COUNTRY HYDROMET DIAGNOSTICS

Maldives
2021 peer review

Peer Reviewer
India Meteorological Department

Alliance for Hydromet Development

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COUNTRY HYDROMET DIAGNOSTICS

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

Report On

MALDIVES

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(Peer reviewed by

India Meteorological Department)

INTRODUCTION

The Country Hydromet Diagnostics responds to the need for a standardized, integrated and operational tool and approach for diagnosing National Meteorological Services, their operating environment, and their contribution to high-quality weather, climate, hydrological and environmental information services and warnings. The Diagnostics is an umbrella tool that draws on and adds value to existing WMO assessment material by synthesizing existing approaches and data into an easily interpretable form, validating the information provided by WMO Members through a peer review process, and obtaining missing information.

The Diagnostics aims at informing policy and investment decision-making, in particular guiding investments of the members of the Alliance for Hydromet Development. The Alliance brings together major development and climate finance partners behind a joint commitment to strengthen developing country hydromet capacity. Through the Diagnostics, developing countries are expected to benefit from better targeted and aligned financial and technical support.

The Country Hydromet Diagnostics is based on the ten most critical elements of the hydromet value cycle, grouped under four categories – enablers, observation and data processing system, service and product production and dissemination, and user and stakeholder interaction. For each value cycle element, a limited number of standardized indicators is used, and each indicator uses explicitly defined data sources. The Assessment of these critical elements of the National Meteorological Service should lead to their maturity level. Note that Level 5 is the highest attainable maturity level in the CHD assessment.

The Diagnostics draws as much as possible on primary data (self-reported and other sources of quantitative data), but to inform the peer review requires additional data, in particular data from country user/client surveys. The WMO Community Platform provides the primary Source of data information requirements for the Diagnostics and the results of the Diagnostics will be integrated in the Platform adding substantial value.

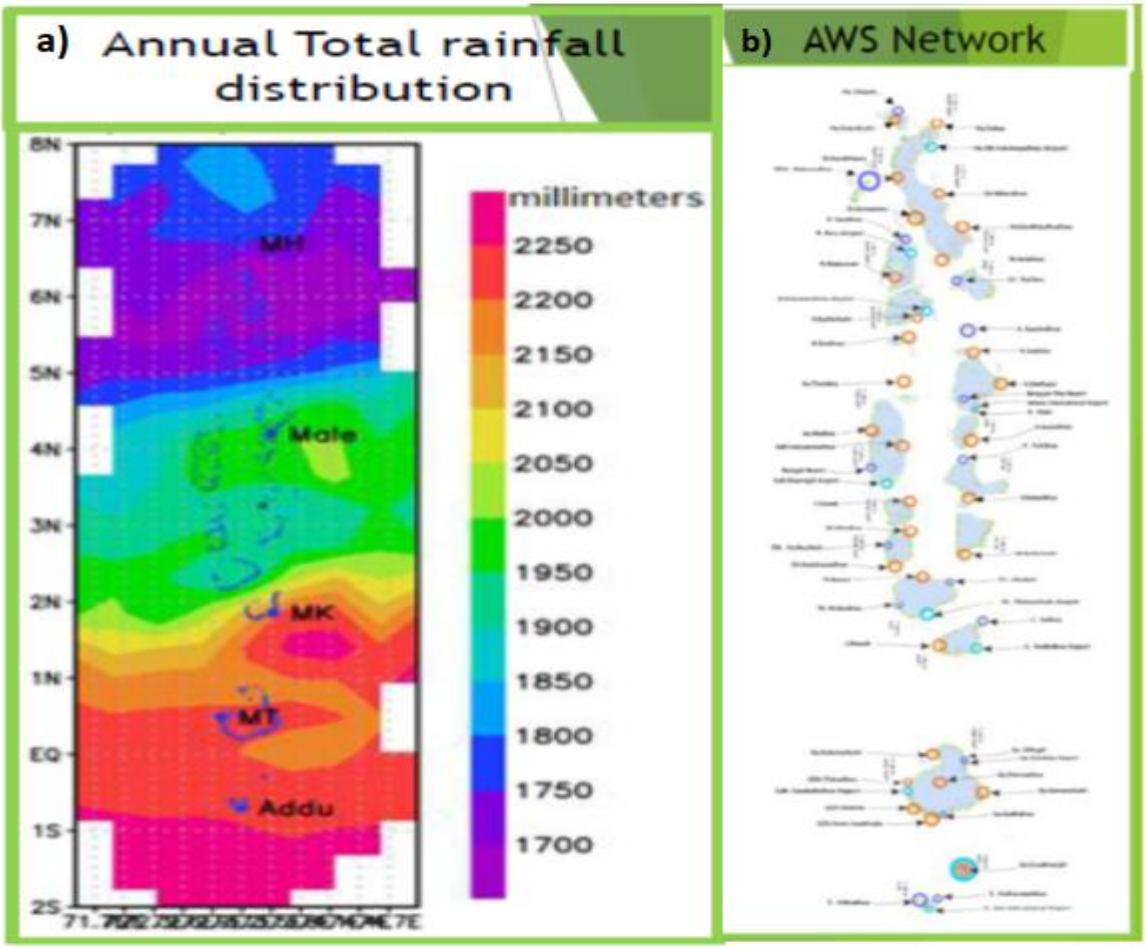
In this report, a draft prototype of the Republic of Maldives, a developing country has been discussed in a test drive mode. In Maldives, both the Meteorological and Hydrological services are provided by the Maldives Meteorological Services (MMS).

Maldives is an archipelago of 1,192 coral islands in the Indian Ocean, grouped into 26 atolls and spread over 860km from latitude 7º6’35”N to latitude 0º42’24”S. Population of over 5 lakhs live in about 200 of these islands including more than 80 islands that are exclusively for tourists. Size of most of these inhabited islands are of less than 1sqkm and predominantly very low-lying areas with more than 80% having ground-level elevation of less than 1m above mean sea level. The unique location and geography of the country make it susceptible to extreme weather hazards like cyclones, strong winds, storm surges, heavy rainfall & floods, and swells. These hazards cause extreme loss of life and damages to property with most at risk are half of the country’s settlements, two-thirds of critical infrastructure, and almost all tourism establishments; all located within 100 meters of the shoreline. Communication and access to the islands from the country’s capital are costly due to the islands’ geographic spread, posing a challenge for communicating forecasts and disaster risks, and for mobilizing emergency

response assistance. Tourism remains the backbone of the country's economy. Fisheries and agriculture are the main livelihoods in rural areas, although agriculture is limited due to availability of cultivable land and freshwater. Tuna is the primary fish export; reef fish is the main source for live bait in tuna fishery. Coral reefs support the fisheries and tourism sectors and reduce the impact of strong waves on shore.

Country information available in WMO database and answers provided by MMS focal points to a questionnaire developed based on the indicators of the CHD have been used as first source information to prepare this report. Various reports related to Maldives meteorological and hydromet capacities have also been used for information of interest in this peer review process. However, it may be mentioned that the main focus of this report is on the MMS.

This report present review of each of the ten most critical elements of the hydromet value cycles based on the information mentioned above and rate each of them with a Maturity level score (based on the assessment of the indicators). At the end, recommendations of the reviewers to help lift up the rating of the maturity level in respect of these critical elements have been listed.



(a) Map showing annual total rainfall distribution over Maldives. (b) AWS network of Maldives.

I. GOVERNANCE AND INSTITUTIONAL SETTING

1.1 Maldives Meteorological Service (MMS) is the designated government agency for providing Meteorological, climatological and Hydrological Services in the country and was established in the early 1940s. At present, it is working under Ministry of Environment, Government of Maldives. MMS's legal mandate and its scope is described by the presidential decree as per Act No.3/68 (11 Nov 1968).

1.2 MMS has Strategic, Operational and Risk Management plans. MMS is part of the Maldives government strategic action plan (SAP) for the period 2019-2023. Under this SAP of Government of Maldives, MMS with other agencies are responsible for strengthen the aeronautical meteorology and multi-hazard early warning capacity, Maritime Safety Information of Navigational and Meteorological warning, meteorological forecast, warnings of missing vessels and other urgent messages pertaining for the safety of the vessel and its crew in line with IMO obligations, Strengthen national institutional framework on DRR and climate resilience, Establish and strengthen national level early warning mechanisms to efficiently disseminate early warning information to the public, etc. A quality management system (ISO 9001-2015) is in place for aviation weather services.

1.3 Government budget is received mostly to cover the recurrent expenditure viz. salaries of the employees of MMS and maintaining infrastructure required for carrying out present operational service responsibilities. Further there is no cost covering arrangement with any other operational agencies like civil aviation or agriculture. Most of the developmental activities are carried out through grant aid projects funded by different countries and international agencies.

1.4 MMS has 104 employees including administration, technical and professional categories. Out of the total employees, 28 are women (about 27%), 79 staff have specialized meteorological education. Staff are mainly engaged in operational services, with limited experts in instrumentation and communication wings and research activities. Budgetary constraints on hiring contractual man power. Number of officials trained in the field include: Master’s degree (2), Bachelor’s Degree (11), all others have either WMO IV, III or II certificates. The lack of manpower with expertise in met instruments is a big issue in maintaining its surface observation network.

1.5 MMS has some experience in the implementation of international funded projects viz. MMS has worked in projects supported by Governments of Japan and Italy under grant aid for implementing establishing AWS network, emergency warning broadcasting series (EWBS), and integrated weather and climate information and decision support system at MMS. The project supported by the Gov. of Italy aims at designing a unified meteorological and climatological information system and decision support system. The system integrates current observing facilities of MMS, including satellite image receiving system, automatic weather stations etc.

Based on the above **Maturity Level 2** can be given to the above important element of the hydro met value cycles of MMS. This is principally because the budget provided at present does not support enhancement of the operational activities (infrastructure and man power) and for research and development activities. It can be lift up if MMS can develop new infrastructure facilities and support in house research activities, implement strategic plans as pert the SAP with the funding support from the government or international assistance.

II. EFFECTIVE PARTNERSHIPS TO IMPROVE SERVICE DELIVERY

2.1 MMS works with National Disaster Management Authority (NDMA) to provide Alerts and Warnings on Natural hazards for effective disaster mitigation. MMS also provides aviation weather services for international air navigation as per ICAO to Civil Aviation Authority of Maldives. It coordinates with NDMA and Public Service Media for disseminating early warning messages.

2.2 MMS has partnership with Regional Multi-Hazard Early Warning System for Asia and Africa (RIMES) for improving weather and climate services. MMS is also actively participating and working together with the countries from south Asia in the regional activities like SASCOF, SWFP etc.

2.3 MMS is working with Government of Italy on ocean weather modelling under grant in air. A project proposal is also in pipeline in MMS to be submitted to Green Climate Fund (GCF).

2.4 Automatic Weather Stations Network has been enhanced with the support of governments of Japan and Italy. Other efforts going on are development of system integration and climate database, and enhanced early warning mechanism by developing mobile App and common alerting protocol (CAP) in accordance with the SAP action plans.

Based on the above, it was felt that the maturity level of MMS is at **Level 3**. To lift this level up, MMS needs to work with national stakeholders like NDMA and international climate agencies to further improve various components of early warning systems such as observation network, extreme weather monitoring, development of climate data base, generate forecast at various spatial and temporal scales, co-design and co-develop tailor made weather and climate application products etc. A permanent training and capacity building facility of weather and climate services for MMS officials and other stakeholders is also need to be set up.

III. OBSERVATIONAL INFRASTRUCTURE

3.1 The observational structure of MMS consists of five (5) Synoptic weather stations with an average horizontal resolution of 150-300km, and one upper-air observation station. MMS has also Automatic Weather Station (AWS) network consisting of 35 AWS. All the five synoptic stations are registered in the WMO Observing System Capability Analysis and Review Tool for Surface (OSCAR/Surface) and are reporting through the Global Telecommunication System (GTS) of WMO. However, AWS data are not shared in GTS.

3.2 For nowcasting and specialized purposes, one Doppler Weather Radar covering an area with effective radius of 200km is being used in addition to the above surface and upper air observation network. Satellite pictures from CMACast system and IMD website are also used.

3.3 The MMS has Standard Operating Procedure for deployment, maintenance, quality assurance and calibration of the equipment of the observational network.

3.4 The automatic surface observation stations (AWS) constitute 87.5% (35 of 40) of the total surface observation stations. However, AWS observations are not listed in the OSCAR database.

Considering the above, based on the geographic areas of Maldives the Maturity level of the observational infrastructure is assessed to be at **Level 3**. It could be lifted up once the working 35 AWS data are shared through the GTS and on establishment of an integrated system for reception, monitoring, archival, quality check and management of weather and climate data. However, though the observation network is good and SOP is in place, there appear to be issues with resources, skills and infrastructure to fulfil its SOP in line with WMO standards. The accessibility of observation sites for calibration and maintenance is also an issue as they are situated in different islands particularly during bad weather.

IV. DATA AND PRODUCTS SHARING AND POLICIES

4.1 Maldives is a very small island with geographical areas of around 300 square km. The surface observation network of 5 synoptic weather stations and 35 AWS is good enough and meet the provisional requirements of the WMO Global Observing Network (GBON). MMS has also 1 Upper Air Station to meet the GBON provisional requirement for upper air sounding stations. Observations from the 5 synoptic observatories and 1 upper air station are shared through GTS.

4.2 There is no data sharing policy and practice of MMS at present for sharing data generated by MMS. However, data are provided to the users upon request free of charge. There is also no cost recovery policy as of now.

4.3 All regional and international partners of Severe Weather Forecasting programme (SWFP) of WMO provide their NWP products on daily basis. Besides these, RIMES provide their NWP products to MMS. MMS has also access to NWP products from Australia & India, and satellite products from CMACast system and IMD website. Australian model raw data are used for post processing locally. WRF model is set up with 27km horizontal resolution with basic run with 12UTC initial and boundary conditions from NCEP GFS data set. This is done without data assimilation and no verification techniques are used for model calibration for the lack of expertise and infrastructure. MMS has also access to the climate data and model products from various regional and global centers like Global Producing Centers for Long-Range Forecasts (GPC-LRFs), WMO Lead Center for Long-Range Forecast Multi Model-Ensembles (LC-LRFMME), Regional Climate Centers (RCCs) etc. as per the regional and global frame work set up by WMO.

Based on the above assessment the maturity level of the Data and Products Sharing and Policies is, therefore, assign to be at **Level 3**. However, the maturity level can be lifted up further if a proper data sharing policy is set up by MMS and efforts are made for mutual sharing of weather and climate data with the stakeholders within the country and codesign and co-produce the tailor-made products for user sectors.

V. NUMERICAL MODEL AND FORECASTING TOOL APPLICATION

5.1 MMS is using the NWP model products from RIMES and those regional and international centers supporting SWFP-SA of WMO. Australian model raw data are also used for post processing locally. MMS also produces monthly and seasonal climate outlooks for the country based on the climate data and model products from various regional and global centers like, GPC-LRFs, LC-LRFMME, RCCs etc.

5.2 MMS is running its WRF model with 27km horizontal resolution with basic run with 12UTC initial and boundary conditions from NCEP GFS data set. At present, there is no infrastructure and capacity to carry out data assimilation and verification of model outputs. However, the products are comparable with other global NWP model forecasts.

5.3 MMS does not have an ensemble forecasting system at weather and climate scales. However, uses the probabilistic forecasts available from various Global NWP and climate prediction centers. Global NWP centers supporting SWFP provide probabilistic forecast based on ensemble prediction to MMS. SASCOF climate outlook forum and WMO GPCs and regional climate centers provide seasonal probabilistic forecast products.

The maturity level for this component is assessed **as Level 3** mainly because of the use of model data from Regional and Global NWP and climate prediction centers. But the WRF model run by the MMS appears to be of little value as it is run at 27km resolution without data assimilation. Further lifting of maturity level may be difficult as MMS does not have immediate plan to upgrade the infrastructure and technical capacity to run NWP models with data assimilation. MMS also lacks capacity to generate sector specific products using freely available climate data and model products from various regional and global operational and research climate centres to provide improved weather and climate services.

VI. WARNING AND ADVISORY SERVICES

6.1 Warning and alert services by MMS cover 24/7. SMS is used to communicate with the designated focal points of the government. Hotline is used to communicate with the National Disaster Management Authority, Maldives National Defense Force, Public service media. The alerts are communicated to the users using social media platforms such as Community Viber Group, Twitter, Facebook, Website, Mobile Application.

6.2 MMS has defined Criteria for hydro-meteo risks impacting the country such as Heavy rain and floods, swell and tidal waves, tropical cyclones, Tsunami, thunderstorms, squall etc which are used for both observing the events and preparing the MET Alerts and Warnings. MMS also occasionally engages with the user community to take their feed-back to improve the alert and advisory service.

6.3 MMS has not implemented the Common Alerting Protocol (CAP) and impact-based forecast and risk-based warning. However, CAP is under testing and development phase.

This component is assessed as **Maturity Level 3.**

VII. CONTRIBUTION TO CLIMATE SERVICES

7.1 Since last more than one year, MMS has started issuing monthly rainfall and temperature forecast outlook. MMS has also been participating in the SASCOF meetings since 2010, the main objective of which is to issue the seasonal forecast outlook over south Asia including Maldives for various seasons such as southwest monsoon (JJAS), northeast monsoon season (OND) and winter seasons (DJF) for the region. The monthly and seasonal climate outlooks are mostly used by water department for planning and management of supply of drinking water for outer islands. MMS also provides climate data to the users upon request.

The maturity level is assessed at **Level 1.** The maturity level can be improved if MMS can implement a proper climate database management system, prepare various data products, and alert and advisories can be generated at extended and medium range scales to various sectors such as tourism, health, transport, energy etc.

VIII. CONTRIBUTION TO HYDROLOGY

8.1 The QPE (Quantitative precipitation estimate) derived from satellite products are available which are mainly used for nowcasting application.

8.2 There is no Standard Operating Procedure (SOP) for the exchange of information between MMS and hydrological agencies.

8.3. A new project is being initiated to identify potential areas of rainfall harvesting and provide this information to island communities.

Considering the above, the maturity level has been assessed as **Level 1**. The level can be increased by improving interaction with the hydrological sectors and providing the climate information and forecast (QPF), flood forecasts etc.

IX. PRODUCT DISSEMINATION AND OUTREACH

9.1 MMS has its own weather studio, daily one TV weather presentation is recorded and aired in the prime time of 3 local TV channels including public service media. Other dissemination tools used are Telephone (dial-weather), direct hotlines with 5 major stakeholders, SMS, Website, Community Viber Group, Twitter and Facebook.

9.2 MMS doesn't have an outreach program of its own. However, it takes advantages of outreach events conducted and co-ordinated by island disaster management authorities with government officials, island communities, NGOs. Interaction also happens with stakeholders and users during the regional user forum conducted associated with the SASCOF or outreach activities initiated by international partners likes RIMES. MMS also conducts awareness programmes in schools and colleges on request.

9.3 Some efforts are made to reach out to marginalized communities, youth, elderly etc. through the communication means mentioned in 9.1 and during the island disaster plan meetings.

Considering the above, the maturity level is assessed at **Level 3.** Further improvement in the maturity level can be by making the website more informative, increasing services to more sectors like tourism and health, and conducting more awareness and capacity building events with user community

X. USE AND NATIONAL VALUE OF PRODUCTS AND SERVICES

10.1 The MMS has no formalized platform to engage with users in order to co-design improved services.

10.2 MMS do not have mechanism to collect feed-back from users regularly. However, recently (in 2019) MMS has conducted Independent user satisfaction survey in local language.

The maturity level of this elements is assessed as **Level 2.** The maturity level can be lifted by setting a mechanism for regular interaction with and collect feedback from stakeholders for co-design and co-produce user specific products.

Summary of the Assessment and key Recommendations to lift up the Maturity Levels

Maturity level	Element of the Value Cycle	Key Recommendations
1	• Contribution to climate services • Contribution to hydrology	• Develop and implement basic Climate services such as proper climate database management system, preparation of various climate data products based on sectorial needs, alert and advisories at extended and medium scales to various sectors such as tourism, health, transport, energy etc. • Improve interaction with the hydrological sectors and providing the climate information and forecast (QPF) in different temporal scales.
2	• Governance and institutional setting • Use and national value of products and services	• Develop new infrastructure facilities with the funding support from the government or international assistance for enhanced operational services and support in house research activities to implement strategic plans as pert the SAP. A proper recruitment policy is required to recruit people with specialised education background like instrumentation, IT, computer science etc. in addition to those with meteorological background to sustain the observational network and develop new computing infrastructure for managing large model data • Need for national platform for regular interaction with and collect feedback from stakeholders for co-design and co-produce user specific products. Use of Facebook or Twitter to gather feedback or input from users can be an obvious starting point for engaging in dialogue with the public.
3	• Effective partnerships to improve service delivery • Observational infrastructure • Data and products sharing and policies • Numerical model and forecasting tool application	• Enhance partnership with national stakeholders like NDMA and international climate agencies to further improve various components of early warning systems such as observation network, extreme weather monitoring, development of climate data base, generate forecast at various spatial and temporal scales, co-design and co-develop tailor made weather and climate

	• Warning and advisory services • Product dissemination and outreach	application products etc. A permanent training and capacity building facility of weather and climate services is needs to be set up for imparting basic meteorological training as per WMO norms to newly joined MMS officials, to conduct refresher courses for working MMS officials and conducting awareness classes for other stakeholders. • Share the data from AWS network through the GTS and establish an integrated system for reception, monitoring, archival, quality check and management of weather and climate data. • Implement a data sharing policy for mutual sharing of weather and climate data and sectoral data with the stakeholders within the country and codesign and co-produce the tailor-made products for user sectors. • Establish a partnership with countries to make available high-resolution NWP model outputs for nowcasting, short range and medium range forecasts in the operational mode to support MMS. Develop capacity to use the NWP model outputs and products, freely available climate data and model products from various regional and global, operational and research climate centres to generate products for providing improved weather climate and hydrometeorological services. • Implement the Common Alerting Protocol (CAP) and impact-based forecast and risk-based warning. • Upgrade website to provide more information like forecasts and alerts at medium and extended range scales, increasing services to more sectors like tourism and health etc., and conducting more awareness and capacity building events with user community

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