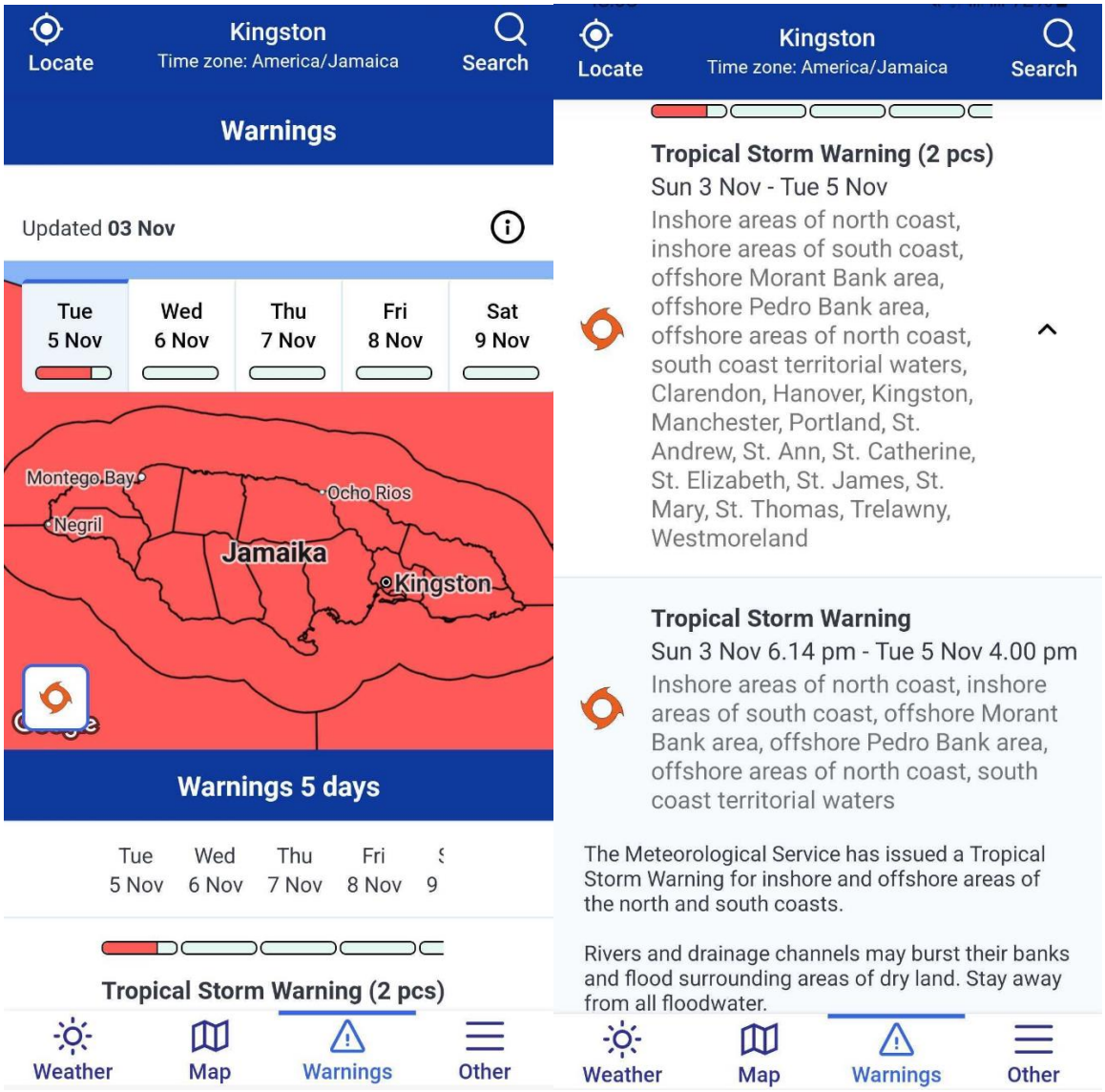

Figure 4 Tropical storm warnings over the entire island and marine area of Jamaica as seen on the MSJ mobile phone app. Map view (left) and text view (right).

6.2. Hydrometeorological hazards for which forecasting and warning capacity is available and whether feedback and lessons learned are included to improve warnings.

The MSJ issues warnings for bush fires, aerodrome warnings, drought, flash floods, high surf, hurricane, seasonal rainfall, temperature, severe weather, small craft warnings, storm surge, thunderstorm, tropical storm, tsunami and high wind.

No direct feedback mechanisms are in place. The MSJ receives feedback on an ad-hoc basis from stakeholders or ODPEM and the National Disaster Management committees, or through organized stakeholder workshops. After hurricane events, the MSJ sends a case evaluation report to the National Hurricane Centre. The previous QMS manager did start the work of collecting and processing the received feedback, but the work has stopped after the staff member left the MSJ. Some actions have been taken as a result of the stakeholder consultations e.g. for marine forecast dissemination.

6.3. Common alerting procedures in place based on impact-based services and scenarios taking hazard, exposure and vulnerability information into account and with registered alerting authorities.

Warnings are delivered in CAP format. The MSJ started providing the impact-based service with the BretCat project where they constructed impact statements related to the list of hazards the MSJ is covering. The work included close collaboration with ODPEM and stakeholder engagement to co-design the statements. As a result, the MSJ now includes predefined warning statements on impacts in the warning messaging. More localized or advanced impact statements are provided by ODPEM. No impact-based modelling or hazard-specific models are currently available, the MSJ would need support in research and development to build dedicated IBF models.

The developed impact statements also include statements on how to reduce the risk of negative effects e.g. which areas to avoid going to and what actions to take at home (see Figure 5 and Figure 6).

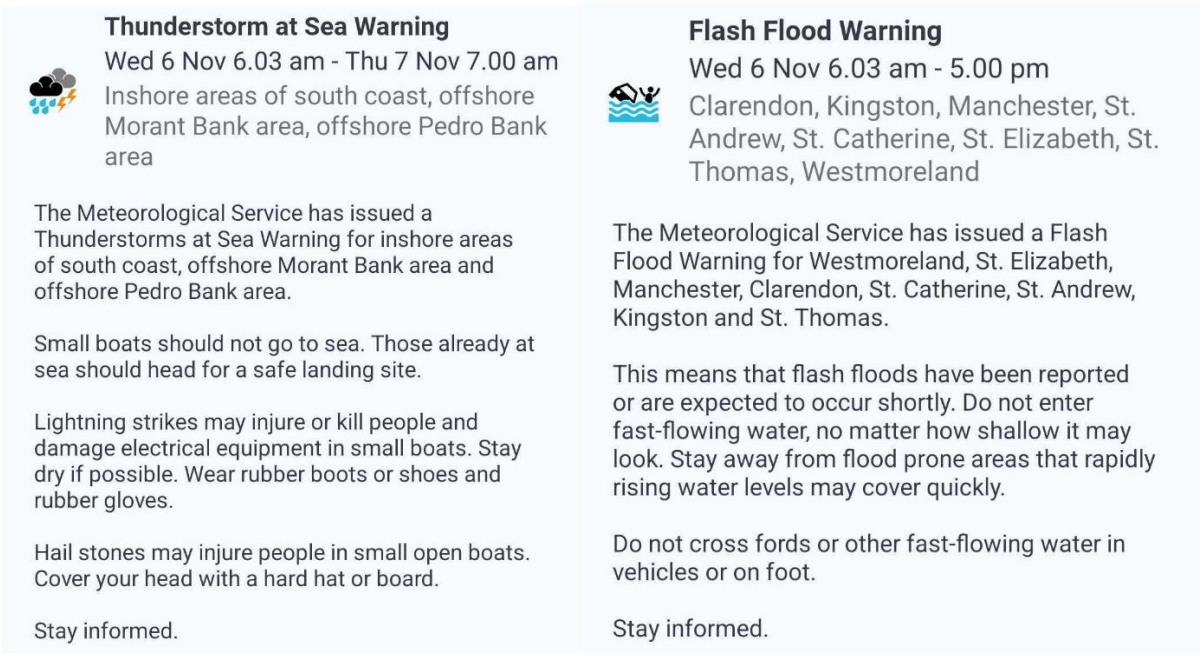

Figure 5 Impact statements for thunderstorm at sea (left) and flash flood (right) from the MSJ mobile app.

The MSJ receives impact information and post-disaster analytics from ODPEM. ODPEM collects the information from different sectors and comprises situational reports that they share with major stakeholders via email or WhatsApp. Most reports need to be requested from the ODPEM.

ODPEM also provides hazard, exposure and vulnerability information to the MSJ. Maps of the low lying and high-risk areas are used in the forecasting work at the MSJ.

Most of the MSJ current staff has been trained in the principle, methods and application of impact-based forecasting, but new staff will need training. Training was provided in the BretCat project and in partnership with Weather Ready Nations, and the MSJ's plan is to continue to expand on training on the topic.

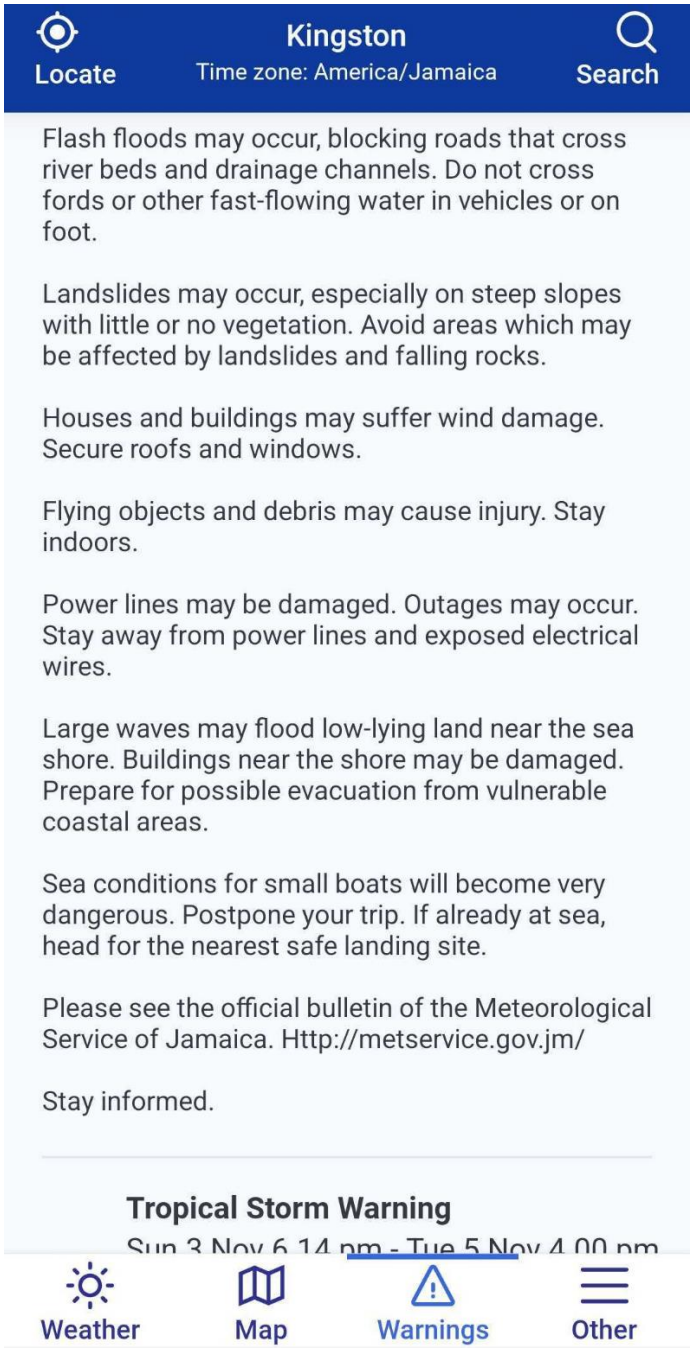

Figure 6 Impact statements attached to a tropical storm warning from the MSJ mobile app.

Summary score, recommendations, and comments for Element 6

The summary score for element 6 is 4 "Weather-related warning service with strong public reach and standard operational procedures driving close partnership with relevant institutions, including disaster management agencies."

To strengthen the warning services the MSJ is **recommended to restart the collection and processing of stakeholder and public feedback and to evaluate its performance regularly**. Based on the feedback the gaps of the current warning dissemination should be assessed. The processed feedback should be reflected in the MSJ service development priorities.

Both MSJ and ODPEM would benefit of **increased human capacity building in impact-based forecasting** (ODPEM to continue having the lead in the effort) and the **research and development of dedicated impact-based forecasting models**.

Since the weather radar data is such an important component for the monitoring and forecasting of hurricanes, thunderstorms, lightning events, high precipitation and flash-floods, it is **recommended to dedicate efforts to fix the weather radar as soon as possible.**

As the MSJ mobile app is fairly new, efforts need to be made to **improve the public outreach and to continuously improve the app's warning products and features based on user feedback**. This further applies to the MSJ website, currently under development.

The forecasting workstation and service provision environment the MSJ is currently using have the tools for versatile automatic dissemination, and the **MSJ's capabilities to utilize all the available tools for automatic warning dissemination should be improved**.

Element 7: Contribution to Climate Services

7.1. Where relevant, contribution to climate services according to the established capacity for the provision of climate services.

The MSJ is providing climate services although there is no act or formal mandate for this. Climate services has been added for the first time to the latest strategic plan (plan is still waiting for the Ministry's approval) as a component. The MSJ's Climate Service Section consists of a Data Acquisition Unit responsible for the set up and maintenance of the network of rainfall and climatological stations, a Data Processing Unit responsible for archiving and analysing of the climatological data and an Applied Meteorological Unit that processes the needs of clients. Such client needs include crop water requirements, designing of criteria for hydrologists and engineers, and climatological information for resolving weather related legal and insurance matters. Most of the work in the unit are done by staff that have joint duties in the weather technical maintenance team, as weather forecasters or in the management team.

The first National Climate Outlook Forum was arranged 2023 and the plan is to start having it annually. The forum will provide key input from the different stakeholders to the MSJ.

The MSJ is providing the following climate services:

- 20-year mean temperatures (1996-2015)
- 30-year mean rainfall (1971-2000) for parishes and stations
- Seasonal Climate Outlook (6 months period) that includes:
    - significant rainfall excess map
    - rainfall outlook for 3 + 3 months
    - short term drought alert outlook
    - day and night time temperatures
- Climate Report with monthly rainfall summary including drought discussion and rainfall outlook for next 3 months

The MSJ is planning to expand the services to include heat forecasts as prolonged heat periods have become more frequent in the area.

The climate outlook includes key messages for users and guidance statements. The MSJ is currently discussing with the agricultural sector (RADA) on co-creation of guidance statements for the sector. A pilot project to train farmers, community groups, water resource agency, and other rural groups to use climate outlook information and to discuss needs e.g. for rainwater harvesting was successfully done. The MSJ is hoping to continue and expand this dialogue and training.

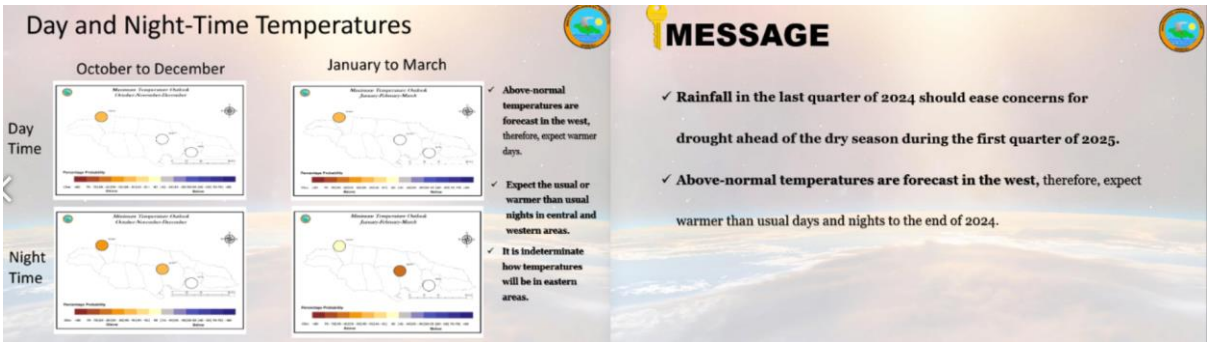

Figure 7 Seasonal climate outlook from the MSJ website

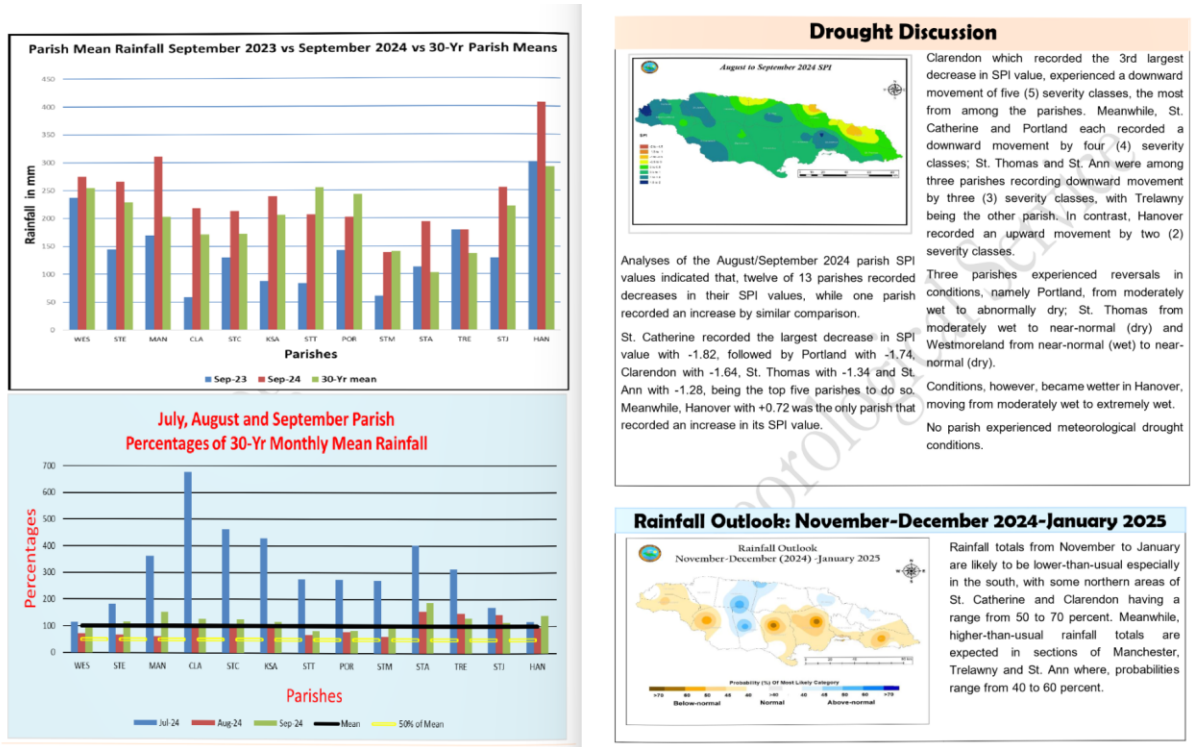

Figure 8 Mean rainfall information, drought discussion and rainfall outlook for 3 months from the climate report available on the MSJ website

Most climate services are available from the MSJ website or shared via email to the main stakeholders.

The main inputs the MSJ is utilizing for service creation are local stations information and the regional climate outlooks provided by CIMH CariCOF Climate Centre. The CIMH hosts a climate forum every month to discuss the updated outlooks. The MSJ does not have direct access to the regional climate model output or the CIMH climate database

information. The University of West Indies are running a regional climate model on project basis (latest project in 2019) and the MSJ could potentially cooperate with these activities.

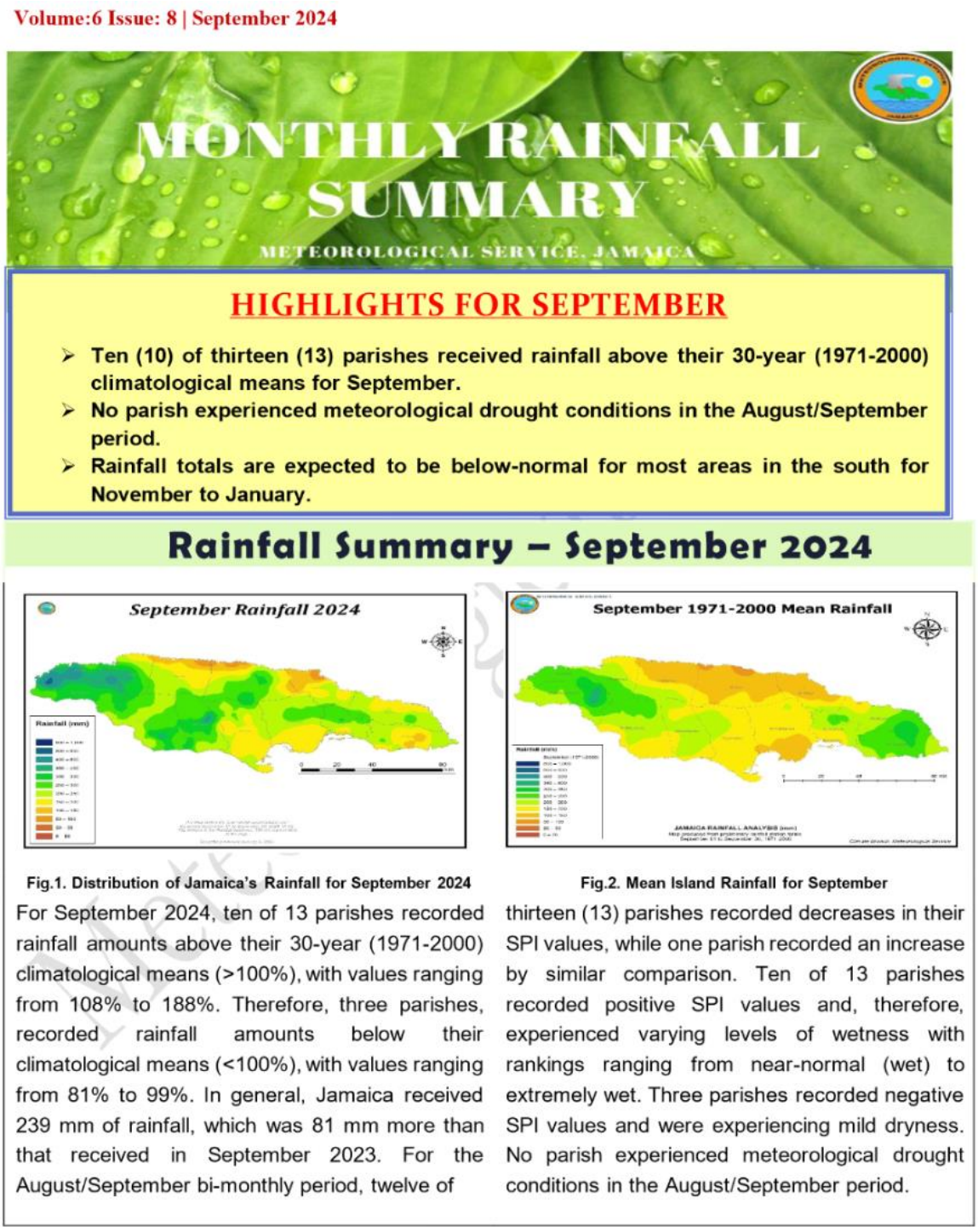

Figure 9 Monthly rainfall summary from the climate report available on the MSJ website

The main shortcoming in the observation infrastructure related to the climate services is the lack of efficient data management or database. Currently all quality control is manual and takes up lot of staff resources. Modernizing the systems to include automatic QC and QA features and tools for data queries, reporting and analytics with possibility to grant access to important stakeholders will make the work more efficient and save time for more value-added work. Open-source solutions (e.g. WMO OpenCDMS) should be preferred as MSJ has experienced license issues when working with commercial systems. Also, the

database needs to be updated to support versatile data filtering and reporting, and optimally granting an access to stakeholders for independent data queries. Currently stakeholders can only request data and products from the MSJ via email or face to face meetings.

The MSJ has started the work for data rescue, but there are still paper records that need to be digitalized. This work will need assistance and staff resources and would be supported by a modern data management system, since now the records are only stored on local computer with a back-up, making the further use of the records inefficient and requiring a lot of manual work.

The draft strategy plan includes establishing a committee or series of stakeholder meetings to work on co-designing of new climate services products. The MSJ is recommended to continue such work after the services have been configured to collect feedback and establish processes for continuous improvement. Currently feedback on provided services are only ad-hoc.

The major limiting factor in providing climate services is currently the shortage of staff. Most staff currently working with the climate services share duties with other units such as weather forecasters, technical maintenance or management unit.

Human capacity development is needed to provide new climate services e.g. services related to prolonged heat episodes, and in how to manage stakeholder and service portfolio. MSJ staff will need to be trained to operate and maintain the modernized data management system and currently there is a shortage of staff with relevant skillsets.

Summary score, recommendations, and comments for Element 7

The summary score for element 7 is 2 "Basic capacity for climate services provision".

The MSJ is recommended to continue and expand regular stakeholder engagement, collect feedback and develop guidance based on this, and to focus on co-designing climate services for the different stakeholders. To support the development of new products and services the MSJ is **recommended to modernize its data management system** including the climate database to facilitate automatic quality control and assurance methods, OSCAR database needs and a user-interface for stakeholders to query data. Additionally, **more staff resources are recommended to be allocated to climate services and the level of human capacity increased with training** on e.g. GIS and data management skills.

A socio-economic benefit assessment is recommended to be made covering also climate services in Jamaica.

Element 8: Contribution to hydrology

8.1. Where relevant, standard products such as quantitative precipitation estimation and forecasts are produced on a routine basis according to the requirements of the hydrological community.

The Water Resources Authority (WRA)[5] is responsible for the management, protection and controlled allocation and use of Jamaica's water resources. The WRA maintains a hydrological database and provides data, information and technical assistance to

[5] The Water Resources Authority's website

government and non-government institutions. WRA is mandated by the Water Resources Act.

The MSJ is routinely sharing precipitation data from its rain gauge network and from weather radar (when available) with the WRA. Most of the data is shared monthly via email. In cases of flooding or other specific events the MSJ also receives requests from the WRA via phone calls or email on additional products such as the rainfall for 12h and 24h period and current rain rates. The WRA will use the data as input for forecasting.

The WRA operates their own rain gauge network with thirty stations and mutually share the precipitation observations with the MSJ. These are collected and shared on a real time data platform to which the MSJ has been granted access. The platform was created as an item in the Pilot Programme for Climate Resilience.

8.2. SOPs in place to formalize the relation between Met Service and Hydrology Agency, showing evidence that the whole value chain is addressed.

There is a Memorandum of Understanding between MSJ and WRA. No SOPs are in place.

8.3. Data sharing agreements (between local and national agencies, and across international borders as required) on hydrological data in place or under development.

The WRA and the MSJ have a Memorandum of Understanding in place where both parties commit to free data sharing between the entities. The informal policy has been to share all data free of charge with the different stakeholders when a need for such services has emerged.

The MSJ is sharing regionally its precipitation information to the CIMH CariCOF climate database and climate outlook.

Besides the cooperation between WRA and the MSJ, both entities are members of the Resource Management Committee with other agencies working with the water sector in Jamaica. The committee is called for meetings four times a year.

8.4 Joint projects/initiatives with hydrological community designed to build hydrometeorological cooperation.

The MSJ was the lead in an integrated flood management pilot project that was funded by World Bank and supported by CREWS. This included consultancy to develop an integrated plan for water resource management with the WRA.

The Pilot Programme for Climate Resilience (PPCR)[6] included investing in a river gauge network and platform for real time data sharing for WRA. The MSJ and WRA were both implementing partners with the Planning Institute of Jamaica as coordinator.

Summary score, recommendations, and comments for Element 8

The summary score for element 8 is 4 "The meteorological, hydrological and water resources sectors have a high-level formal agreement in place and an established working relationship and data sharing take place, but institutions still tend to develop products and services in isolation".

The MSJ is recommended to develop updated SOPs with the WRA. Improving the MSJ status by passing the relevant legislation will elevate the MSJ to an equal status with the WRA.

[6] PPCR website

To enhance the data sharing between the MSJ and WRA or other water sector stakeholders it is **recommended to develop the meteorological database to include tools for real time data sharing** (e.g. how WRA's renewed data platform works). This would improve data availability (real time instead of monthly) and decrease the manual work for the MSJ coming from current data sharing practices.

Fixing the currently non-operational weather radar will support not only the MSJ but also WRA as it offers much needed real-time precipitation information covering the entire country.

Going forward the **MSJ and WRA are recommended to strengthen the collaboration also beyond sharing of observations,** e.g. in the field of numerical modelling, where weather models could be utilized as input for the hydrological models. The MSJ is **recommended to actively participate in water sector events, collaborations and stakeholder engagement for co-creation of services.**

Element 9: Product dissemination and outreach

9.1. Channels used for user-centred communication and ability to support those channels (for example, does the NMHS operate its own television, video or audio production facilities? Does it effectively use cutting-edge techniques?).

The MSJ has recently updated and modernized its website and launched a weather app. With more than 1.8 million smartphone users in the country, the weather app provides an important channel to reach the citizens. Increasing the awareness of the available app and directing public users to this has been a the MSJ priority for 2023/2024. Besides increasing the use of the app, improving the MSJ's social media presence has been highlighted as a key action. The MSJ is actively present on Instagram (9.4 thousand followers), Facebook (1.8 thousand followers) and X (52.4 thousand followers).

Through the social media channels, the MSJ share weather updates, warnings and outlooks in the form of text, images, bulletins and short videos. Normally the user engagement is quite low on the channels but in case a hazardous weather event is approaching (recent example was Hurricane Beryl) the content is well used and commented on. Particularly, videos explaining the current and forecasted situation are well received. The MSJ does not operate a video studio and most video material is created for social media purposes. Social media platforms are the main channel for the MSJ to reach young people.

The MSJ used to operate a SMS service to receive climate products, but the service is no longer available. The MSJ is planning to restart the service and expand it to include warning and emergency communications. Thus, the SMS service could act as the backup for the weather app dissemination.

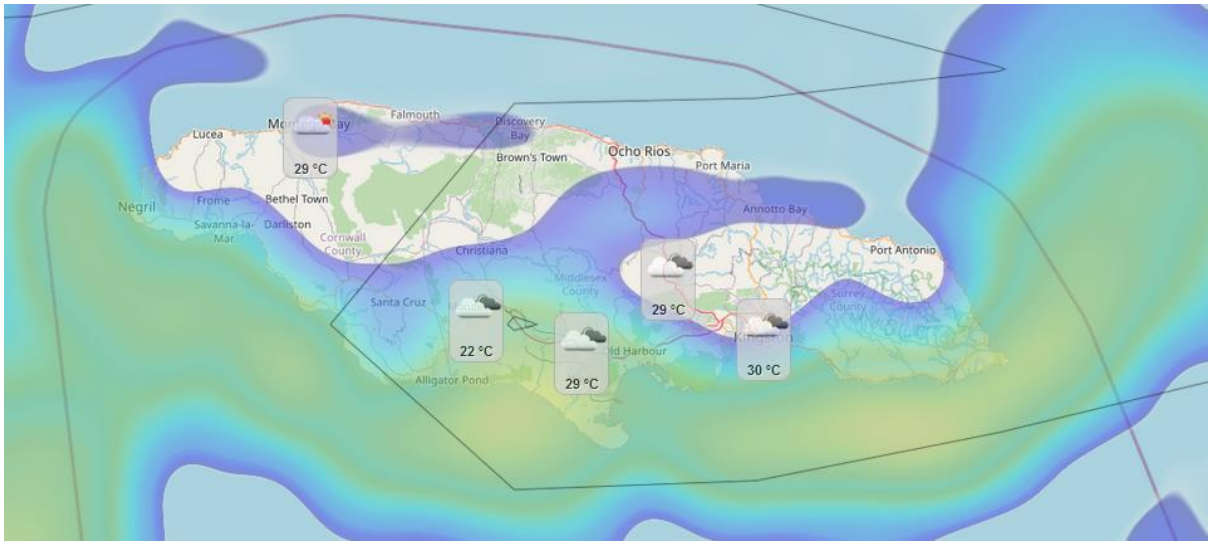

Figure 10 Interactive map with rainfall, pressure and observation information from the cities available from the MSJ website.

The main weather forecasting products excluding warning products available via the MSJ website are:

- Daily weather forecast
- 3-day weather forecast
- Point-forecast for 3-day weather forecast
- Aviation forecast
- Marine forecast
- Wind forecast
- News releases on current weather events
- Maps on satellite/radar (when available) information

Fri 01-Nov Sunrise 06:06 AM Sunset 05:34 PM						Sat 02-Nov Sunrise 06:06 AM Sunset 05:34 PM						Sun 03-Nov Sunrise 06:07 AM Sunset 05:33 PM			
6AM	9AM	12PM	3PM	6PM	9PM	6AM	9AM	12PM	3PM	6PM	9PM	6AM	9AM	12PM	3PM
												Weather Icon			
22.3°	26.8°	27.6°	26.1°	23.4°	21.7°	21.7°	26.1°	28.6°	27.2°	24.2°	22.5°	22.9°	23.7°	23.9°	22.9°
Wind (gusts) m/s															
1.6	0.8	0.9	1.1	1.5	1.6	1.8	1.2	1.4	2.1	2.1	2.2	1.3	1.3	1.1	1.2
Precipitation amount mm															
0	0	0.7	0.5	0.5	0.2	0	0	0.1	0.3	0.2	0.4	0.7	0.2	1.2	7.1
Humidity															
87%	68.6%	70.6%	81.9%	90.3%	92.5%	92.2%	72.4%	61.9%	69.2%	82.6%	92.2%	96.3%	93.4%	93.4%	97.1%

Figure 11 3-day weather point forecast in chart format available on the MSJ website.

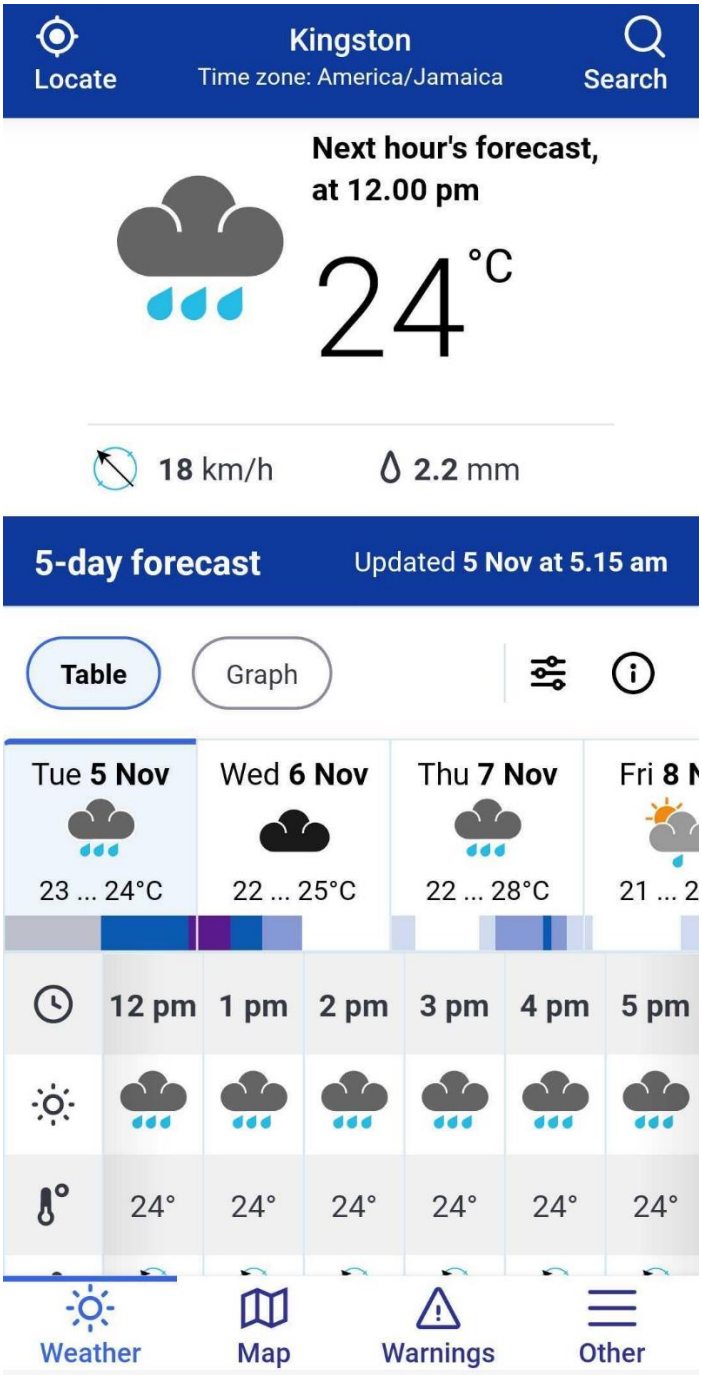

Figure 12 Weather forecast view for the next hours and upcoming 5-day forecast as presented in the MSJ mobile app.

Products are presented in charts, maps and text format. For the social media accounts, the MSJ is also producing versatile animations and videos to increase the appeal of the products.

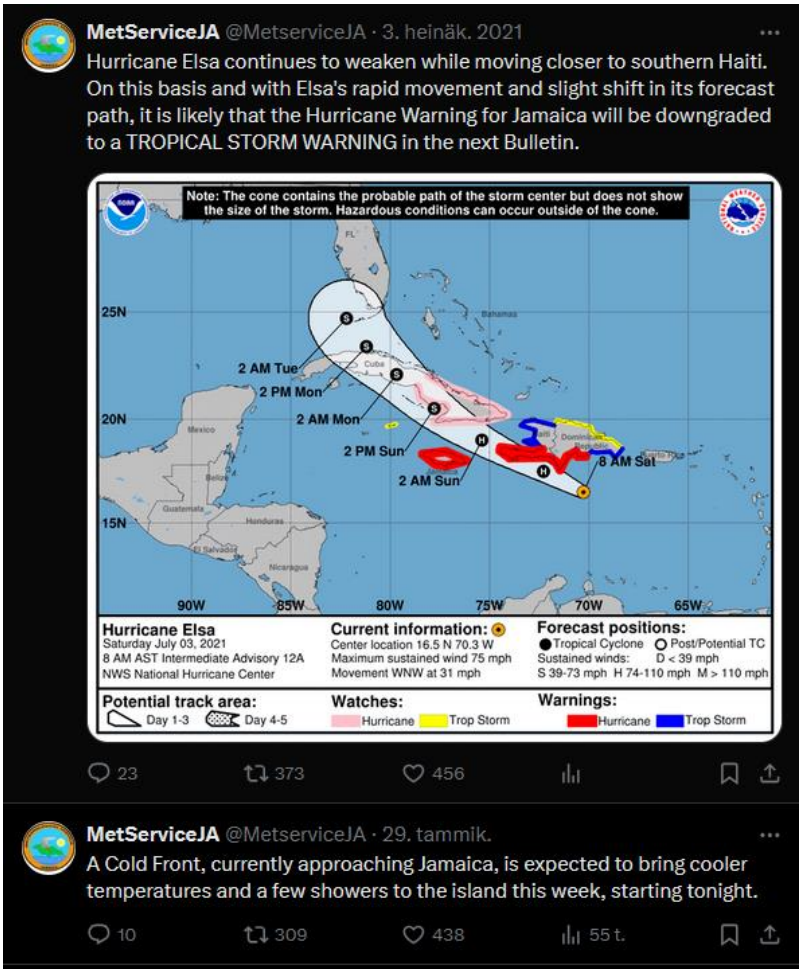

Figure 13 Example of social media content shared on the MSJ's X account.

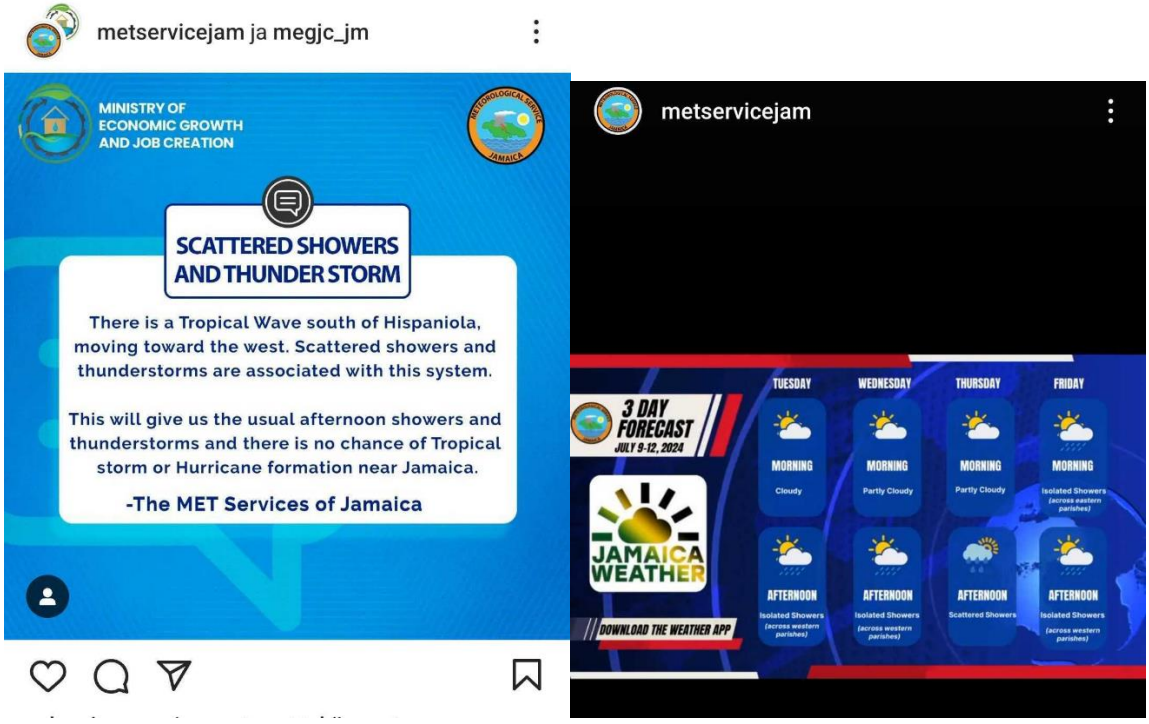

Figure 14 Example of social media content shared on the MSJ's Instagram account.

Figure 15 Example of warning bulletins shared on the MSJ's Facebook page

9.2. Education and awareness initiatives in place.

The MSJ is participating in educational fairs (speakers and printed material) and hosts visits for schools to the observation sites and forecasting office. The visits happen annually as weather and climate are included in the school curriculum.

Informative videos for the public on how to prepare for a hurricane event e.g. which supplies to purchase, and a hurricane event checklist has been prepared and shared jointly with the MSJ, Ministry of Economic Growth and Job Creation and ODPEM to increase the public awareness and knowledge. ODPEM also host a large range of public education and training courses on topic such as disaster management, safety, emergency planning, search and rescue and others.

9.3. Special measures in place to reach marginalized communities and indigenous people.

ODPEM has the responsibility of reaching out at community level in case of disasters. Critical partners working with ODPEM to help reach marginalized communities are the Jamaica Council for Persons with Disabilities and the Jamaican Red Cross.

The MSJ has identified youth as a group they are targeting with special measures, mainly by actively participating in social media platforms (Instagram, Facebook and X) and creating content in video and graphic formats.

Summary score, recommendations, and comments for Element 9

The summary score for element 9 is 3 "A moderately effective communication and dissemination strategy and practices are in place, based only on in- house capabilities and supported by user-friendly website."

Key shortcomings that are **recommended to be improved are strengthening the MSJ´s communication presence**. Much of communication and interaction with the public is done using social media channels. To combat false information and actively set the tone of the discussion the MSJ will need to invest more in its media presence to increase its media footprint and keep up with the rapid pace of social media. This additional work will require additional resources, e.g. establishing a communication unit or a position for a communication manager.

The MSJ is also **recommended to start following user statistics** for the MSJ weather app and website and to continue to improve these two selected channels. The priority has been to strengthen the visibility of the new MSJ weather app and to direct users from other channels e.g. email chains to it.

The MSJ is also **recommended to improve their capability to utilize existing tools in the forecasting system to create automatically updated and disseminated products** to the website, mobile app and social media channels.

Element 10: Use and national value of products and services

10.1. Formalized platform to engage with users in order to co-design improved services.

For disaster risk reduction activities, the Office for Disaster Preparedness and Emergency Management (ODPEM)[7] hosts a national multi-sector consultative platform in which the services for warning and disaster management are discussed.

Besides the ODPEM platform and the National Climate Outlook Forum there is no other formalized platform to engage with stakeholders and service users. Recently the MSJ has tested surveying a large number of users for the co-design purposes for new products within the BReTCAT project. As results two new co-designed products were developed. The MSJ has also included a direct feedback channel to the newly launched the MSJ weather app and the renewed MSJ website.

10.2. Independent user satisfaction surveys are conducted, and the results used to inform service improvement.

No independent user satisfaction surveys have been conducted.

10.3. Quality management processes that satisfy key user needs and support continuous improvement.

The MSJ is currently only implementing small parts of a Quality Management System (QMS) on the air navigation services. Previously QMS was implemented for the air navigation services, although not certified, but after some staff changes the capabilities were mainly lost and the process has faded. The MSJ is planning to train new staff for the implementation and to expand the coverage beyond air navigation to all of the meteorological and climate warning services.

[7] ODPEM website https://www.odpem.org.jm/

Summary score, recommendations, and comments for Element 10

The summary score for element 10 is 2 "service development draws on informal stakeholder input and feedback".

Based on the feedback from the stakeholder engagement the MSJ is **recommended to engage key stakeholders on a regular basis** (recommended frequency is annual) **to discuss its service and product portfolio, and to introduce and co-design new products and services.**

The MSJ is also **recommended to start collecting user satisfaction input**. The feedback should be collected ideally annually from all main stakeholders and public users, and it needs to be processed and used to support service improvements, new service development and prioritization of tasks. It is recommended to use this input when drafting and updating the MSJ strategy and start reporting the satisfaction score. The MSJ is also recommended to follow up on user statistics for the MSJ weather app and website and feedback channels.

Since there is a lack of recent socio-economic benefits assessment, it is **recommended to revise and update the assessment** and consider the expanded service portfolio of the MSJ. Such an assessment would be beneficial to increase the local awareness of MSJ's value and to support the ongoing process of establishing a meteorological legislation and strengthening the MSJ's status.

The MSJ is recommended to train staff in the QMS implementation and to start consistently applying this, first to air navigation services and then expanding to weather and climate warning services with the aim to conform with ISO 9001:2015 standards. Previously QMS capabilities were only in the hands of few experts and the capabilities lost as they moved on from the MSJ, therefore it is important to train several of the staff for the implementation.

Annex 1 Consultations (including experts and stakeholder consultations)

The CHD was developed as part of the SOFF Readiness Phase. During this time FMI made two missions to Jamaica. The following stakeholders were consulted:

- Staff and Director of the MSJ
- Consultation of CIMH on regional training and calibration capabilities
- National Oceanic and Atmospheric Administration – Upper Air Program Manager
- IDB
- CHD workshop for main stakeholders included:
    - Water Resources Agency
    - Office of Disaster Preparedness and Emergency Management
    - National Water Commission
    - Civil Aviation Authority
    - National Fisheries Authority
    - Jamaica Public Service
    - Ports Authority of Jamaica
    - Airports Authority of Jamaica
    - PAC Kingston Airport Limited
    - University of West Indies
    - Rural Agricultural Development Authority
    - Jamaica Defence Force Coast Guard
    - Media – RJR Communications Group
    - Maritime Authority of Jamaica
    - Food for the Poor

Figure 16 CHD Workshop participants.

Annex 2 Urgent needs reported

The following critical gaps have been identified:

- There is currently no legislation for meteorological services to stipulate MSJ's mandate and responsibilities. The development of the national legislation that grants the MSJ the status of an Authority is necessary. Cost-recovery mechanisms are recommended to be included in the bill to improve MSJ's ability for sustainable budget development. When the status has been strengthened, the MSJ is recommended to formalize key relationships with national stakeholders.
- The MSJ has identified staff shortage and is recommended to continue to identify key positions (climate services, quality managements, communications etc.) that are lacking from the staff roster or need more dedicated staff to them and start the recruitment process to fill these.
- Operation and maintenance plans including life-cycle plans, annual maintenance and calibration activities and SOPs needs to be developed or updated to support sustainable operation of the systems. In case the regional calibration centre capabilities are not improved the MSJ will need to establish service relations with other laboratories. The plans need to be reflected in the annual budget.
- Currently no Quality Management System is followed by the MSJ. The MSJ is recommended to train staff in the QMS implementation, expand QMS from aviation services to cover all MSJ services and to start consistently applying this.
- The MSJ is recommended to continue with close stakeholder engagement in a coordinated and regular manner and continue the discussion on needs and services and the co-design work of new ones. There is a lot of potential in improving the collaboration with the Academia and CIMH in research, model development and sharing of model data.
- The MSJ is recommended to strengthen their human capability in utilizing automatic product dissemination, model editing and post-processing, introducing AI based methods and initiating forecast verification, improving capabilities in impact-based forecasting and QMS.
- Major gaps in the observation system are the manual GBON observation stations that need to be updated to automatic ones, the malfunctioning of the weather radar, which needs to be repaired as soon as possible. Additionally, there is a clear need for a lightning observation network and marine observation network, both which needs support and could benefit from a region wide solution. There is neither no integrated data management system to store and process all observation data in one system and allow automated data processing, QA/QC and modern data dissemination methods.
- Continuing the development of the MSJ mobile app and website based on user feedback and improving the public awareness of using them and overall communication presence also in the social media platforms

Annex 3 Information supplied through WMO

Peer adviser acknowledges the material and templates provided by SOFF throughout the Readiness phase.

Annex 4 List of materials used

In addition to WMO guides, the following materials were utilized:

- The MSJ web page
- The MSJ shared material bout their organization and draft reports with the peer advisor
    -
- Material developed as part of previous FMI-MSJ collaboration.
- CMO Resolution 1 – CMC51: Regional Arrangement For Meteorological Forecast and Warning Services Among CMO Member States
- Online material included as reference to this document