

COUNTRY HYDROMET DIAGNOSTICS

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



July 2024

Antigua and Barbuda NMHS Peer Review Report

Reviewing Agency: Met Office

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WORLD
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Weather
and climate
data for
resilience



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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.

	
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Glossary

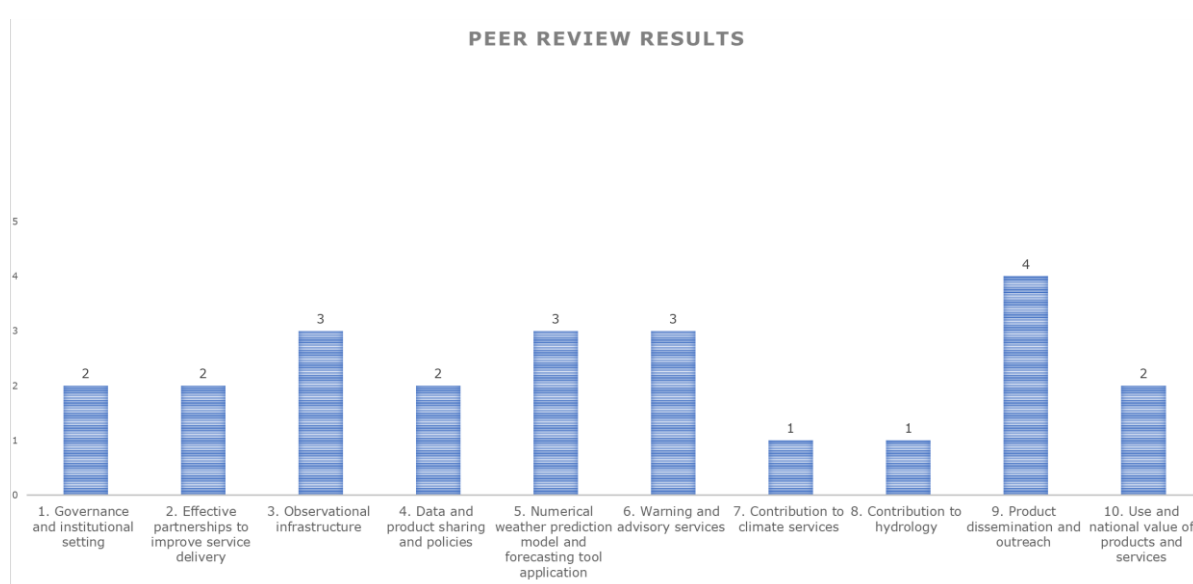
ABAA	Antigua & Barbuda Aviation Authority
ABMS	Antigua & Barbuda Meteorological Services
AROME	Meteo France model
ASSI	Air Safety Support International
AWS	Automatic Weather Stations
CCRIF	Caribbean Catastrophe Risk Insurance Facility
CIMH	Caribbean Institute for Meteorology & Hydrology
CMO	Caribbean Meteorological Organisation
CPT	Climate Predictability Tool
DoE	Department of Environment
ECMWF	European Centre for Medium-Range Weather Forecasts
EDIS	NWS Email Data Input System
EEZ	Exclusive Economic Zone
ELMT	Entry Level Meteorological Technician
EW4All	Early Warnings 4 All
FMI	Finnish Meteorological Institute
GBON	Global Basic Observing Network
GCF	Green Climate Fund
GDP	Gross Domestic Product
GEFS	Global Ensemble Forecast System
GFS	Global Forecast System
GIS	Geographical Information Systems
GTS	Global Telecommunication System
HRRR	High-Resolution Rapid Refresh model
IBEW	Impact-Based Early Warnings
ICAO	International Civil Aviation Organisation
ICT	Information and Communications Technology
INDCP	Intended Nationally Determined Contribution Plan
ISO	International Standards Organisation
METAR	Aviation meteorological code
MHEWS	Multi-Hazard Early Warning System
NASA	US National Aeronautics & Space Administration
NCAR	US National Center for Atmospheric Research
NCOF/RCOF	National/Regional Climate Outlook Forum
NFP	National Focal Point
NHC	US National Hurricane Centre
NM(H)S	National Meteorological (& Hydrological) Service
NOAA	US National Oceanic and Atmospheric Administration
NWS	US National Weather Service
ODA	Official Development Assistance
OSCAR	Observing Systems Capability Analysis & Review tool
OTAR 174	Overseas Territories Aviation Requirement Part 174
PoP	Probability of Precipitation
PWS	Public Weather Service

QMS	Quality Management System
RSMC	Regional Specialised Meteorological Centre
SEB	Socio-Economic Benefit
SLA	Service Level Agreement
SOFF	Systematic Observations Financing Facility
SOP	Standard Operating Procedure
SIDS	Small Island Developing State
STEM	Science, Technology, Engineering & Mathematics
SWFP	Severe Weather Forecasting Programme
SYNOP	Synoptic meteorological code
UA	Upper Air
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
USAID	US Agency for International Development
USD	US Dollar
VCBIA	V C Bird International Airport
WDQMS	WIGOS Data Quality Monitoring System
WIGOS	WMO Integrated Global Observing System
WIS	WMO Information System
WMC	World Meteorological Centre
WMO	World Meteorological Organisation

Executive Summary

Ten critical hydrometeorological elements have been assessed by the peer advisory and beneficiary against maturity of service within the Antigua and Barbuda national context. Antigua and Barbuda currently has maturity scores between 1 and 4 across the ten value chain elements – key gaps are identified and remedial recommendations offered. The Antigua and Barbuda Meteorological Services (ABMS) achieves results with a limited budget, especially in relation to outreach and communication of the meteorological message to users, but requires development across many capability areas; key focus should be applied, in particular, to consideration of:

- Climate & hydrological services
- The governance context, data sharing and understanding the national value of products and services provided
- Establishing effective partnerships



Element	Maturity level score
1. Governance and institutional setting	2
2. Effective partnerships to improve service delivery	2
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	1
8. Contribution to hydrology	1
9. Product dissemination and outreach	4
10. Use and national value of products and services	2

Gaps, Urgent Needs and Key Recommendations

Governance & Institutional Settings:

- ABMS should work with the Government of Antigua & Barbuda to formalise its mandate via legislation and service level agreements.
- ABMS should review the provision of services, including to neighbouring territories, with a view to appropriate funding and cost recovery, according to service level agreements.
- ABMS should seek support and funding for a refresh of the existing 2021-2025 strategic plan and agree tangible and achievable goals with its owning ministry for adoption; ABMS should also implement an operating plan and appropriate risk management framework to underpin the effectiveness of that strategic plan.
- ABMS should undertake a Socio-economic Benefit (SEB) study in relation to meteorological services provided and improve understanding of the critical role of those services and international obligations across government.
- ABMS should work with their owning ministry to ensure appropriately skilled staff can be resourced and trained.
- ABMS should ensure that all projects that they engage with make provision for implementation resource and sustainable ongoing funding.

Effective Partnerships to Improve Service Delivery:

- ABMS should explore potential with other bodies nationally & internationally (including across Antigua and Barbuda government) to develop mutually beneficial partnerships, notably where efficiencies may offset funding challenges.

Observational Infrastructure:

- ABMS should aim to access all available data (eg CIMH) and review sustainable new approaches to the operation of existing observations networks and potential sources of new data (and sources of funding for that) in their strategy refresh.
- ABMS should review its arrangements for National Focal Points and engagement with respect to WIGOS, Oscar and WDQMS.

Data & Product Sharing & Policies:

- ABMS should continue to engage in the Systematic Observations Funding Facility (SOFF) that can help to alleviate issues of maintaining operational GBON stations.
- ABMS should review the requirement and practicality within the context of the Antigua and Barbuda government to put in place arrangements for enhanced data sharing activities.

Numerical Model & Forecasting Applications:

- ABMS should continue to periodically review their use of NWP outputs as provision by WMCs and RSMCs continues to evolve.

Early Warning and Advisory Services:

- ABMS should aim to initiate regular reviews of warning performance, both internally and based on third party feedback where possible.
- ABMS should identify a pathway towards implementing sustainable impact-based warnings via exploitation of opportunities such as the implementation of the Smart Met Warning service or GCF EW4All project.

Contribution to Climate Services:

- As part of their ongoing strategy refresh, ABMS should engage with the A&B Department of Environment to assess national requirements for climate services and therefore the need to build an appropriate and sustainable national capability.

Contribution to Hydrology:

- As part of their ongoing strategy refresh, ABMS should engage with the Antigua & Barbuda Government and the Public Utilities Authority to assess national requirements for hydrological services and therefore the need to build an appropriate and sustainable national capability.

Product Dissemination & Outreach:

- ABMS should continue to explore evolving means of communicating key warnings and engaging the community in outreach activities.

Use of National Products and Values:

- ABMS should consider as part of their strategy refresh how QMS, user satisfaction and the needs of users can be reasonably consulted and accommodated within the context of the national scenario.

Chapter 1: General information

Introduction

Overview

Antigua and Barbuda is an independent nation, in the Leeward Islands part of the Eastern Caribbean. The country consists of two major islands, Antigua to the south and Barbuda to the north, which are c.40 km apart, plus several smaller islands, notably Redonda in the SW. The total area of the country is c.440 km² but the geography of the two main islands is significantly different with Antigua having forested hills and multiple coastal bays while Barbuda is a low-lying and much flatter island, with differences primarily relating to underlying geology. The capital is St. John's on Antigua, the nation's largest city & port; Codrington is Barbuda's settlement. Antigua and Barbuda also has a maritime Exclusive Economic Zone (EEZ) of c.110,089 km².

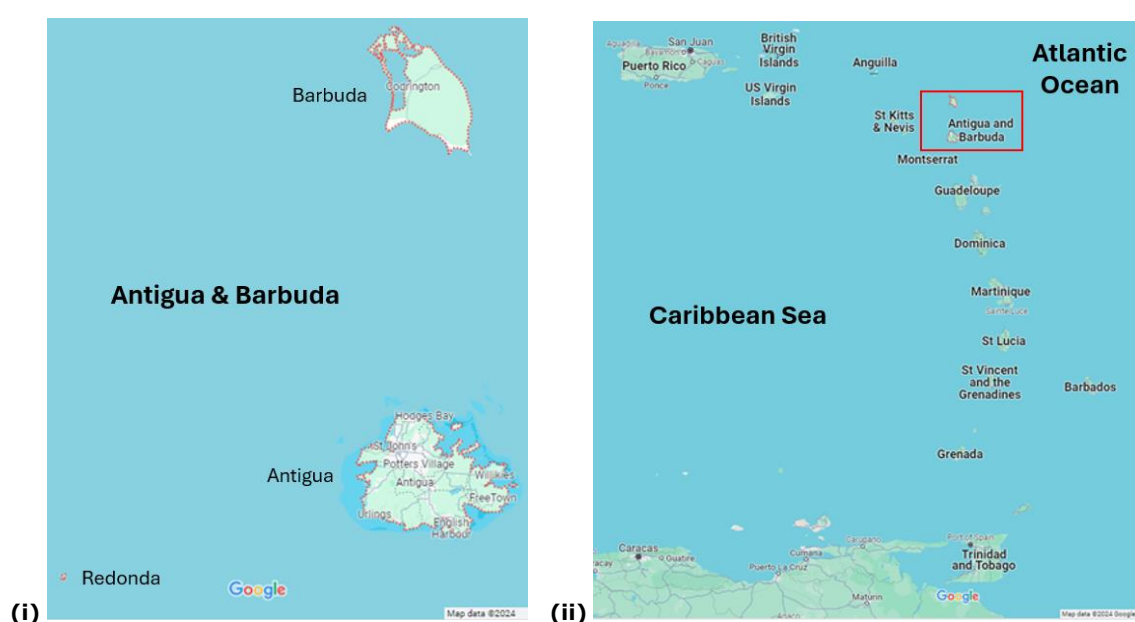


Figure 1. Map of (i) Antigua & Barbuda and (ii) the its location within the broader Caribbean region (Google Maps)

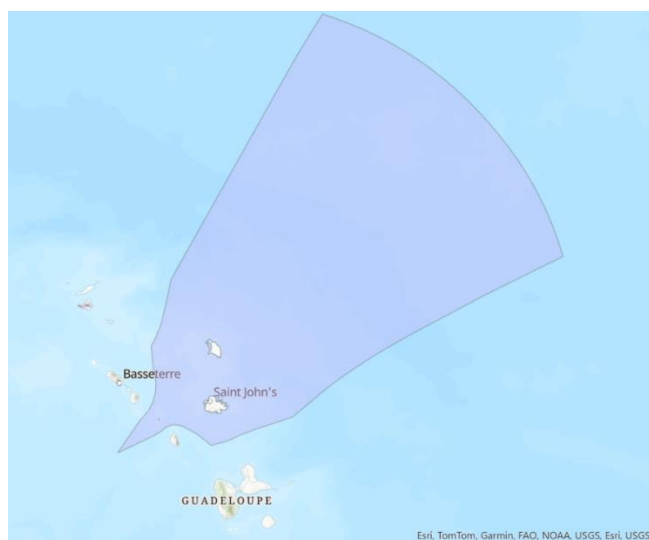


Figure 2. Map of the Antigua & Barbuda Maritime Exclusive Economic Zone (EEZ) (Esri)

The population of Antigua & Barbuda is c.94,298 with a GDP per capita of c. US\$21,560 (2023 World Bank), the vast majority of whom live on the island of Antigua. Antigua and Barbuda is considered a Small Island Developing State (SIDS) and the country's economy is heavily dependent on tourism (80% by GDP and 70% by employment) and natural resources.

Climate & Natural Hazards

Antigua & Barbuda has a dry tropical maritime climate, subject to a consistent Easterly Trade Wind regime for much of the year. The islands experience very low rainfall for the majority of the year and are thus subject to drought with limited groundwater and no permanent rivers as a result. As such, reliance on seawater desalination techniques account for c.60% of the national water supply. According to the World Bank Climate Change Knowledge Portal, "Antigua and Barbuda is exposed economically, environmentally and socially to projected climate change impacts. Analysis of climate change for the island also projects accelerated coastal erosion and inundation, lower average annual rainfall, increased rainfall intensity causing flooding and a likely increase in tropical storm intensity".

Extreme weather, notably in the form of tropical storms or hurricanes, is a particular risk during the peak hurricane season through the northern hemisphere summer and autumn. On 6th September 2017, the Category 5 Hurricane Irma, with peak 285 km/h winds, devastated the vast majority of buildings and structures on Barbuda, with c.1,800 people subsequently evacuated to Antigua and requiring many millions USD to rebuild homes and infrastructure. Extreme weather and in particular hurricanes threaten life and property in Antigua and Barbuda and also the economy, noting the islands' dependence on tourism.



Figure 3. Damage caused to Codrington in Barbuda by Hurricane Irma, September 6th 2017 (BBC image)

The National Meteorological Service

The Antigua and Barbuda Meteorological Service (ABMS) is a department within the Government of Antigua & Barbuda and has both national and international responsibilities, covering a diverse range of activities. These include making observations to WMO and ICAO standards, forecasting the impacts of tropical cyclones, and representing Antigua and Barbuda internationally. The ABMS is comprised of the following sections under a Director and Deputy Director:

- Operational Meteorology
- Applied Meteorology
- Information Systems/Technical
- Quality Management
- Administration
- Communication

To deliver to the meteorological needs of Antigua and Barbuda, 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 and supported by national government and international frameworks.

CHD methodology

This report has been prepared using CHD operational guidance in support of the WMO GBON SOFF initiative. An initial desktop review was performed based on information provided by ABMS. An in-country visit was also undertaken alongside work to support SOFF delivery, with interviews held with both ABMS and the Antigua and Barbuda Aviation Authority (ABAA), primarily at V. C. Bird International Airport (VCBIA). This report presents the ten most critical hydrometeorological elements assessed against maturity of service with recommendations to remediate specific issues.

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 ABMS is a government-owned department of the Ministry of Tourism, Investment, Civil Aviation and Transportation (single ministry), providing Public Weather Service (PWS) or other services to the state or to the public only. ABMS do not currently provide commercial services, and this is currently being reviewed by the Ministry of Finance. The Director ABMS reports to the Permanent Secretary within the ministry; the Director is the Permanent Representative of Antigua and Barbuda with the WMO. No national legislation, formal mandate or regulatory framework relating to responsibility for providing weather observations currently exists in Antigua and Barbuda. Draft legislation has been produced and submitted to the owning Ministry ("DRAFT ANTIGUA AND BARBUDA METEOROLOGICAL SERVICE BILL"), but this has yet to be progressed by the ministry, with no indicative timeline for resolution available presently.

ABMS is the provider for all public meteorological, climate and environmental services for Antigua & Barbuda, via a single budget allocation, with mostly informal arrangements for particular sectors such as aviation, marine and media. Though not formally mandated, ABMS provides all national warnings for extreme weather including tropical cyclones, flooding and marine hazards; warnings are also exchanged cross-border regionally via the Caribbean Meteorological Agency (CMO) and Regional Association linkages. ABMS is the Meteorological Authority for aviation services (as per ICAO Annex 3) and are the met service provider. ABMS has experience of delivering climatology and agrometeorology services but these are limited due to resources and there is no shared responsibility with other bodies in Antigua and Barbuda for e.g. hydrology or air quality.

Developing an understanding of the importance of meteorological services in the national context outside of ABMS has been challenging, including the consequences of e.g. NMS ICAO non-compliance in its responsibilities in providing Meteorological Services for International Air Navigation, another core deliverable for ABMS. In addition to national services, ABMS provides some public and aviation weather forecasts for other territories in the region including the British Virgin Islands, Montserrat, Anguilla and St Kitts & Nevis. Letters of Agreement (LoA) with the three neighbouring British Overseas Territories exist for aviation services (regulated by [Air Safety Support International, ASSI](#), a regulatory subsidiary to the UK Civil Aviation Authority for the British Overseas Territories) but these are unfunded, have expired and the ability to meet [OTAR 174 compliance](#) is therefore currently challenging.

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

A Strategic Plan ("ANTIGUA & BARBUDA METEOROLOGICAL SERVICE NATIONAL STRATEGIC PLAN AND FRAMEWORK FOR WEATHER, WATER AND CLIMATE SERVICE 2021-2025"), has been developed alongside WMO, but has not been able to be implemented due to lack of resources and funding. Key goals articulated in the plan include:

- Strategic goal 1: Regulatory environment and early warning systems in place to deliver weather, water, and climate services

- Strategic goal 2: Antigua and Barbuda Meteorological Services has adequate infrastructure to deliver weather, water, and climate services
- Strategic goal 3: Strengthened partnerships with stakeholders and interagency coordination and communication
- Strategic goal 4: Antigua and Barbuda Meteorological Services has adequate quality management system and human resources to develop and deliver weather, water, and climate services.

The current strategic plan is nearing its final year and requires a refresh to remain relevant, but this would require further support and funding to develop this.

ABMS has an Operating Plan which is mainly expressed as a set of processes / Standard Operating Procedures (SOP) rather than a combined operating plan. There is a need to further develop this to span the gap between SOPs and strategy, including action plans to deliver strategy / vision. ABMS are in discussion with ASSI to get ISO 9001 Quality Management System (QMS) status with respect to meteorological aviation services. Meeting QMS standards will require further development of policies and plans in other operational areas.

No risk management plan is currently in place - some initial risk assessments around contingency / continuation of services has been articulated, but nothing broader at present.

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

The operational budget provided by the Antigua & Barbuda government for all services is c.\$1m USD – this funds all activities including public and aviation services (there is no cost recovery currently for the latter). Budget has been relatively stable over recent years, but has not increased in real terms as costs have increased and some additional responsibilities have been requested. There is usually a deficit between budget requested and budget allocated, also between budget allocated and budget received. This has impacted resourcing and the ability to provide some services, eg climatology. No financial reports are available for the ABMS as it is not treated independently from the owning department, but indicative recent budgetary figures provided by the ABMS Director are as follows:

- 2021. 2.2m ECD (East Caribbean Dollar)
- 2022 2.6m ECD (2.4m ECD received from ministry)
- 2023 3m ECD

80% of costs are for staff remuneration, ABMS do not receive investment or network maintenance costs. c.16% are financial obligations to be paid by the government to other international bodies (CIMH, WMO etc), but these are in arrears. This leaves very little for enhancing capacity or lifecycling existing capabilities, thus external project funding is critical for fundamental deliverables, including for the observations network.

No SEB assessment has been undertaken for either ABMS or more widely in Antigua & Barbuda in terms of demonstrating the value of operating meteorological or wider environmental services. There has been regional discussion and some plans to undertake

this in the Caribbean region – the need for this is understood, however, funding and resource must be found to do this.

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.

ABMS has minimum requirements for certain roles, whether during the recruitment process or in subsequent training:

- Meteorologist - BSc in relevant discipline
- Forecaster – required to be BIPM compliant, CIMH ([Caribbean Institute for Meteorology and Hydrology](#)) is the approved training body
- Met Techs - Entry Level Meteorological Technician ([ELMT](#)) - mainly observers, need to undergo training for 4 months.

There is no formal training policy but most staff (with current exception of one Met Tech) are currently meeting the standards outlined above.

The ICT team double up as the observations network management and maintenance team but are currently not trained in equipment maintenance, leading to a limited capacity to maintain the network. There is a wide range of equipment in use across the network due to piecemeal implementation by external projects and lack of training on equipment, which exacerbates this challenge.

ABMS is currently understaffed and therefore unable to deliver some services appropriately, e.g. climatology. ABMS maintains a single meteorologist on duty who has to deal with everything on their shift – there is a need for separate benches, notably for aviation. There are currently around 42 positions in the ABMS structure, of which 12 further positions are awaiting approval following a Prime Ministerial pledge.

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

A number of projects, e.g. relating to observing infrastructure, have been successfully implemented but have left a legacy of unsupported diverse technologies and unsupported operations in the long term. Most of these projects have been managed by external bodies (CIMH, 5 Cs, Dept of Environment) - all project management aspects are being managed by external bodies where ABMS does not have this resource available.

Some projects have been proposed but not progressed as they have not addressed fundamental needs of the ABMS in terms of infrastructure and development or have encountered difficulties in resourcing or release of funding. A grant has been made available through the Caribbean Catastrophe Risk Insurance Facility (CCRIF) to contribute to the cost of spares and repairs of existing stations and towards improving the transmission and collection of data at ABMS, including the development and improvement of IT infrastructure – release of funds via the government has been delayed.

Green Climate Fund (GCF) funding was also made available under Component 3 of a 5-year GCF Build Project being implemented by the Department of the Environment (DoE) within the Government of Antigua & Barbuda. Overall, the GCF project aims to move

Antigua and Barbuda's building sector toward climate resilient sustainable development by facilitating the upgrade of selected build infrastructure, including the branch of the VC Bird International Airport which houses ABMS, to withstand extreme weather events, notably Category 4 and 5 hurricanes. More specifically, Component 3 would directly benefit ABMS by strengthening weather and climate information services to facilitate early action in the building sector to respond to extreme (weather) climate events, including activities that contribute to the development of effective Multi-Hazard Early Warning Systems (MHEWS). Both aspects of GCF investment would benefit ABMS and mitigate risks of extreme weather on both the NMS's infrastructure and on the wider population of Antigua & Barbuda. ABMS has been unable to progress the Component 3 proposal to date due to resource constraints, and this component is being repurposed. A separate GCF Early Warnings For All (EW4All) project set to comprehensively address MHEWS development in Antigua and Barbuda is in preparation.

Summary score and recommendations for Element 1

Assessed maturity score: LEVEL 2 - Effort ongoing to formalize mandate, introduce improved governance, management processes and address resource challenges.

Recommendations:

- ABMS should work with the Government of Antigua & Barbuda to formalise its mandate via legislation and service level agreements
- ABMS should review the provision of services, including to neighbouring territories, with a view to appropriate funding and cost recovery, according to service level agreements
- ABMS should seek support and funding for a refresh of the existing 2021-2025 strategic plan and agree tangible and achievable goals with owning ministry for adoption; ABMS should also implement an operating plan and appropriate risk management framework to underpin the effectiveness of that strategic plan
- ABMS should undertake a Socio-economic Benefit (SEB) study in relation to meteorological services provided and improve understanding of the critical role in Antigua & Barbuda of those services and international obligations across government
- ABMS should work with their owning ministry to ensure appropriately skilled staff can be resourced and trained
- ABMS should ensure that all projects that they engage with make provision for implementation resource and sustainable ongoing funding

Element 2: Effective partnerships to improve service delivery

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

There are no specific partnerships in place for service provision with the exception of aviation, e.g. with neighbouring British Overseas Territories (see above).

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.

CIMH provide training and support into the national institutions in the region, but otherwise there are no current partnerships or projects in place nationally or internationally with other public/private sector organisations or research/academia. There is no specific legislation concerning the commercial provision of information and services in Antigua and Barbuda by third parties, the approach is permissive, allowing private sector participation in service provision without any specific conditions. Presently, however, there is no current upward trend in private sector involvement in meteorological services locally.

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

CIMH has relationships with some Official Development Assistance (ODA) partners, but there has been limited flow down to national institutions; CIMH does though provide training and support to ABMS and other regional NMSs. CMO ([Caribbean Meteorological Organisation](#)) has had limited effectiveness to date in raising funds / supporting resource mobilisation.

See also information on CCRIF and GCF funding in Section 1.5 with respect to direct relationships with donors.

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.

No specific new products and services are currently outlined or research projects undertaken with resources being focussed on maintaining existing key services. Some engagement has been undertaken with various projects to enhance capability including:

- FMI (Finnish Meteorological Institute) Smart Met Project has taken place; not currently operated.
- GCF project to support capacity development, mainly providing assistance to individuals for training and education; CRIFF funded capacity development / training on risk transfer approaches and products for Antigua Government (see Section 1.5).
- Attended pre-COF to receive training. CIMH workshop on engagement between water resources and met to look at co-developing water resources project.
- USAID funded Directors Masters qualifications. Some targeted courses including agro-meteorology.
- GIS training has been delivered

Summary score, recommendations, and comments for Element 2

Assessed maturity score: LEVEL 2 - Limited partnerships and mostly excluded from relevant finance opportunities.

Recommendations:

- ABMS should explore potential with other bodies nationally & internationally (including across Antigua and Barbuda government) to develop mutually beneficial partnerships, notably where efficiencies may offset funding challenges.

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 23 Surface Land stations operated by ABMS in Antigua & Barbuda (see Fig 4 below), giving an average horizontal resolution for Surface synoptic observations of c.19km² per station, noting the caveat that many of these stations are not reporting regularly or are reporting only some elements at times. The single GBON Surface observation at VC Bird International Airport (VCBIA) currently represents the whole 440km² of the Antigua and Barbuda land area. Stations report hourly across parameters including temperature, humidity, rainfall, pressure and wind, but calibration and maintenance are a challenge with limited spares provision related to donated network capability. Observations are more limited in Barbuda due to maintenance access and hurricane impact.

There is no national Upper Air (UA) coverage in Antigua and Barbuda.

No observations are undertaken within the ocean area due to financial, logistical and overall absence of resources.

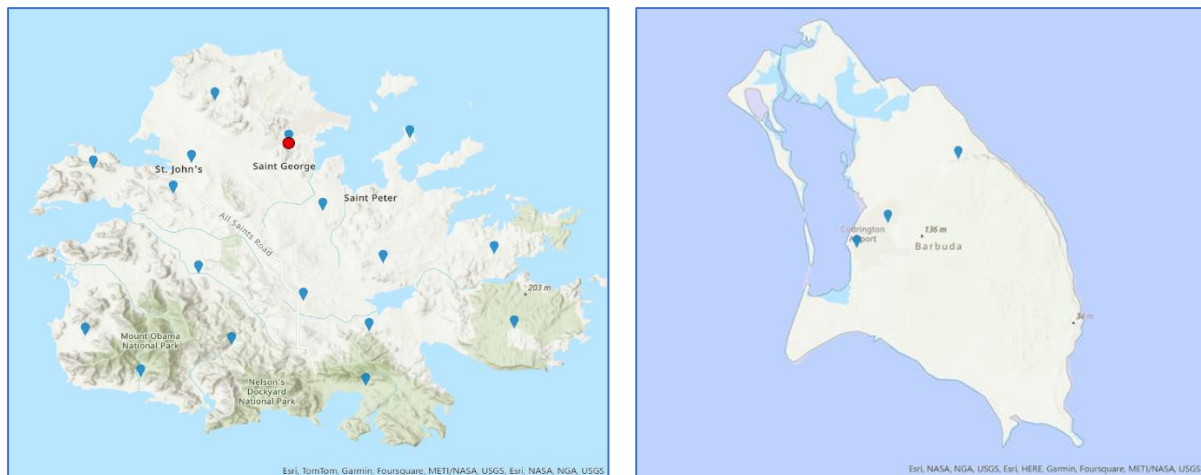


Figure 4. Existing Antigua (left) & Barbuda (right) Surface stations incl V C Bird International Airport GBON station (in RED)

3.2. Additional observations used for nowcasting and specialized purposes.

No additional local observations are available for these purposes, though ABMS has access to international satellite data and weather radar data from neighbouring Guadeloupe (Meteo France).

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

ABMS has various operating processes in place but cannot undertake observing sensor calibration locally and has limited capability in terms of observing system maintenance and quality control. ABMS does have an arrangement in place with CIMH to undertake calibration, but this has not been achievable due to limited/lack of resources (human, infrastructural, etc) in this area at the CIMH; as such, ABMS is keen to explore third party commercial supplier approaches. ABMS has an OSCAR National Focal Point (NFP), trained in metadata review and refresh, and a WDQMS NFP, undertaking monitoring of WDQMS to understand performance of the VCBIA GBON site. ABMS does not currently have a formal WIGOS NFP due to resourcing constraints but will nominate one at the earliest opportunity.

3.4 Implementation of sustainable newer approaches to observations.

No new sustainable approaches to observations are currently planned to be implemented by ABMS and there is no National WIGOS Implementation Plan in place outside of ambitions stated in the ABMS Strategy.

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

The entire ABMS weather station network is automated (100% covering temperature/ humidity/ pressure/ wind/ rainfall), albeit with manual-only (0% automation) parameters of cloud base/ cloud cover/ present weather/ visibility additionally being reported at VCBIA (with the whole message submitted in SYNOP/METAR form manually). The network reports in real time to the main ABMS office at VCBIA with the exception of 6 CIMH stations which are exported via satellite direct to CIMH – ABMS cannot decode or use this data directly. It is recommended that ABMS either seek resolution for CIMH data access or, if not possible, review the technical challenge of maintaining all stations where that places strain on the resources of ABMS for little or no benefit. A new AWS station has been deployed at Parham. ABMS has access to the Meteo France Guadeloupe weather radar to monitor hazards in real time.

Summary score, recommendations, and comments for Element 3

Assessed maturity score: LEVEL 3 - Moderate network with some gaps with respect to WMO regulations and guidance and with some data quality issues.

Recommendations:

- ABMS should aim to access all available data (eg CIMH) and review sustainable new approaches to the operation of existing observations networks and potential sources of new data (and sources of funding for that) in their strategy refresh
- ABMS should review its arrangements for National Focal Points and engagement with respect to WIGOS, Oscar and WDQMS

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.

Only one of the 23 Surface stations operated by ABMS is a GBON station – VCBIA. VCBIA was not compliant at the June 2023 GBON baseline assessment, but has subsequently achieved periodic compliance on WDQMS (>80%). ABMS do their best to ensure compliance but this depends on ensuring the sustainability of the station via e.g. availability of spares for maintenance. Ensuring WIS 2.0 migration using appropriate protocols is a work in progress, noting current sustainability of the dependence on a local manual interface linking to the US National Weather Service's (NWS) EDIS ([Email Data Input System](#)) for SYNOP dissemination.

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

There is no national WIGOS partnership agreement or other agreement across national government in place for open sharing of observations between ABMS and third parties. No observation data is currently being shared, other than real-time data to aviation / GBON. No climate products produced are shared and there is no formal facility or data policy in place for requests for historic records.

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

ABMS is reliant on model and satellite data from WMO partners to undertake its forecast duties with respect to tropical cyclones and other hazards. COROBAR was previously used but most third party data is now accessed through the GTS/via the internet (which can be limited and slow at times). Data is acquired through collaboration with the Severe Weather Forecasting Programme ([SWFP](#)) for the Caribbean region and the National Hurricane Centre ([NHC](#)) for information on tropical depressions, storms, hurricanes - using Region IV agreement to coordinate through RSMC Miami.

Model data includes use of the Global Forecast System ([GFS](#); 22km resolution every 6 hours) from the US National Centers for Environmental Information (NCEP), downloaded then using WINGRIDDS software to interrogate; convection capable [HRRR](#) high resolution model covers the region and the Global Ensemble Forecast System ([GEFS](#)) and Japanese Met Agency (JMA) output is also used to give some ensemble information. [ECMWF](#) products are being used (9km resolution every 12 hours), but no direct access to data to allow for own interpretation / analysis. ABMS may also look at other models at times, including MeteoFrance [AROME](#) output for region, products such as possibility of precipitation. Web services like [Windy](#) are also used to give indicative information.

Satellite information is being used from online sources, notably NASA/NOAA; Guadeloupe radar coverage is accessed online and ABMS also use observations from its own stations across island.

Summary score, recommendations, and comments for Element 4

Assessed maturity score: LEVEL 2 - 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.

Recommendations:

- ABMS should continue to engage in the Systematic Observations Funding Facility (SOFF) that can help to alleviate issues of maintaining operational GBON stations.
- ABMS should review the requirement and practicality within the context of the Antigua and Barbuda government to put in place arrangements for enhanced data sharing activities.

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.

Model data, including gridded data, charts and text, is accessed from WMCs and RSMCs as articulated above in Section 4.3. Access to these products is highly reliable and has improved over recent years. Training on use of these data sources is taken as part of vocational and regionally-provided training.

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

ABMS does not have the capability to run any models on site, instead using third party diagnostics / products as articulated in Section 4.3. There is particular focus on use of deterministic outputs to produce forecasts and warnings. These include:

- Aviation forecasts every six hours (hourly or less for Trend forecasts, on-demand for take-off forecasts)
- Aviation warnings (Aerodrome and wind shear) as required
- National 24-hour forecasts (including state of the sky, chance of precipitation, wind direction and speed, sea state, max and min temperatures, every 12 hours, with amendments as required.
- Regional 24-hour forecast (clouds, precipitation, wind and seas) every 24 hours
- National 4-day forecasts (same parameters as above) every 24 hours.
- Public weather alerts (tropical cyclones, flash floods, heat, air quality, marine (rough seas and high surfs), tornadoes/waterspouts, high wind (outside of tropical cyclones), as required.
- ABMS are also responsible for issuing tsunami alerts, though it should be noted that training and resources to adequately deliver these alerts is limited.

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

ABMS products do have some probabilistic content within their products and services (eg rain likelihood) and ensemble outputs are used to produce forecasts and warnings. ABMS use GEFS and ECMWF ensembles data, but limited interrogation is possible in house; there is no capacity to post-process NWP, but ABMS use web tools to provide i.e. Probability of Precipitation (PoP) / other diagnostics on probability information.

Summary score, recommendations, and comments for Element 5

Assessed maturity score: LEVEL 3 - 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.

Recommendations:

- ABMS should continue to periodically review their use of NWP outputs as provision by WMCs and RSMCs continues to evolve.
- ABMS would benefit by having access to marine model outputs to assist with inshore waters forecasting.

Element 6: Warning and advisory services

6.1. Warning and alert service cover 24/7.

ABMS operate a 24/7/365 warning service via a meteorologist bench shift roster, as part of a Multi Hazard Early Warning System (MHEWS) across Antigua & Barbuda. SOPs are in place for the delivery of warnings.

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

Warnings are issued by ABMS for the following events:

- Wind;
- Tropical cyclone;
- High Seas/ ;
- Rough seas in open waters, driven by the wind
- Flash-floods;
- Drought/Dry spell;
- Heat wave;
- Dust and ash pollution;

Recipients are primarily the public and other government ministries, using a number of channels including web, direct email, hotline, media centre for TV and social media. All MHEWS are produced manually and some resilience fail-safes are used to ensure warning

production occurs when required including power back up, but there is no data and internet back-up. These warnings are issued on a threshold-based approach; an internal archiving process exists for tropical cyclone and flood warnings, but performance evaluation is, however, not currently undertaken and lessons learnt are not recorded.

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.

There is a relationship in place with the National Office of Disaster Services, but not currently formalised and no SOPs are in place for delivery of warnings to relevant authorities and stakeholders. It is aimed to move to an Impact-Based Early Warning (IBEW approach), but this would require implementation including revision of SOPs, training and development. While advice on actions that can be taken to reduce risks are given in warnings, no supporting impact information or models are available and tools are currently not sufficient.

Warnings are being provided in CAP format are being provided by ABMS with the Director providing quality control prior to publication. The Smart Met Warning service (FMI) is available to ABMS, but is not operational at this time due to the resource-constrained need for revision of SOPs, training and development to implement this fully.

Summary score, recommendations, and comments for Element 6

Assessed maturity score: LEVEL 3 - Weather-related warning service with modest public reach and informal engagement with relevant institutions, including disaster management agencies.

Recommendations:

- ABMS should aim to initiate regular reviews of warning performance, both internally and based on third party feedback where possible.
- ABMS should identify a pathway towards implementing sustainable impact-based warnings via exploitation of opportunities such as the implementation of the Smart Met Warning service or GCF EW4All project.

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.

ABMS has, in the past, produced seasonal outlooks, Agrometeorology bulletin and summaries but these ceased due to staffing issues. Archiving of real time data for climate purposes is limited in scope and a fallback is employed in the completion of the (paper) daily record as a bulwark against on premise IT failure; no current data rescue activities are currently undertaken. There are no interfaces for users to access climate information outside of ABMS and no decision support products or services are able to be provided at present. The Climate products produced (above) have been used in Regional Climate Outlook Forums (RCOFs) and used a Climate Predictability Tool (CPT) to downscale using

observed information from the Islands. The RCOF and NCOF (National Climate Outlook Forum) process looks at how this is then applied at a national level.

There is no National Framework for Climate Services but the Intended Nationally Determined Contribution Plan (INDCP) has been produced and a new one is being prepared. The Department of the Environment (DoE) is the focal point within the Antigua and Barbuda government to the UNFCCC and have mainly engaged with negotiations - the IPCC focal point, however, is ABMS. There is only limited review at present of socioeconomic benefits of investment in observing networks, data management, monitoring and systems that enable the production and delivery of climate information or services.

Summary score, recommendations, and comments for Element 7

Assessed maturity level: LEVEL 1 - Less than basic Capacity to provide Climate Services

Recommendations:

- As part of their ongoing strategy refresh, ABMS should engage with the Antigua and Barbuda Department of Environment to assess national requirements for climate services and therefore the need to build an appropriate and sustainable national capability.

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.

Hydrological services are limited both within ABMS and across government and it has been questioned whether there is a specific requirement for them. Flood warnings are issued by ABMS, but, where there are no persistent rivers or bodies of fresh water, there has been seen to be no modelling requirement and focus is mainly on pluvial impacts based on statistical relationships.

Though mainly focused on access to potable water across the island through desalination, the Public Utilities Authority manage water resources in Antigua and Barbuda and they provide the designated hydrological advisor for Antigua and Barbuda to WMO. ABMS does not provide standard hydrological data and products to the Public Utilities Authority and there is no specific coordination between the two organisations.

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 no flood management plan in Antigua and Barbuda and no formalised relationship between ABMS and the Public Utilities Authority.

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

There are no data sharing agreements in place within Antigua & Barbuda or with neighbouring territories.

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

There are no current projects intended to build hydrometeorological cooperation.

Summary score, recommendations, and comments for Element 8

Assessed maturity score: LEVEL 1 - No or very little meteorological input in hydrology and water resource management.

Recommendations:

As part of their ongoing strategy refresh, ABMS should engage with the Antigua and Barbuda Government and the Public Utilities Authority to assess national requirements for hydrological services and therefore the need to build a relationship and an appropriate and sustainable national capability.

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?).

A variety of communication channels are used by ABMS to disseminate products, services and warnings at a national and local level. Email is used to disseminate forecast to other government partners. ABMS has a TV studio in place with a live link to the National Public Broadcaster for daily weather presentations and ad hoc content. A studio is also used to produce forecasts for dissemination on social media (YouTube, Twitter, Facebook). ABMS does not have an app; its website provides text forecasts and links to social media platforms. ABMS does not employ any other broadcast media. ABMS provides a hotline service on which severe weather events are recorded and accessed by the many radio stations. Interviews are given on-demand whenever something significant is about to happen.

9.2. Education and awareness initiatives in place.

ABMS engaged in some STEM-related activities and has developed relationships with education providers at a school level with some outreach and visits. World Met Day celebrations are planned, visiting schools, holding national essay writing competitions and inviting students to present weather on the TV. ABMS attend career fairs, social clubs (eg Rotary, Lions etc), insurance association, other departments, to raise careers awareness and speak around the impacts of the hurricane season.

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

Some communities have been invited to work with the ABMS to develop targeted services and ABMS have also explored different approaches where users may speak languages other than English, but, other than that, no marginalised groups have systematically been targeted for enhanced communication measures. This has primarily been a challenge of resource availability.

Summary score, recommendations, and comments for Element 9

Assessed maturity score: LEVEL 4 - A large fraction of the population is reached using various communication techniques and platforms, in collaboration with partners, and a userfriendly and informative website and apps. Outreach and education activities occur regularly.

Recommendations:

ABMS should continue to explore evolving means of communicating key warnings and engaging the community in outreach activities and are planning to employ specialist staff for this purpose.

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.

There is a national committee aimed at coordinating approaches to DRR in Antigua & Barbuda but there is no multi-sector consultative platform to foster enhanced dialogue or tailor services and no SEB studies have been undertaken on the value of hydrometeorological services. ABMS does engage with ASSI and neighbouring BOTs on aviation services, but there has been little evolution from e.g. TAFs, METARs, etc.

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

No user satisfaction surveys have been undertaken. Aviation sector service improvements are generally driven by ICAO requirements.

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

ABMS have, in part, implemented a QMS for generic meteorological services and would intend to do so for aviation services with ASSI to comply with OTAR-174– but currently unfunded so timeline for delivery is unknown. ABMS does not conduct quality management reviews for climate related activities.

Summary score, recommendations, and comments for Element 10

Assessed maturity score: LEVEL 2 - Service development draws on informal stakeholder input and feedback.

Recommendations:

- ABMS should consider as part of their strategy refresh how QMS, user satisfaction and the needs of users can be reasonably consulted and accommodated within the context of the national scenario.

Annex 1 Consultations (including experts and stakeholder consultations)

Meetings were held with the Director and Deputy Director of ABMS (Dale Destin and Lorne Salmon respectively) the Antigua & Barbuda Aviation Authority and the UNDP as part of bringing together the information underpinning this CHD.

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.

- ABMS should strive to establish a legal mandate, strategy and SLAs for its core activities
- ABMS should look to demonstrate the benefit of its services to its owner to leverage greater sustainable investment and support of human resources
- ABMS should aim to establish the requirement for and more sustainable support of climate and hydrological services within Antigua & Barbuda
- ABMS should target partnering with other organisations where possible to achieve mutually beneficial aims and offset funding challenges

Annex 3 Information supplied through WMO

The peer adviser acknowledges the guidance provided by SOFF in documents and templates throughout the Readiness phase, notably the CHD EW4All Datasheet for Antigua & Barbuda, which established a useful baseline prior to subsequent discussions with stakeholders on mission.

Annex 4 List of materials used

The peer adviser utilised the following materials:

- Various ABMS materials including: the Draft Antigua and Barbuda Met Bill (2023); Antigua and Barbuda Strategic Plan (2021); CMO Meteorology Policy; Review of Aviation Met Services provided to the East Caribbean British Overseas Territories (2023)
- Online material provided as links in this document.
- Web pages of the ABMS (<https://antiguamet.com>).
- Interview data, in person contributions and personal communication provided during the drafting of this report.

