

# 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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## Belize NMHS Peer Review Report

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

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## Executive Summary

Belize is located on the Central American mainland, forming part of the Yucatan peninsula, with a population of approximately 450,000 on a total land area of 22,960km<sup>2</sup>.

Belize comprises several geographical regions ranging from flat, low lying coastline to the central mountainous region.

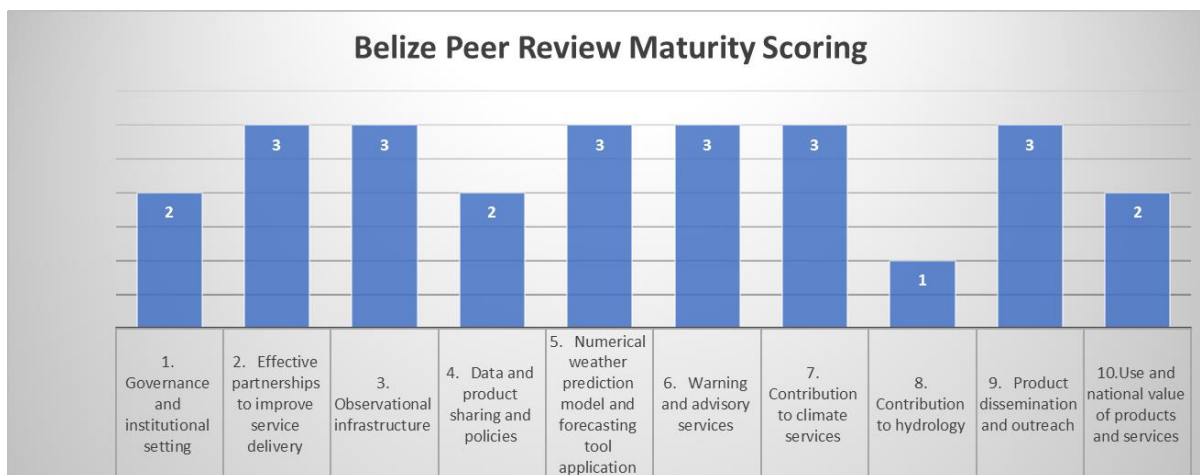
Belize is subject to a range of hydrometeorological hazards including hurricanes and tropical cyclones, thunderstorms, drought, large waves and swell.

The National Meteorological Service of Belize is the leading governmental authority on weather and climate. It provides meteorological and climate-based products and services to the Belizean public including user-friendly reports on all weather and climate related events and hazards. NMS Belize is also responsible for providing aviation weather information and forecast as well as specialised weather forecasts for the agriculture, forestry, marine, military and tourism sectors. NMS Belize have defined responsibilities in government acts related to the National Emergency Management Organisation (NEMO) Disaster Risk Management (DRM) services and the Department of the Environment's National Environmental Appraisal Committee (NEAC). Formalisation of the draft legislation defining the roles and responsibilities for NMS of Belize is a priority to strengthen the legal mandate for weather and climate services in Belize and the regional and global obligations of the NMS.

The NMS are experiencing a severe staff and skills shortages and are dependent on individuals over-delivering. This situation is not sustainable and NMS Belize have initiated a restructuring plan that is being reviewed by the Ministry of the Public Service. The existing budget consistently falls below the amount required to cover staff emoluments, operational costs, capital investments, and training and development.

The observation network of Belize comprises 54 surface observation sites and 1 upper air station. The stations are comprised of a mix of sensors and station types obtained through different funding sources. The average resolution of the total surface network is 30km, though many sites do not record all necessary parameters for GBON and do not share data internationally. Standard operating procedures are in place for aspects of the observation network, though they are largely outdated and no longer fit for purpose. The development and implementation of SOPs for all deployment, maintenance, calibration, QA and monitoring of the observation network have been recommended and supported through the Systematic Observations Financing Facility (SOFF).

The NMS have an existing and out-of-date Strategic Development Plan that's partially incorporated in its parent ministry's strategic plan. The NMS have a draft Operational Plan and require a Risk Management Plan. It is vital that the issues of staffing, skills and budget allocation are addressed as well as securing a clear legislative mandate, sustainable observations and IT operations and strengthened collaboration with government, regional and international partners to ensure the ongoing capability of NMS Belize to provide its critical services to the people of Belize and the regional and global community.



**Fig 1: Summary of Maturity Level Assessment of National Meteorological Service of Belize**

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

**Table 1: Summary of Maturity Level Assessment of National Meteorological Service of Belize as in Fig 1 above.**

# Chapter 1: General information

## Introduction



Figure 1: Map of Belize courtesy © 2024 worldatlas.com

Belize is located on the eastern coast of Central America, between latitudes 15.75° and 18.50° North and longitudes 87.50° and 89.25° West. Belize borders Mexico to the north, Guatemala to the west and south, and the Caribbean Sea to the east.

Belize covers a total land area of 22,960 km<sup>2</sup> (8,867 miles<sup>2</sup>), of which 95% is located on the mainland and five per cent is distributed over more than 1,060 islands. Belize has the lowest population density in Central America and the 2nd highest population growth rate in the region.

Belize comprises several geographical regions, each with its unique characteristics :

- Most of the northern half and much of the extreme southern third of the country, plus the entire coastal area and all the islands, are flat and low-lying. Large sections of the coastline have an elevation of less than 1 meter to a distance of several miles inland.
- Meanwhile, in the northern half, topography of the land rises to a maximum of approximately 250 meters above mean sea level (AMSL) in the extreme west of the country.

- The central part of the country is dominated by the Maya Mountain/Mountain Pine Ridge massif, rising to 1,124 meters AMSL (3,688 ft) at its highest point.

Northern Belize has a subtropical climate with an annual rainfall of 1500 mm (60 inches). Southward, the climate becomes increasingly tropical and the annual rainfall increases to 3800 mm (150 inches).

Average maximum temperatures are near 85°F and average minimum temperatures are in the low 70's, with summer around 8°F warmer than winter.

The climate is characterized by a marked wet and dry season separated by a cool transitional period. The rainy season begins in the south in mid-May and arrives in the north around mid-June. The rainy season continues through to November, but most locations experience about a ten-day drier period in August. The cool transition period occurs from November through to February. Then, the true dry season follows from February to April and is produced by strong anticyclones in the Atlantic that generate a persistent stable south-easterly airflow across the country.

About 60% of annual precipitation occurs during the rainy season, produced primarily by tropical systems, particularly tropical waves which progress across the country, as well as occasional tropical cyclones.

Belize lies within the hurricane belt. Historically, tropical storms and hurricanes have affected the country once every three years. Belize City, the former capital, was destroyed twice by hurricanes in the 20th century. Hurricanes can affect any part of the country, but are more frequent in the north.

The longest river in Belize, the Belize River, courses for about 180 miles (290 kilometres) through the country, serving as an essential water source and a historic transportation route. Other key rivers include the Hondo River, which forms part of the northern border with Mexico, and the Sarstoon River delineating the southern boundary with Guatemala.



Photo 1: Belize River (Nick Taylor - Belize, CC BY 2.0, <https://commons.wikimedia.org/w/index.php?curid=25009446>)

Numerous islands or cayes pepper Belize's coastal waters, most notably Ambergris Caye, which is the largest. These islands are an integral part of Belize's geography, contributing to its biodiversity and offering unique habitats for many species.

### **The National Meteorological Service of Belize (NMS)**

The NMS has both national and international responsibilities, covering a diverse range of activities. These include making observations to GBON and ICAO standards, forecasting the impacts of tropical cyclones, and representing Belize at WMO and IPCC. The NMS Belize is comprised of an Administrative Section and three technical sections, Weather Analysis and Forecasting, Climate Services Section and the Electronics and Information Technology. To deliver to the needs, the NMS requires a team of highly qualified and motivated staff, with a broad range of skills and experience, led with strong and clear



leadership. To be able to successfully deliver to these responsibilities, it is essential that NMS Belize receive the correct recognition and support from their government.

## CHD methodology

The approach taken followed the Country Hydromet Structure and included interviews with the NMS and other government departments in Belize, including Agriculture, Civil Aviation, Sustainable Development, Climate Change and Disaster Risk Management.

# 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**

The National Meteorological Service of Belize (NMS)<sup>1</sup> is an agency in the Ministry of Sustainable Development, Climate Change and Disaster Risk Management. The NMS have a Letter of Agreement (LOA) with the Department for Civil Aviation defining meteorological services required for aviation services.

In addition, the NMS have defined responsibilities in government acts related to the National Emergency Management Organisation (NEMO) Disaster Risk Management (DRM) services and the Department of the Environment's National Environmental Appraisal Committee (NEAC).

There is a drafted Cabinet Paper and draft legislation defining the roles and responsibilities for NMS of Belize with other government departments. Formalisation of these will strengthen the legal mandate for weather and climate services in Belize and the regional and global obligations. These obligations include cooperation and subscriptions with regional and global institutions including the regional climate centre at CIMH, support to WMO on WIS2 implementation regionally, representing Belize at IPCC, and serving on several WMO Expert Teams (agriculture risk management, climate services for region IV, etc).

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

The NMS have an existing and out-of-date Strategic Development Plan that's partially incorporated in its parent ministry's <sup>2</sup>strategic plan. The NMS have a draft Operational Plan and require a Risk Management Plan. There is a need to re-develop all three plans and get them signed off by the ministry to ensure that there is adequate support and resources available to successfully implement these plans.

### **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**

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<sup>1</sup> <https://nms.gov.bz/about/purpose/>

<sup>2</sup> <https://sustainabledevelopment.gov.bz/>



The budget<sup>3</sup> allocation varies from year to year but is consistently below requirement by around ~70%. In 2023-2024 the total allocated to this department was BZD \$1,677,754, or ~USD \$838,877.

At least 80% of the budget is allocated to personnel emoluments with inadequate funding for other important aspects such as operational and maintenance costs. Moreover, the existing budget consistently falls below the amount required to cover staff emoluments, operational costs, capital investments, and training and development. There needs to be greater recognition of the socio-economic value of the NMS by government. A cost benefit analysis or socio-economic benefit study would provide supporting evidence to government of the critical value of the NMS to the country's economic growth and development.

#### **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 NMS is currently comprised of thirty (30) staff members with an equal split among females (15) and males (15). Eight (8) out of the total compliment of staff are supportive/administrative staff while the other 22 are technical staff. Of the technical staff members, two are trained at the master's degree level while 6 are trained at the bachelor's degree level. The remainder are trained at the associate degree level or high school. The technical staff members are divided into three sections.

- Weather Analysis and Forecasting
- Climate Services
- Electronics and IT Section

Given the very limited number of people in the department, several staff members are moved from section to section playing multiple roles.

Opportunities for formal training (bachelors degree level and upward) in Meteorology or Climatology are very limited. There is no academic institution in the country that offers these types of degrees. Therefore, training is usually done abroad and is therefore quite expensive. Scholarship opportunities are also very limited in these areas.

The NMS are experiencing a severe staff and skills shortages and are dependent on individuals over-delivering. For example, the NMS Climate Services section only has three staff and are required to deliver services and products to a wide array of local and regional stakeholder groups. There is limited capacity to develop staff to be able to effectively deliver adequate climate services. This situation is not sustainable. An increase in capacity and capability across the organisation would help alleviate this situation. The NMS have initiated a restructuring plan that is being reviewed by the Ministry of the Public Service. Once approved, this plan will address some of the issues faced including eliminating redundant posts, creating new relevant posts, updating job descriptions, upgrading pay scales and updating job requirements. This will ensure that the department is more fit for purpose and is able to effectively deliver the products and services required by stakeholders and the Belizean public.

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<sup>3</sup> <https://www.nationalassembly.gov.bz/wp-content/uploads/2023/03/DRAFT-ESTIMATES-OF-REVENUE-AND-EXPENDITURE-FOR-FISCAL-YEAR-2023-24.pdf>

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

NMS has a successful track record over the years with around 4 projects currently ongoing and 2 projects in concept note development stage.

It's strong collaboration with the Ministry of Agriculture, Food Security and Enterprise (MAFSE) has secured two projects:

1) The Climate Resilient Smallholder Agriculture Project (CRESAP) between the NMS, Farmer Cooperatives, Academic Institutions etc. valued at US \$300,000 to Enhance Climate Resilience to targeted farmers.

2) Resilient Rural Belize Programme valued at US \$256,000 to (i) build, rehabilitate and maintain climate-resilient rural infrastructure; and (ii) to foster small farmers' capacities to work with market-driven and climate change adaptive farming practices and technology. These projects are facilitating the development of a mobile app with irrigation scheduling and monitoring capabilities, enhancement of agricultural climate services products, capacity building and the procurement of computer equipment, weather station spares, etc.

The Energy Resilience for Climate Change Adaptation Project (ERCAP) valued at US \$707,000 is aimed at enhancing the resilience of Belize's energy system to adverse weather and climate change impacts. Investments were made in the procurement of weather stations, a lightning detection network, a data integrator, Flood Early Warning System and transportation equipment.

The Enhancing Adaptation Planning and Increasing Climate Resilience in the Coastal Zone and Fisheries Sector of Belize Readiness project being executed by the Ministry of Blue Economy and Civil Aviation (MBECA) and the Food and Agriculture Organization (FAO) seeks to increase the resilience of the Coastal Zone and Fisheries Sectors of Belize to the projected impacts of climate change valued at US \$600,000 with US \$40,000 allocated to the NMS for the procurement of water level sensors to monitor wave height and sea level rise data.

There is limited capacity, however, to support research and development projects and lack of awareness in the research community of the benefit the NMS can bring to a project.

### **Summary score and recommendations for Element 1**

Belize is assessed as **Maturity Level 2** on the CHD scale – ***effort ongoing to formalize mandate, introduce improved governance, management processes and address resource challenges.***

The NMS of Belize has been functioning without clear legal mandate, but the department is recognized nationally and within the government for delivering on its traditional functions which include among other things, providing public-good weather forecasts and alerts on severe weather including tropical cyclones. In addition to its traditional functions, the department over the years has taken on additional roles such as providing climate services, developing specialized forecast products for the aviation, maritime, agricultural and tourism sectors. Therefore, the department contributes significantly to Belize's socio-economic development. There is a need to demonstrate the value of the department which should result in a commitment from government to strengthen the

legal and institutional framework governing the NMS. This includes the passage of legislation to establish the NMS giving it full legal mandate of its roles and responsibilities. This will go hand in hand in ensuring an effective budgetary allocation that will ensure that the department is able to fulfil said roles, duties, responsibilities and obligations and is able to effectively grow to meet the demands from the public and stakeholders. Overall, the government needs to recognise the financial benefits of investing in the NMS.

## Element 2: Effective partnerships to improve service delivery

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

The NMS have a good working relationship with the Department of Civil Aviation, that includes an LOA that outlines the products and services delivered to aviation as well as cooperation between the two departments. In addition, there is a good working relationship with the Ministry of Agriculture and NEMO, but there is no formal LOA or MOU in place with these agencies. However, an SOP exists with NEMO as it relates to hurricane emergencies.

The department has some working relationship with the Department of the Environment since based on law, the Chief Meteorologist sits on the Department of the Environment's National Environmental Appraisal Committee (NEAC) and provides guidance on weather and climate related matters that may impact potential development projects.

NMS are always willing to develop partnerships, but greater awareness of their potential would lead to a greater awareness and acceptance to include them in partnerships.

### **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.**

NMS have effective partnerships in place with CMO, the Caribbean Institute for Meteorology and Hydrology (CIMH), Fortis Belize etc. and has been a partner on the EUREC4A project investigating cloud physics, feedback and organization and provided case studies on drought for the UNDRR GAR 21 Special Report on Drought. Strengthening is required for partnerships with academia, research and innovation, and other regional partners, such as Caribbean Community Climate Change Centre (CCCCC).

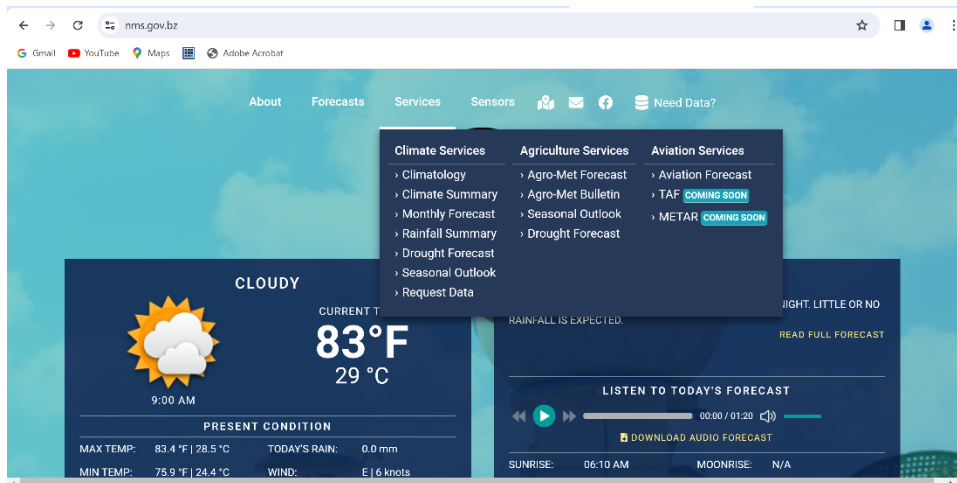
There is potential to collaborate on other similar projects, but there isn't the capacity to undertake full time research activity due to current limited staffing.

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

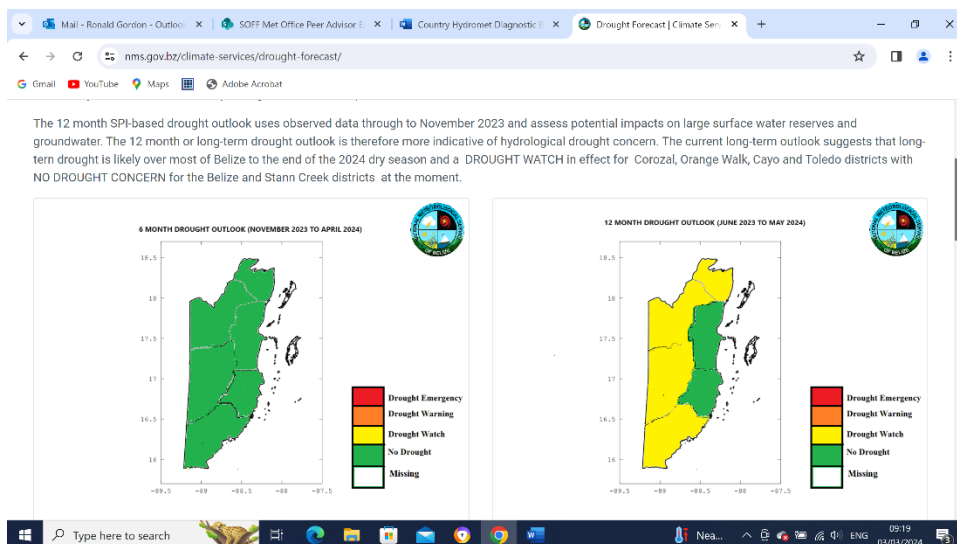
There are none of these types of relationship in place. This is managed by other ministries and organizations such as the Climate Finance Unit in the Ministry of Economic Development and the National Climate Change Office (NCCO) and there needs to be greater awareness of NMS potential to include them when securing funding.

### **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.**

There are only limited products and services developed through partnerships, only some enhancement of business-as-usual products. This is largely due to lack of staff and recognition. Through the CRESAP project, automatized routines will be developed to produce forecasts, agro-climatic bulletins, agro-climatic indices, data visualization and analysis. The mobile app being developed by the Resilient Rural Belize Project will assist in the dissemination of weather and climate forecasts, CAP alerts, pest risk forecasts and irrigation schedule information. A public education and awareness campaign will be executed between the NMS and the extension officers in MAFSE on the utility of the mobile app and interpretation of the climate forecasts, outlooks and data. The Participatory Integrated Climate Services for Agriculture (PICSA) program developed by the University of Reading will also be implemented in Belize through the CRESAP project.



**Figure 2.41: NMS website front page showing different forecasts, services and products (www.nms.gov.bz)**



**Figure 2.42: Example of drought forecast issued by the NMS using the SPI**

## Summary score, recommendations, and comments for Element 2

Belize is assessed as **Maturity Level 3** on the CHD scale – **Moderately effective partnerships but generally regarded as the weaker partner in such relationships, having little say in relevant financing initiatives**

There are some existing partnerships with some government departments, but these can be strengthened further by developing or refreshing MoUs with partners. Establish partnerships with other departments, such as Health and Tourism.

There is a partnership in place with the private sector (FORTIS Belize), but partnerships with Academia need to be developed.

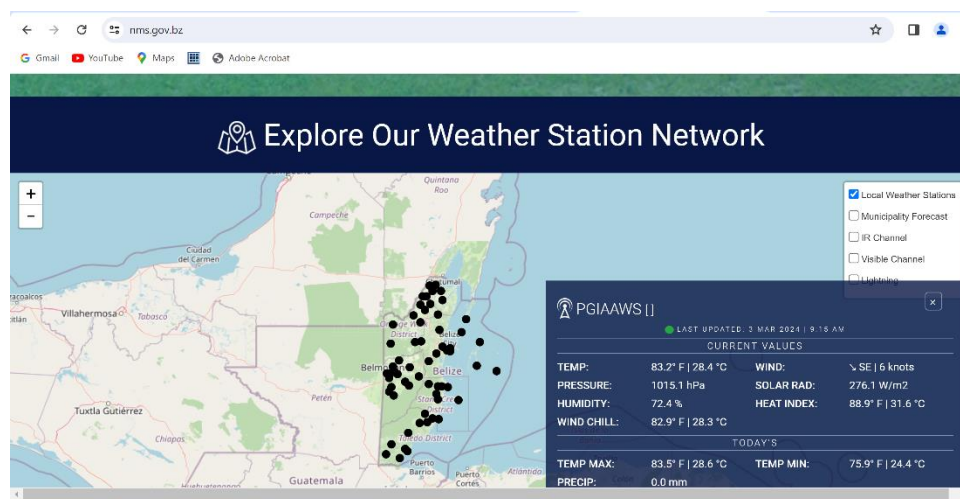
### Element 3: Observational infrastructure

#### 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.

Resolution of existing GBON compliant surface network: 200km

Resolution of future GBON compliant surface network: 100km

The surface observation network of Belize comprises 54 surface observation sites of which 1 is currently GBON compliant with an additional site to be improved to GBON compliance through SOFF. The remaining stations are comprised of a mix of sensors and station types obtained through different funding sources. The average resolution of the total surface network is 30km, though many sites do not record all necessary parameters for GBON and do not share data internationally.



**Figure 3.1: The NMS network of weather stations. Each dot corresponds to a weather station.**

Resolution of GBON compliant upper air network:

There is a single upper air observing site in Belize and it is operated to GBON compliance with support from the US NWS. The resolution of the network is therefore considered to meet the GBON spatial resolution criteria of 500km as this distance extends beyond the borders of Belize in all directions.

#### 3.2. Additional observations used for nowcasting and specialized purposes.

Some specialised observations are undertaken as part of a project in collaboration with FORTIS Belize for meteorological monitoring in the Macal River catchment area / watershed. Fortis Belize operates three hydroelectric facilities on the Macal River in western Belize – the Mollejon, Chalillo, and Vaca dams.

There are no additional observations collected or used for nowcasting in Belize.

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

Standard operating procedures are in place for aspects of the observation network, though they are largely outdated and no longer fit for purpose. The development and implementation of SOPs for all deployment, maintenance, calibration, QA and monitoring of the observation network are recommended in the National Contribution Plan along with recommendations for staff training in these areas where appropriate.

### **3.4 Implementation of sustainable newer approaches to observations.**

The modernisation of the Belize observation network has been taking place over the last 10 years, with the introduction of a significant proportion of AWS in place of manual observations and the development of IT infrastructure, data management and transmission and monitoring software.

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

NMS Belize currently operate 54 AWS and 22 manual observation sites (71% automatic weather stations)

### **Summary score, recommendations, and comments for Element 3**

Belize is assessed as **Maturity Level 3** on the CHD scale - ***Moderate network with some gaps with respect to WMO regulations and guidance and with some data quality issues.***

NMS Belize operate a substantial network comprising 54 AWS and 22 manual observation sites, as well as some specialised observations in the Macal river catchment area. The observation network has been substantially modernised and expanded over the last 10 years along with the supporting IT and data management infrastructure. It is recommended that, as set out in the SOFF National Contribution Plan for Belize, the development and implementation of SOPs for all deployment, maintenance, calibration, QA and monitoring of the observation network is undertaken to ensure the sustainable operation of the network.

## 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.**

Currently 1 surface station exchanges data internationally and the national contribution plan includes recommendations to improve a second surface site to GBON standard and share data internationally. Data from the remaining surface observation sites are not currently exchanged internationally, though the improvements in IT infrastructure and software to be implemented through SOFF will increase the potential for these data to be shared in the future.

The single upper air observation site is GBON compliant and exchanges data internationally.

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

There is a data sharing agreement within NMS Belize for the sharing of observation data. There is a need for data policy, including the various agreements, that also need to be updated. There are existing agreements with government ministries within Belize (Agriculture ministry, the Department of Environment, the National Emergency Management Organisation and the Hydrology Unit and the Department of Civil Aviation) to provide data and derived products as well as direct access to observation data from NMS Belize via API.

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

Products from global forecast models such as the GFS, EC, NAM, and ICON are freely available over the internet and are accessed by forecasters when producing weather forecasts for the country. The forecasters also have access to NOAA satellite imagery which are also freely available over the internet. Raw model data from the GFS and NAM are also accessed via FTP and this data is used in a visualization tool developed by the NMS to forecast daily maximum and minimum temperature as well as rainfall totals for different municipalities across the country. The NMS also has access to a regional WRF model run by the CIMH whose product is also available on the internet via the CIMH's website. The CIMH runs a regional WRF model and is available to the forecasters. To perform seasonal rainfall and temperature forecast the department uses a tool developed at the CIMH that incorporates the Climate Predictability Tool (CPT).

### **Summary score, recommendations, and comments for Element 4**

Belize is assessed as **Maturity Level 2** on the CHD scale - ***A limited amount of GBON compliant data is shared internationally. The existing data sharing policies or practices or the existing infrastructure severely hamper two-way data sharing.***

There is a need for a formal data sharing policy, but there are some existing agreements in place. Recommendation to develop policy and to reach agreements with global forecasting centres.

## 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.**

For nowcasting purposes (less than one hour), the department uses tools such as its one weather radar, lightning detection system, freely available satellite imagery, and automatic weather station to track severe weather and issue short-term alerts and warnings.

When it comes to forecast going out from one to four days the department uses numerical weather prediction model products. These include globally available models such as the GFS, EC, NAM, and ICON. as well as regional WRF model run at the CIMH in Barbados

For Seasonal Climate Forecasts, the NMS utilizes model outputs from the International Research Institute for Climate and Society (IRI) Climate Predictability Tool (CPT) together with global dynamical climate models in a tool called CAROGEN, European Centre for Medium-Range Weather Forecasts (ECMWF), NCEP coupled forecast system model version 2 (CFSV2) and North American Multi-Model Ensemble (NMME) models.

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

The NMS was running in the Weather Research and Forecasting (WRF) Model. However, there was some hardware issues and this was discontinued. Therefore, no numerical model is run internally at the moment. However, there is plan to reinstall the WRF model and run it at 3-km. The NMS downscales the GFS model to the municipality level using a visualization tool developed in house. However, this downscaling is strictly mathematical extrapolation and there is no dynamic or statistical downscaling involved in this process. There is no internal data assimilation. Verification is performed subjectively. There is no objective tool being used to perform verification of the numerical model products/forecasts.

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

Probabilistic forecasts are only produced on seasonal timescales, using statistical techniques, not ensembles. This is done using the Climate Predictability Tool (CPT) for seasonal rainfall and temperature forecasts extending out to 3 and 6 months. The output from product is based on probability of above normal, normal and below normal rainfall and temperature. Using these outputs the NMS issues a rough quantitative rainfall and temperature forecasts at the seasonal time-scales (3 and 6 months).

### **Summary score, recommendations, and comments for Element 5**

Belize is assessed as **Maturity Level 3** on the CHD scale - ***Prediction based mostly on model guidance from external and limited internal sources (without data assimilation) and remoted sensed products in the form of maps, figures and digital data and cover nowcasting, short and medium forecast time ranges.***



## Element 6: Warning and advisory services

### 6.1. Warning and alert service cover 24/7.

The NMS operates 24/7 on a shift system with at least one forecaster on duty at all times. That person is constantly monitoring the weather situation and if conditions warrants it, warnings are produced for strong wind, thunderstorms, excess heat, heavy rainfall (but not flooding), tropical cyclones and rough seas. Dissemination channels need to be improved, such as Common Alerting Procedures (CAP) see 6.3. Currently, these warnings are disseminated using the NMS's website and via radio. However, the timeliness and reach of these alerts could be improved using CAP to disseminate them via SMS or radio and television interrupts.

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

The NMS issues alerts and warnings for all hydro-meteorological hazards except for flooding which is the responsibility of the National Hydrological Service (NHS). The NHS utilized rainfall forecasts issued by the NMS to develop their flood forecasts, alerts and warnings. However, there is need for improved coordination between both departments. This would require the adoption of an MOU along with an SOP. There has been attempts to develop such coordination mechanisms but these have not been working effectively in an operational setting.

### 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.

The NMS has implemented the Common Alerting Protocol (CAP) on a limited basis. Forecasters are able to use CAP to send warnings and alerts that go to the NMS CAP feed. However, there still needs to be partnership with the local radio and television stations and mobile phone companies to have the alerts disseminated via these media. Under a technical agreement project funded through the Caribbean Development Bank, the NMS will be piloting multi-hazard impact-based forecasting in a specific community within the country. This is a two year project that will start in the second quarter of 2024 and last through to 2026. Tropical Cyclone (TC) warnings are done in collaboration with NEMO.

### Summary score, recommendations, and comments for Element 6

Belize is assessed as **Maturity Level 3** on the CHD scale - ***Weather-related warning service with modest public reach and informal engagement with relevant institutions, including disaster management agencies.***

## 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 National Framework for Climate Services (NFCS) in Belize launched in 2013 with further implementation required, such as strengthening relationships with academia and other sectors. The NMS have a good relationship with the agricultural sector which included the co-development of specialized products targeting this sector. These include the Agro-Met Bulletins as well as a specialized agro-met weather forecasts. The NMS also participates in a monthly dialog with key players in the agriculture sector in which the implications of the seasonal forecasts on different crops as well as its implications on different pest risks are discussed. However, the working relationship with the health, energy and marine sectors require strengthening in order to co-develop climate services and products targeting these sectors. The NMS hosts an Annual National Climate Outlook Forum (NCOF) in which several stakeholders participate and this is an opportunity to further strengthen the working relationship with the other key sectors. The focal point to the Intergovernmental Panel on Climate Change (IPCC) resides within the NMS and the department plays a key role in contributing valuable information to the science of climate change as well as providing data that highlights the reality of climate change at the local level.

### Summary score, recommendations, and comments for Element 7

Belize is assessed as **Maturity Level 3** on the CHD scale - **Essential Capacity for Climate Services Provision. It is recommended that NMS Belize continue to further develop the working relationship with the health, energy and marine sectors to support the development of climate products and services targeting those sectors.**

## 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 NMS does not issue quantitative precipitation forecasts at the weather time-scale but does so at the seasonal (3 and 6 month time scale). The National Hydrological Service uses the qualitative forecasts issued by the NMS to develop their flood forecasting. However, as mentioned previously, there is room for improved coordination between the two departments.

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

NMS have Standard Operating Procedures (SOP) in place, but they are currently in draft form and need to be finalised.

### **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 Hydrology Unit prioritise water management rather than flooding which is the responsibility of the Hydrology Agency.

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

Some specialised observations are undertaken as part of a project in collaboration with FORTIS Belize for meteorological monitoring in the Macal River catchment area / watershed. Fortis Belize operates three hydroelectric facilities on the Macal River in western Belize – the Mollejon, Chalillo, and Vaca dams.

## **Summary score, recommendations, and comments for Element 8**

Belize is assessed as **Maturity Level 1** on the CHD scale - ***No or very little meteorological input in hydrology and water resource management. It is recommended that the SOP formalising the relation between the met service and hydrology agency is finalised and implemented.***

## 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 primary means of disseminating information is via the NMS's website. The department also uses its Facebook page to share information and also communicates to users via radio and telephone. There is plenty of room for improvement. For example, the department does not have a fulltime communications or PR officer on staff. Television weather broadcast has been done in the past, but this is not something that is regularly budgeted for and requires support from donors. When it was done it was in association with a private television company as the NMS does not operate its own television network. The department plans to do in house video production within a year and use this means to also communicate weather forecasts.

### **9.2. Education and awareness initiatives in place.**

NMS conducts moderate educational information and outreach. This is typically done via visits to schools especially during their career days. The department also participates in few annual fairs where material concerning the NMS and its operations are presented to the public. The Education and awareness initiatives could be improved with more funding.

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

NMS has awareness of these groups, but their restricted resources do not allow special measures. The main radio station in the country through which the weather forecast is broadcasted has coverage country-wide therefore all communities in the country have access to the weather reports and forecasts via this medium. However, there are indigenous communities where language may be a barrier and there is currently no measures to address this. Also, the NMS has so far not been able to address persons living with disabilities such as hearing disabilities. This is something that can be considered in the future if there are enough resources.

## **Summary score, recommendations, and comments for Element 9**

Belize is assessed as **Maturity Level 3** on the CHD scale - ***A moderately effective communication and dissemination strategy and practices are in place, based only on in house capabilities and supported by user friendly website. It is recommended that further outreach and communication activities are undertaken as outlined in the SOFF National Contribution Plan for Belize.***

## 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.**

The NCOF has a feedback process and NMS has previously conducted surveys for aviation, but the response has been not forthcoming. There is currently nothing in place for the general public however the department plans to conduct online survey via its website to gauge the public feedback and therefore improve the products and services offered.

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

As indicated above, these are not being done currently but the department plans to develop online user surveys to get feedback from users and therefore improve services.

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

Due to the lack of resources by the NMS there are limited quality management processes in place. The department has been working on developing a QMS for the aviation sector but this has been stalled for the past several years with less than 25% completion.

### **Summary score, recommendations, and comments for Element 10**

Belize is assessed as **Maturity Level 2** on the CHD scale - ***Service development draws on informal stakeholder input and feedback.***

It is recommended that NMS Belize pursue the plan to conduct online surveys via its website to gather public feedback.

## Annex 1 Consultations (including experts and stakeholder consultations)

Meetings with Ministry of Agriculture, Civil Aviation Authority, Inter-American Development Bank, Ministry of Sustainable Development, Climate Change and Disaster Risk Management.

## Annex 2 Urgent needs reported

The most urgent need for the NMS, is to receive the correct level of recognition and support from government to carry out the tasks expected of them.

## Annex 3 Information supplied through WMO

WIGOS Data Quality Monitoring System

## Annex 4 List of materials used

Belize Observation Network Summary document – NMS Belize

Draft Belize Meteorological Services Bill - Caribbean Meteorological Organization Five Year Strategic Development Plan (2021-2025) For the National Meteorological Service of Belize Prepared by: Ronald Gordon Chief Meteorologist Proposed Restructuring Of The National Meteorological Service Of Belize – NMS Belize

UK Met Office internal visit reports

(WMO-No. 1195) Guidelines on the Role, Operation and Management of National Meteorological and Hydrological Services.

[https://library.wmo.int/doc\\_num.php?explnum\\_id=4221](https://library.wmo.int/doc_num.php?explnum_id=4221)