NMHS Capacity Development Assessment

Assessing the current status and priority needs of Climate Information Services in Africa

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GFCS Global Framework for Climate Services

World Meteorological Organization

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TABLE OF CONTENTS

ACRONYMS AND ABBREVIATIONS

ACMAD	African Centre of Meteorological Application for Development
AMCOW	The African Ministers Council on Water
AMESD	The African Monitoring of Environment for Sustainable Development
AMTC	Advanced Meteorological Technicians Course
ANACIM	Agence Nationale de l'Aviation Civile et de la Météorologie (The Senegal Meteorological Agency)
APFM	The Associated Programme on Flood Management
API	Application Programming Interface
AWS	Automatic Weather Station
BSc	Bachelor of Science
CADRI	Capacity for Disaster Reduction Initiative
CAF	Cancun Adaptation Framework
CCAFS	Climate Change, Agriculture and Food Security
CDO	Climate Data Operators
CDT	Climate Data Tool
CFS	Coupled Forecast System
CICERO	Centre for International Climate and Environmental Research
CIF	Climate Investment Funds
CIS	Climate Information Service(s)
CMA	China Meteorological Administration
CMI	Chr. Michelsen Institute
COF	Climate Outlook Forum
COSMO	Consortium for Small-scale Modeling
CPC	Climate Prediction Center
CPT	Climate Predictability Tool
CREWS	Climate Risk and Early Warning Systems
CSAG	Climate System Analysis Group
DCCMS	Malawi Department for Climate Change and Meteorological Services
DFID	Department for International Development
EAMAC	L'École africaine de la météorologie et de l'aviation civile (African School of Meteorology and Civil Aviation)
ECMWF	European Centre for Medium-Range Weather Forecasts
ECRP	Enhancing Community Resilience Project
ENACTS	Enhancing National Climate Services initiative
EW's	Early Warnings
GCF	Green Climate Fund
GFCS	Global Framework for Climate Services
GFDRR	Global Facility for Disaster Reduction and Recovery
GFS	Global Forecast System
GIS	Geographic information system
G-WADI	The Global Network on Water and Development Information for Arid Lands
GWP	Global Water Partnership
GWP-Cap-Net	Global Water Partnership Capacity development Network
HWRP	Hydrology and Water Resources Programme

ICPAC	IGAD (InterGovernmental Authority on Development) Climate Prediction and Application Centre
IDMP	The Integrated Drought Management Programme
IFI	International Flood Initiative
IFM	Integrated Flood Management
IFRC/RC	International Federation of Red Cross and Red Crescent
IFRMP	Integrated Flood Risk Management Plan
IMTR	Institute of Meteorological Training and Research
IRI	International Research Institute for Climate and Society
IT	Information technology
LDCF	Least Developed Countries Fund
LDCs	Least Developed Countries
LEAP	The Livelihoods, Early Assessment, and Protection
Mbps	Megabits Per Second
MMTC	Middle Level Meteorological Technicians Course
MOUs	Memorandum Of Understanding
MSc	Master of Science
NAMA	Nationally Appropriate Mitigation Action
NAP	National Adaptation Plans
NAPA	National Adaptation Plans of Action
NCO	netCDF Operators
NFCS	National Framework for Climate Services
NGO's	Non-governmental organization
NMA	National Meteorology Agency
NMHS	National Meteorological and Hydrological Service
NOAA	National Oceanic and Atmospheric Administration
NWP	Numerical weather prediction
PhD	Doctor of Philosophy
PI	Principal Investigator
PPCR	The Pilot Programme on Climate Resilience
PRESAL	Renforcement de la gestion des terres et des écosystèmes des Niayes et de la Casamance dans un contexte de changements climatiques (UNDP)
PRESAO	PRÉvisions Saisonnières en Afrique de l'Ouest - RCOF for West Africa
PUMA	Preparation for Use of MSG (Meteosat Second Generation) in Africa
QC	Quality Control
RCOFs/NCOFs	Regional and National Climate Outlook Forums
RMTC	Regional Meteorological Training Centre
SADC CSC	Southern African Development Community Climate Services Centre
SARCOF	The Southern African Regional Climate Outlook Forum
SCAM	Specialized Course in Aviation Meteorology
SCF	Strategic Climate Fund
SMS	Short Message Service
SOP	Standard Operating Procedures
SRBMP	Shire River Basin Management Programme
SSA	Sub-Saharan Africa
ToT	Training of Trainers
UKMO	United Kingdom Met Office
UMTS	Universal Mobile Telecommunications System

UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNFCCC	United Nations Framework Convention on Climate Change
UNISDR	United Nations International Strategy for Disaster Reduction
UN-REDD	United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries
USAID	United States Agency for International Development
V&A	Vulnerability and Adaptation
VSAT	Very Small Aperture Terminal
WACDEP	The Water, Climate and Development Programme
WCIDS	Weather and Climate Information and Decision-Support Systems
WFP	World Food Programme
WHO	World Health Organization
WMO	World Meteorological Organization
WRF	Weather Research and Forecasting

EXECUTIVE SUMMARY

Following the establishment of the Global Framework for Climate Services (GFCS) in 2009, the need to deliver climate services has become mainstream (and expected) amongst National Meteorological and Hydrological Services (NMHSs). This expected delivery of climate services includes the appropriate engagement and capacity development of users of climate information. The delivery of user-relevant climate information is one of many roles performed by NMHSs; however, many do not have the expertise or capacity required in order to perform deep engagement between providers and users. This problem is exacerbated by an uneven distribution of scientific capacity, globally, with Africa being underdeveloped in this respect.

The following brief provides high-level recommendations from a project aimed at working with NMHSs to a) identify capacity gaps in delivering climate information services and b) identify priority interventions aimed at bridging the identified gaps. The project focuses on seven countries including, Senegal, Ethiopia, Rwanda, Malawi, Mali, Cote d'Ivoire and Niger. This work is part of the larger USAID funded Sustainable Climate Information Services Project (Sustainable CIS project).

Identification of capacity gaps and recommendations for country-specific interventions

The assessment of capacity in developing climate information services was structured around the five GFCS pillars, namely: Climate Services Information System, Capacity Development, Research and Prediction, Observation and Monitoring and User Interface Platform. The study did not analyze how NMHSs can raise revenue or form partnerships to address these gaps. Another part of the Sustainable CIS project is developing a financial planning tool[1] to help NMHSs in this regard.

The following describes the specific capacity gaps in each country evaluated as well as specific recommendations for filling them.

Ethiopia:
The Ethiopia NMHS performs well under the Climate Services Information System pillar and moderately well for the Capacity Development and Research and Prediction pillars. Capacity gaps exist under the Observation and Monitoring and User Interface Platform GFCS pillars.

To further strengthen this NHMS climate services provision capacity it is recommended that the NMHS prioritizes **implementing its strategic plan** to modestly expand surface and upper air stations, enhance the units satellite data reception and processing system. Priority should be made for the **development of a staff training protocol/program**. Such a program would further improve staff capacity in engagement with users of climate information, ensuring the production of relevant information and the effective communication of such information. Additionally, priority should be made for the **development of IT skills and bandwidth upgrades** to ensure the NMHS is able to produce and communicate forecasts.

[1] The financial planning tool is under development and will be available on www.climatelinks.org in late 2018.

Cote d'Ivoire:
The Cote d'Ivoire NMHS is found to have major capacity gaps across the board with regards to its performance under each of five pillars of the GFCS. However, the NMHS is making progress under the Research and Prediction pillar.

It is recommended that this NMHS prioritizes the **expansion of surface and upper air stations**. Additionally, training is imperative to ensure these stations are monitored by trained observers. **Capacity development** is needed for weather monitoring, weather and seasonal predictions and user engagement. The **NMHS should engage relevant government structures** and participate in policy development and planning related to the climate. The NMHS should **improve their internet presence** to create channels for communication.

Malawi:
The Malawi NMHS performs well under the Climate Services Information System pillar and is making progress under the Research and Predictions and User Interface Platform pillars. Major capacity gaps exist under the Observation and Monitoring and Capacity Development GFCS pillars.

It is recommended that this NMHS prioritizes **investment into the expansion of surface and upper air stations**. Optimally, this should be accompanied by the use of a **climate database management system** and quality control practices. It is suggested that the NMHS **strengthen their research capacity** by creating a clear research agenda and incentivizing further technical and academic training for staff. The **seasonal prediction products of the NMHS should be enhanced**. Additionally, the NMHS needs **improvements and development in IT infrastructure and personnel**, particularly in terms of providing uninterrupted power supplies and better bandwidth.

Mali:
The Mali NMHS performs well under the Climate Services Information System and User Interface Platform pillar and moderately well for the Capacity Development. Capacity gaps exist under the Observation and Monitoring and Research and Prediction GFCS pillars.

It is recommended that this NMHS prioritizes the expansion of surface station network with a significant **increase in the number of Automatic Weather Stations (AWS)**. The NMHS should also prioritize the **development and training of meteorological technicians and forecasters**. Additionally, **upgrades to current IT infrastructure and personnel** is suggested**.**

Niger:
The Niger NMHS is found to have major capacity gaps across the board with regards to its performance under each of five pillars of the GFCS. However, the NMHS is making progress under the Climate Services Information System pillar.

It is recommended that this NMHS prioritizes the **expansion of surface and upper air stations**, with a specific focus on Automatic Weather Stations (AWS). A **strategic 5-year plan that addresses human capacity development in terms of forecasting, climate services, user engagement, hardware and software development** is suggested. Furthermore, priority should be given to the **training and development of senior forecasters and personnel skilled in user engagement**.

Rwanda:
The Rwanda NMHS performs well under the Climate Services Information System and User Interface Platform pillar. The NMHS performs moderately well for the Capacity Development, Research and Prediction, and Observation and Monitoring GFCS pillars.

To further strengthen this NHMS climate services provision capacity it is recommended that the NMHS prioritizes the **expansion of upper air stations and more frequent data backup.** The NMHS should also **prioritize the capacity development of forecasters and personnel skilled in user engagement** including an effort to train or recruit a climate services specialist. The NMHS also requires **an upgrade to the current IT infrastructure and personnel.**

Senegal:
The Senegal NMHS performs well under the Climate Services Information System pillar and moderately well for the Capacity Development and User Interface Platform pillars. Capacity gaps exist under the Observation and Monitoring and Research and Predictions GFCS pillars.

It is recommended that this NMHS prioritizes investment into the **improvement and expansion of observation stations**. The NMHS together with Senegalese and international research institutions should **engage in and incentivize research**. The **seasonal prediction products** of the NMHS should be enhanced.

High-level priority capacity development interventions recommended for all NMHS in the project

Based on the country analyses, there are three priority recommendations that apply to all NMHSs studied.

Priority 1: Expand weather monitoring networks.

Expanding observation stations networks and training staff in data quality control will generate more data to aid climate services. This should include the establishment of funding mechanisms which can assist with the operating and maintenance (O&M) costs of these station networks and the provision of standard, accessible and freely available databases. **The expansion of such networks should be based on the required use of the data**. For example: climate monitoring requires accurate information, whereas early warning systems necessitate receiving data in real time, with less emphasis on high accuracy. **Combining remotely sensed data** (e.g. from satellites, radar, lightning) and data from weather stations, buoys, planes and upper air monitoring, **can help expand monitoring coverage** with reduced O&M costs.

Priority 2: Produce and communicate quantitative medium range forecasts (3-10 days)

Medium range forecasts are challenging to produce without appropriate computational infrastructure and qualified personnel. However, available online data, for example from the **Global Forecast System (GFS)** can be either physically or statistically downscaled. In most cases, **NMHS staff need to be trained** to make use of existing forecasts, combine different sources of data, and use

existing software tools to produce and disseminate local products. **Bandwidth is an additional noteworthy constraint in Africa (as is its cost)**. The bandwidth needed to access forecast data (especially for downloading model boundary conditions) is sometimes beyond the budget of many African NMHS. Moreover, **investments are needed in hardware and expertise** in order to physically downscale global forecasts. Statistically downscaling forecasts is a computationally easier option in many cases, but requires extensive skills training to enable staff to derive the fundamental equations that underpin any statistical downscaling.

Priority 3: Develop staff capacities for research, development of user-orientated products and communications

Most NMHS are understaffed in terms of technically qualified research and development personnel, as well as staff capable of engaging climate information users, understanding their needs and translating those needs into research and development tasks. This is due to both a limited number of technical staff (who often have little time to spend on research and development), as well as very few staff who are trained to engage users in multidisciplinary environments and develop products based on their needs. **It is recommended that NMHSs recruit and develop new and young staff to fill these positions as well as train existing staff who can supervise the research and development of new products.** In some cases, this may mean restructuring groups within the NMHS to take advantage of existing expertise (e.g., in Agrometeorology), but these research and development groups should be able to cover product development across a wide range of sectors and users.

Common barriers and suggested solutions to implementing priority interventions

There are several barriers to addressing the priority interventions listed above (besides direct investment in equipment and technologies). These are detailed below along with suggested solutions:

- **Governmental finances and budgets allocated to NMHS**. Limited budgets place a burden on salaries, as well as the operation and maintenance of equipment and forecasting systems;
  Lobbying government ministries, including finance ministries, can help to elevate the importance assigned to NMHS, especially in dealing with disasters and providing useful information to sectors including aviation. This helps NMHS when requesting increased funds.
- **Freezes on recruitment tied to available budgets.** Some NMHS are prevented from recruiting new staff, limiting their ability to expand and develop new products and services;
  Again, lobbying government for extra funds to recruit more staff can help, as well as restructuring existing staff and groups within the NMHS. A formal strategy to develop services and associated staff can help to understand what positions are needed.
- **Institutional mandates and cooperation, including data sharing**. In the development of climate services, NMHS are often required to work with other government departments, NGOs/CSOs and the private sector. This requires flexibility in attitudes to mandates and institutional cooperation, which is sometimes difficult within rigid government structures;
  Enter into memorandums of understanding/agreement with external organizations to share data and develop new products, as well as engage different users of climate information. Undertake joint work based on these MoUs/MoAs.

- **Short-term project-based funding from external donors**. This can stretch the capacity of NMHS to satisfy project requirements when several projects are ongoing at the same time. It can also result in uncoordinated development of technical and human capacities, which dissipate when project funding finishes.
  Formally convene a strategic oversight group within the NMHS to coordinate donor funding, based on a strategic plan for the development of the NMHS.

For NMHSs to be able to deliver effective climate services, it is clear that these barriers need to be tackled in tandem with investments in technical capacities and access to modern state of the art equipment. Indeed, if these barriers are not addressed at the same time as investments in equipment and technology, then it is likely that such investments will ultimately either fail or not lead to the service they were intended to provide. However, by addressing these barriers, providing access to newer and improved technologies (including lower cost instruments where appropriate), developing core capacity to undertake research and development of user-orientated products, NMHSs in Africa could provide climate services which serve their populations and help drive future development.

1. INTRODUCTION

Since the institution of the Global Framework for Climate Services (GFCS) in 2009, the need to deliver climate services has become mainstream (and expected) amongst National Meteorological and Hydrological Services (NMHSs) and Climate Science Research Institutions. This has coincided with an increased demand for climate information, particularly from a politico-institutional level, driven, in part by reporting requirements under the United Nations Framework Convention on Climate Change (UNFCCC) (COP19, 2013), the Sendai framework for disaster risk reduction (UNISDR, 2015), and the 2030 agenda for sustainable development[2].

In addition, the GFCS framework expects the development of climate services to include appropriate engagement and capacity development of users of climate information. However, the delivery of user-relevant climate information has not been effective in the past. Many NMHSs and climate science research institutions do not have the expertise or capacity required to deliver climate information meaningfully through appropriate engagement with providers and uses. This is exacerbated by an uneven distribution of scientific capacity, globally, to develop and deliver climate information services with an underdevelopment of scientific capacity in Africa (Hewitson, 2015).

In recognition of the need to build capacity to effectively provide climate information services for rain-fed agriculture, United States Agency for International Development (USAID) implemented a learning agenda to better understand how to develop effective, sustainable country-led climate information service programs in Sub-Saharan Africa – the I.LEARN.CIS (Climate Information Service) research program. The Winrock-led Assessing Sustainability and Effectiveness of Climate Information Services in Africa (the Sustainable CIS project) is a recipient of funding from the I.LEARN.CIS program.

Assessing Sustainability and Effectiveness of Climate Information Services (CIS) in Africa Sustainable CIS project

The aim of the Sustainable CIS project is to conduct research to better understand how to design and implement sustainable CIS models within and alongside NMHSs. The project is led by Winrock International and has four partnerships with the International Research Institute for Climate and Society (IRI), the Climate System Analysis Group (CSAG), the AGRHYMET Regional Center, and the GFCS. The overall project objective is to develop models and options for the sustainable delivery of CIS in Sub-Saharan Africa (SSA), and to consolidate and extend knowledge on existing CIS in SSA. These project outputs will be geared toward the identification and improvement of existing CIS programs provided by the public and private sectors, as well as design and assess potentially new CIS not yet implemented, but relevant to develop within local contexts.

The project has three components of work:

1.) A sustainability assessment, which develops an evaluation approach to assess the capacities of NMHS to deliver CIS over time, conducts a baseline assessment of select NMHS, and advises how to bridge existing gaps.
2.) Identification of options to improve the sustainability of CIS. This includes an assessment of the market for CIS in SSA, private sector models that participate in CIS, and development of

[2] https://sustainabledevelopment.un.org/post2015/transformingourworld

sustainable financial models (or guiding principles) for CIS delivery in SSA.

3.) Partnership building, synthesis, sharing and uptake of knowledge and lessons learned.

This report contributes to the first component and draws on the completed baseline assessments[3] by Dinku *et al.* (2018) from each NMHS, together with the metrics developed to assess effectiveness and sustainability of NMHS's to deliver CIS. The report focusses on the seven countries of Senegal, Ethiopia, Rwanda, Malawi, Mali, Cote d'Ivoire, and Niger.

Objectives of this study

This study aims to report on the current capacity within each assessed NMHS to deliver effective CIS *(chapter 2&4)*. The gap between this current capacity and optimum/desired capacity is then assessed *(chapter 4)*. Capacity deficits are prioritized and matched to suitable and cost-effective capacity development initiatives that could be utilized to sustainably increase capacity of African NMHS's to effectively deliver CIS *(chapter 5)*. The methodological approach to assessing and identifying capacity development needs is described in *chapter 3*.

To inform the report, the following steps were undertaken:

- Previous capacity development initiatives at each of the NMHS's in the study were reviewed and documented
- Survey results reporting on each of the GFCS pillars were analyzed to identify capacity gaps
- A desktop review of available capacity development initiatives
- An expert prioritization of capacity development needs
- Priority capacity development needs were matched to appropriate interventions such as existing capacity development initiatives and/or additional recommendations (such as potential institutional partnerships).

[3] The baseline assessment identifies NMHS existing capacities within each of the five pillars of the GFCS. This baseline assessment was conducted through a comprehensive survey conducted within each of the 7 NMHS's included in the project. Survey questions included 11 themes including capacity pertaining to; communication, user interaction, research, NMHS governance, observation and monitoring, remote sensing, computing, data, climate services, staff qualifications and finance. The methodology and results of this baseline study are detailed in a separate report.

2. NMHS CAPACITY DEVELOPMENT INITIATIVES TO DATE

There has been an extensive range of capacity building initiatives for National Hydrological and Meteorological Services (NHMS) in Africa. They target regional to national scales, are often managed by multilateral, bilateral and non-governmental organizations, utilize a wide range of funding mechanisms including both grants and loans from climate and development funds. Often, they will include a range of activities related to NHMS operations, including investment in both infrastructure (e.g. gauging stations, atmospheric observations, forecasting systems etc.) and human capacity. These activities include: improving weather and seasonal forecasting; improving the ability to translate weather and seasonal forecasts into flood and agricultural impacts (as well as other sectors); establishment/strengthening and operationalizing of early warning systems; development of hazard mapping and related vulnerability mapping; strengthening service delivery of weather, climate and hydrological information; and strengthening engagement with institutions involved in using weather and climate information e.g. Ministries of water, agriculture and disaster preparedness. The links between different sectors often depends on both the current facilities, the demand or need for information/activities, the development state of the country, as well as the availability of qualified personnel to undertake activities.

It is not possible to cover all previous initiatives, but Table 1 provides relevant examples of some of the multi-country/regional projects and recent initiatives specific to some of our target countries. From an international/regional perspective the following are relevant:

Multi-country/regional projects and supporting initiatives	Description
Support for participation in Regional and National Climate Outlook Forums (RCOFs/NCOFs). Wide range of funders including USAID.	RCOFs produce consensus-based, user-relevant climate outlook products in real time to reduce climate-related risks and support sustainable development for the coming season in sectors of critical socioeconomic significance for the region in question.
Global Framework for Climate Services (GFCS) of the World Meteorological Organization (WMO)	GFCS provides a worldwide mechanism for coordinated actions to enhance the quality, quantity and application of climate services.
United Nations Development Programme (UNDP) – strengthening climate information and early warning systems in Africa	UNDP, with funding through the Global Environment Facility, the Green Climate Fund and bilateral donors is supporting the development of climate information (CI) and Early Warning Systems (EWS) across Africa, Asia and the Pacific to help them respond to both short-term/rapid onset climatic hazards (e.g. cyclones, floods and storms), as well as long-term/slow onset hazards (e.g. drought and long-term climate change).
Africa Hydromet Programme	With funding from the Green Climate Fund this programme is strengthening the adaptive capacity and climate resilience of vulnerable communities by developing hydro-meteorological weather warning services to support adaptation planning.
Climate Risk and Early Warning Systems (CREWS) implemented by WMO, Global Facility for Disaster Reduction and Recovery (GFDRR), World Bank and United Nations International Strategy for Disaster Reduction (UNISDR)	The CREWS initiative supports Least Developed Countries (LDCs) and Small Island Developing States (SIDS) to significantly increase the capacity to generate and communicate effective, impact-based, multi-hazard, gender-informed early warnings to protect lives, livelihoods, and assets.

Multi-country/regional projects and supporting initiatives	Description
Hydrology and Water Resources Programme (HWRP)	HWRP promotes the effective use of hydrology in sustainable development to reduce the risk and impacts of water-related disasters and to support effective environmental management at international, regional, national and basin levels.
International Flood Initiative [IFI, United Nations Educational, Scientific and Cultural Organisation (UNESCO) and WMO)	The overall aim of the initiative is to build capacity in countries to understand and better respond to floods by taking advantage of their benefits while at the same time minimizing their social, economic and environmental risks.
The Pilot Programme on Climate Resilience (PPCR of the World Bank), implemented jointly with the African Development Bank, and the World Bank Group	The PPCR is funded by the Strategic Climate Fund (SCF), one of the two Climate Investment Funds (CIF). It is designed to demonstrate ways that developing countries can make climate risk and resilience part of their core development planning. It helps countries build on their National Adaptation Programs of Action and helps fund public and private sector investments identified in climate resilient development plans.
Global Facility for Disaster Reduction and Recovery - GFDRR Hydromet Weather and Climate Information and Decision-Support Systems [Weather and Climate Information and Decision-Support Systems (WCIDS)]	GFDRR provides analytical work, technical assistance, and capacity building to help vulnerable nations improve resilience and reduce risk.
UNDP/ Global Water Partnership Capacity development Network (GWP-Cap-Net): Capacity Building for Integrated Water Resources Management	GWP-Cap-Net UNDP is an international network for capacity development in sustainable water management. It is made up of a partnership of autonomous international, regional and national institutions and networks committed to capacity development in the water sector.
The Associated Programme on Flood Management (APFM)	The APFM is a joint initiative of the (WMO) and the Global Water Partnership (GWP). It promotes the concept of Integrated Flood Management (IFM) as a new approach to flood management.
The Integrated Drought Management Programme (IDMP)	Integrated Drought Management mitigates drought risk and builds drought resilience by addressing multiple components of drought management, including disaster risk reduction, climate adaptation strategies and national water policies. Integrated Drought Management accounts for the needs of all stakeholders affected by drought. In 2013, the WMO and the GWP launched the IDMP to address drought issues more effectively. IDMP provides advice and guidelines to communities, countries and regions affected by drought through the Integrated Drought Management Help Desk.
Water, Climate and Development Programme for Africa (WACDEP) – a joint program between the GWP and the African Ministers Council on Water (AMCOW)	The WACDEP aims to integrate water security and climate resilience in development planning processes, build climate resilience and support countries to adapt to a new climate regime through increased investments in water security.
The Global Network on Water and Development Information for Arid Lands [G-WADI (UNESCO)] initiative	G-WADI is an initiative of UNESCO's International Hydrological Programme whose mission is to strengthen the capacity to manage the water resources of arid and semi-arid areas around the globe through a network of international and regional cooperation.
The National Adaptation Plans of Action (NAPA)	NAPAs provide a process for LDCs to identify priority activities that respond to their immediate needs to adapt to climate change, ultimately leading to the implementation of projects aimed at reducing the economic and social costs of climate change.

Multi-country/regional projects and supporting initiatives	Description
The National Adaptation Plans (NAP)	The NAP process was established under the Cancun Adaptation Framework (CAF). It enables Parties to formulate and implement NAPs as a means of identifying medium- and long-term adaptation needs and developing and implementing strategies and programs to address those needs. It is a continuous, progressive and iterative process which follows a country-driven, gender-sensitive, participatory and fully transparent approach.
National Communications to UNFCCC, including vulnerability and adaptation assessments	These are reporting requirements for signatories to the UNFCCC Non-Annex I Parties are required to submit their first NC within three years of entering the Convention, and every four years thereafter.
Customized products for the International Federation of Red Cross and Red Crescent (IFRC/RC) Societies	These have been developed through partnerships with the International Research Institute (IRI) at Columbia University; National Oceanic and Atmospheric Administration, National Aeronautics and Space Administration, the Dartmouth Flood Observatory and African Centre of Meteorological Application for Development.

Table 1 Capacity building initiatives for Climate Information Services

These ongoing efforts have built experience, learning, and communities of practice, albeit within small numbers of NHMS staff with often rapid turnovers in key positions. This is often a consequence of a lack of technological skills in many countries, and that NHMS staff are often paid government salaries which cannot compete with private sector salaries for similarly qualified personnel. Naturally, under such circumstances, technical staff will move to either the private sector (especially technology companies such as telecoms, internet service providers etc.), or international organizations such as Non-governmental organization (NGO's) and multilateral aid organizations. The promotion of experts to managerial positions also depletes institutions of technical expertise. Unfortunately, this drain on capacity means that initiatives often repeat similar trainings for new personnel, preventing a critical mass of capacity being developed, further limiting prospects for developing in-house training within each organization and increasing the need for external consultants. This situation is likely to persist as long as the pool of qualified personnel remains low.

The impact of these initiatives on a particular NHMS depends on whether they see a practical benefit to their everyday work and the capacity of individual countries to respond to and accommodate the initiatives. This includes their capacity for financial management, resource allocation and extra staff to take on extra assignments/work. NMHS engagement is likely to increase if the NHMS has been significantly and materially involved in the design of the project and can see an immediate benefit to their everyday operations. Active participation is less likely if they are required to provide data and analyses for a project which they were not initially aware of, for which they receive no benefits, or if it involves providing data to third parties. Country commitments to international processes such as those under the UNFCCC are usually given a high priority. Some of these initiatives, such as National Adaptation Plans of Action (NAPAs), National Adaptation Plans (NAP'S) and Vulnerability and Adaptation (V&A) assessments under the UNFCCC, whilst requiring the participation of the NHMS, often focus on historical data analysis, hazard and risk assessments or developing future climate scenarios. These are specialized applications and whilst they help build capacity in data analysis (and in particular promotes interactions with sectoral users) these skills are not always pertinent to the typical daily activities of NHMS (though they could be if multi-hazard risk assessment were to become part of disaster risk management processes). The development of close relationships between NHMS and sectoral users is an iterative and evolutionary process.

The following (Table 2) provides country-specific initiatives (including both internal and development-related projects), that have recently been building capacity in aspects of CIS. Many of the projects are cross sectoral and cross cutting in terms of the GCFS pillars that they address and therefore have not been classified in terms of the pillars they support. Rather they take a problem/service orientated focus, requiring investments in all pillars of the GFCS to address CIS delivery constraints.

<table>
<tr><th colspan="4">Ethiopia</th></tr>
<tr><th>Observing networks</th><th>Data analysis and processing</th><th>Forecasting and predictions</th><th>Service delivery</th></tr>
<tr><td rowspan="3">Training on the utilisation of installed meteorological stations.

Implementing partner/funder:
Promoting autonomous adaptation at the community level in Ethiopia Project (UNDP)</td><td rowspan="3">Training on Geographic information system (GIS) and Linux; Matlab and R; Fortran; IRI Data library.

Implementing partner/funder:
Self-funded</td><td>Training on Climate Predictability Tool (CPT); Climate Data Operators (CDO) and netCDF Operators (NCO); Weather Research and Forecasting (WRF).

Implementing partner/funder:
Self-funded</td><td>Investment in the national meteorological infrastructure through the installation of automated weather stations.

Implementing partner/funder:
The Livelihoods, Early Assessment, and Protection (LEAP) food security early warning tool of the World Food Programme (WFP) and the World Bank.</td></tr>
<tr><td rowspan="2">Training on Seasonal climatic information and risk management (concepts of climatic information and risk, climatic indicators and variables, climatic decisions, types of risk and risk management options).

Implementing partner/funder:
The Coping with Drought and Climate Change Project (UNDP)</td><td>Undertake training of small holder farmers and kebele development agents so that they can interpret and use weather information.

Implementing partner/funder:
Promoting autonomous adaptation at the community level in Ethiopia Project (UNDP)</td></tr>
<tr><td>Series of induction training seminars for agricultural extension workers and meteorological personnel.

Implementing partner/funder:
A Training of Trainers on Weather and Climate Information and Products for Agricultural Extension Services in Ethiopia Project</td></tr>
</table>

Cote d'Ivoire			
Observing networks	**Data analysis and processing**	**Forecasting and predictions**	**Service delivery**
On-the-job training in **Operational Climatology, Agrometeorology** at ACMAD, AGRHYMET (Niger), National Oceanic and Atmospheric Administration (NOAA) / Climate Prediction Center (CPC), Washington DC (United States of America), and Turkey. *Implementing partner/funder:* Self-funded	**Courses on** Operational Agroclimatology, Operational Climatology **and** Satellite meteorological applications. *Implementing partner/funder:* Self-funded	Attended short courses in **seasonal forecasting** at African Centre of Meteorological Application for Development (ACMAD) and AGRHYMET *Implementing partner/funder:* PRÉvisions Saisonnières en Afrique de l'Ouest - RCOF for West Africa (PRESAO) process.	
Courses on Agrometeorology. *Implementing partner/funder:* Self-funded		On-the-job training in **Seasonal Climate Prediction** at ACMAD, AGRHYMET (Niger), National Oceanic and Atmospheric Administration (NOAA) / Climate Prediction Center (CPC), Washington DC (United States of America). *Implementing partner/funder:* Self-funded	
		Courses on **Seasonal Forecasts, Use and interpretation of numerical weather forecasts for Africa and Maritime forecasts.** *Implementing partner/funder:* Self-funded	

Malawi			
Observing networks	**Data analysis and processing**	**Forecasting and predictions**	**Service delivery**
Courses on **advanced meteorological technician**, **postgraduate diplomas in meteorology** and courses on **electrical and electronics engineering.** ***Implementing partner/funder*** Institute of Meteorological Training and Research (IMTR, Nairobi), University of Nairobi, University of Malawi, the Polytechnic **All courses paid by donors (not specified)**	**Courses on** applied meteorology and computer sciences. ***Implementing partner/funder*** University of Reading (UK). University of Malawi, the Polytechnic. Funded by donor (not specified) and Malawi government.	Attended short courses on **seasonal forecasting** at Institute of Meteorological Training and Research (IMTR) and Southern African Development Community Climate Services Centre (SADC CSC). *Implementing partner/funder:* The Southern African Regional Climate Outlook Forum (SARCOF).	Development of **user-driven climate services for food security, health, as well as disaster risk reduction.** *Implementing partner/funder:* The GFCS- The Climate Services Adaptation Programme in Africa implemented by World Meteorological Organization (WMO), IFRC, WFP, World Health Organization (WHO), Centre for International Climate and Environmental Research (CICERO), Chr. Michelsen Institute (CMI) and Climate Change, Agriculture and Food Security (CCAFS) under the GFCS
Establishment of a **network of automatically reporting meteorological and hydrological monitoring stations**. In addition, the program developed **early warnings and alerts, including the use of mobile applications to disseminate warnings.** *Implementing partner/funder:* The Strengthening climate information and early warning systems in Eastern and Southern Africa for climate resilient development and adaptation to climate change – Malawi (UNDP, 2013-2017, $3.6million), funded	**Supported development of** hydrological modelling for the Shire basin. *Implementing partner/funder:* The Integrated Flood Risk Management Plan (IFRMP) (World Bank, 2012-2018, $3.9 million) for the Shire Basin is a component of the $100 million World Bank Shire River Basin Management Programme (SRBMP).	**Investments in hydro-meteorological capacity for early warnings (EWs) and forecasting, development and dissemination of tailored products.** These products include those for smallholder farmers and fishers, thereby strengthening capacities of communities to respond to climate-related disasters. *Implementing partner/funder:* The Green Climate Fund (GCF)-funded project Saving Lives and Protecting Agriculture based Livelihoods in Malawi: Scaling Up the Use of Modernized Climate Information and Early Warning Systems (2015).	

through Least Developed Countries Fund (LDCF).		**Supported d**evelopment of the **downscaling and seasonal forecasts at the NHMS.** *Implementing partner/funder:* The Integrated Flood Risk Management Plan (IFRMP) (World Bank, 2012-2018, $3.9 million) for the Shire Basin is a component of the $100 million World Bank Shire River Basin Management Programme (SRBMP).	
		Development of **flood and drought early warning systems** with a focus on mitigation and risk reduction initiatives in 11 vulnerable districts. *Implementing partner/funder:* The Enhancing Community Resilience Project (ECRP, 2011-2016, US$1.36 million) was funded largely by the British Department for International Development (DFID).	
Mali			
Observing networks	**Data analysis and processing**	**Forecasting and predictions**	**Service delivery**
Short-term professional trainings including: International seminar on **climate system and climate change**, China Meteorological Administration (CMA), China (Beijing) *Implementing partner/funder:* Unknown	**Short-term professional trainings including:** **Training on** climate data management **in the Tchek republic** *Implementing partner/funder:* Unknown **Training on** climate data management by Meteo France International (MFI) **in Toulouse, France.**	**Short-term professional trainings including:** Various training workshops organized by the AGRHYMET regional Center on **crop water balance and yield forecasting models, GIS and Mapping, seasonal forecasting** *Implementing partner/funder:* Unknown	Strengthened to generate and use climate, geotechnical and socio-economic data to support the monitoring and projection of climate risks. *Implementing partner/funder:* Program for the Support of the National Strategy for Adaptation to Climate Change in Mali.

Training on **station Synergie** by Meteo France International (MFI) in Toulouse, France *Implementing partner/funder:* Unknown **Satellite Images** at EAMAC, Niger. *Implementing partner/funder:* Unknown	*Implementing partner/funder:* Unknown	**Short range forecast** at NOAA *Implementing partner/funder:* Unknown **Weather forecast** for mid altitude regions at Météo France *Implementing partner/funder:* Unknown Workshop on **climate variability and prediction**, Ankara Turkey. *Implementing partner/funder:* Unknown	**Short-term professional trainings including:** Training on **public weather service**, CMA, China (Beijing) *Implementing partner/funder:* Unknown Training course on **climate service for disaster prevention**, Florence, Italy. *Implementing partner/funder:* Unknown
Niger			
Observing networks	**Data analysis and processing**	**Forecasting and predictions**	**Service delivery**
Engineering diplomas in instrument and micro-computing. *Implementing partner/funder:* AGRHYMET Regional Centre, Niamey (Niger)			Attended the GFCS/NOAA International Climate Training Workshop **short-term professional training on climate services**. *Implementing partner/funder:* Organized by NOAA and ACMAD. Attended a training workshop on the **development of climate services for disaster prevention.** *Implementing partner/funder:* IBIMET.

Rwanda			
Observing networks	**Data analysis and processing**	**Forecasting and predictions**	**Service delivery**
BSC in Meteorology, **Advanced Meteorological Technicians Course** (AMTC), **Middle level meteorological Technicians Course** (MMTC), **MSC in AgroMeteorology**, and **Specialized Course in Aviation Meteorology** (SCAM) *Implementing partner/funder:* WMO Regional Training Center in Nairobi.	**Workshops and trainings topics include: different** modelling techniques**,** training on weather radar and remote sensing data interpretation**,** training on CPT**,** training on Climate Data Tool (CDT)**,** climate modelling **and** ArcGIS **applications** Implementing partner/funder: WMO sponsored via Regional Meteorological Training Centre (RMTC).	Training in **production of seasonal outlooks**. *Implementing partner/funder:* IGAD (InterGovernmental Authority on Development) Climate Prediction and Application Centre (ICPAC).	
Senegal			
Observing networks	**Data analysis and processing**	**Forecasting and predictions**	**Service delivery**
Training on **satellite meteorology**. *Implementing partner/funder:* ACMAD / AGRHYMET.		Attendance of capacity building workshops including the preliminary trainings organized in parallel with regional fora on **seasonal forecasting.** *Implementing partner/funder:* PRÉvisions Saisonnières en Afrique de l'Ouest - RCOF for West Africa (PRESAO).	Training on **project management and web development.** *Implementing partner/funder:* ACMAD / AGRHYMET.

Training of at least 25 officers from the Regional meteorological department, to **maintain and repair equipment, computer infrastructure and telecommunications, including cost -effective technologies to interface with existing equipment/software.** *Implementing partner/funder:* Renforcement de la gestion des terres et des écosystèmes des Niayes et de la Casamance dans un contexte de changements climatiques (PRESAL) – UNDP project		Training on **seasonal forecast**. *Implementing partner/funder:* ACMAD / AGRHYMET.	

Table 2 Country-specific relevant capacity development initiatives

3. METHODOLOGICAL APPROACH TO ASSESSING AND IDENTIFYING CAPACITY DEVELOPMENT NEEDS

Approaches to needs assessments

According to Altschuld (2004), Kaufman (1994), and Watkins & Kaufman (1996) a need is the gap or discrepancy between current performance and desired performance. By definition a needs assessment is 'a systematic process for determining and addressing needs, or "gaps" between current conditions and desired conditions or "wants"' (Kizlik, 2010) (See figure 1). There are a number of well-known books particularly concerning the theoretical underpinnings and ways of implementing needs analyses (Kaufman, 1994; Soriano, 1995; Reviere, Berkowitz, Carter & Ferguson, 1996; Altschuld & Witkin, 1999). A capacity needs assessment is an essential step that leads an organization (or unit) to put organizational structures, trainings, teachings and/or management systems in place, leading to performance improvement solutions. These solutions empower individuals and ultimately the organization (or unit) as a whole. Capacity needs assessments enhance monitoring and evaluation through the creation of an analysis baseline, thereby enabling one to track progress. Such an assessment can also create an awareness and a desire for transformation and restructuring (Stephen & Triraganon, 2009).

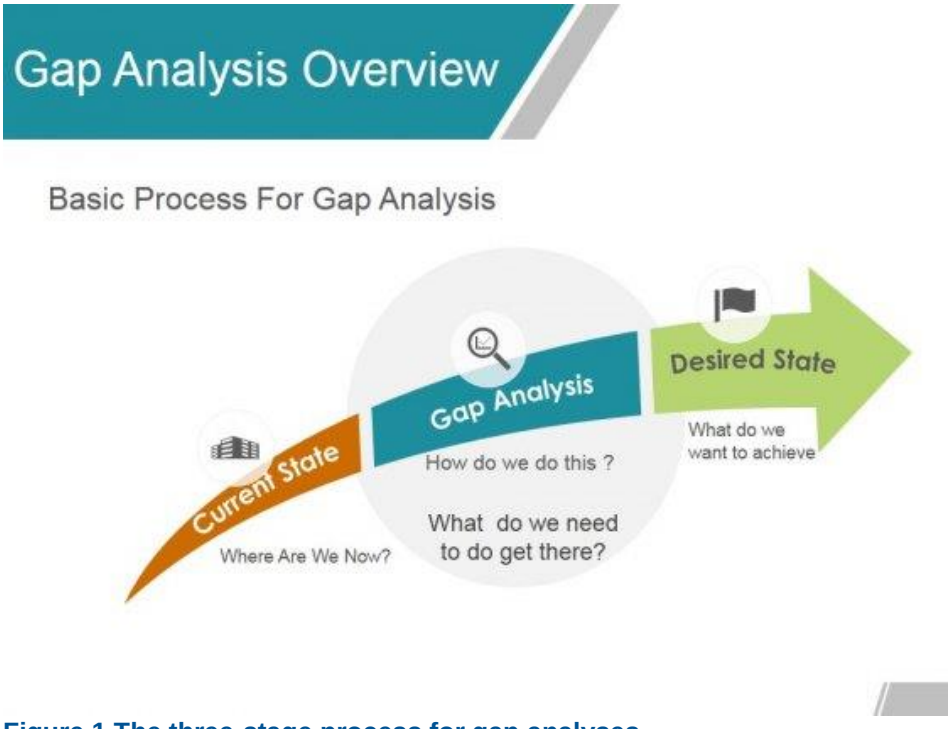

Figure 1 The three-stage process for gap analyses

An overview of capacity development

A broad definition for capacity is the ability to perform tasks and produce outputs, to define and solve problems, and to make informed decisions and choices (European Commission, 2007). According to

the Capacity for Disaster Reduction Initiative (CADRI)[4] capacity should be viewed from three distinct but related perspectives:

- **Individual**: the skills and knowledge vested in individuals, communities and groups.
- **Organizational**: the internal policies, systems and strategies that enable an organization to operate and to achieve its goals.
- **Enabling environment/Institutional**: the wider society within which individuals and organizations function.

According to the UNDP (UNDP, 2008a) there is an additional perspective to those mentioned above, this being the perspective of **knowledge base**, referring to "the creation, absorption and diffusion of information and expertise towards effective development solutions".

It is widely understood that capacity issues are interconnected and that the process of analysis and capacity development should be as continuous and iterative as possible (Stephen & Triraganon, 2009). The UNDP (2009) sees capacity development as the process through which individuals, organizations and societies obtain, strengthen and maintain the capabilities to set and achieve their own development objectives over time. Simply put, if capacity is the means to plan and achieve, then capacity development describes the ways to those means. Types of capacity building activities are numerous and a few of which include providing access to resources/publications, online and in person trainings/facilitation, coaching and consulting; coordinating alliances/online social networks/peer exchange; and grants/scholarships. It is important to note that identifying capacity development needs is a capacity strengthening process in its own right and value can be drawn from each of the steps taken throughout the assessment.

Capacity needs assessments are used across a multitude of sectors and themes from broad methodologies developed by the UNDP (UNDP, 2009) to more specific applications in local and national government institutions (Kessy & Kaswamila, 2014; UN-REDD National Programme, 2012), health education (Stevens & Gillam, 1998; Gilmore, 2011), social science (Reviere, Berkowitz, Carter & Ferguson, 1996), conservation ecology (Jennings, 2000) and education and scientific research (UNESCO, 2013) to mention a few.

The approach to needs assessment and capacity development in this study

As recognized in the literature, it is imperative that capacity assessments are adapted to local requirements or the organisation involved (UNDP, 2008a). Available literature on general methodologies for evaluating and addressing capacity needs do not comprehensively meet the needs of this study and thus a series of existing guides, methodologies and templates[5] (UNESCO, 2013; Witkin & Altschuld, 1995; Stephen & Triraganon, 2009; UNDP, 2008b) were adapted to create a comprehensive, bespoke, and analytical method to assess capacity needs/gaps in selected NMHSs. This method, framed within and drawing on the existing literature, is described below.

[4] https://www.cadri.net/en/areas-we-work/capacity-development
[5] http://templatelab.com/gap-analysis-templates/

Methodological steps in this study:

To identify capacity development gaps in selected NMHS, a bespoke **capacity needs assessment** was conducted. An incremental approach was taken to perform the capacity needs assessment for each institution.

Steps undertaken prior to this study as part of the NMHS capacity assessment (Dinku *et al.* 2018).

An approach to evaluate the capacity of national CIS was developed. The approach comprises an evaluation framework, a set of metrics based on that framework that measure capacity, a survey questionnaire designed to collect data needed for the metrics, and a data collection and analysis protocol.

The **evaluation framework** combines two schemas the WMO developed to guide the NMHS enterprise: the five pillars of the Global Framework for Climate Services (GFCS) and World Meteorological Organizations (WMO) four categories of NMHS.

The GFCS defines a system for CIS that consists of five pillars, which identify the essential functions of the NMHS:

1. Observations and Monitoring;
2. Research, Modeling and Prediction;
3. Climate Service Information System;
4. User Interface Platform; and,
5. Capacity Development.

WMO's NMHS Categories apply a set of criteria to group the CIS offered by NMHS into four categories:

1. Basic Climate Services (Category 1);
2. Essential Climate Services (Category 2);
3. Full Climate Services (Category 3); and
4. Advanced Climate Services (Category 4).

A set of **metrics** were generated to measure the extent to which a NMHS satisfies each criterion in the evaluation framework. The team developed the metrics through a combination of literature review and expert judgment. The metrics elaborate what a NMHS has to achieve to perform the functions specified under each of the pillars and classify the capacity of a NMHS into one of the four categories within each pillar.

To gather data on the metrics, a **questionnaire** was developed consisting of eleven sections: 1) Governance; 2) NMHS staff capacity; 3) Observing stations; 4) Computing infrastructure; 5) Data; 6) Remote sensing; 7) Climate services; 8) Communication of data and information products; 9) Interaction with users; 10) Research; and 11) Financial questions. Each section was designed as a stand-alone questionnaire.

Data collection was executed through in-person or online surveys, with subsequent follow-up with relevant NMHS staff. The different sections were given to targeted NMHS staff to ensure respondents were equipped to answer questions.

Steps in the capacity needs assessment (this study):

- Based on the metrics table and categorizations of each NMHS, capacity gaps and associated **recommended capacities** *(chapter 4)* were identified. Such capacities consisted of essential capacities (those required to completely fulfill the requirements of the category into which the NMHS current falls), and desirable capacities (those that fulfill the requirements for the subsequent category). For instance, increasing the capacity of the NMHS from a basic NMHS to an essential NMHS or an essential NMHS to a full NMHS.
- This formed the foundation for an expert **prioritization of capacity needs** *(chapter 5)*. This was undertaken using expert judgment based on the level of impact that would result from filling the identified capacity gap, together with the feasibility of filling the capacity gap. The capacity needs were categorized as either high, medium or low priority.
- Next, **suggested interventions were identified** *(chapter 5)* to assist in the achievement of each prioritized capacity need. Suggested interventions (both within and external to the NMHS) were drawn from subjective expertise in addition to a collation of human capacity development options available to each NMHS (see separate training options spreadsheet attachment).

4. BASELINE CAPACITIES OF EACH NMHS

As a basis for the capacity needs assessment, it was necessary to first outline current capacities of each NMHS. Accordingly, this chapter provides the following for each evaluated country:

- Summary description of baseline capacities of each NMHS and within each GFCS pillar.
- Capacities met or lacking within each NMHS as evaluated against the criteria listed for a Category 1, 2 or 3 NMHS service (available in Annex 1).
- Recommendations to improve services currently provided by NMHS to either solidify its classification in a particular category of move into a higher category.

High level findings in baseline capacity across all NMHS's

Observations and Monitoring
Three of the seven NMHS evaluated (Senegal, Rwanda and Ethiopia) fulfill the requirements for Category 1 services under this GFCS pillar. Mali partially satisfies the criteria for Category 1 services, while Niger, Cote d'Ivoire, and Malawi do not meet the requirements. Rwanda partially meets the requirements in Category 2. None of the other NMHS meet the Category 2 or Category 3 requirements for the Observation and Monitoring pillar.

Research and Predictions
The same three NMHSs (Senegal, Rwanda, and Ethiopia) satisfy the requirements for a Category 1 service under this GFCS pillar. Cote d'Ivoire, Mali, and Malawi partially satisfy the criteria for a Category 1 service, while Niger does not meet the criteria. Rwanda and Ethiopia partially satisfy the criteria for a Category 2 service. None of the NMHSs meet the Category 3 requirements.

Climate Services Information System
All NMHSs except Niger and Cote d'Ivoire fulfill requirements for Category 1 under this GFCS pillar. Niger partially satisfies the Category 1 requirements, while Cote d'Ivoire does not. Neither Cote d'Ivoire nor Niger meet the criteria for Category 2, while the others satisfy the requirements fully. Rwanda partially meets Category 3 service requirements for this pillar, while the other NMHS do not.

User Interface Platform
Senegal, Mali, and Rwanda fulfill requirements for Category 1 under this GFCS pillar. Malawi partially fulfills the requirements for Category 1, while the others do not. Mali and Rwanda meet the requirements for Category 2, and Senegal partially meets these requirements. Mali and Rwanda partially meet the requirements for Category 3.

Capacity Development
Senegal, Mali, Rwanda, and Ethiopia fulfill the requirements for a Category 1 service under this GFCS pillar, while the others do not. These same countries partially fulfill the criteria for Category 2. None of the NMHSs meet the criteria for Category 3.

These findings are summarized in Table 3

GFCS Pillar	NMHS Category	Senegal	Cote d'Ivoire	Niger	Mali	Rwanda	Ethiopia	Malawi
1 O&M	1							
	2							
	3							
2 R&P	1							
	2							
	3							
3 CIS	1							
	2							
	3							
4 UIP	1							
	2							
	3							
5 CDV	1							
	2							
	3							

Table 3 Scores for the different NMHS for the three WMO Categories (1=Basic Climate Services; 2=Essential Climate Services; 3=Full Climate Services) under each the of five GFCS pillars (O&M= Observations and Monitoring; R&P=Research, Modeling and Prediction; CIS=Climate Services Information System; UIP= User Interface Platform; and, CDV= Capacity Development.) Green and yellow colors indicate that required criteria have been met or partially met, while red means the criteria have not been met.

Country: Ethiopia

The Ethiopia NMHS meets the criteria for Category 2 for the Climate Services Information System pillar, partially fulfills the criteria for a Category 2 service for the Capacity Development and Research and Prediction pillars and fulfills the requirements for a Category 1 for the Observation and Monitoring pillar. The NMHS partially meets the criteria for Category 2 and Category 3 for the User Interface Platform pillar.

Pillar 1. Observation and Monitoring

Summary

Ethiopia's NMA comfortably fulfills the Observation and Monitoring criteria for Category 1. Whilst a modest increase in the number of upper air stations would be beneficial, especially if they were to assimilate these data into their regional modelling efforts, it is difficult to recommend a precise number as it depends on the current geographic coverage and the availability of staff and funds to operate and maintain these equipment (typically USD 100 per measurement this implies a minimum operating costs of 73,000 per station if measuring twice per day). Further increases in the number of stations, including Automatic Weather Stations (which similarly need to be assessed for operating costs) and upper air stations, and enhancing existing satellite data reception and processing system can move NMA to Category 2.

Progress to Category 3 would require substantial investment in expanding surface (including AWS) and upper air stations and having a written procedure for station inspections and maintenance. It is

worth noting that investments in increasing the numbers of stations should not just be dependent on operating staff and equipment costs, but also on the service for which they will be used and the climatology of the area (i.e., there may be justification for dense networks of stations monitoring short term intense rainfall over mountain catchments, such as for flood monitoring), but the density can be less for monitoring long-term drought over relatively flat and climatically homogeneous landscapes.

Pillar 2. Research and predictions

Summary

The Ethiopia NMHS partially fulfills the criteria for a Category 2 service with respect to Research and Predictions. To fully satisfy requirements for Category 2, the NMHS should improve the educational level of staff such as hiring more individuals with Doctor of Philosophy (PhD) degrees in meteorology. Greater human capital should assist the NMHS to improve prediction capacity to provide 10-day weather forecasts and use dynamic approaches to generate seasonal and sub-seasonal forecasts. The NMHS should also invest in greater internet speed.

A larger investment in educational level of staff, more engagement in leading roles in research, greater sophistication of forecast products, and a larger investment in computational hardware (such as high-performance computers and faster internet) would be needed for the NMHS to meet the requirements of a Category 3 NMHS.

Pillar 3: Climate Services Information System

Summary

The Ethiopia NMHS partially fulfills the criteria of a Category 3 service under this Climate Services Information System pillar. There are aspects within each category that are not fully met. The NMHS would have to invest more in the range of products that it produces, specializing the products for particular users, and communicating climate information to specific users through its website in to meet Category 3 requirements.

Pillar 4: User Interface Platform

Summary

The Ethiopia NMHS partially meets the criteria for Category 2 and Category 3 for the User Interface Platform pillar. To fully meet the criteria for Category 2, the NMHS would need to train an additional staff member in engagement with users (such as that documented in Consultative Workshop on National Framework on Climate Services in Ethiopia[6]), and establish a practice of documenting and incorporating feedback from users about the usefulness and effectiveness of climate information products and services, and then redesign information products and services.

Pillar 5: Capacity Development

Summary

The Ethiopia NMHS partially fulfills the criteria for a Category 2 service for Capacity Development. To fully meet the criteria for a Category 2, the Ethiopia NMHS would need to improve corruption safeguards, such as independent auditing, invest in human capital, and improve internet connection speeds. The NMHS needs additional investments in human capital and technological capacity to satisfy requirements for Category 3.

[6] Consultative Workshop on National Framework on Climate Services in Ethiopia available at http://gfcs.wmo.int

Country: Cote d'Ivoire

The Cote d'Ivoire NMHS partially fulfills the requirements for a Category 1 NMHS under the Research and Prediction pillar and does not meet the requirements for any of the other pillars.

Pillar 1. Observation and Monitoring

Summary

Cote d'Ivoire does not meet the Observation and Monitoring criteria for Category 1 and had the lowest score among the seven NMHS participated in the survey for this pillar. Bringing Cote d'Ivoire to Category 1 would require investment in expanding surface and upper air stations, manning stations with trained observers, and undertaking data rescue.

Pillar 2. Research and Predictions

Summary

The Cote d'Ivoire NMHS partially fulfills the criteria for a Category 1 NMHS under this pillar and would need to improve weather forecasts and expand the range of seasonal forecasts to do so. To meet Category 2 criteria, the NMHS would need to improve human and technological capacity and expand forecasting to include medium range outlooks.

Pillar 3: Climate Services Information System

Summary

The Cote d'Ivoire NMHS does not fulfill the criteria for a Category 1 NMHS for Climate Services Information System. The NMHS would need to expand the range of forecasts, improve access to software for producing climate statistics, as well as improve communication with users to meet the criteria for Category 1. The NMHS does not have a website and offers limited data sharing.

Pillar 4: User Interface Platform

Summary

The Cote d'Ivoire NMHS does not fulfill the criteria for a Category 1 NMHS for the User Interface Platform pillar. The NMHS would need to improve communication with users of climate information and capacity to co-produce climate information with users in order to meet the requirements for Category 1.

Pillar 5: Capacity Development

Summary

The Cote D'Ivoire NMHS does not fulfill the criteria for a Category 1 NMHS under the Capacity Development pillar. To do so, the NMHS would need to improve training, expand its participation in national policies and plans related to climate, and improve access to software for computation of climate statistics.

Country: Malawi

The Malawi NMHS meets the requirements for Category 1 and 2 for the Climate Services Information System pillar and partially meets Category 1 requirements for the Research and Predictions and User Interface Platform pillars. It does not meet the Category 1 requirements for the other GFCS pillars.

Pillar 1. Observation and Monitoring

Summary

Malawi's Department of Climate Change and Meteorological Services (DCCMS) only meets some of the criteria for Category 1 for the Observation and Monitoring pillar. To meet Category 2 criteria, it

would need to improve coverage of upper air observation stations, strengthen station inspection, and back up climate data regularly.

Pillar 2. Research and Predictions
Summary
The main reason why the Malawi NMHS does not fully meet the requirements for a Category 1 NMHS in the Research and Predictions pillar is that it was unable to provide information about the number of research projects and experiments in which the staff participate. Therefore, the baseline assessment could not take participation in research at the NMHS into account.

Based on available data, the NMHS would need to expand the range of seasonal forecasts to fully satisfy the requirements for a Category 1 service. The NMHS should improve human and technological research capacity and expand the range of weather, seasonal, and monthly forecasts to satisfy the criteria of a Category 2 NMHS in Research and Predictions.

Pillar 3: Climate Services Information System
Summary
The Malawi NMHS fulfills the criteria for a Category 2 under this pillar, though there are aspects within the two categories that are not fully met, such as range of forecast products and access to software for computing climate statistics. The NMHS should expand the range of products and improve the information that it communicates to users of climate information on its website to move up to a Category 3 NMHS for Climate Services Information System.

Pillar 4: User Interface Platform
Summary
The Malawi NMHS partially fulfills the criteria for a Category 1 NMHS for the User Interface Platform pillar. To move to a Category 2 NMHS, it would need to improve documentation of user needs and feedback, incorporate feedback into a redesign of products, enhance the training of users, and improve the website.

Pillar 5: Capacity Development
Summary
The Malawi NMHS does not fulfill the criteria for a Category 1 NMHS for Capacity Development. To satisfy the criteria, the NMHS would need to expand participation in the national policy process and strengthen human and technological capacity.

Country: Mali

The Mali NMHS partially fulfills Category 3 criteria under the User Interface Platform pillar, fulfills Category 2 criteria under the Climate Services Information System pillar, partially satisfies requirements for Category 2 under the Capacity Development pillar, and partially meets requirements for a Category 1 NMHS in Observation and Monitoring and Research and Predictions.

Pillar 1. Observation and Monitoring
Summary
Mali NMHS partially meets the Observation and Monitoring criteria for Category 1. However, this is partly because of the size of the country and the inhabited proportion of the country. Mali NMHS may meet the criteria for Category 1 by expanding surface observation networks and strengthening station inspection.

Pillar 2. Research and Predictions

Summary

The Mali NMHS partially fulfills the research and predictability criteria for a Category 1 under the Research and Predictions pillar. However, the production of a regular three-day weather forecasts and a seasonal outlook for temperatures would place it comfortably within this category. The NMHS could satisfy requirements for Category 2 if it improves human and technological capacity sufficiently to broaden the range of more sophisticated climate information products.

Pillar 3: Climate Services Information System

Summary

The Mali NMHS fulfills the criteria for Category 2 for the Climate Services Information System pillar. If the NMHS expands the range of climate information products, improves its website, and improves software the criteria could be satisfied more completely. More advanced improvements in these same categories would enable the NMHS to meet requirements for Category 3.

Pillar 4: User Interface Platform

Summary

The Mali NMHS partially fulfills the criteria for a Category 3 under the User Interface Platform pillar. However, there are aspects within each category that are not fully met. For example, no staff are trained in climate services/user engagement. Furthermore, the NMHS should improve its website, including providing access to national observations and forecast information (for a national interactive media outlet) via website and Application Programming Interfaces (APIs).

Pillar 5: Capacity Development

Summary

The Mali NMHS partially fulfills the criteria for Category 2 under the Capacity Development pillar. To strengthen its status as a Category 2 NMHS, it would need to improve training, representation of staff in specialized areas, software, internet speed, and computing capacity. The NMHS would have to make further progress in computing capacity and internet speed, as well as establish a status as an independent institution, to satisfy the requirements for Category 3.

Country: Niger

The Niger NMHS partially meets requirements for Category 1 for the Climate Services Information System pillar but does not meet criteria for any of the other pillars.

Pillar 1. Observation and Monitoring

Summary

The Niger Meteorological Agency (Niger NMHS) does not meet criteria required for Category 1 NMHS for the Observation and Monitoring pillar. However, only four of the 13 criteria for Category 1 are not met and Niger NMHS can fulfill them improving coverage of upper air observation stations and increasing proportion of Class III and above stations.

Pillar 2. Research and Predictions

Summary

The Niger NMHS does not fulfill criteria for a Category 1 NMHS for the Research and Predictions pillar and would need to improve weather forecasts and access to the internet to satisfy them.

Pillar 3: Climate Services Information System

Summary

The Niger NMHS partially fulfills criteria for a Category 1 NMHS for the Climate Services Information System pillar and would need to improve its policies for sharing data and providing information to users of climate information to do so. The NMHS should offer a wider range of products and maintain better software and a website to communicate them. Further improvements along the same lines would enable the NMHS to qualify as a Category 2 NMHS.

Pillar 4: User Interface Platform

Summary

The Niger NMHS does not fulfill criteria for a Category 1 NMHS under this pillar and would need. In order to fully meet Category 1 NMHS status, formal strategic procedures for user engagement must be put place, including formal training for staff in climate services/user engagement.

Pillar 5: Capacity Development

Summary

The Niger NMHS does not fulfill criteria for a Category 1 NMHS under the Capacity Development pillar due to a deficit of trained personnel in some of the essential services and a very poor internet connection.

Country: Rwanda

The Rwanda NMHS partially meets criteria for Category 3 under the Climate Information Service and User Information Platform pillars and partially meets Category 2 criteria for the Observation & Monitoring, Research & Predictions, and Capacity Development pillars.

Pillar 1. Observation and Monitoring

Summary

The Rwanda Meteorological Agency (Rwanda's NMHS) meets the criteria required for Category 1 under the Observation and Monitoring pillar and partially meets criteria for Category 2. The small size of the country has partly helped in meeting the station density conditions but still needs to increase the density of upper air stations.

Pillar 2. Research and Predictions

Summary

The Rwanda NMHS partially fulfills the criteria of a Category 2 NMHS under the Research and Predictions pillar. The NMHS could fully meet Category 2 requirements by developing human resources (through academic and technical training), increasing participation in research, and improving technological capacity. The NMHS could meet the criteria for Category 3 by investing much more in improvements in these capacities (as above) as well as greatly expanding the range of climate products it produces.

Pillar 3: Climate Services Information System

Summary

The Rwanda NMHS partially fulfills the criteria for a Category 3 under the Climate Services Information System pillar. The NMHS should improve the range of climate information products it produces, the frequency with which it produces seasonal forecasts, and the availability of products on its website to fully meet the criteria for Category 3. However, the Rwanda NMHS is currently a top performing African NMHS.

Pillar 4: User Interface Platform

Summary

The Rwanda NMHS partially fulfills the criteria for a Category 3 NMHS under the User Interface Platform pillar though there are aspects within each category that are not fully met. For example, no staff members are trained in climate services/user engagement. The NMHS should expand its interaction with the sectors, enhance procedures for gathering feedback from users, and improve the website to provide access to national observations and forecast information for any national interactive media outlet to meet Category 3 criteria.

Pillar 5: Capacity Development

Summary

The Rwanda NMHS partially fulfills criteria for a Category 2 NMHS for the Capacity Development pillar. To meet criteria for Category 2 NMHS, it would need to strengthen governance, improve the qualifications of the staff in specialized areas, and strengthen its training program. It should invest in technological capacity, including software, and higher speed internet. Rwanda NMHS would need further improvements along the same lines, including high performance computing, to satisfy criteria for a Category 3 NMHS.

Country: Senegal

The Senegal NMHS meets the criteria for Category 2 for the Climate Services Information System pillar, partially meets criteria for Category 2 under the User Interface Platform and Capacity Development pillars, and meets criteria for Category 1 under the Observation and Monitoring and Research and Predictions pillars.

Pillar 1. Observation and Monitoring

Summary

The Senegal Meteorological Agency (ANACIM= Agence Nationale de l'Aviation Civile et de la Météorologie) does meet the criteria required for Category 1 for the Observation and Monitoring pillar, but not the other two categories.

Pillar 2. Research and Predictions

Summary

The Senegal NMHS fulfills criteria for a Category 1 NMHS under the Research and Predictions pillar with a perfect score. To meet the criteria for a Category 2, the NMHS needs to develop its research program, in particular access to research literature and bandwidth, expand the range of weather and climate information products, and improve access to software needed to produce these outputs.

Pillar 3: Climate Services Information System

Summary

The Senegal NMHS fulfills the criteria for a Category 2 NMHS for the Climate Services Information System pillar. The development of a broader range of climate information products, and especially more advanced products tailored to users' needs, would enable Senegal NMHS to move up to a Category 3 NMHS under this pillar.

Pillar 4: User Interface Platform

Summary

The Senegal NMHS partially fulfills the criteria for a Category 2 NMHS for the User Interface Platform pillar. To meet the criteria fully, it needs to improve engagement with users, including communication of information on the website and building capacity of staff in climate services/user engagement through training. To move to Category 3, it would need to put in place mechanisms to co-produce information with an increased number of sectors (currently it co-produces information with the Agriculture and Water sector). Furthermore, it should provide access to national observations and forecast information (for a national interactive media outlet) via website and APIs.

Pillar 5: Capacity Development

Summary

The Senegal NMHS partially fulfills criteria for a Category 2 NMHS under the Capacity Development pillar though there are aspects within Category 1 and 2 that are not fully met. Participation in national climate related policies and plans is limited, there is no staff training protocol, there is insufficient capacity in software, no high-performance computer, and internet capacity is less than 10 Mpbs. To move to Category 3 NMHS, Senegal's NMHS would need to further improve its technological capacity.

5. CAPACITY DEVELOPMENT PRIORITISATION AND INTERVENTIONS

The following section proposes interventions that each NMHS could consider to strengthen their current categorization within a particular pillar and/or move up to the next category if possible. These suggested interventions are based on recommendations developed during an analysis of the survey responses of each NMHS. The full series of proposed interventions per country are available in the following section and in Tables 4-10.

Country: Ethiopia

The Ethiopia NMHS meets the criteria for Category 2 for the Climate Services Information System pillar, partially fulfills criteria for a Category 2 service for the Capacity Development and Research and Prediction pillars, and fulfills the requirements for a Category 1 NMHS with respect to the Observation and Monitoring pillar. The NMHS partially meets the criteria for Category 3 for the User Interface Platform pillar. The following interventions are proposed to strengthen the different pillars so as to provide enhanced weather and climate services to a wider user community.

The Ethiopia NMHS should prioritize implementing its strategic plan to expand surface and upper air stations.
A modest increase in the number of upper air stations would be beneficial for Ethiopia. Additionally, an increase in the number of surface (including AWS) and upper air stations, and enhancement of satellite data reception and processing would further strengthen its climate services provision capacity.

The Ethiopia NMHS should prioritise building capacity within the NMHS for prediction and user engagement through the development of a staff training protocol/program.
The development of such a program would facilitate skills development in prediction, user engagement, and IT capacity. Personnel should receive training in: (a) ways to engage with users of climate information and the production and analysis of relevant climate metrics; (b) the presentation of these metrics in a way that is useful to the user. Such a program could be developed formally with the assistance of local and regional universities, the eSIAC program at the University of Reading, the EUMETRAIN online program, CSAG winter school, the COMET MetEd program – (https://www.meted.ucar.edu/training_detail.php). See training options spreadsheet attachment.

Expanding formal technical or academic qualifications could be incentivized through the creation of a bursary scheme to fund full- and part-time studies at local or international universities/institutions. This scheme could contractually oblige the bursary recipient to work at the NMHS for a set time once their studies are completed and the qualification achieved.

The Ethiopia NMHS should prioritize development of IT skills and attempt to acquire higher bandwidth access to the internet.
If there is no full-time IT specialist currently able to assist with both desktop and operational prediction computational support, this position should be filled. Bandwidth should be upgraded to at least 50Mbs to facilitate data downloading to produce and disseminate a medium-range forecast.

For further capacity development intervention options see Table 4 below.

Pillar	Existing category	Recommended Capacities			
		Essential Capacities (to fulfill requirements for current category	**Suggested Interventions**	**Desirable Capacities (to fulfill requirements for higher categories)**	**Suggested Interventions**
1. Observation and monitoring	**1**	**Invest in expansion upper air stations.**	**Add more upper air stations, placed strategically to optimize coverage.**	**Increase number of surface (including AWS) and upper air stations.**	**Increase number of surface stations.** Increase number of upper air stations. **Increase number of AWS.** Enhance existing satellite data reception and processing system.
2: Research and Predictions	**2 partially**			**Development of personnel in terms of academic qualifications.**	**Conduct training of entry and mid-level meteorological technicians.** **Through bursaries incentivise PhD studies for students in exchange for an NMHS contract post study.** **Explore potential part time PhD studies through local universities for existing staff. Consult training options spreadsheet attachment for further options.**
				Develop capacity for the production and dissemination of a medium range forecast.	Consult online medium range forecasts. Develop capacity to run COSMO operationally daily (increased bandwidth, compute capacity and storage). Training e.g. WMO regional centre and Egyptian Meteorological Authority (See training options spreadsheet attachment). COSMO developers training. Assess forecast skill.
				Installation of high-speed internet.	**Upgrade bandwidth, ideally to 50 Mbps.**
3: Climate Services Information System	**2**	**Develop written guidelines to govern the provision of climate information products and services to users.**	**Develop a set of SOPs for each sector, including:** • **Identification of different public and private sector users of climate information;** • **A formal plan of engagement with users, including funding required for engagement;** • **Guidelines for the development and testing of**	**Expand the range of advanced climate information products on past, present and future climate.**	**Requires training in production of easily understandable tabular and graphical information AND of the climate data to be used for the generation of these.**

Pillar	Existing category	Recommended Capacities			
			products, including required human resources, software and time required; **Assessing the primary communication channels and methods for both dissemination and collection of feedback from users/recipients of climate information.**		
		Perform homogenization of climate data.	Digitize existing paper records, focusing on variables that are: • Required for specific services in particular locations e.g. wind forecasts in/around Lakes, rainfall/temperature in specific agricultural areas • Non-existent or sparse in the existing electronic database. *Assess the time series of digital data for step changes, sensor degradation, unrealistic extremes, utilizing out of range and in-homogeneity tests.*	Issuance of analyses and interpretation of climate statements for specific users.	Training of forecasting staff to deliver tailored forecasts for specific user communities.
		Expand the suite of advanced climate information products.	**Develop capacity to use GIS and spatial tools to interpolate station observations and combine with satellite environmental and model raster data. Work with stakeholders to develop new informative visualisations of data, e.g. cumulative rainfall, (focusing on decision-centric information).**		
		Improve access to software for computation and display of basic statistics.	Acquire software (preferably freely available open source tools) to develop maps, climate atlas, as well as statistical and other software for time series analysis and display.		

Pillar	Existing category	Recommended Capacities			
4: User interface Platform	**0**	**Formal training in engaging with users.**	**Training or recruitment of an additional extension officer or climate service specialist.** **Provide a facilitated environment in which forecasters and representatives from the user communities are able to discuss forecast needs and products.**	Document user feedbacks and use those feedback to improve products.	Document in writing user feedback to assess the usefulness and effectiveness of the information and services provided. Establish procedures to incorporate user feedback into the redesign of climate information products and services and the development of new products and services.
		Documentation (in writing) of user feedback.	**Create an internal Frequently Asked Questions repository of user questions and comments.**	Development of website, API and mobile network tools.	Recruit staff with requisite skill set to facilitate good internet presence of the forecast products of the NMHS.
5: Capacity Development	**2 partially**	**Staff training protocol.**	**Adopt or create a training program for skills development and advancement within the NMHS.**	**Further staff training, staff qualifications.**	**Through bursaries incentivise PhD studies for students in exchange for an NMHS contract post study.** **Explore potential part time PhD studies through local universities for existing staff.** **Consult training options spreadsheet attachment for further options**
		Train staff in data rescue.	**Consult training options spreadsheet attachment for further options. Develop a set of procedures and a plan (including required human resources, time and costs) to digitize all old paper records, including the use of automated procedures for both imaging and digitizing records. This should also include the use of cloud resources where possible and a plan for off-site archiving/backup of all digital databases.**	**Strengthened IT resources**	**If there is currently no position for a full-time IT specialist this should be created and filled.**
				Improve corruption safeguards, including independent auditing of appropriation, procurement and expenditure policies.	Engage independent auditors to assess procurement and expenditure policies. Consult with government (including finance ministries) and donors to arrive at procedures and regulations which will satisfy international requirements.

Table 4 Ethiopia - recommended capacities and suggested interventions, per GFCS pillar. Bold text refers to urgent priorities, standard text refers to medium term priorities, italicized text refers to long-term priorities.

Country: Cote d'Ivoire

The Cote d'Ivoire NMHS only partially fulfills the Research and Prediction pillar of a Category 1 NMHS but does not meet criteria for a Category 1 NMHS under all the other pillars. The following interventions are proposed to fully satisfy the all the pillars of a Category 1 NMHS.

The Cote d'Ivoire NMHS should prioritize investment in the exaptation of surface and upper air stations and trained observers.

As a top priority, substantial investment is required to increase the number of surface (including AWS) and upper air stations significantly. The current and new stations would need to be manned by trained observers; thus, training observers is very critical. Cote d'Ivoire Met would also need to ensure the quality of stations observations thorough the use of advanced quality control procedures and tools. There are freely available tools such as the CDT from the International Research Institute for Climate and Society (https://github.com/rijaf/CDT). Cote d'Ivoire Met could also augment its station observations with proxies, for instance by implementing ENACTS (https://iri.columbia.edu/resources/enacts/).

The Cote d'Ivoire NMHS should prioritize building capacity within the NMHS for weather monitoring, weather and seasonal prediction and user engagement.

The NMHS could either create a training program for current forecasting personnel to improve skills in the technical aspects of weather monitoring and both weather and seasonal prediction, or send relevant personnel to courses offered at other institutions (see training options Spreadsheet attachment). Training a cadre of extension officers (involved in external engagement with users of climate information) for the production and dissemination of relevant climate metrics is also suggested. These training requirements are extensive and will need to be prioritized and carefully planned, depending on the priorities for the NHMS e.g. weather vs seasonal forecasts, s and revenue generation etc.

The Cote d'Ivoire NMHS should engage relevant government structures and participate in the formulation of climate related policy and planning.

The Director of the NMHS could write to the Minister of Transport (the ministry to which the NMHS is accountable) to request formal participation in policy and planning activities related to meteorology and climate.

The Cote d'Ivoire NMHS should develop an internet presence including improving internet bandwidth.

Personnel with skills in web development should be trained or recruited to develop an internet presence for the NMHS. This website could then be tailored and developed as a vehicle for external communication and issuing alerts/warnings, including via mobile phones [either as Short Message Service (SMS) or Universal Mobile Telecommunications System (UMTS) based services]. This internet presence and interaction with the public would further promote visibility within the Ministry of Transport and within government more widely. Other NMHS provide an array of climate information products through their webpage by implementing ENACTS (https://iri.columbia.edu/resources/enacts/). Cote d'Ivoire may consider implementing this approach.

For further capacity development intervention options see Table 5 below.

Pillar	Existing category	Recommended Capacities and suggested interventions			
		Essential Capacities (to fulfill requirements for current category	**Suggested Interventions**	**Desirable Capacities (to fulfill requirements for higher categories)**	**Suggested Interventions**
1. Observation and monitoring	**0**	**Some increase in number of surface stations that are manned by trained observers.**	**Invest in training of observers.** **Increase number of surface stations.**	**Expansion of surface and upper air stations (including AWS), using advanced QC tools, using trained observers.**	**Increase number of surface stations, and most of these should be Class III and above.** **Increase number of AWS (currently zero).** Increase number of upper air stations. **Ensure that stations (at least those Class III and above) are manned by trained observers.** **Use advanced quality control procedures and tools (use of CDT is recommended).** **Regular inspection of stations and incorporate remote sensing and other proxies with the conventional datasets.**
		Significant increase in number of upper-air stations.	**Increase number of upper air stations.** **Increase number of Class III and above stations.**	**Incorporate remote sensing data to enhance station observations.**	**Implementation of ENACTS (Consult with IRI).**
2: Research and Predictions	**1 partially**	**Provide weather forecast for up to 3 days at least twice a week.** **Disseminate seasonal outlooks of rainfall and temperature probabilities each season.**	**Upgrade/fix the existing PUMA/SYNERGY system to provide access to ECMWF and UKMO forecasts. Training for forecasters to use the system.** **Develop methods for disseminating the seasonal forecast utilising the most appropriate methods i.e. radio, TV, internet and GPRS/GSM services.**	Improve weather forecasts to cover at least 10 days. Produce and disseminate a monthly rainfall and temperature predictions. Broaden seasonal forecasts to include temperature and include an assessment of uncertainty in the seasonal forecast.	If it is not possible to produce these 10-day forecasts in-house, it is possible to obtain data to produce them from the ECMWF/GFS data repositories or source the forecast. Consult online medium range forecasts. Develop temperature seasonal forecasts using CPT and online seasonal forecasts from IRI, CFS and ECMWF. Training e.g. WMO regional centre and Egyptian Meteorological Authority (See training options spreadsheet attachment) Assess forecast skill.
				The NMHS should improve technical capacity, in particular access to software tools for weather and climate forecasting.	Ensure that access to SYNERGY is working and that all users are trained to use the system. Further training can be

Pillar	Existing category	Recommended Capacities and suggested interventions				
						established on using their existing software (R, CPT, SYSTAT, R-INSTAT and QGIS) to analyse observations and weather/climate datasets e.g. combining weather/climate and other geographical/environmental information to assess risks to people and infrastructure.
					An already good research program could facilitate studies towards higher degrees such as a PhD.	Create a bursary scheme and/or secondment to universities for higher degrees.
					Improved internet bandwidth.	**If possible upgrade bandwidth to 50 Mbps.**
3: Climate Services Information System	**0**	**Development of a website that hosts climate information products.**	**Training or recruitment of staff develop web content and to administer the hardware component of the server.**		**Provide a dedicated weather/climate information dissemination website.**	**Consult IRI and ENACTS map room Develop a work plan for developing the products and associated website dissemination.** Training or recruitment of staff develop web content and to administer the hardware component of the server.
		Improved provision of climate data.	**Provide data free of charge to a broader range of institutions, including education institutions.**		Perform homogenization of climate data.	Digitize existing paper records, focusing on variables that are: • Required for specific services in particular locations e.g. wind forecasts in/around Lakes, rainfall/temperature in specific agricultural areas • Non-existent or sparse in the existing electronic database. Assess the time series of digital data for step changes, sensor degradation, unrealistic extremes, utilizing out of range and in-homogeneity tests.
		Expanded set of climate information products.	**Expand range of climate statistics for major climate variables and offer seasonal temperature forecasts.**		*Contribute to national early warning systems.*	
		Improve access to software for computation and display of basic climate statistics.	**Training to use existing software (preferably freely available open source tools e.g. QGIS, SYSTAT, R-INSTAT, R) to develop maps/climate atlases and statistically analyse data.**			

Pillar	Existing category	Recommended Capacities and suggested interventions				
4: User interface Platform	**0**	**Increased interaction with, and hence feedback from users to assess their needs.** Develop procedures that will enable staff to co-produce climate information in collaboration with users, so that the information products serve the needs of decision makers well.	**Training or recruitment of an extension officer or climate service specialist.** Formalise collaboration between more sectors e.g. MOUs with public and private partners. Undertake formal consultations within sectors to understand information requirements and assess appropriate presentations of data/information. Engage on a semi-regular basis with different government departments and private sector entities.		**Formal training for staff of climate services/user engagement.**	**Training or recruitment of a climate services specialist. Training should make allowance for travel and prolonged stay at a CS institution that could provide such training. Consultation with relevant government departments (e.g. agriculture, water, energy).**
		Provide a dedicated weather/climate information dissemination website.	**Develop a website that communicates climate information to users.**		Mechanisms in place to co-produce climate information and products with different sectors.	Collaborative applied research projects in the co-production of information products Formalise collaboration between more sectors e.g. MOUs with public and private partners. Undertake formal consultations within sectors to understand information requirements and assess appropriate presentations of data/information. Engage on a semi-regular basis with different government departments and private sector entities.
		Documentation (in writing) of user feedback.	*Create an internal Frequently Asked Questions repository of user questions and comments.*		Written procedure for incorporating user feedback into the redesign of information products and services.	Document in writing user feedback to assess the usefulness and effectiveness of the information and services provided. Establish procedures to incorporate user feedback into the redesign of climate information products and services and the development of new products and services.
5: Capacity Development	**0**	**Staff training protocol.**	**Adopt or create a training program for skills development and advancement within the NMHS.**		Further staff training, staff qualifications.	Conduct training of entry and mid-level meteorological technicians.
		Participation in national policies and plans.	**Apply to relevant government structures for inclusion of senior staff to participate in the**		**Strengthened IT resources.**	**If there is currently no position for a full-time IT specialist this should be created and filled.**

Pillar	Existing category	Recommended Capacities and suggested interventions				
			development of national climate related policies.			
		Train staff in data rescue.	**Consult training options spreadsheet attachment for further options.** **Develop a set of procedures and a plan (including required human resources, time and costs) to digitize all old paper records, including the use of automated procedures for both imaging and digitizing records. This should also include the use of cloud resources where possible and a plan for off-site archiving/backup of all digital databases.**			
		Improve access to software for computation and display of basic climate statistics.	**Training to use existing software (preferably freely available open source tools e.g. QGIS, SYSTAT, R-INSTAT, R) to develop maps/climate atlases and statistically analyse data.**			
		Improve access to computers connected to the internet.	**Develop a strategy (including costs and budget allocations) for improving internet bandwidth and connectivity. Upgrade all bandwidth to a minimum of 5Mbit/s, preferably 10Mbit/s. Where computers need to be, but are not connected, install extra switches and cables.**			

Table 5 Cote d'Ivoire - recommended capacities and suggested interventions, per GFCS pillar. Bold text refers to urgent priorities, standard text refers to medium term priorities, italicized text refers to long-term priorities.

Country: Malawi

The Malawi NMHS meets most indicators for a Category 2 NMHS for the Climate Services Information System pillar and partially fulfills the criteria for a Category 1 NMHS for the Research & Prediction and User Interface Platform pillars. It does not meet criteria for a Category 1 NMHS for the rest of the pillars. The following interventions are proposed to strengthen and develop the different pillars.

The Malawi NMHS should prioritize investment in the exaptation of surface, and upper air stations and obtain a climate database management system.

Investment is required to expand the number of surface (including AWS) and upper air stations. A climate database management system is needed as well as advanced quality control procedures and tools. There are freely available tools such as the CDT form the International Research Institute for Climate and Society (https://github.com/rijaf/CDT). Station observations could also be augmented with proxies, for instance by implementing ENACTS (https://iri.columbia.edu/resources/enacts/).

The Malawi NMHS should prioritize the development of a research department and capacitate staff for research.

Interventions include the formulation of a clear research agenda in a white paper that identifies research priority areas and staffing portfolios/requirements to address these areas. One of these research areas should include user engagement and the production of tailored/user-specific climate information.

Study for further formal technical or academic qualifications could be incentivized through the creation of a bursary scheme to fund full- and part-time studies at local or international universities/institution should this be desirable. The bursary scheme could contractually oblige the bursary recipient to work at the NMHS for a set time once their studies are completed and the qualification achieved. Collaboration with Malawian and international research institutions is highly recommended.

The seasonal prediction products of the Malawi NMHS should be enhanced.

A discussion of other publicly available seasonal forecasts [e.g. IRI, ECMWF and Coupled Forecast System (CFS)] and related consistencies/inconsistencies with respect to the issued forecast or Climate Outlook Forum (COF) should be included in disseminated materials.

Updated seasonal forecasts should be issued every month, either from the forecasting centres above or the forecast developed in-house.

The Malawi NMHS should prioritise development of IT infrastructure and personnel.

The acquisition of uninterruptable power supplies of sufficient power should be prioritised in addition to air conditioning for the computational cluster. A backup power generator should also be installed to cope with frequent power outages. Bandwidth should be upgraded, ideally to 50 Mbps to facilitate the download of data for the production and/or dissemination of a medium-range forecast and the enhanced seasonal forecast. Unfortunately, the cost of this speed is prohibitively high in Malawi and realistically 10 Mbps may be a more affordable option.

For further capacity development intervention options see Table 6 below.

Pillar	Existing category	Recommended Capacities and suggested interventions			
		Essential Capacities (to fulfill requirements for current category	**Suggested Interventions**	**Desirable Capacities (to fulfill requirements for higher categories)**	**Suggested Interventions**
1. Observation and monitoring	**0**	**Increase number of upper air stations.**	**Increase number of upper air stations by at least one station.**	**Further expansion of surface and upper air stations, using advances QC tools, regular inspection of AWS, and incorporate remote sensing and other proxies with the conventional datasets.**	**Increase number of surface stations, and these should be Class III and above.**
		Strengthen station inspection.	**Increase number of manual stations inspected every year.**		**Increase number of upper air stations.**
		Install Climate Database Systems.	**Maintains electronic backup of climate data and backed up data regularly.**		**Use advanced quality control procedures and tools (use of CDT is recommended).**
		Digitize undigitized climate data.	Digitize existing paper records, focussing on variables that are: • Required for specific services in particular locations e.g. wind forecasts in/around Lakes, rainfall/temperature in specific agricultural areas • Non-existent or sparse in the existing electronic database. **Develop a set of procedures and a plan (including required human resources, time and costs) to digitize all old paper records, including the use of automated procedures for both imaging and digitizing records. This should also include the use of cloud resources where possible and a plan for off-site archiving/backup of all digital databases.**		**All of AWS should be inspected at least once a year.** Incorporate remote sensing data to enhance station observations (implementation of ENACTS recommended). Increase the number of stations reporting daily.
2: Research and Predictions	**1 partially**	**Development of a clear research agenda.**	**Develop a white paper for research (if this doesn't already exist) Identifying priority areas for research Assigning staff to work on each of those.**	**Incentivization schemes for research and recruiting more staff with PhDs and providing them with resources needed, such as online access to literature.**	**Incentivisation for research involvement (including bursaries tied to projects?) Staffing and time put aside for research involvement.** **Allowing data sharing for research.** **Assign funding from existing projects for research activities**

Pillar	Existing category	Recommended Capacities and suggested interventions			
				Collaboration with local or international research institutions could improve access to research projects and research literature. Collaboration with other African universities and international institutions, including University of Cape Town, University of Nairobi etc. Collaboration with regional centres (e.g. SADC, ICPAC).	
		Participate in more research projects with in-country or international research institutions.	**Strengthen participation in collaborative research projects Collaboration through local universities and institutes such as Malawi University of Science and Technology and Chancellor College (Zomba).**	Improve access to software tools for weather and climate forecasting, including statistical and dynamical downscaling.	Install and utilise AMESD/SYNERGY systems. **Training to use existing software (preferably freely available open source tools e.g. QGIS, SYSTAT, R-INSTAT, R) to develop maps/climate atlases and statistically analyse data.** Training on developing Model Output Statistics (statistical downscaling) for weather forecast applications. Support to use COSMO as a weather forecasting (NWP) model, including training and improving the bandwidth to download boundary conditions for the model.
		Expand seasonal forecasts to include temperature.	If it is not possible to produce these forecasts in-house, develop temperature seasonal forecasts using CPT and online seasonal forecasts from IRI, CFS and ECMWF. Training (e.g. WMO regional centre and Egyptian Meteorological Authority). See training options spreadsheet attachment. Assess forecast skill.	**Communication of uncertainties in the seasonal prediction products and a monthly rainfall and temperature product.**	**Discuss other publicly available seasonal forecasts (IRI, ECMWF and CFS) and related consistencies/inconsistencies with respect to their own statistical forecast. Include discussion in disseminated materials. Issue updated seasonal forecasts every month, including their own statistical forecast.**
				Develop capacity for the production and dissemination of a medium range forecast.	Consult online medium range forecasts. Develop capacity to run COSMO operationally daily (increased bandwidth, compute capacity and storage) Training e.g. WMO regional centre and Egyptian Meteorological Authority (See training options spreadsheet attachment) COSMO developers training. Assess forecast skill.
				Improved internet bandwidth.	**If possible upgrade bandwidth to 50 Mbps.**

Pillar	Existing category	Recommended Capacities and suggested interventions			
3: Climate Services Information System	**2**	**Improve access to software for computation and display of basic climate statistics.**	**Training to use existing software (preferably freely available open source tools e.g. QGIS, SYSTAT, R-INSTAT, R) to develop maps/climate atlases and statistically analyse data.**	Improve the NMHS web page to provide tailored climate analysis, prediction and monitoring products, on seasonal to climate change time scale for major sectors. Broaden the range of seasonal forecasts and advanced climate information products in different formats.	Based on discussions/interactions with users develop a set of images/graphics and text descriptions to be disseminated via website. Engage an IT/web designer to plan website and cost of hosting e.g. at an offsite data centre which maintains 24/7 availability. .
		Perform homogenization of climate data.	Digitize existing paper records, focussing on variables that are: • Required for specific services in particular locations e.g. wind forecasts in/around Lakes, rainfall/temperature in specific agricultural areas • Non-existent or sparse in the existing electronic database. *Assess the time series of digital data for step changes, sensor degradation, unrealistic extremes, utilizing out of range and in-homogeneity tests.*		
4: User interface Platform	**1 partially**	*Document, in writing, feedback that users have about the climate information produced.*	*Create an internal Frequently Asked Questions repository of user questions and comments.*	An assessment of user information requirements.	Undertake formal consultations within sectors to understand information requirements and assess appropriate presentations of data/information. Engage on a semi-regular basis with different government departments and private sector entities.
				Improve the website to include a broader range of advanced climate information products.	Based on discussions/interactions with users develop a set of images/graphics and text descriptions to be disseminated via website. Engage an IT/web designer to plan website and cost of hosting e.g. at an offsite data centre which maintains 24/7 availability.
				Establish a mechanism for incorporating user feedback into the redesign of the information provided.	Develop user-specific mechanisms i.e. different modes for a water manager vs a subsistence farmer. Investigate use of GSM/GPRS mobile mechanisms for public feedback, workshops/town meetings for specific target audiences, radio phone ins etc.

Pillar	Existing category	Recommended Capacities and suggested interventions			
				Conduct more training to explain to users how to access and use climate information products.	Engage in sector specific trainings, collaborating and partnering with other user-orientated organisations where possible (using intermediary organisations). Utilise partnerships through ongoing projects.
5: Capacity Development	**0**	Expand participation in national policy processes.	Expand the numbers of people (including young technicians) involved in disaster management meetings, the NAP and other development processes.	**Strengthened IT resources.**	**Acquire finance for a generator and higher capacity uninterrupted power supplies.** *Air conditioned room for existing computer hardware.* **Upgrade bandwidth, ideally to 50 Mbps.**
		Establish a protocol for training required of different staff members. *Further staff training, staff qualifications*	*Increase opportunities of scholarship to further train existing staff* **Conduct training of entry and mid-level meteorological technicians.** *Through bursaries incentivise PhD studies for students in exchange for an NMHS contract post study.* *Explore potential part time PhD studies through local universities for existing staff.* *Consult training options spreadsheet attachment for further options*		
		Train staff in data rescue.	Consult training options spreadsheet attachment for further options and organisations to organise training. Additionally develop a set of procedures and a plan (including required human resources, time and costs) to digitize all old paper records, including the use of automated procedures for both imaging and digitizing records. This should also include the use of cloud resources where possible and a plan for off-site archiving/backup of all digital databases.		
		Recruit or train existing staff with PhD degrees to improve research capacities and with business	This should be tied to a formal strategy for the development of DCCMS over the next 10 years, so that the specific qualifications for the management staff		

Pillar	Existing category	Recommended Capacities and suggested interventions				
		qualifications to help develop services/revenue generation.	are decided in advance and form part of the wider development of technical and business capacity at DCCMS			

Table 6 Malawi - recommended capacities and suggested interventions, per GFCS pillar. Bold text refers to urgent priorities, standard text refers to medium term priorities, italicized text refers to long-term priorities.

Country: Mali

The Mali NMHS partially fulfills criteria for Category 3 under the User Interface Platform pillar, fulfills criteria for Category 2 under the Climate Services Information System pillar, partially satisfies requirements for Category 2 under the Capacity Development pillar, and partially meets requirements for Category 1 NMHS under the Observation & Monitoring and Research & Predictions pillars. The following interventions are proposed to develop Capacity Development, Observation & Monitoring and Research & Predictions pillars into Category 2 pillars.

The Mali NMHS should prioritize expanding surface station network with significantly increased number of AWS.

A modest increase in the number of surface-based station with more focus on AWS would be very beneficial for Mali. And strengthening of regular station. In sections would ensure the continuity and quality of observations.

The Mali NMHS should prioritize the development and training of meteorological technicians and forecasters.

Funding should be solicited to train personnel on technical aspects of weather monitoring and prediction at all levels, from entry level to senior technicians. This training should include the presentation of uncertainties in seasonal forecast products.

The pursuit of further formal technical or academic qualifications could be incentivized through the creation of a bursary scheme to fund full- and part-time studies at local or international universities/institutions. Such a scheme could contractually oblige bursary recipients to work at the NMHS for a set time once their studies are completed and qualifications are achieved.

The Mali NMHS should upgrade current IT infrastructure and personnel.

Bandwidth should be upgraded, ideally to 50Mbs to facilitate downloading data for the production and/or dissemination of medium-range forecasts. The NMHS should also employ an IT specialist to manage the network and develop a web presence for disseminating forecasts and alerts/warnings.

For further capacity development intervention options see Table 7 below.

Pillar	Existing category	Recommended Capacities and suggested interventions			
		Essential Capacities (to fulfill requirements for current category)	**Suggested Interventions**	**Desirable Capacities (to fulfill requirements for higher categories)**	**Suggested Interventions**
1. Observation and monitoring	**1 partially**	**Just some increase in number of surface stations would be enough to be in Category 1.**	**Increase number of surface stations.**	**Expansion of surface and upper air stations (including AWS).**	**Increase number of surface stations and most of these should be Class III and above.** **Increase number of AWS.** **Increase number of upper air stations.**
				More stations reporting regularly (daily).	Ensure at least 75% of stations that are above Class III reported to NMHS headquarters every day.
				Use advanced system for satellite data reception and processing datasets.	Enhance existing satellite data reception and processing system.
2: Research and Predictions	**1 partially**	**Provide weather forecast for up to 3 days at least twice a week.**	**Upgrade/fix the existing PUMA/SYNERGY system to provide access to ECMWF and UKMO forecasts. Training for forecasters to use the system and/or extend the forecasts for up to 3 days.**	**Provide weather forecasts for up to 10 days.** **Produce and disseminate monthly rainfall and temperature predictions.**	**Upgrade/fix the existing PUMA/SYNERGY system to provide access to ECMWF and UKMO forecasts. Training for forecasters to use the system and/or extend the forecasts for up to 10 days.** Consult GFS/ECMWF medium range forecasts for 1 month and disseminate.
		Disseminate seasonal outlooks of rainfall and temperature probabilities each season. Expand the range of seasonal forecasts to include temperature.	If it is not possible to produce these forecasts in-house, develop temperature seasonal forecasts using CPT and online seasonal forecasts from IRI, CFS and ECMWF. Training e.g. WMO regional centre and Egyptian Meteorological Authority (See training options spreadsheet attachment). Assess forecast skill. **Develop methods for disseminating the seasonal forecast utilising the most appropriate methods i.e. radio, TV, internet and GPRS/GSM services.**	Develop human capacity for the production and dissemination of a medium range forecast. Increase range of specializations represented among the staff.	Consult online medium range forecasts. Training e.g. WMO regional centre and Egyptian Meteorological Authority (See training options spreadsheet attachment). Assess forecast skill.
				An already good research program could facilitate studies towards higher degrees such as a PhD.	Create a bursary scheme and/or secondment to universities for higher degrees.
				Improved internet bandwidth.	**If possible upgrade bandwidth to 50Mbs.**
				Improve access to software tools for weather and climate forecasting, including statistical and dynamical downscaling.	Install and utilise AMESD/SYNERGY systems. Training to use software (preferably freely available open source tools e.g. QGIS, SYSTAT, R-INSTAT, R, excel) to develop maps/climate atlases and statistically analyse data.

Pillar	Existing category	Recommended Capacities and suggested interventions				
						Training on developing Model Output Statistics (statistical downscaling) for weather forecast applications.
3: Climate Services Information System	**2 partially**	**Improve access to software for computation and display of basic climate statistics.**	**Training to use software (preferably freely available open source tools e.g. QGIS, SYSTAT, R-INSTAT, R, excel) to develop maps/climate atlases and statistically analyse data.**		Strengthen the production of advanced climate information products in different tabular and graphical formats.	Add more sector specific products to the ENACTS map rooms. Digitize existing paper records, focussing on variables that are either non-existent or sparse in the existing electronic database. Develop capacity to use GIS and spatial tools to interpolate station observations and satellite and model raster data. Acquire software (preferably freely available open source tools) to develop maps and atlas Requires training in production of easily understandable tabular and graphical information AND of the climate data to be used for the generation of these.
		Perform homogenization of climate data.	Digitize existing paper records, focussing on variables that are: • Required for specific services in particular locations e.g. wind forecasts in/around Lakes, rainfall/temperature in specific agricultural areas • Non-existent or sparse in the existing electronic database. *Assess the time series of digital data for step changes, sensor degradation, unrealistic extremes, utilizing out of range and in-homogeneity tests.*		**Data dissemination website.**	**Recruit staff with requisite skill set to facilitate good internet presence of the forecast products of the NMHS.**
		Expand the range of climate information products on the website.	**Develop capacity to use GIS and spatial tools to interpolate station observations and combine with satellite environmental and model raster data. Work with stakeholders to develop new informative visualisations of data, e.g. cumulative rainfall, (focussing on decision-centric information).**			

Pillar	Existing category	Recommended Capacities and suggested interventions			
4: User interface Platform	**2 partially**	Formal training in engaging with users.	Training or recruitment of an extension officer or climate service specialist.	Development of website and API tools.	Recruit staff with requisite skill set to facilitate good internet presence of the forecast products of the NMHS.
		Improve website to include advanced climate information products.	Based on discussions/interactions with users develop a set of images/graphics and text descriptions to be disseminated via website. Engage an IT/web designer to plan website and cost of hosting e.g. at an offsite data centre which maintains 24/7 availability.		
5: Capacity Development	**1**	**Improve access to software for computation and display of basic climate statistics.**	**Training to use software (preferably freely available open source tools e.g. QGIS, SYSTAT, R-INSTAT, R, excel) to develop maps/climate atlases and statistically analyse data.**	**Improve corruption safeguards such as independent auditing of appropriation, procurement and expenditure policies.**	**Engage independent auditors to assess procurement and expenditure policies.** **Consult with government (including finance ministries) and donors to arrive at procedures and regulations which will satisfy international requirements.**
				Improve representation of different specializations among the staff.	This should be tied to a formal strategy for the development of NHMS over the next 10 years, so that the specific qualifications of staff are decided in advance and form part of the wider development of technical and business capacity at the NHMS.
				Strengthen staff training and staff qualifications.	Conduct training of entry and mid-level meteorological technicians. Through bursaries incentivise PhD studies for students in exchange for an NMHS contract post study. Explore potential part time PhD studies through local universities for existing staff. Consult training options spreadsheet attachment for further options.
				Improve access to software tools for weather and climate forecasting, including statistical and dynamical downscaling.	Utilise AMESD/SYNERGY systems. Training to use software (preferably freely available open source tools e.g. QGIS, SYSTAT, R-INSTAT, R, excel) to develop maps/climate atlases and statistically analyse data.

Pillar	Existing category	Recommended Capacities and suggested interventions				
						Training on developing Model Output Statistics (statistical downscaling) for weather forecast applications. Investigate the potential for developing WRF or COSMO as an NWP model. This would initially be a development process to investigate the skill and appropriate configurations of the model. Before engaging in this activity there needs to be appropriate resources and skilled personnel, including sufficient bandwidth for downloading boundary conditions.
					Strengthened IT resources.	If there is currently no position for a full-time IT specialist, this should be created and filled.

Table 7 Mali - recommended capacities and suggested interventions, per GFCS pillar. Bold text refers to urgent priorities, standard text refers to medium term priorities, italicized text refers to long-term priorities.

Country: Niger

The Niger NMHS partially meets requirements for Category 1 NMHS for the Climate Services Information System pillar but Category 1 criteria are not met for any of the other pillars. The suggested interventions below would ensure that Category 1 indicators for all pillars are met as well as some Category 2 indicators.

The Niger NMHS should prioritize investment in the expansion of surface and upper air stations

Niger NMHS would need to expand the number of surface and upper air stations significantly and the addition of AWS (currently none) should the top priority. The quality of station observations should also be ensured through strengthened station inspections and the use of advanced quality control procedures and tools. There are freely available tools for data quality control such as the CDT form the International Research Institute for Climate and Society (https://github.com/rijaf/CDT). Niger's NMHS may also consider augmenting station observations with proxies; for instance by implementing ENACTS (https://iri.columbia.edu/resources/enacts/).

A strategic plan that addresses capacity development within the Niger NMHS should be developed.

The NMHS should work with the relevant government ministries (e.g., transport) to develop a 5-year plan that addresses human capacity development in terms of forecasting, climate services, user engagement, hardware and software development.

The Niger NMHS should prioritize training and development of senior forecasters within the NMHS and personnel skilled in user engagement.

Funding should be dedicated for training in technical aspects of weather monitoring and prediction for forecasters at all levels, from entry level to senior technicians. Training in the presentation of uncertainties in seasonal forecast products should be included. Additionally, a climate services specialist should be trained or recruited.

The pursuit of further formal technical or academic qualifications could be incentivized through the creation of a bursary scheme to fund full- and part-time studies at local or international universities/institution. This scheme could contractually oblige the bursary recipient to work at the NMHS for a set time once their studies are completed and qualifications are achieved.

For further capacity development intervention options see Table 8 below.

Pillar	Existing category	Recommended Capacities and suggested interventions			
		Essential Capacities (would fulfill the requirements of the current category)	**Suggested intervention**	**Desirable Capacities (would fulfill the requirements for higher categories)**	**Suggested intervention**
1. Observation and monitoring	**0**	**Train more observers.**	**Invest in training of observers.**	**Expansion of surface (particularly AWS) and upper air stations.**	**Increase number of surface stations and most of these should be Class III and above.** **Increase number of AWS (currently zero).** **Increase number of upper air stations.**
		Strengthen station inspection.	Increase number of upper air stations. **Significantly increase inspection of Class III and above stations** **Increase inspection of Class III and above stations.**	**Regular inspection of stations using advances QC tools.**	**Use advanced quality control procedures and tools (use of CDT is recommended).**
				Strategic plan for strengthening the observation system.	**Prepare strategic plans for strengthening the observation system.**
				Incorporate remote sensing and other proxies with the conventional datasets.	**Incorporate remote sensing data to enhance station observations (implementation of ENACTS recommended).**
2: Research and Predictions	**0**	**Improve weather forecast to at least 3 days.**	**Improve weather forecasts to forecast at least for the next 3 days.**	Produce and disseminate a monthly rainfall and temperature predictions.	If it is not possible to produce these forecasts in-house, it is possible obtain data to produce them from the GFS data repository or source the forecast.
		Expand seasonal outlooks to include temperature probability.	If it is not possible to produce these forecasts in-house, develop temperature seasonal forecasts using CPT and online seasonal forecasts from IRI, CFS and ECMWF. Training e.g. WMO regional centre and Egyptian Meteorological Authority (See training options spreadsheet attachment). Assess forecast skill.	**Communicate the uncertainties associated with seasonal forecasts.**	**Discuss other publicly available seasonal forecasts (IRI, ECMWF and CFS) and related consistencies/inconsistencies with respect to their own statistical forecast. Include discussion in disseminated materials.** **Issue updated seasonal forecasts every month, including their own statistical forecast.**
		Increased bandwidth is essential.	**If possible, upgrade bandwidth to 5 Mbps.**	Develop human capacity for the production and dissemination of a medium range forecast.	Consult online medium range forecasts. Training e.g. WMO regional centre and Egyptian Meteorological Authority (See training options spreadsheet attachment).

Pillar	Existing category	Recommended Capacities and suggested interventions			
					Assess forecast skill.
				Recruiting more staff with PhDs and providing them with resources needed, such as online access to literature.	Collaboration with local or international research institutions could improve access to research projects and research literature. Collaboration with other African universities and international institutions, including University of Cape Town, University of Nairobi etc. Collaboration with regional centres (e.g. SADC, ICPAC).
				Increased bandwidth to 10 Mbps.	**If possible, upgrade bandwidth to 10 Mbps.**
3: Climate Services Information System	**1 partially**	**Improve provision of climate data and climate information products.**	**Establish written procedures to guide the provision of climate information and services.** **Expand the provision of data free of charge, at least to academic institutions.** **Expand the range of seasonal outlooks to include temperature.** **Expand the climate information products available on the website.**	Implementation of ENACTS map rooms.	**Consult IRI and ENACTS map room.** **Develop a work plan for developing the products and associated website dissemination.**
		Improve access to software for computation and display of basic climate statistics.	**Training to use software (preferably freely available open source tools e.g. QGIS, SYSTAT, R-INSTAT, R, excel) to develop maps/climate atlases and statistically analyse data.**	Perform homogenization of climate data.	Digitize existing paper records, focussing on variables that are: • Required for specific services in particular locations e.g. wind forecasts in/around Lakes, rainfall/temperature in specific agricultural areas • Non-existent or sparse in the existing electronic database. *Assess the time series of digital data for step changes, sensor degradation, unrealistic extremes, utilizing out of range and in-homogeneity tests*
				Expand the range of advanced climate information products.	Add more sector specific products to the ENACTS map rooms.

Pillar	Existing category	Recommended Capacities and suggested interventions			
					Digitize existing paper records, focussing on variables that are either non-existent or sparse in the existing electronic database. Develop capacity to use GIS and spatial tools to interpolate station observations and satellite and model raster data. Acquire software **(preferably freely available open source tools e.g. QGIS, SYSTAT, R-INSTAT, R, excel) to develop maps/climate atlases and statistically analyse data.** Requires training in production of easily understandable tabular and graphical information and of the climate data to be used for the generation of these.
				Improve website to include advisories.	Based on discussions/interactions with users develop a set of images/graphics and text descriptions to be disseminated via website. E Engage an IT/web designer to plan website and cost of hosting e.g. at an offsite data centre which maintains 24/7 availability.
4: User interface Platform	**0**	**Improve data, products and services based on user feedback.**	**Establish a strategic plan and procedures for engaging users of climate information.** **Train staff in user engagement.** **Document user feedback in writing so that the NMHS can improve products and services in response to feedback.**	Has a written procedure for incorporating user feedback into the redesign of information products and services. Documents user feedback in writing.	Develop user-specific mechanisms i.e. different modes for a water manager vs a subsistence farmer. Investigate use of GSM/GPRS mobile mechanisms for public feedback, workshops/town meetings for specific target audiences, radio phone ins etc. Formalise these methods and the recording of feedback information into a standard operating procedure and easily accessible database.
			Improve availability of climate information on the website.	Two staff members with training in climate services/user engagement.	Training or recruitment of an extension officer or climate service specialist, to develop a user services team.

Pillar	Existing category	Recommended Capacities and suggested interventions			
5: Capacity Development	**0**	Establish a protocol for the types of training staff are required to complete. Improve staff training to include training for entry-level meteorological technicians and training in quality control procedures.	Develop a document which lists the types of training each level of staff is required to complete, whether refresher courses are needed and the frequency they should be undertaken. The requirements should be based on available resources within Niger i.e. personnel should be able to receive required trainings at national organisations if possible. **Conduct training of entry and mid-level meteorological technicians.** *Consult training options spreadsheet attachment for further options.*	Further staff training, staff qualifications.	Conduct training of entry and mid-level meteorological technicians. Through bursaries incentivise PhD studies for students in exchange for an NMHS contract post study. Explore potential part time PhD studies through local universities for existing staff. Consult training options spreadsheet attachment for further options
		Strengthened internet connection.	**If possible, upgrade bandwidth to 10 Mbps.**	Strengthened IT resources.	If possible upgrade bandwidth to 50 Mbps. Employ an IT specialist to manage the network and develop a web presence Install climate controlled computer centre with one high performance computer.
		Improve access to software for computation and display of basic climate statistics.	**Training to use software (preferably freely available open source tools e.g. QGIS, SYSTAT, R-INSTAT, R, excel) to develop maps/climate atlases and statistically analyse data.**	Maintain corruption safeguards including independent auditing of appropriation, procurement and expenditure policies.	Engage independent auditors to assess procurement and expenditure policies. Consult with government (including finance ministries) and donors to arrive at procedures and regulations which will satisfy international requirements.
		Recruit staff who have an education in management.	This should be tied to a formal strategy for the development of the NHMS over the next 10 years, so that the specific qualifications for the management staff are decided in advance and form part of the wider development of technical and business capacity the NHMS	At least one person with at least 2 years of education in management.	Employ a person with an MBA qualification.

Table 8 Niger - recommended capacities and suggested interventions, per GFCS pillar. Bold text refers to urgent priorities, standard text refers to medium term priorities, italicized text refers to long-term priorities.

Country: Rwanda

The Rwanda NMHS partially meets criteria for Category 3 under the Climate Information Service and User Information Platform pillars, and partially meets Category 2 criteria under the Observation & Monitoring, Research & Predictions, and Capacity Development pillars. The suggested interventions below would ensure that Category 2 indicators of all pillars are met.

The Rwanda NMHS should prioritize expanding upper air stations and more frequent data backup

An increase in the number of upper air stations and backup of climate data at weekly intervals would enhance the Rwanda NMHS climate services capacity.

The Rwanda NMHS should prioritize training and development for forecasters within the NMHS and personnel skilled in user engagement.

Funding should be dedicated to train personnel on technical aspects of weather monitoring and prediction of forecasters at all levels, from entry level to senior technicians. Training in the presentation of uncertainties in seasonal forecast products should also be included. Additionally, a climate services specialist should be trained or recruited.

The pursuit of further formal technical or academic qualifications could be incentivized through the creation of a bursary scheme to fund full- and part-time studies at local or international universities/institution. This scheme could contractually oblige the bursary recipient to work at the NMHS for a set time once their studies are completed and the qualification achieved.

The Rwanda NMHS should upgrade current IT infrastructure and personnel.

Bandwidth should, ideally, be upgraded to at least 50Mbs to facilitate the dissemination of current and new forecast products. An IT professional should also be employed if not currently available.

For further capacity development intervention options see Table 9 below.

Pillar	Existing category	Recommended Capacities and suggested interventions				
		Essential Capacities (would fulfill requirements for the current category)	**Suggested intervention**		**Desirable Capacities (to fulfill requirements for a higher category)**	**Suggested intervention**
1. Observation and monitoring	**1**	Expand upper air observation and ensure data are backed up regularly.	Improve coverage of upper air observation stations. Backup climate data at least every month.		**Increase number of upper air stations or better system for satellite data reception processing.**	**Increase number of upper air stations.** Enhance existing satellite data reception and processing system.
2: Research and Predictions	**1**	Training and development of senior meteorological technicians.	Training in technical aspects of weather monitoring. See training options spreadsheet attachment for options. Expand the range of seasonal outlooks to include temperature.		**Collaboration with local or international research institutions could improve access to research projects and research literature.**	**Collaboration with other African universities and international institutions, including University of Cape Town, University of Nairobi etc. Collaboration with regional centres (e.g. SADC, ICPAC).**
					Development of staff through career advancement training.	**Conduct training of entry and mid-level meteorological technicians.** **Through bursaries incentivise PhD studies for students in exchange for an NMHS contract post study.** **Explore potential part time PhD studies through local universities for existing staff. Consult training options spreadsheet attachment for further options**
					Expand the range of seasonal and monthly forecasts, especially to include temperature.	If it is not possible to produce these forecasts in-house, it is possible obtain data to produce them from the ECMWF/CFS data repository or source the forecast. Additional training on the use of CPT for statistical predictions of temperature on seasonal timescales.
					Communicate uncertainty of seasonal forecasts to users.	**Discuss other publicly available seasonal forecasts (IRI, ECMWF and CFS) and related consistencies/inconsistencies with respect to their own statistical forecast. Include discussion in disseminated materials.** **Issue updated seasonal forecasts every**

Pillar	Existing category	Recommended Capacities and suggested interventions				
						month, including their own statistical forecast.
					Improve access to software tools for weather and climate forecasting, including statistical and dynamical downscaling.	Utilise AMESD/SYNERGY systems. **Training to use existing software (preferably freely available open source tools e.g. QGIS, SYSTAT, R-INSTAT, R) to develop maps/climate atlases and statistically analyse data.** Training on developing Model Output Statistics (statistical downscaling) for weather forecast applications.
					Improve access to computers connected to a higher speed internet at greater than 10 Mbps.	**Increase bandwidth and install additional switches/cabling where necessary.**
3: Climate Services Information System	2	**Expand the range of basic climate statistics and variables for which they are produced.**	**Training to use software (preferably freely available open source tools e.g. QGIS, SYSTAT, R-INSTAT, R, excel) to develop maps/climate atlases and statistically analyse data.**		Strengthen the production of advanced climate information products in different tabular and graphical formats.	Digitize existing paper records, focussing on variables that are either non-existent or sparse in the existing electronic database. Develop capacity to use GIS and spatial tools to interpolate station observations and satellite and model raster data. Acquire software (preferably freely available open source tools) to develop maps and atlas. Add more climate information products to the ENACTS map rooms.
		Expand seasonal outlooks to include temperature.	If it is not possible to produce these forecasts in-house, it is possible obtain data to produce them from the ECMWF/CFS data repository or source the forecast. Additional training on the use of CPT for statistical predictions of temperature on seasonal timescales.		Expand the range of seasonal outlooks and increase the frequency with which they are produced.	If it is not possible to produce these forecasts in-house, it is possible obtain data to produce them from the ECMWF/CFS data repository or source the forecast. Additional training on the use of CPT for statistical predictions of user-relevant statistics on seasonal timescales. Produce forecasts every month.
		Improve access to software for computation and display of basic climate statistics.	**Training to use software (preferably freely available open source tools e.g. QGIS, SYSTAT, R-INSTAT, R, excel) to develop maps/climate atlases and statistically analyse data.**		**Provide more specialized (tailored) climate analysis, prediction and monitoring products, on seasonal to climate change time scale for major sectors on the website.**	**Assess user requirements and test visualisations with users to determine the most appropriate ways of presenting data.**

Pillar	Existing category	Recommended Capacities and suggested interventions				
		Perform homogenization of climate data.	Digitize existing paper records, focussing on variables that are: • Required for specific services in particular locations e.g. wind forecasts in/around Lakes, rainfall/temperature in specific agricultural areas • Non-existent or sparse in the existing electronic database. *Assess the time series of digital data for step changes, sensor degradation, unrealistic extremes, utilizing out of range and in-homogeneity tests.*			**Training to use software (preferably freely available open source tools e.g. QGIS, SYSTAT, R-INSTAT, R, excel) to develop maps/climate atlases and statistically analyse data.** Develop web site for appropriate formats and dissemination – engage web site developer.
4: User interface Platform	**2**	Formal training.	Formal training in climate services/user engagement.		Strengthen engaging with users.	Training or recruitment of an extension officer or climate service specialist. Expand interaction with sectors through MOUs. Conduct surveys of various users, including government departments and ministries, to collect feedback about the interpretation and usefulness of climate forecasts and other information products.
					Development of website and API tools.	Recruit staff with requisite skill set to facilitate good internet presence of the forecast products of the NMHS.
5: Capacity Development	**1**	Expand participation in national climate related policies and plans.	Engage young professionals and technicians, as well as established staff, in disaster management meetings and longer term development climate-related processes e.g. NAPs, NAMAs etc.		Strengthen corruption safeguards, including independent auditing of procurement, appropriation, and expenditure policies.	Engage independent auditors to assess procurement and expenditure policies. Consult with government (including finance ministries) and donors to arrive at procedures and regulations which will satisfy international requirements.
		Improve baseline qualifications of their technical staff.	**Strengthen the training program, especially to include training for entry-level meteorological technicians.**		**Strengthened IT resources.**	**If possible upgrade bandwidth to 50 Mbps.** **If there is currently no position for a full-time IT specialist this should be created and filled.**
					Expand the range of specializations represented among the staff, including climate, seasonal prediction, Agromet, Hydromet, and NWP.	Assess the priority requirements for training. Select 2-3 specialists for each training to ensure continuity and resilience to staff leaving. Also start a training of trainers program where trained staff are

Pillar	Existing category	Recommended Capacities and suggested interventions				
						required to train further staff in-house, ensuring that capacity is institutionalised. See training options spreadsheet attachment for options.
					Strengthen the training program, in particular to include training for mid-level meteorological technicians.	Conduct training of entry and mid-level meteorological technicians. See training options spreadsheet attachment for options
					Improve access to software tools for weather and climate forecasting, including statistical and dynamical downscaling.	Utilise AMESD/SYNERGY systems. **Training to use existing software (preferably freely available open source tools e.g. QGIS, SYSTAT, R-INSTAT, R) to develop maps/climate atlases and statistically analyse data.** Training on developing Model Output Statistics (statistical downscaling) for weather forecast applications.

Table 9 Rwanda - recommended capacities and suggested interventions, per GFCS pillar. Bold text refers to urgent priorities, standard text refers to medium term priorities, italicized text refers to long-term priorities.

Country: Senegal

The Senegal NMHS meets criteria for Category 2 for the Climate Services Information System pillar, partially meets criteria for Category 2 for the User Interface Platform and Capacity Development pillars, and meets criteria for Category 1 under the Observation and Monitoring and Research and Predictions pillars. The suggested interventions below may help to fulfill or strengthen Category 2 criteria for these pillars.

The Senegal NMHS should invest in improving and expanding observation stations

Senegal NMHS should increase the number of surface stations, focusing on AWS and Class III and above stations. It would also benefit from an increase in the number of upper air stations.

The Senegal NMHS should engage in and incentivize research.

Collaboration with Senegalese and international research institutions in existing and developing new research projects is highly recommended. The development of a data sharing policy between the NMHS and collaborators would be a vehicle for inclusion in research projects and facilitate the development of new user-orientated products.

The seasonal prediction products of the Senegal NMHS should be enhanced.

A discussion on other publicly available seasonal forecasts (e.g. IRI, ECMWF and CFS) and related consistencies/inconsistencies with respect to the issued forecast or COF should be included in disseminated materials.

For further capacity development intervention options see Table 10 below.

Pillar	Existing category	Recommended Capacities and Suggested Interventions			
		Essential Capacities (would fulfill requirements for current category)	**Suggested intervention**	**Desirable Capacities (would fulfill the requirements for a higher category)**	**Suggested intervention**
1. Observation and monitoring	**1**	Increased stations.	Increase proportion of Class II and above stations.	**Some increase in number of surface stations that are manned by trained observers.**	**Increase number of surface stations (Class III and above, and AWS).** Enhance existing satellite data reception and processing system.
		Data rescue.	Rescue/digitize remaining rainfall and temperature data.	**Significant increase in number of upper-air stations.**	Increase number of upper air stations.
2: Research and Predictions	**1**			**Incentivization schemes for research.**	**Incentivisation for research involvement (including bursaries tied to projects?).** **Staffing and time put aside for research involvement.** **Allowing data sharing for research.** **Assign funding from existing projects for research activities**
				Collaboration with local or international research institutions could improve access to research projects and research literature.	Collaboration with other African universities and international institutions, including University of Cape Town, University of Nairobi etc. Collaboration with regional centres (e.g. SADC, ICPAC).
				Communication of uncertainties in the seasonal prediction products (currently communication is done by giving probability or ranges).	**Discuss other publicly available seasonal forecasts (IRI, ECMWF and CFS) and related consistencies/inconsistencies with respect to their own statistical forecast. Include discussion in disseminated materials.**
				Develop human capacity for the production and dissemination of a medium range forecast.	Consult online medium range forecasts. Training e.g. WMO regional centre and Egyptian Meteorological Authority (See training options spreadsheet attachment). Assess forecast skill

Pillar	Existing category	Recommended Capacities and Suggested Interventions			
				Improve access to software tools for weather and climate forecasting, including statistical and dynamical downscaling.	**Utilise AMESD/SYNERGY systems.** **Training to use existing software (preferably freely available open source tools e.g. QGIS, SYSTAT, R-INSTAT, R) to develop maps/climate atlases and statistically analyse data.** **Training on developing Model Output Statistics (statistical downscaling) for weather forecast applications.**
				Increased bandwidth to 10 Mbps.	**If possible, upgrade bandwidth to 10 Mbps.**
3: Climate Services Information System	**2**	Develop guidelines for providing information services to users of climate information.	Guidelines should be based on feedback and interactions with users on the most appropriate forms and visualisation of information. It should include the most appropriate dissemination channels, an assessment of the capacity of the NHMS to deliver the products and costings for the production and dissemination of products.	Expand the range of climate information products, especially more advanced products tailored to users' needs.	Develop capacity to use GIS and spatial tools to interpolate station observations and satellite and model raster data. Training to develop climate risk information based on both climate hazards and exposure/vulnerability data. Produce the analysis and development of user-oriented statistics.
		Expand the range of basic climate statistics.	**Training to use software (preferably freely available open source tools e.g. QGIS, SYSTAT, R-INSTAT, R, excel) to develop maps/climate atlases and statistically analyse data.**	Produce analyses and interpretation of climate statements or products for the general public and other users.	This requires developing a user-services team who are capable of translating weather/climate information into both colloquial terms, and into local languages.
		Improve access to software for computation and display of basic climate analysis.	**Training to use software (preferably freely available open source tools e.g. QGIS, SYSTAT, R-INSTAT, R, excel) to develop maps/climate atlases and statistically analyse data.**	Provide specialized (tailored) climate analysis, prediction and monitoring products, on seasonal to climate change time scale for major sectors on the website.	Assess user requirements and test visualisations with users to determine the most appropriate ways of presenting data. Training to use software (preferably freely available open source tools e.g. QGIS, SYSTAT, R-INSTAT, R, excel) to develop maps/climate atlases and statistically analyse data. Develop web site for appropriate formats and dissemination – engage web site developer.
		Perform homogenization of data.	Digitize existing paper records, focussing on variables that are: • Required for specific services in particular locations e.g. wind forecasts in/around Lakes, rainfall/temperature in specific agricultural areas		

Pillar	Existing category	Recommended Capacities and Suggested Interventions			
			• Non-existent or sparse in the existing electronic database. *Assess the time series of digital data for step changes, sensor degradation, unrealistic extremes, utilizing out of range and in-homogeneity tests.*		
4: User interface Platform	**1**			Documentation (in writing) of user feedback.	Create an internal Frequently Asked Questions repository of user questions and comments.
				Procedures on how this feeds back into the redesign of the information.	
				Formal training in engaging with users.	Training or recruitment of an extension officer or climate service specialist. Provide a facilitated environment in which forecasters and representatives from the user communities are able to discuss forecast needs and products.
				Mechanisms to co-produce information with and increased number of sectors.	Collaborative applied research projects in the co-production of information products. Formalise collaboration between more sectors e.g. MOUs. Undertake formal consultations within sectors. Engage on a semi-regular basis with different government departments.
				Expand training that explains to users how to access and/or use climate information products.	Engage in sector specific trainings, collaborating and partnering with other user-orientated organisations where possible (using intermediary organisations). Utilise partnerships through ongoing projects.
				Communicate more advanced climate information products via the website.	Assess user requirements and test visualisations with users to determine the most appropriate ways of presenting data. Training to use software (preferably freely available open source tools e.g. QGIS, SYSTAT, R-INSTAT, R, excel) to develop maps/climate atlases and statistically analyse data.

Pillar	Existing category	Recommended Capacities and Suggested Interventions			
					Develop web site for appropriate formats and dissemination – engage web site developer.
5: Capacity Development	**2 partially**	Increase participation in national climate related planning and policies.	Engage young professionals and technicians, as well as established staff, in disaster management meetings and longer-term development climate-related processes e.g. NAPs, NAMAs etc.	**Improve access to software tools for weather and climate forecasting, including statistical and dynamical downscaling.**	**Utilise AMESD/SYNERGY systems.** **Training to use existing software (preferably freely available open source tools e.g. QGIS, SYSTAT, R-INSTAT, R) to develop maps/climate atlases and statistically analyse data.** **Training on developing Model Output Statistics (statistical downscaling) for weather forecast applications.** **Investigate the potential for developing WRF or COSMO as an NWP model. This would initially be a development process to investigate the skill and appropriate configurations of the model. Before engaging in this activity there needs to be appropriate resources and skilled personnel, including sufficient bandwidth for downloading boundary conditions**
		Develop a staff training protocol.	Develop a document which lists the types of training each level of staff is required to complete, whether refresher courses are needed and the frequency they should be undertaken. The requirements should be based on available resources within Rwanda i.e. personnel should be able to receive required trainings at national organisations if possible.	**Strengthened IT resources.**	**If there is currently no position for a full-time IT specialist this should be created and filled.** **Invest in high performance computing**
		Improve access to software for computation and display of basic climate statistics.	**Training to use software (preferably freely available open source tools e.g. QGIS, SYSTAT, R-INSTAT, R, excel) to develop maps/climate atlases and statistically analyse data.**		

Table 10 Senegal - recommended capacities and suggested interventions, per GFCS pillar. Bold text refers to urgent priorities, standard text refers to medium term priorities, italicized text refers to long-term priorities.

High level priorities across all NMHS's

The three high priority interventions relevant to all NMHSs are outlined as follows:

1. **Expansion of networks of weather monitoring networks.**
   - observation networks, training in methods of quality control of data from the network (including software training) and the creation of funding mechanisms that would facilitate (a) costs associated with operating & maintaining (O&M) the station network; (b) providing standard and accessible databases of observations, which are accessible to NHMS personnel and external institutions with which they collaborate (e.g. government departments dealing with agriculture and water resources) and (c) the free availability of these data.
   - The expansion of monitoring networks should be based on the required use of the data. For example, for early warning purposes, accuracy is not as important as timeliness in receiving the data, whereas for climate monitoring purposes timing is less critical than accuracy). On the other hand if the purpose is to model the hydrology of a watershed it is important to have stations that sample the headwaters (in mountainous areas) which are responsible for generating runoff. This may require a denser network of stations than if drought over a relatively flat area (e.g. a desert) is being monitored; the relative heterogeneity of these different climates, parameters (in this case rainfall) and service should be the determinant of the required station density, and not be based on arbitrary densities e.g. every 25km (as is assumed according to WMO guidelines currently adopted in the metrics). These considerations are critically important as they also affect the choice, numbers and costs of equipment, and hence the capability to O&M the equipment, which is a significant overhead undertaken using very limited budgets by most African NHMS.
   - The use of remote sensing to derive climate parameters (e.g., satellite-based rainfall estimates) and low cost Automatic Weather Stations (AWS) are other ways in which annual O&M costs can be lowered while still providing services and expanding coverage of the surface observation network.

2. **Production and dissemination of quantitative medium range forecast (3-10 days)**
   - Although medium range forecasts are difficult to produce without appropriate computational infrastructure and qualified personnel, a wide range of such forecasts are available online. The Global Forecast System (GFS) offers data for analysis and may be either statistically or physically (running an NWP model) downscaled, though this often requires capacity building. However, without running an NWP model or statistically downscaling European Centre for Medium-Range Weather Forecasts (ECMWF)/GFS forecasts, it is difficult to develop quantitative forecasts. Most NHMS combine different sources of information using expert opinion leading to a qualitative forecast which users often interpret as not being accurate. Thus training on the production and/or dissemination of existing forecasts should be provided as well as ways in which different data sources can be combined and the software tools available to undertake this work (See training options spreadsheet attachment). The appropriate methods and training is case dependent due to both different levels of statistical skills and model implementation in each NMHS, as well as the target service for which the data will be used. Often the simpler statistical downscaling approach is ignored in favor of dynamical modelling which takes longer and more resources to set up.

- An important constraint in many countries is access to external/international bandwidth. Some countries have access to GFS and ECMWF/EUMETCAST either through the internet or through Very Small Aperture Terminal (VSAT) communications which are expensive and low bandwidth. The cost of bandwidth provided by national carriers and/or private telecom companies is often prohibitively high in developing countries and the annual costs sometimes exceed the budgetary means of NHMS. Yet this is a fundamental requirement, especially if running a NWP model.
- As stated, access to bandwidth for downloading gigabytes of boundary conditions every day for the NWP model is a requirement. Yet while some NWP models are very data intensive (e.g. WRF) others such as Consortium for Small-scale Modeling (COSMO) are provided with minimum boundary conditions through the German weather service, making them less demanding of bandwidth. Even if bandwidth and boundary conditions are not a restriction, appropriate hardware (depending on the size of the domain and resolution) and technical human skills are required to run the model and test it (to evaluate its skill).
- Model output statistics (statistical downscaling) can be a low cost and simpler way of downscaling forecasts, utilizing less bandwidth (only downloading a limited number of ECMWF/GFS fields) and the historical observations from the countries climate database. However, deriving the fundamental equations is a skilled task and any country looking to do this (possibly ahead of, or in conjunction with developing NWP capacity) will need extensive training.

3. **Develop staff capacities for research, development of user-orientated products and communications**
    - Most NMHS are understaffed in terms of technically qualified research and development personnel, as well as staff capable of engaging climate information users, understanding their needs, and translating them into research and development tasks. This is due to both a limited number of technical staff (who often have limited time to spend on research & development), as well as few staff who are trained to engage users in multidisciplinary environments and develop products based on their needs. It is recommended that NMHS recruit and develop new and young staff to fill these positions as well as train existing staff who can supervise the research and development of new products. In some cases, it may mean restructuring groups within the NMHS to take advantage of existing expertise (e.g., in Agrometeorology), but these research and development groups should be able to cover product development across a wide range of sectors and users.

The study did not analyse how NMHSs can raise revenue or form partnerships to address these gaps, though the Sustainable CIS project is developing a financial planning tool to help NMHSs in this regard.

Common barriers and solutions to implementing priority interventions

There are several barriers to addressing the priority interventions listed above (besides direct investment in equipment and technologies). These are explained below, along with suggested solutions (in italics):

- **Governmental finances and budgets allocated to NMHS**. Limited budgets place a burden on salaries, as well as the operation and maintenance of equipment and forecasting systems;
  Lobbying government ministries, including finance ministries, can help to elevate the importance assigned to NMHS, especially in dealing with disasters and providing useful information to sectors including aviation. This helps NMHS when requesting increased funds.
- **Freezes on recruitment.** Tied to available budgets, some NMHS are prevented from recruiting new staff, limiting their ability to expand and develop new products and services;
  Also lobbying government for extra funds to recruit more staff, as well as restructuring existing staff and groups within the NMHS. A formal strategy to develop services and associated staff can help to understand what positions are needed.
- **Institutional mandates and cooperation, including data sharing**. In the development of climate services, NMHS are often required to work with other government departments, NGOs/CSOs and the private sector. This requires flexibility in attitudes to mandates and institutional cooperation, which is sometimes difficult within rigid government structures;
  Enter into memorandums of understanding/agreement with external organisations to share data and develop new products, as well as engage different users of climate information. Undertake joint work based on these MoUs/MoAs.
- **Short-term project-based funding from external donors.** This can stretch the capacity of NMHS to satisfy project requirements when several projects are ongoing at the same time. It can also result in uncoordinated development of technical and human capacities, which dissipate when project funding finishes.
  Formally convene a strategic oversight group within the NMHS to coordinate donor funding, based on a strategic plan for the development of the NMHS

For NMHS to be able to deliver effective climate services, it is clear that these barriers must be tackled in tandem with investments in technical capacities as well as access to modern state-of-the-art equipment. Indeed if these barriers are not addressed at the same time as investments in equipment and technology, it is likely that such investments will ultimately either fail or not lead to the service they were intended to provide. However, by addressing these barriers, providing access to newer and improved technologies (including lower cost instruments where appropriate), developing core capacity to undertake research and development of user-orientated products, NMHS in Africa could provide climate services which serve their populations and help drive future development.

REFERENCES

Altschuld, J.W. & Witkin, B. R. (1999). From Needs Assessment to Action: Transforming Needs into Solution Strategies.

Altschuld, J. W. (2004). Emerging dimensions of needs assessment. Performance Improvement, 43(1).

COP19 (2013) 'Report of the Conference of the Parties on its nineteenth session, held in Warsaw from 11 to 23 November 2013 Addendum Part two: Action taken by the Conference of the Parties at its nineteenth session', in *Report of the Conference of the Parties on its nineteenth session, held in Warsaw from 11 to 23 November 2013 Addendum Part two: Action taken by the Conference of the Parties at its nineteenth session*. Available at: http://unfccc.int/resource/docs/2013/cop19/eng/10a03.pdf#page=2 (Accessed: 19 December 2017).

Dinku, T., Madajewicz, M., Curtis, A., Connor, S., Usher, J., O'Sullivan, R., Steynor, A., Tadross, M., Traore, S., Hauswirth, D., Kloppers, K. & Lennard, C (2018). Development of Metrics to Assess National Meteorological Services in Africa. Assessing Effectiveness and Sustainability of Climate Information Services in Africa. International Research Institute for Climate and Society (IRI), 61 Route 9W, Palisades, NY 10960 USA. USAID Contract No: AID-OAAA-A-16-0056

European Commission (2007). Tools and methods Series: Reference Document No 1. Institutional Assessment and Capacity Development: Why, what and how? Luxembourg: Office for Official Publications of the European Communities. ISBN 978-92-79-04597-4.

Gilmore, G. D. (2011). Needs and Capacity Assessment Strategies for Health Education and Health Promotion. Jones & Bartlett Publishers.

Hewitson, B. (2015) 'To build capacity, build confidence', *Nature Publishing Group*, 8. doi: 10.1038/ngeo2465.

Jennings, M.D. (2000). Gap analysis: concepts, methods, and recent results. Landscape Ecology 15: 5–20.

Kaufman, R A. (1994). A needs assessment Audit. Performance and Instruction, 33(2), 14-16.

Kessy, J. & Kaswamila, A. (2014). Analytical Framework Model for Capacity Needs Assessment and Strategic Capacity Development within the Local Government Structure in Tanzania. Open Journal of Soil Science, 4, 502-508.

Kizlik, B. (2010). "Needs Assessment Information", ADPRIMA.

Reviere, R., Berkowitz, S., Carter, C.C. & Ferguson, C.G. (1996). Needs Assessment: A Creative and Practical Guide for Social Scientists. Washington, DC: Taylor and Francis.

Sendai Framework for Disaster Risk Reduction 2015-2030. United Nations Office for Disaster Risk Reduction (UNISDR), 2015. Available at: https://www.preventionweb.net/files/43291_sendaiframeworkfordrren.pdf

Soriano, F. (1995). Conducting Needs Assessments: A Multidisciplinary Approach

Stephen, P. & Triraganon, R. (2009). Strengthening Voices for Better Choices: A capacity needs assessment process. Gland, Switzerland: IUCN.

Stevens, A. & Gillam, S. (1998). Needs assessment: from theory to practice. *BMJ*; 316:1448.

UN General Assembly, Transforming our world: the 2030 Agenda for Sustainable Development, 21 October 2015, A/RES/70/1. Available at: http://www.refworld.org/docid/57b6e3e44.html

UNDP (2008a). Capacity assessment methodology: User's guide. New York: UNDP.

UNDP (2008b). Capacity Assessment PRACTICE NOTE.

UNDP (2009). Capacity Development: A UNDP Primer.

UNESCO (2013). Towards Effective Capacity Development Capacity Needs Assessment Methodology (CAPNAM) for Planning and Managing Education.

UN-REDD National Programme (2012). Capacity Needs Assessment of Government Institutions at Central, Regional, District and Local Levels for the Establishment and Management of a REDD+ Scheme in Tanzania.

Watkins, R. & Kaufman, R. (1996). An update on relating needs assessment and needs analysis. Performance Improvement, 35(10), 10-13.

Witkin, B. R. & Altschuld, J.W. (1995). Planning and conducting needs assessments: A practical guide. Sage Publications, Inc.

ANNEX 1: DETAILED BASELINE CAPACITIES OF EACH NMHS

Country: Ethiopia

The Ethiopia NMHS meets the criteria for Category 2 for the Climate Services Information System pillar, partially fulfills the criteria for a Category 2 service for the Capacity Development and Research and Prediction pillars, fulfills the requirements for a Category 1 NMHS with respect to the Observation and Monitoring pillar. The NMHS partially meets the criteria for Category 3 for the User Interface Platform pillar.

Pillar 1. Observation and Monitoring

Summary

Ethiopia's NMA fulfills most of the Observation and Monitoring criteria for Category 1. However, modest increase in the number of upper air stations would be beneficial. Further increase in number of surface [including Automatic Weather Station (AWS)] and upper air stations and enhancing existing satellite data reception and processing system can move NMA to Category 2. Progress to Category 3 would require substantial investment in expanding surface (including AWS) and upper air stations and having a written procedure for station inspections and maintenance.

Category 1 – Basic NMHS functionality Meets

Review

- Strength: The NMA fulfills most of the Observation and Monitoring criteria for a Category 1 NMHS.
- Weakness: Very sparse coverage of upper air stations.

Recommendations

- Invest in the expansion of upper air stations.

Category 2. Essential NMHS functionality Does not meet

Review

- Strength: At least 90% of NMA's stations are manned by trained observers, and NMA maintains electronic backup of its climate data and backs up data regularly. It performs quality checks using advanced quality control procedures and tools. In addition at least 75% of Class III and above stations are inspected every year
- Weakness: Coverage of surface and upper air stations are too sparse to be in Category 2.

Recommendations

- Increase the number of surface stations, including AWS;
- Increase the number of AWS;
- Increase the number of upper air stations;
- Enhancing the existing satellite data reception and processing system.

Category 3 – Full NMHS functionality Does not meet

Review

- Strength: NMA has performed a needs assessment to determine the density and type of stations needed for different applications. Bases on this, the Agency has formulated a long-term strategic plan for expanding the station network and observed climate variables. Currently all stations are manned by trained observers, and all Class III and above stations are inspected every year.

- Weakness: Sparse coverage of surface and upper air stations.

Recommendations

- Investment in expanding the surface (including AWS) and upper air stations;
- Invest in proper written procedures for station inspections and maintenance.

Pillar 2. Research and predictions

Summary

The Ethiopia NMHS partially fulfills the criteria for a Category 2 service with respect to Research and Predictions. In order to fully satisfy the requirements for Category 2, the NMHS should improve the educational level of staff. A suggestion would be to hire more individuals with Doctor of Philosophy (PhD) degrees in meteorology. Greater human capital should assist the NMHS in improving prediction capacity to provide 10-day weather forecasts and to use dynamical approaches to generate seasonal and sub-seasonal forecasts. The NMHS should also invest in greater internet speed. A larger investment in educational level of staff, more engagement in leading roles in research, greater sophistication of forecast products, and a larger investment in computational hardware (such as high-performance computers and faster internet) would be needed for the NMHS to meet the requirements of a Category 3 NMHS.

Category 1 – Basic NMHS functionality Meets

Review

- Strengths: The Ethiopia NMHS fulfills all research and prediction criteria for a Category 1 NMHS. The NMHS participated in more than 2 research projects in the last 5 years. It provides a weather forecast for up to 5 days and seasonal outlooks for rainfall and temperature. It has adequate internet.
- Weaknesses: None

Recommendations

- None

Category 2. Essential NMHS functionality Partially meets

Review

- Strengths: The Ethiopia NMHS gives staff incentives to participate in research and provides needed resources such as access to online literature, basic computing facilities, including software and tools for advanced processing. The service has staff with a range of specializations. The staff participate in research projects, and produce and disseminate seasonal and monthly forecasts, including forecast uncertainties,
- Weaknesses: The NMHS does not provide daily weather forecasts for up to 10 days nor does it use dynamical approaches. In addition, fewer than 5% of the staff possess a PhD. Bandwidth capacity of the internet is less than 10 Mbps.

Recommendations

- Recruit more staff with PhD in meteorology and/or provide staff with opportunities to undertake studies toward a PhD;
- Produce and disseminate a 10-day forecast;
- Use dynamical approaches to produce seasonal and monthly forecasts;
- Invest in higher speed internet, greater than 10 Mbps.

Category 3 – Full NMHS functionality Does not meet

Review

- Strengths: The staff have led research grant proposals in the past 5 years. The staff evaluate and communicate the performance of forecasts, run climate models and organize at least one National Climate Outlook Forums (NCOF) per year.
- Weaknesses: The NMHS does not have the capacity in terms of hardware, software and personnel skills to produce predictions required in this category.

Recommendations

- Invest much more in recruiting staff with PhD in meteorology and/or provide staff with opportunities to undertake studies toward a PhD;
- Engage staff in leading collaborative research projects and the writing of reports and publications;
- Produce seasonal outlooks more frequently;
- Produce a greater range of more advanced products;
- Invest in high performance computers and considerably faster internet, more than 100 Mbps.

Pillar 3: Climate Services Information System

Summary

The Ethiopia NMHS partially fulfills the criteria of a Category 3 service for the Climate Services Information System pillar. There are aspects within each category that are not fully met. The NMHS would have to invest more in the range of products that it produces, specializing the products for particular users, and communicating climate information to specific users through its website in order to meet the requirements of Category 3.

Category 1 – Basic NMHS functionality Meets

Review

- Strengths: At a governance level, the Ethiopia NMHS has clear policy guidelines on data access and provides data free of charge to government ministries and education institutions. Staff produce basic climate statistics for major climate variables and produce and disseminate seasonal rainfall and temperature outlooks. The NMHS has a dedicated website with basic climate information.
- Weaknesses: The NMHS does not have written guidelines for the provision of products and services to users of climate information. Access to software for computation and display of basic climate statistics is somewhat limited.

Recommendations

- Develop written guidelines to govern the provision of climate information products and services to users;
- Improve access to software for computation and display of basic statistics.

Category 2. Essential NMHS functionality Meets

Review

- Strengths: The NMHS performs advanced statistical analyses and contributes to national early warning systems through early warning information and advisories. The NMHS responds to user needs and has produced and/or refined products in response to user feedback in the last 2 years. The dedicated website includes forecasts and advisories.
- Weaknesses: The range of advanced climate information products could be expanded. The NMHS does not perform homogenization of climate data.

Recommendations

- Expand the suite of advanced climate information products;
- Perform homogenization of climate data.

Category 3 – Full NMHS functionality Partially meets

Review

- Strengths: The Ethiopia NMHS has produced climate information products tailored to national policy and national action plans. The NMHS produces some advanced products and communicates them on the website.
- Weaknesses: The range of advanced climate information products (that the NMHS produces and communicates on its website) that are tailored to the needs of particular sectors are limited. Additionally, the NMHS needs to strengthen analyses and interpretation of climate information and products for the general public and other users in order to meet the requirements of Category 3.

Recommendations

- Increase the frequency with which seasonal outlooks are produced;
- Expand the range of advanced climate information products in different tabular and graphical formats;
- Expand the production of specialized climate analysis, prediction, and monitoring products on seasonal and climate time scales tailored to the needs of users in the major sectors and communicate them on the website;
- Strengthen the issuance of analyses and interpretation of climate statements and products for specific users.

Pillar 4: User Interface Platform

Summary

The Ethiopia NMHS partially meets the criteria for Category 2 and Category 3 for the User Interface Platform pillar. In order to fully meet the criteria for Category 2, the NMHS should train an additional staff member in engagement with users, and should establish a practice of documenting and incorporating the feedback that users provide about the usefulness and effectiveness of climate information products and services to assist in then redesign of information products and services.

Category 1 – Basic NMHS functionality Meets

Review

- Strengths: The NMHS has a strategic plan for engagement with users of climate information. The NMHS has signed Memorandum Of Understanding (MOUs) and has procedures in place to co-produce climate information with at least five sectors. Additionally, the NMHS has produced climate information in response to user requests in the last 2 years, and it communicates some advanced climate information through its website.
- Weaknesses: Gaps remain in staff training.

Recommendations

- Formally train staff in engaging with users. This formal training would be a recommendation to strengthen capacity and ensure user engagement that would benefit both the users and the Ethiopia NMHS itself;

Category 2. Essential NMHS functionality Partially meets

Review

- In the past three years the Ethiopia NMHS has assessed the requirements of climate information users in different sectors. This has supported the production of tailored climate information products in response to users' requests and needs. The NMHS provides training that explains to users how to access and use climate information products and services. The NMHS has mechanisms in place to co-produce climate information products with the Agriculture, Water, Health, Energy and Transport sectors in Ethiopia. The NMHS has begun the process for a National Framework for Climate Services. The NMHS communicates some advanced climate information products through its website.
- Weaknesses: The NMHS does not document user feedback and use it to improve products. The NMHS does not have staff trained in engagement with users.

Recommendations

- Document in writing user feedback to assess the usefulness and effectiveness of the information and services provided;
- Establish procedures to incorporate user feedback into the redesign of climate information products and services and the development of new products and services;
- Train staff in user engagement.

Category 3 – Full NMHS functionality Partially meets

Review

- The Ethiopia NMHS partially meets the User Interface Platform requirements of a Category 3 NMHS.

Recommendations

- The development of website and API tools, improving access to advisories tailored to specific users' needs and national observation and forecast information.
- The NMHS should create a communication network with users of climate information via social media and mobile network platforms.

Pillar 5: Capacity Development

Summary

The Ethiopia NMHS partially fulfills the criteria for a Category 2 service for Capacity Development. In order to fully meet the criteria for a Category 2 service in Capacity Development, the Ethiopia NMHS would need to improve corruption safeguards, such as independent auditing, invest in human capital, and improve internet connection speeds. The NMHS needs additional investments in human capital and technological capacity to satisfy requirements for Category 3.

Category 1 – Basic NMHS functionality Meets

Review

- Strengths: The Ethiopia NMHS has a formalized governance structure and participates in climate related policies and plans. Staff have basic training in some essential services. The NMHS has an adequate number of senior meteorological technicians with MSc and PhD degrees. The NMHS has some staff with an education in management. All staff have access to basic computing resources and 1 Mbps internet capacity.
- Weaknesses: Lack of staff trained in data rescue

Recommendations

- Improve the training protocol that staff are required to complete and its frequency;

- Train staff in data rescue;
- Improve access to software for the computation and display of basic climate statistics.

Category 2. Essential NMHS functionality Partially meets
Review
- Strengths: NMHS is governed as a semi-independent body under a Ministry. It employs technical staff with a broad range of specializations, including staff educated in management. The NMHS has considerable computing capacity, including software for statistical and dynamical weather and climate forecasting, at least one high-powered computer, and climate-controlled environment for technical equipment.
- Weaknesses: Gaps remain in governance, staff education and training, and internet connection.

Recommendations
- Improve corruption safeguards, including independent auditing of appropriation, procurement and expenditure policies;
- Recruit more senior meteorological technicians with MSc and PhD degrees;
- Provide training for entry and mid-level meteorological technicians;
- Improve internet connection speeds to exceed 10 Mbps.

Category 3 – Full NMHS functionality Does not meet
Review
- Strengths: The Ethiopia NMHS has formal written policies that govern partnership agreements and data sharing. The NMHS has staff who specialize in developing applications of climate information for different sectors, and staff who have at least 3 years of education in management. The NMHS helps to train staff from other climate services.
- Weaknesses: IT resource capacity and staff education prevent the NMHS from meeting the criteria for a Category 3 service.

Recommendations
- Recruit more senior meteorological technicians with MSc and PhD degrees;
- Increase IT resource capacity. In particular, increase internet connection speeds to exceed 100 Mbps and invest in 3 or more high-performance computers.

Country: Cote d'Ivoire

The Cote d'Ivoire NMHS partially fulfills the requirements for a Category 1 NMHS with respect to the Research and Prediction pillar, and does not meet the requirements for the other pillars.

Pillar 1. Observation and Monitoring
Summary
Cote d'Ivoire does not meet the Observation and Monitoring criteria for Category 1. In fact, its score in this pillar is the lowest of the seven NMHS participated in the survey. Bringing Cote d'Ivoire to Category 1 would require investment in expanding surface and upper air stations, manning stations with trained observers, and undertaking data rescue.

Category 1 – Basic NMHS functionality Does not meet
Review

- Strength: Cote d'Ivoire Met inspects at least 50% of stations that are Class III and above every year, maintains electronic climate database with regular back up, and uses basic quality control procedures and tools.
- Weakness: Cote d'Ivoire Met does not meet many of the Observation and Monitoring criteria for a Category 1 NMHS.

Recommendations

- Invest in training of observers;
- Increase the number of surface stations;
- Add at least one upper air station;
- Increase the number of Class III and above stations.

Category 2. Essential NMHS functionality Does not meet

Review

- Strength: The strengths include station inspection, staff access to computing facilities, needs assessment for station expansion, and strategic plans for station expansion.
- Weakness: Many of the indicators are not met and substantial investment would be required to move up to Category 2.

Recommendations

- Increase the number of surface stations, of which most of these should be Class III and above;
- Increase the number of AWS (currently zero);
- Ensure that stations (at least those Class III and above) are manned by trained observers;
- Use advanced quality control procedures and tools such as the CDT;
- Enhance the current system for reception, digital processing and display of satellite data;
- Incorporate remote sensing data to enhance station observations; this may be accomplished by implementing Enhancing National Climate Services initiative (ENACTS);
- Deploy several weather radars.

Category 3 – Full NMHS functionality Does not meet

Review

- The Cote d'Ivoire NMHS does not meet the Observation and Monitoring requirements of a Category 3 NMHS.

Recommendations

- None.

Pillar 2. Research and Predictions

Summary

The Cote d'Ivoire NMHS partially fulfills the criteria for a Category 1 NMHS for the Research and Predictions pillar. The NMHS could fulfill criteria for Category 1 by improving weather forecasts and expanding the range of seasonal forecasts. In order to meet Category 2 criteria, the NMHS needs to improve human and technological capacity, and expand forecasting to include medium range outlooks.

Category 1 – Basic NMHS functionality Partially Meets

Review

- Strengths: The NMHS staff participate in research projects and experiments. The NMHS also has adequate internet connectivity for a Category 1 service.

- Weaknesses: The NMHS lacks sufficient capacity in providing weather forecasts and seasonal outlooks to fully meet the Category 1 criteria.

Recommendations

- The NMHS should build capacity to provide weather forecasts for at least the next 3 days as well as seasonal temperature outlooks.

Category 2. Essential NMHS functionality Does not meet

Review

- Strengths: The Cote d'Ivoire NMHS employs staff with a range of specializations, and the staff participate in research. The staff have reasonably good access to the internet, and therefore are able to access online literature.
- Weaknesses: The NMHS has relatively low capacity in terms of education of meteorologists, and technology. These weaknesses may be partly responsible for the limited range of climate information products.

Recommendations

- Improve weather forecasts to cover at least 10 days;
- Broaden seasonal forecasts to include temperature and include an assessment of uncertainty in the seasonal forecast;
- Produce and disseminate monthly rainfall and temperature predictions;
- An already good research program could be improved by recruiting more staff with PhD degrees in meteorology and providing incentives to conduct research;
- The NMHS should improve technical capacity, in particular access to software tools for weather and climate forecasting and internet bandwidth.

Category 3 – Full NMHS functionality Does not meet

Review

- The Cote d'Ivoire NMHS does not meet the Research and Predictions requirements of a Category 3 NMHS.

Recommendations

- None

Pillar 3: Climate Services Information System

Summary

The Cote d'Ivoire NMHS does not fulfill the criteria for a Category 1 NMHS for Climate Services Information System. The NMHS would need to expand the range of forecasts (as noted under the previous pillar), improve access to software for producing climate statistics, as well as improve communication with users in order to meet the criteria for Category 1. The NMHS does not have a website and offers limited data sharing.

Category 1 – Basic NMHS functionality Does not meet

Review

- Strengths: At a governance level, the Cote d'Ivoire NMHS has clear policy guidelines on the provision of climate information services, and provides data free of charge to government ministries. The NMHS produces most basic climate statistics for major climate variables.

- Weaknesses: The Cote d'Ivoire NMHS produces a limited range of forecasts, does not have sufficient technological capacity, and does not have sufficient resources for communicating with users.

Recommendations

- Provide data free of charge to a broader range of institutions, including education institutions;
- Expand the range of climate statistics for major climate variables and offer seasonal temperature forecasts;
- Improve access to software for computation and display of basic climate statistics;
- Develop a website that hosts climate information products.

Category 2. Essential NMHS functionality Does not meet

Review

- Strengths: The NMHS produces and disseminates early warning information and advisories and has produced new products or refinements to products in response to user requests over the last 2 years
- Weaknesses: The NMHS does not contribute to the national early warning system or have a dedicated website with climate products, forecasts, and advisories. Climate data homogenization is not performed

Recommendations

- Provide a dedicated weather/climate information dissemination website
- Perform homogenization of climate data
- Contribute to national early warning systems

Category 3 – Full NMHS functionality Does not meet

Review

- The NMHS does not meet the Climate Services Information System requirements of a Category 3 NMHS.

Recommendations

- None

Pillar 4: User Interface Platform

Summary

The Cote d'Ivoire NMHS does not fulfill the criteria for a Category 1 NMHS for the User Interface Platform pillar. The NMHS would need to improve communication with users of climate information and capacity to co-produce climate information with users in order to meet the requirements for Category 1.

Category 1 – Basic NMHS functionality Does not meet

Review

- Strengths: A set of strategic plans and procedures have been put in place by the Cote d'Ivoire NMHS to ensure that users requests for weather forecasts and questions raised around basic climate information are met with advice and guidance. The NMHS has signed MOUs with two different sectors, and at least 1 staff member has received training in engagement with users of climate information.
- Weaknesses: The NMHS has limited capacity to engage with users to produce climate information, communicate that information to users, and document the usefulness of information provided.

Recommendations

- Develop procedures that will enable staff to co-produce climate information in collaboration with users, so that the information products serve the needs of decision makers well;
- To document user feedback about climate information provided so that the information products can be improved over time;
- Develop a website that communicates climate information to users.

Category 2. Essential NMHS functionality Does not meet

Review

- Strengths: In terms of user engagement, the NMHS has conducted an assessment of user information requirements in different sectors in the last 3 years as well as produced tailored climate information products in response to user requests in the last 2 years. The NMHS has also started the process for the National Framework for Climate Services(NFCS)
- Weaknesses: The user engagement procedures are still lacking in several areas. There are insufficient mechanisms in place to co-produce climate information products, user feedback is no documented, there are insufficient staff trained in climate services/user engagement and the website does not have some advanced climate information products

Recommendations

- Put in mechanisms to co-produce climate information products with at least 3 sectors
- Document user feedback in writing
- Implement written procedures for incorporating user feedback into the redesign of information products and services
- Train at least 2 staff members in climate services/user engagement
- Enhance website to incorporate some advanced climate information products

Category 3 – Full NMHS functionality Does not meet

Review

- The NMHS does not meet the User Interface Platform requirements of a Category 3 NMHS.

Recommendations

- None

Pillar 5: Capacity Development

Summary

The Cote D'Ivoire NMHS does not fulfill the criteria for a Category 1 NMHS with regard to Capacity Development. The NMHS would need to improve the training, expand its participation in national policies and plans related to climate, and improve access to software for computation of climate statistics in order to meet the Category 1 requirements.

Category 1 – Basic NMHS functionality Does not meet

Review

- Strengths: The Cote d'Ivoire NMHS has a formalized governance structure and participates in some climate related policies and plans. The NMHS trains entry-level meteorological technicians, and staff have training in database management and quality control. Most staff have access to computers connected to the internet at 1 Mbps internet capacity.

- Weaknesses: The training capacity and technological capacity for producing basic climate statistics are limited, as is engagement in national policies and plans.

Recommendations

- Expand participation in national policies and plans;
- Establish protocol for training required by different types of staff;
- Train staff in data rescue;
- Improve access to software for computation and display of basic climate statistics;
- Improve access to computers connected to the internet.

Category 2. Essential NMHS functionality Does not meet

Review

- Strengths: The NMHS has technical capacity in the specialisations of climate, seasonal prediction, agromet, hydromet and Numerical weather prediction (NWP). In addition, at least 50% of their meteorological technicians at senior level and above have MSc or PhD degrees in meteorology. This human resource capacity is supported by a high-performance computer.
- Weaknesses: There are a number of areas where the indicators for a Category 2 NMHS are not fully met. For instance, there could be an improvement in the training of entry and mid-level meteorological technicians, and an improvement in staff access to software tools for weather and climate forecasting, including statistical and dynamical downscaling. IT resources could be improved by installing a climate-controlled computer centre with backup power and power protection as well as increasing internet bandwidth to greater than 10 Mbps.

Recommendations

- Further staff training/qualifications
- Strengthened IT resources

Category 3 – Full NMHS functionality Does not meet

Review

- The NMHS does not meet the Capacity Development requirements of a Category 3 NMHS.

Recommendations

- None

Country: Malawi

The Malawi NMHS meets the requirements for Category 1 and 2 for the Climate Services Information System pillar, and it partially meets Category 1 requirements for the Research and Predictions and User Interface Platform pillars. It does not meet the Category 1 requirements for the other GFCS pillars.

Pillar 1. Observation and Monitoring

Summary

Malawi's Department of Climate Change and Meteorological Services (DCCMS) meets only some of the criteria for Category 1 for the Observation and Monitoring pillar. It can meet the criteria required for Category 2 by improving coverage of upper air observation stations, strengthening station inspection, and backing up climate data regularly.

Category 1 – Basic NMHS functionality Does not meet

Review

- Strength: At least 75% of Malawi Met stations are manned by trained observers, and coverage of surface stations is at least one station every 50 km. It maintains electronic climate database, and uses basic quality control procedures.
- Weakness: Malawi Met does not backup climate data often and has not digitized many of its climate data.

Recommendations

- Add at least one upper air observation station;
- Strengthen station inspection;
- Back up climate data at least every month;
- Conducted data rescue.

Category 2. Essential NMHS functionality Does not meet

Review

- Strength: At least 90% of DCCMS's stations are manned by trained observers, and all of AWS are inspected at least once a year. DCCMS has access to computing capacity for data collection, storage, and transmission. It has strategic plans for station expansion.
- Weakness: The number of surface and upper air stations are too sparse for a NMHS Category 2 and Malawi Met does not use proxy data to augment its observations.

Recommendations

- Increase the number of surface stations, and these should be Class III and above;
- Increase number of upper air stations;
- Backup of data climate data at least every week;
- Use advanced quality control tools such as CDT;
- Strengthen inspection;
- Perform basic station needs assessments;
- Incorporate remote sensing data to enhance station observation, for e.g. through implementation of ENACTS.

Category 3 – Full NMHS functionality Does not meet

Review

- DCCMS does not meet the Observation and Monitoring requirements of a Category 3 NMHS.

Recommendations

- None

Pillar 2. Research and Predictions

Summary

The main reason why the Malawi NMHS does not fully meet the requirements for a Category 1 NMHS in the Research and Predictions pillar is that the NMHS was unable to provide information about the number of research projects and experiments in which the staff participate. Therefore, the baseline assessment could not take participation in research at the NMHS into account.

Based on available data, the NMHS would need to expand the range of seasonal forecasts in order to fully satisfy the requirements for a Category 1 service. The NMHS should improve human and technological research capacity, and expand the range of weather, seasonal, and monthly forecasts in order to satisfy the criteria of a Category 2 NMHS in Research and Predictions.

Category 1 – Basic NMHS functionality Partially meets

Review

- Strengths: The Malawi NMHS fulfills most research and prediction criteria for a Category 1 NMHS, such as providing weather forecasts for up to 3 days and seasonal rainfall forecasts.
- Weaknesses: The NMHS does not provide a temperature seasonal forecast. We could not evaluate participation in research.

Recommendations

- If there is a lack of participation in research projects, the Malawi NMHS should attempt to participate in more research projects with in-country or international research institutions;
- Expand seasonal forecasts to include temperature.

Category 2. Essential NMHS functionality Does not meet

Review

- Strengths: The NMHS provides incentives for staff to participate in research. The NMHS employs staff with a range of competencies. Staff use dynamical approaches to produce a range of seasonal outlooks. Most staff have access to computers connected to the internet.
- Weaknesses: The NMHS needs to improve access to research resources, and the range of forecast products as well as the human and technological capacities to produce them in order to meet the requirements for a Category 2 service.

Recommendations

- The NMHS should build research capacity by recruiting more staff with PhDs in meteorology and providing them with resources needed, such as online access to literature;
- Provide a weather forecast for up to 10 days;
- Expand the range of seasonal and monthly forecast products and communicate uncertainties;
- Improve access to software tools for weather and climate forecasting, including statistical and dynamical downscaling;
- Invest in internet faster than 10 Mbps.

Category 3 – Full NMHS functionality Does not meet

Review

- The NMHS does not meet the Research and Predictions requirements of a Category 3 NMHS.

Recommendations

- None

Pillar 3: Climate Services Information System

Summary

The Malawi NMHS fulfills the criteria for a Category 2 NMHS for Climate Services Information System. There are aspects within the two categories that are not fully met, such as range of forecast products and access to software for computing climate statistics. The NMHS should expand the range of products and improve the information that it communicates to users of climate information on its website to move up to a Category 3 NMHS for Climate Services Information System.

Category 1. Basic NMHS functionality Meets

Review

- Strengths: At a governance level, the Malawi NMHS has clear policy guidelines on the provision of Climate Information Services and provides data free of charge to government ministries and education institutions. Staff produce most basic climate statistics for major climate variables.
- Weaknesses: The NMHS should improve capacity to produce basic climate statistics and seasonal outlooks.

Recommendations

- Provide seasonal temperature outlooks;
- Improve access to software for computation and display of basic climate statistics.

Category 2. Essential NMHS functionality Meets

Review

- Strengths: The Malawi NMHS performs advanced statistical analyses and contributes to national early warning systems through early warning information and advisories. ENACTS map rooms have been implemented. The NMHS responds to user needs and has produced and/or refined products in response to user feedback in the last 2 years.
- Weaknesses: The NMHS does not perform homogenization of climate data.

Recommendations

- Perform homogenization of climate data.

Category 3 – Full NMHS functionality Does not meet

Review

- Strengths: In terms of climate information communication, the Malawi NMHS issues analyses and interpretation of climate statements or products for the general public, and has produced tailored products for the national policy/action plans. It produces advanced climate information in different tabular and graphical formats.
- Weaknesses: The range of seasonal outlooks is limited and the webpage does not provide sufficient specialized products.

Recommendations

- Improve the NMHS web page to provide tailored climate analysis, prediction and monitoring products, on seasonal to climate change time scale for major sectors;
- Broaden the range of seasonal forecasts and advanced climate information products in different formats.

Pillar 4: User Interface Platform

Summary

The Malawi NMHS partially fulfills the criteria for a Category 1 NMHS for the User Interface Platform pillar. In order to move to a Category 2 NMHS, the Malawi NMHS would need to improve its documentation of user needs and feedback, incorporate feedback into a redesign of products, enhance the training of users and improve the website.

Category 1 – Basic NMHS functionality Partially meets

Review

- Strengths: Together with a strategic plan and procedure for user engagement, at least two staff members have been trained to interact with users around requests for seasonal forecasts and basic climatological queries. Such interactions have occurred in the past two years. The NMHS

has a procedure in place to co-produce climate information with users, and it has signed an MOU with several sectors. The website communicates basic climate information to users.

- Weaknesses: The NMHS does not document feedback from users of climate information.

Recommendations

- Document, in writing, feedback that users have about the climate information produced.

Category 2. Essential NMHS functionality Does not meet

Review

- Strengths: In the past two years the Malawi NMHS has produced tailored products in response to user's requests. The NMHS has mechanisms in place to co-produce climate information with the Agriculture, Water and Health sectors. The NMHS has implemented or started the process for NFCS. It also communicates some advanced climate information on its website.
- Weaknesses: The NMHS's interaction with users still lacks capacity in terms of understanding users' needs for climate information, training users, and providing a range of products.

Recommendations

- A written assessment of user information requirements would be beneficial in identifying users' needs;
- Document user feedback in writing in order to assess the usefulness and effectiveness of the information and services provided;
- Establish a mechanism for incorporating user feedback into the redesign of the information provided;
- Conduct more training to explain to users how to access and use climate information products;
- Improve the website to include a broader range of advanced climate information products.

Category 3 – Full NMHS functionality Does not meet

Review

- The Malawi NMHS does not meet the User interface Platform requirements of a Category 3 NMHS.

Recommendations

- None

Pillar 5: Capacity Development

Summary

The Malawi NMHS does not fulfill the criteria for a Category 1 NMHS for Capacity Development. In order to satisfy the criteria, the NMHS would need to expand participation in the national policy process, and strengthen human and technological capacity.

Category 1 – Basic NMHS functionality Does not meet

Review

- Strengths: The NMHS participates in climate related policies and plans. Staff have basic training in essential services. Most staff have access to basic computing resources and 1 Mbps internet capacity.
- Weaknesses: Trained human, and technological capacities are limited.

Recommendations

- Establish a formalized, written governance structure;
- Expand participation in national policy processes;
- Increase opportunities of scholarship to further train existing staff.
- Establish a protocol for training required of different staff members;
- Train staff in data rescue;
- Recruit or train existing staff with PhD degrees to improve research capacities and with business qualifications to help develop services/revenue generation.

Category 2. Essential NMHS functionality Does not meet

Review

- Strengths: The NMHS has some safeguards against corruption. It has some staff with a range of specializations including NWP. Staff have some access to software tools for weather and climate forecasting and there is some training conducted for entry and mid-level meteorological technicians
- Weaknesses: A number of the indicators of a Category 2 NMHS are not fully met. These include the need to improve corruption safeguards, improve training of entry and mid-level meteorological technicians and improve access of staff to software and tools for weather and climate forecasting. There are weaknesses in staff qualifications with more staff with MSc's and PhDs required, in particular. The internet connection speed does not meet the Category 2 requirement of 10 Mbps. The NMHS does not have high performance computing capacity.

Recommendations

- Strengthened IT resources;
- Establish a protocol for training required of different staff members, including further staff training, staff qualifications;
- Recruit or train existing staff with PhD degrees to improve research capacities and with business qualifications to help develop services/revenue generation.

Category 3 – Full NMHS functionality Does not meet

Review

- The Malawi NMHS does not meet the Capacity Development requirements of a Category 3 NMHS.

Recommendations

- None

Country: Mali

The Mali NMHS partially fulfills criteria for Category 3 for the User Interface Platform pillar, fulfills criteria for Category 2 for Climate Services Information System pillar, partially satisfies requirements for Category 2 for the Capacity Development pillar, and partially meets requirements for a Category 1 NMHS in Observation and Monitoring and Research and Predictions.

Pillar 1. Observation and Monitoring

Summary

Mali NMHS (Mali NMHS) partially meets the Observation and Monitoring criteria for Category 1. However, this is partly because of the size of the country and the proportion inhabited part of the country. Mali NMHS may meet the criteria for Category 1 by expanding surface observation networks, and strengthening station inspection.

Category 1 – Basic NMHS functionality Partially meets

Review

- Strength: Mali NMHS meets most of Observation and Monitoring criteria for a Category 1 NMHS. At least 75% of all stations are manned by trained observers. Additionally, coverage of upper air observation stations is at least one station every 500 km. Mali NMHS maintains an electronic climate database, backed up data at least every month and has been conducting data rescue.
- Weakness: Sparse surface station network and weak station inspection.

Recommendations

- Expand surface observation network by 106 and strengthen station inspection.

Category 2. Essential NMHS functionality Does not meet

Review

- Strength: Mali NMHS uses advanced quality control tool (CDT) for ensuring quality of observations, maintains computing capacity for data collection, storage, transmission and research, has performed basic station needs assessment and has strategic plans for station expansion. It has incorporated remote sensing data to enhance station observations through the ENACTS and operates set radars with good area coverage.
- Weakness: Mali NMHS operates very few AWS as well as sparse upper air station coverage.

Recommendations

- Increase number of AWS and number of upper air stations;
- Strengthening station inspection;
- Ensure at least 75% of stations that are above Class III reported to NMHS headquarters every day;
- Enhance the current a system for reception, digital processing and display of satellite data.

Category 3 – Full NMHS functionality Does not meet

Review

- Mali NMHS does not meet the Observation and Monitoring requirements of a Category 3 NMHS.

Recommendations

- None.

Pillar 2. Research and Predictions

Summary

The Mali NMHS partially fulfills the research and predictability criteria for a Category 1 NMHS for the Research and Predictions pillar. However, the production of a regular three-day weather forecast and a seasonal outlook for temperatures would place it comfortably within this category. The NMHS would satisfy the requirements for Category 2 if it could improve human and technological capacity sufficiently to broaden the range of more sophisticated climate information products.

Category 1 – Basic NMHS functionality Partially Meets

Review

- Strengths: The Mali NMHS has participated in at least two research projects in the last 5 years. The NMHS has access to adequate internet speed.
- Weaknesses: The forecast products are limited.

Recommendations

- Provide weather forecasts for up to 3 days;
- Provide seasonal temperature outlooks.

Category 2. Essential NMHS functionality Does not meet

Review

- Strengths: The Mali NMHS provides incentives for staff to engage in research and gives them access to online literature and basic computing resources. The staff have participated in at least 5 research projects in the last 5 years. Specialist technical functions in different forecasting disciplines are present. The staff produce a range of seasonal forecasts each season and provides some assessment of the forecast uncertainty.
- Weaknesses: Human and technological capacity are not sufficient, and neither is the range of climate information products.

Recommendations

- An already good research program should recruit more staff with PhD degrees in meteorology and/or facilitate studies towards a PhD;
- Increase range of specializations represented among the staff;
- Provide weather forecasts for up to 10 days;
- Expand the range of seasonal forecasts to include temperature;
- Produce and disseminate monthly rainfall and temperature predictions;
- Develop human capacity for the production and dissemination of a medium range forecast;
- Improve access to software tools for weather and climate forecasting, including statistical and dynamical downscaling;
- Improved internet bandwidth.

Category 3 – Full NMHS functionality Does not meet

Review

- The Mali NMHS does not meet the Research and Predictions requirements of a Category 3 NMHS.

Recommendations

- None

Pillar 3: Climate Services Information System

Summary

The Mali NMHS fulfills the criteria for Category 2 for the Climate Services Information System pillar. The NMHS could expand the range of climate information products, improve its website, and improve software in order to satisfy the criteria more completely. More advanced improvements in these same categories would enable the NMHS to fulfill requirements for Category 3.

Category 1 – Basic NMHS functionality Meets

Review

- Strengths: At a governance level, the Mali NMHS has clear policy guidelines on the provision of climate information services and provides data free of charge to government ministries and education institutions. Staff produce basic climate statistics for major climate variables and communicate these on the website.
- Weaknesses: The NMHS could improve the range of products and the software for producing them.

Recommendations

- Disseminate seasonal temperature outlooks;
- Improve access to software for computation and display of basic climate statistics.

Category 2. Essential NMHS functionality Meets

Review

- Strengths: The NMHS performs advanced statistical analyses and contributes to national early warning systems through early warning information and advisories. ENACTS map rooms have been implemented. The NMHS responds to user needs and has produced and/or refined products in response to user feedback in the last 2 years.
- Weaknesses: The NMHS does not perform homogenization of data and has a limited range of products on the website.

Recommendations

- Perform homogenization of data;
- Expand the range of climate information products on the website.

Category 3 – Full NMHS functionality Does not meet

Review

- Strengths: The NMHS has issued analyses and interpretation of climate statements or products for the general public and/or specific users in the last two years. The NMHS have produced tailored information products for national policies and action plans in the last 5 years. The NMHS also produces advanced climate information in different formats.
- Weaknesses: The NMHS needs to expand the range of climate information products and improve the website.

Recommendations

- The NMHS should expand the range of seasonal outlooks, particularly to include temperature;
- There is scope to strengthen the production of advanced climate information products in different tabular and graphical formats;
- The NMHS should improve the website to include tailored climate analysis, prediction and monitoring products, on seasonal to climate change time scale for major sectors.

Pillar 4: User Interface Platform

Summary

The Mali NMHS partially fulfills the criteria for a Category 3 NMHS in the User Interface Platform pillar. There are however aspects within each category that are not fully met. For example, no staff members of the NMHS are trained in climate services/user engagement. Furthermore, the NMHS should improve its website, including providing access to national observations and forecast information (for a national interactive media outlet) via website and Application Programming Interface's (API's).

Category 1 – Basic NMHS functionality Meets

Review

- Strengths: The NMHS has a strategic plan for engaging with users of weather forecasts and climate information. The NMHS has signed MOUs with five sectors and has procedures in place to co-produce climate information with sectors. The NMHS has interacted with users over the last 2 years and documents feedback from users about the climate information products in writing. A website communicates basic climate information to users.
- Weaknesses: No staff have been trained in engaging with users and offering Climate Information Services.

Recommendations

- Formal training in engagement with users. Such training would benefit both the users and the Mali NMHS itself (through built capacity).

Category 2. Essential NMHS functionality Meets

Review

- Strengths: In the past three years the Mali NMHS has interacted with and assessed the requirements of climate information users in one or more sectors. This has secured the production of tailored climate information products in response to user's requests and needs. One such tailored product is a web-based platform for sharing information with users. Through training programs in the past 2 years, Mali NMHS is active in assisting users to interpret and make use of climate predictions and products. The NMHS has mechanisms in place to co-produce climate information products with the Agriculture, Water, Health, Energy and Transport sectors. Documentation (in writing) of user feedback is conducted to assess the usefulness and effectiveness of the information and services provided. Together with this documentation, procedures are in place to feed this information back into the redesign of the information. The NMHS has implemented or started the process for NFCS.
- Weaknesses: The website includes few advanced climate information products and staff are not trained in user engagement.

Recommendations

- Formal training in climate services/user engagement;
- Improve the website to include advanced climate information products.

Category 3 – Full NMHS functionality Partially meets

Review

- Strengths: Mali NMHS has produced tailored climate information products for national policy development or national Action Plans in the past 5 years. As mentioned above, Mali NMHS have mechanisms in place to co-produce climate information products with multiple sectors. The NMHS communicates with users of climate information via social media and mobile network platforms.
- Weaknesses: Access to advisories tailored to specific users' needs and national observations and forecast information, via website and API, for use by national interactive media outlets is not provided.

Recommendations

- The development of website and API tools, improving access to advisories tailored to specific users' needs and national observation and forecast information.

Pillar 5: Capacity Development

Summary

The Mali NMHS partially fulfills the criteria for Category 2 in the Capacity Development pillar. In order to strengthen its status as a Category 2 NMHS, the Mali NMHS would need to improve training, representation of staff in specialized areas, software, internet speed, and computing capacity. The NMHS would have to make further progress in computing capacity and internet speed, as well as establish a status as an independent institution, in order to satisfy the requirements for Category 3.

Category 1 – Basic NMHS functionality Meets

Review

- Strengths: The Mali NMHS has a formalized governance structure and participates in climate related policies and plans. The NMHS has sufficient senior technical staff with MSc and PhD degrees, and a strong basic training program. There are some staff with education in management. All staff have access to basic computing resources and 1 Mbps internet capacity.
- Weaknesses: Software is somewhat limited.

Recommendations

- Improve access to software for computation and display of basic climate statistics.

Category 2. Essential NMHS functionality Partially Meets

Review

- Strengths: The NMHS has some safeguards against corruption. It has some staff with a range of specializations. Staff have access to software tools for weather and climate forecasting. The NMHS maintains an appropriate environment for operation of computing hardware.
- Weaknesses: Training is not conducted for entry and mid-level meteorological technicians. There are remaining weaknesses in access to software. Internet connection speed does not meet the Category 2 requirement of 10 Mbps. The NMHS does not have high performance computing capacity.

Recommendations

- Improve corruption safeguards such as independent auditing of appropriation, procurement and expenditure policies;
- Improve representation of different specializations among the staff;
- Strengthen staff training and staff qualifications;
- Improve access to software tools for weather and climate forecasting, including statistical and dynamical downscaling;
- Strengthen IT resources, such as faster internet and high performance computing.

Category 3 – Full NMHS functionality Does not meet

Review

- Strengths: The Mali NMHS has formal, written partnership and data sharing policies. It has a sufficient number of senior technical staff with MSc and PhD degrees. It has staff who specialize in applications for different sectors. The NMHS provides training to other NMHSs. At least 3 staff have education in management.
- Weaknesses: The NMHS does not meet the IT resource capacity requirements of a Category 3 NMHS.

Recommendations

- Establish status as an independent body under a ministry;
- Increase IT resource capacity significantly, including internet speed and high performance computing.

Country: Niger

The Niger NMHS partially meets requirements for Category 1 for the Climate Services Information System pillar. Category 1 criteria are not met for any of the other pillars.

Pillar 1. Observation and Monitoring

Summary

The Niger Meteorological Agency (Niger NMHS) does not meet criteria required for Category 1 NMHS for the Observation and Monitoring pillar. However, only four of the 13 criteria for Category 1 are not met and Niger NMHS can fulfill the criteria for Categry1 by improving coverage of upper air observation stations and increasing proportion of Class III and above stations.

Category 1 – Basic NMHS functionality Does not meet

Review

- Strength: Niger NMHS is close to meeting criteria required for Category 1. It has good coverage of surface stations, and at least 50% of those are above Class III and reported every day. Niger NMHS maintains electronic climate database and maintains backs up data at least every month. It has been conducting data rescue, and operates the PUMA system for the reception and display of satellite data.
- Weakness: Most of the stations are Class IV (measure only rainfall), and the stations that are Class III and above are inspected regularly.

Recommendations

- Increase the number of upper air stations;
- Increase the number of Class III and above stations;
- Significantly increase inspection of Class III and above stations;

Category 2. Essential NMHS functionality Does not meet

Review

- Strength: At least 75% of the Niger NMHS stations are manned by trained observers, and all of AWS are inspected at least once a year. Niger NMHS has access to computing capacity for data collection, storage, and transmission. It has strategic plans for station expansion.
- Weakness: The main weakness is that there are no AWS. The number of other surface and upper air stations are too sparse for a NMHS Category 2 and Niger NMHS does not use proxy data to augment its observations.

Recommendations

- Increase the number of AWS (currently zero);
- Increase the number of upper air stations;
- Backup of climate data at least every week;
- Use advanced quality control tools such as CDT;
- Incorporate remote sensing data to enhance station observations (e.g. by implementing of ENACTS).

Category 3 – Full NMHS functionality Does not meet

Review

- Niger NMHS does not meet the Observation and Monitoring requirements of a Category 3 NMHS.

Recommendations

- None.

Pillar 2. Research and Predictions

Summary

The Niger NMHS does not fulfill criteria for a Category 1 NMHS for the Research and Predictions pillar. The NMHS would need to improve weather forecasts and access to the internet to satisfy the requirements for Category 1.

Category 1 – Basic NMHS functionality Does not meet

Review

- Strengths: The NMHS has participated in at least two research projects in the last 5 years. It disseminates seasonal outlooks for rainfall probability.
- Weaknesses: The weather forecasting service is limited. Internet connectivity is poor.

Recommendations

- Improve weather forecasts to forecast at least the next 3 days;
- Expand seasonal outlooks to include temperature probability;
- Increased bandwidth access is essential.

Category 2. Essential NMHS functionality Does not meet

Review

- Strengths: The NMHS provides incentives for staff to participate in research, including providing access to online literature sources (with most staff having access to a computer). They use dynamical approaches generating sub-seasonal and seasonal forecast products and staff have access to some software tools required for weather forecasting and downscaling.
- Weaknesses: The NMHS should strengthen their research portfolio by participating in more research projects and increasing the number of staff with PhDs. They do not product a monthly rainfall and temperature forecast nor a 10-day weather forecast. The internet capacity is under the required 10 Mbps to meet a Category 2 NMHS.

Recommendations

- Produce and disseminate a monthly rainfall and temperature predictions
- Communicate the uncertainties associated with seasonal forecasts
- Develop human capacity for the production and dissemination of a medium range forecast
- Recruit more staff with PhDs and provide them with resources needed, such as online access to literature
- Increased bandwidth to 10 Mbps

Category 3 – Full NMHS functionality Does not meet

Review

- The NMHS does not meet the Research and Predictions requirements of a Category 3 NMHS.

Recommendations

- None

Pillar 3: Climate Services Information System

Summary

The Niger NMHS partially fulfills the criteria for a Category 1 NMHS for the Climate Services Information System pillar. The NMHS would need to improve its policies for sharing data and providing information to users of climate information in order to meet the requirements for Category 1. The NMHS should offer a wider range of products, and requires better software to produce them and a better website to communicate them. Further improvements along the same lines would enable the NMHS to qualify as a Category 2 NMHS.

Category 1 – Basic NMHS functionality Partially Meets

Review

- Strengths: The Niger NMHS has clear policy guidelines on data access, provides data free of charge to government ministries, and produces basic climate statistics for major climate variables. Some basic weather and seasonal information is disseminated via a dedicated NMHS website. Staff have access to some software for computation and display of basic climate analysis.
- Weaknesses: The NMHS does not have guidelines for sharing information products with users. Range of products, access to software, and information available on the website are limited.

Recommendations

- Establish written procedures to guide the provision of climate information and services;
- Expand the provision of data free of charge, at least to academic institutions;
- Expand the range of seasonal outlooks to include temperature;
- Improve access to software for computation and display of basic climate statistics;
- Expand the climate information products available on the website.

Category 2. Essential NMHS functionality Does not meet

Review

- Strengths: The Niger NMHS performs some advanced statistical analyses and contributes to national early warning systems through early warning information and advisories. The NMHS responds to user needs, and it has produced and/or refined products in response to user requests in the last 2 years.
- Weaknesses: The Niger NMHS produces a limited range of information products, and has not implemented ENACTS map rooms.

Recommendations

- Expand the range of advanced climate information products;
- Perform homogenization of data;
- Implement ENACTS map rooms;
- Improve website to include advisories.

Category 3 – Full NMHS functionality Does not meet

Review

- The NMHS does not meet the Climate Services Information System requirements of a Category 3 NMHS.

Recommendations

- None

Pillar 4: User Interface Platform

Summary

The Niger NMHS does not fulfill criteria for a Category 1 NMHS with regards to the User Interface Platform pillar. In order to fully meet Category 1 NMHS status, formal strategic procedures for user engagement must be put place, including formal training for staff in climate services/user engagement. Some of this is already being dealt with through a GFCS USAID project where climate & health and climate & water working groups are starting to co-produce bulletins for the first time.

Category 1 – Basic NMHS functionality Does not meet

Review

- Strengths: The NMHS has signed MOU's with at least 5 sectors and has procedures in place to co-produce climate information that serves the needs of users with multiple sectors. The NMHS has interacted with users over the past two years.
- Weaknesses: The Niger NMHS does not have formal strategic procedures in place for engaging users of climate information. It does not document users' feedback with respect to the usefulness of climate information in writing, therefore it has limited ability to improve services in response to feedback. No staff have been trained to engage with users to provide climate information. Information on the website is limited.

Recommendations

- Establish a strategic plan and procedures for engaging users of climate information;
- Train staff in user engagement;
- Document user feedback in writing so that the NMHS can improve products and services in response to feedback;
- Improve availability of climate information on the website.

Category 2. Essential NMHS functionality Does not meet

Review

- Strengths: The Niger NMHS has strong engagement with users in that they have conducted an assessment of user information requirements in the last 3 years, have signed MOUs with at least 3 sectors, produced user-tailored information and have mechanisms in place to co-produce climate information products with at last 3 sectors. The NMHS has also implemented or started the process for the National Framework for Climate Services.
- Weaknesses: The NMHS has an insufficient number of staff members trained in climate services/user engagement. There is no procedure in place for documenting user feedback and incorporating this feedback into the redesign of climate information products. The website could be improved to contain advanced climate information products

Recommendations

- Improve website
- Document user feedback in writing
- Institute written procedure for incorporating user feedback into the redesign of information products and services
- Employ or train two staff members with training in climate services/user engagement

Category 3 – Full NMHS functionality Does not meet

Review

- The NMHS does not meet the User Interface Platform requirements of a Category 3 NMHS.

Recommendations

- None

Pillar 5: Capacity Development

Summary

The Niger NMHS does not fulfill the criteria for a Category 1 NMHS for the Capacity Development pillar. The aspects of Category 1 that are not met include a deficit of trained personnel in some of the essential services and a very poor internet connection.

Category 1 – Basic NMHS functionality Does not meet

Review

- Strengths: The Niger NMHS meets the governance requirements for a Category 1 NMHS. The Niger NMHS has a formalized governance structure and participates in climate related policies and plans. The NMHS has an adequate number of senior meteorological technicians with MSc and PhD degrees. Staff have basic training in database management. Most staff have access to computers connected to the internet.
- Weaknesses: Training capacity is weak. Internet connection speed is less than 1 Mbps.

Recommendations

- Establish a protocol for the types of training staff are required to complete;
- Improve staff training to include training for entry-level meteorological technicians and training in quality control procedures;
- Improve access to software for computation and display of basic climate statistics;
- Strengthen internet connection;
- Recruit staff who have an education in management.

Category 2. Essential NMHS functionality Does not meet

Review

- Strengths: The staff are well qualified with at least 50% of the meteorological technicians at senior level and above having an MSc or PhD degree and staff qualified in NWP. The Niger NMHS also has a climate-controlled computer centre with backup power and power protection.
- Weaknesses: The NMHS does not provide training of entry and mid-level meteorological technicians and could improve the number of staff in specific specialisations. Corruption safeguards are not included in governance policies. IT resources could be improved by providing at least one high performance computer and strengthening internet bandwidth to greater than 10 Mbps

Recommendations

- Further staff training, staff qualifications
- Strengthened IT resources
- Maintain corruption safeguards including independent auditing of appropriation, procurement and expenditure policies
- At least one person with at least 2 years of education in management

Category 3 – Full NMHS functionality Does not meet
Review

- The NMHS does not meet the Capacity Development requirements of a Category 3 NMHS.

Recommendations

- None

Country: Rwanda

The Rwanda NMHS partially meets criteria for Category 3 for the Climate Information Service and User Information Platform pillars, and partially meets Category 2 criteria for the Observation & Monitoring, Research & Predictions, and Capacity Development pillars.

Pillar 1. Observation and Monitoring
Summary
The Rwanda Meteorological Agency (Rwanda NMHS) meets the criteria required for Category 1 for the Observation and Monitoring pillar and also partially meets the criteria for Category 2. The small size of the country has partly helped in meeting the station density conditions. Rwanda NMHS still need to improve the density of upper air stations.

Category 1 – Basic NMHS functionality Meets
Review

- Strength: Rwanda NMHS meets all the conditions required for Category 1 NMHS, except for the density of upper air stations and frequency of data backup.
- Weakness: None

Recommendations

- Improve the coverage of upper air observation stations;
- Backup climate data at least every month.

Category 2. Essential NMHS functionality Partially Meets
Review

- Strength: Most of the Rwanda NMHS stations (over 90% are manned by trained observers. The Agency maintains electronic backup of data and backs up data at least every week. It has good stations density with at least one station every 20 km and uses CDT for quality control of station observations. A good number of stations that are Class III and above are inspected every year. Rwanda NMHS has performed basic station needs assessment and has strategic plans for station expansion. It has incorporated remote sensing data (to enhance station observations) and the implementation of ENACTS.
- Weakness: The main weakness is that Rwanda NMHS does not back up climate data often enough.

Recommendations

- Increase the number of upper air stations;
- Backup of data climate data at least every week;
- Enhance the existing satellite data reception and processing system.

Category 3 – Full NMHS functionality Does not meet
Review

- Rwanda NMHS does not meet the Observation and Monitoring requirements of a Category 3 NMHS.

Recommendations

- None.

Pillar 2. Research and Predictions

Summary

The Rwanda NMHS partially fulfills the criteria of a Category 2 NMHS for Research and Predictions pillar. The NMHS could fully meet Category 2 requirements by developing human resources (through academic and technical training), increasing participation in research, and improving technological capacity. The NMHS could meet the criteria for Category 3 by investing much more in improvements along the same lines (as above) as well as greatly expanding the range of climate products that it produces.

Category 1 – Basic NMHS functionality Meets

Review

- Strengths: The staff at the Rwanda NMHS have participated in at least 2 research projects in the last 2 years. They provide weather forecasts for up to 3 days and seasonal rainfall outlooks. They have sufficient access to the internet.
- Weaknesses: Seasonal outlooks do not include temperature.

Recommendations

- Expand the range of seasonal outlooks to include temperature

Category 2. Essential NMHS functionality Partially meets

Review

- Strengths: The NMHS provides incentives for staff to engage in research and offers them basic resources to facilitate research, such as access to online literature and basic computing services. Staff produce and disseminate a ten-day weather forecast, as well as monthly and seasonal forecast with an assessment of uncertainties associated with the seasonal forecast.
- Weaknesses: The NMHS lacks adequate staffing capacity in terms of higher academic qualifications and a range of specializations. Staff participation in research is not sufficient for Category 2, and the range of climate information products is limited. Internet bandwidth is low and software capacity is not fully adequate.

Recommendations

- Improve the capacity of staff to participate in research projects;
- Recruit more staff with PhD degrees in meteorology, develop staff through studies towards higher degrees such as a PhD and training in a range of specializations, such as seasonal prediction, Agrometeorology, hydrometeorology, etc.;
- Expand the range of seasonal and monthly forecasts, especially to include temperature;
- Communicate uncertainty of seasonal forecasts to users;
- Improve access to software tools for weather and climate forecasting, including statistical and dynamical downscaling;
- Improve access to computers connected to a higher speed internet, with Mbps greater than 10.

Category 3 – Full NMHS functionality Does not meet

Review

- Strengths: The NMHS staff take a leading role on research projects, with staff serving as PI's on grant applications in the last 5 years and leading collaborative research on weather or climate prediction. Staff use dynamical approaches to generate seasonal forecasts. The NMHS organizes at least one NCOF per year.
- Weaknesses: The NMHS lacks sufficiently educated staff, and the range of climate information products is too limited for a Category 3 service. The NMHS also does not have high performance computing capacity.

Recommendations

- Invest in staff with PhD level education in meteorology;
- Expand the range of advanced climate information products to include downscaled climate prediction and projection products;
- Invest in capacity to run climate models, including the needed technological capacity such as high performance computers;
- Invest in high speed internet.

Pillar 3: Climate Services Information System

Summary

The Rwanda NMHS partially fulfills the criteria for a Category 3 NMHS for the Climate Services Information System pillar. The NMHS should improve the range of climate information products that it produces, the frequency with which it produces seasonal forecasts, and the availability of products on its website to fully meet the criteria for Category 3. However, the Rwanda NMHS is currently a top performing African NMHS.

Category 1 – Basic NMHS functionality Meets

Review

- Strengths: At a governance level, the Rwanda NMHS has clear policy guidelines on the provision of Climate Information Services and provides data free of charge to government ministries and education institutions. Staff produce basic climate statistics for major climate variables and seasonal forecasts for rainfall. The NMHS has a website with basic climate information.
- Weaknesses: The NMHS should expand the range of basic products and improve access to software needed to produce them.

Recommendations

- Expand the range of basic climate statistics and variables for which they are produced;
- Expand seasonal outlooks to include temperature;
- Improve access to software for computation and display of basic climate statistics.

Category 2. Essential NMHS functionality Meets

Review

- Strengths: The NMHS produces advanced climate products in various formats and contributes to national early warning systems through early warning information and advisories. ENACTS map rooms have been implemented. The NMHS responds to user needs and has produced and/or refined products in response to user feedback in the last 2 years. The NMHS provides climate information, including advisories, on its website.
- Weaknesses: The NMHS does not perform homogenization of climate data.

Recommendations

- Perform homogenization of climate data.

Category 3 – Full NMHS functionality Partially meets

Review

- Strengths: The Rwanda NMHS has issued analyses and interpretation of climate statements or products for the general public or specific users in the last two years, and has produced tailored climate information products for national Policy or national action plans in the last 5 years.
- Weaknesses: The NMHS produces a somewhat limited range of products for Category 3.

Recommendations

- Expand the range of seasonal outlooks and increase the frequency with which they are produced;
- There is scope to strengthen the production of advanced climate information products in different tabular and graphical formats;
- Provide more specialized (tailored) climate analysis, prediction and monitoring products, on seasonal to climate change time scale for major sectors on the website.

Pillar 4: User Interface Platform

Summary

The Rwanda NMHS partially fulfills the criteria for a Category 3 NMHS for the User Interface Platform pillar. There are however aspects within each category that are not fully met. For example, no staff members of the NMHS are trained in climate services/user engagement. The NMHS should expand its interaction with the sectors, enhance its procedures for gathering feedback from users about information products and services, and improve the website to provide access to national observations and forecast information for any national interactive media outlet in order to meet Category 3 criteria.

Category 1 – Basic NMHS functionality Meets

Review

- Strengths: Rwanda NMHS have in place a set of strategic plans and procedures, ensuring users of weather forecasts and climate information are engaged. Users have been engaged in the past two years. The NMHS has signed MOUs with sectors and has procedures in place to co-produce climate information with multiple sectors. The NMHS has a website that provides basic climate information.
- Weaknesses: No staff are trained to engage with users and provide Climate Information Services.

Recommendations

- Train staff to engage with users and provide Climate Information Services.

Category 2. Essential NMHS functionality Meets

Review

- Strengths: In the past three years the Rwanda NMHS has interacted with and assessed the requirements for climate information among users in one or more sectors. This has secured the production of tailored climate information products in response to user's requests and needs. One such tailored product is a web-based platform for sharing information with users that has some advanced climate information products. Through training programs in the past 2 years, Rwanda NMHS is active in assisting users to interpret and make use of climate

predictions and products. The NMHS has mechanisms in place to co-produce climate information products with the Agriculture, Water, Health, Energy and Transport sectors in Rwanda. Documentation (in writing) of user feedback is conducted to assess the usefulness and effectiveness of the information and services provided. Together with this documentation, procedures are in place to feed this information back into the redesign of the information. The NMHS has implemented or started the process for National Framework for Climate Services.

- Weaknesses: No staff are trained to engage with users and provide Climate Information Services.

Recommendations

- Formal training in climate services/user engagement.

Category 3 – Full NMHS functionality Partially meets

Review

- Strengths: In the past 5 years Rwanda NMHS has produced tailored climate information products for national policy development or national Action Plans. Members of staff are specialized in applications for different sectors, and as mentioned above Rwanda NMHS have mechanisms in place to co-produce climate information products with multiple sectors. The NMHS communicates with users of climate information via social media and mobile network platforms, and it posts advisories on its website.
- Weaknesses: Procedures for collecting feedback could be improved and website could be strengthened. Access to national observations and forecast information, via website and API, for use by national interactive media outlets is not provided.

Recommendations

- Conduct surveys of various users, including government departments and ministries, to collect feedback about the interpretation and usefulness of climate forecasts and other information products;
- Expand interaction with sectors through MOUs;
- Develop website and API tools to provide easier access to national observation and forecast information.

Pillar 5: Capacity Development

Summary

The Rwanda NMHS partially fulfills criteria for a Category 2 NMHS for the Capacity Development pillar. In order to be categorized as a Category 2 NMHS, the Rwanda NMHS would need to strengthen governance, improve the qualifications of the staff in specialized areas, and strengthen its training program. It should invest in technological capacity, including software, and higher speed internet. The NMHS would need further improvements along the same lines, also including high performance computing, in order to satisfy criteria for a Category 3 NMHS.

Category 1 – Basic NMHS functionality Meets

Review

- Strengths: The Rwanda NMHS has a formalized governance structure. An adequate number of senior meteorological technicians have MSc or PhD degrees. Staff have basic training in most essential services. The NMHS has staff who are educated in management. Most staff have access to basic computing resources and 1 Mbps internet capacity.

- Weaknesses: The NMHS's participation in national climate related policies and plans is limited. The training program has weaknesses. Access to software should be improved.

Recommendations

- Expand participation in national climate related policies and plans;
- Strengthen the training program, especially to include training for entry-level meteorological technicians;
- Improve access to software for computation and display of basic climate statistics.

Category 2. Essential NMHS functionality Partially meets

- Strengths: The NMHS has the status of an independent body under a ministry. An adequate number of senior meteorological technicians have MSc or PhD degrees. Staff have education in management. The NMHS has at least one high performance computer and maintains an appropriate environment for the safety and performance of the technical equipment.
- Weaknesses: Corruption safeguards could be strengthened. Human resource capacity is lacking in the breadth of specializations. Training is not conducted for entry and mid-level meteorological technicians. Software should be improved. Internet connection speed does not meet the Category 2 requirement of 10 Mbps.

Recommendations

- Strengthen corruption safeguards, including independent auditing of procurement, appropriation, and expenditure policies;
- Expand the range of specializations represented among the staff, including climate, seasonal prediction, Agromet, Hydromet, and NWP;
- Strengthen the training program, in particular to include training for mid-level meteorological technicians;
- Improve access to software tools for weather and climate forecasting, including statistical and dynamical downscaling;
- Strengthen IT resources to include faster internet.

Category 3 – Full NMHS functionality Does not meet

Review

- Strengths: The NMHS has formal partnership and data sharing policies. It provides training for other NMHS services. Staff specialize in applications for different sectors. A sufficient number of senior meteorological technicians have MSc or PhD degrees. Staff have management education.
- Weaknesses: The technological capacity is weak for a Category 3 service.

Recommendations

- Invest in high performance computers;
- Invest in high speed internet, greater than 100 Mbps.

Country: Senegal

The Senegal NMHS meets the criteria for Category 2 for the Climate Services Information System pillar, partially meets criteria for Category 2 for the User Interface Platform and Capacity Development pillars, and meets criteria for Category 1 for the Observation and Monitoring and Research and Predictions pillars.

Pillar 1. Observation and Monitoring

Summary

The Senegal Meteorological Agency (ANACIM= Agence Nationale de l'Aviation Civile et de la Météorologie) does meet the criteria required for Category 1 for the Observation and Monitoring pillar, but not the other two categories.

Category 1 – Basic NMHS functionality Meets

Review

- Strength: At least 75% of all stations are manned by trained observers, coverage of surface and upper air observation stations is at least one station every 50 km and 500 km, respectively. ANACIM maintains an electronic climate database and this data is backed up at least every month. It also operates the PUMA system for reception and display of satellite data.
- Weakness: The proportion of Class III and above stations to the total number of stations is low.

Recommendations

- Increase the proportion of Class II and above stations;
- Rescue/digitize remaining rainfall and temperature data.

Category 2. Essential NMHS functionality Does not meet

Review

- Strength: Most of ANACIM's stations (over 90%) are manned by trained observers. The Agency maintains electronic backup of data and backs up data at least every week. It has used CDT for quality control of station observations. A good number of stations that are Class III and above, including AWS, are inspected at least once a year. ANACIM has performed basic station needs assessment and has strategic plans for station expansion. It has incorporated remote sensing data to enhance station observations with the implementation of ENACTS.
- Weakness: The number of AWS and upper air observation stations is no sufficient.

Recommendations

- Increase the number of surface stations (Class III and above including AWS);
- Increase the number of upper air stations;
- Enhance existing satellite data reception and processing system.
- Train additional technicians on station O&M.

Category 3 – Full NMHS functionality Does not meet

Review

- ANACIM does not meet the Observation and Monitoring requirements of a Category 3 NMHS.

Recommendations

- None.

Pillar 2. Research and Predictions

Summary

The Senegal NMHS fulfills criteria for a Category 1 NMHS for the Research and Predictions pillar with a perfect score. In order to meet the criteria for a Category 2 NMHS, the NMHS would need to develop its research program, in particular access to research literature and bandwidth, expand the range of weather and climate information products, and improve access to software needed to produce these outputs.

Category 1 – Basic NMHS functionality Meets

Review

- Strengths: The Senegal NMHS fulfills all criteria for a Category 1 NMHS. Staff participated in at least two research projects in the last 5 years. The NMHS produces a 3 day weather forecast as well as seasonal forecasts for rainfall and temperature. Staff have adequate access to the internet.

Recommendations

- None

Category 2. Essential NMHS functionality Does not meet

Review

- Strengths: Five percent of the staff have PhDs, and the staff represent a range of specializations. The staff participated in at least 5 research projects in the last 5 years. The NMHS produces seasonal outlooks for rainfall and temperature.
- Weaknesses: The research program has weaknesses. Seasonal and monthly predictions are produced and disseminated but there is no communication of uncertainties associated with these predictions. The range of weather and climate products is limited for Category 2, and software needed to produce climate information needs more investment. The internet connection is slow.

Recommendations

- The NMHS could provide incentives for active research either financially or through career progression or through further studies towards higher degrees such as a PhD in meteorology;
- Staff need online access to literature sources;
- Expand the range of information products to include: 10-day forecasts, monthly rainfall frequency forecasts, assessments of uncertainty of seasonal forecasts, dynamical approaches to seasonal and sub-seasonal forecasts;
- Communicate uncertainties in the seasonal prediction products to users;
- Improve access to software tools for weather and climate forecasting, including statistical and dynamical downscaling;
- Invest in higher speed internet, faster than 10 Mbps.

Category 3 – Full NMHS functionality Does not meet

Review

- The Senegal NMHS does not meet the Research and Predictions requirements of a Category 3 NMHS.

Recommendations

- None

Pillar 3: Climate Services Information System

Summary

The Senegal NMHS fulfills the criteria for a Category 2 NMHS for the Climate Services Information System pillar. The development of a broader range of climate information products and especially more advanced products tailored to users' needs would enable Senegal NMHS to move up to a Category 3 NMHS for the Climate Services Information System pillar.

Category 1. Basic NMHS functionality Meets

Review

- Strengths: At a governance level, the Senegal NMHS has clear guidelines for providing data, and provides data free of charge to government ministries and education institutions. Staff produce most basic climate statistics for major climate variables. The NMHS produces seasonal outlooks for rainfall and temperature, and disseminates weather and climate information through a website.
- Weaknesses: The NMHS does not have written procedures that guide provision of Climate Information Services to users. The range of basic climate statistics could be expanded and the staff would benefit from better access to software to produce them.

Recommendations

- Develop guidelines for providing information services to users of climate information;
- Expand the range of basic climate statistics;
- Improve access to software for computation and display of basic climate analysis.

Category 2. Essential NMHS functionality Meets

Review

- Strengths: The Senegal NMHS produces some advanced climate information products in various formats and contributes to national early warning systems through early warning information and advisories. ENACTS map rooms have been implemented. The NMHS responds to user needs and has produced and/or refined products in response to user feedback in the last 2 years. The NMHS has a dedicated website with climate forecasts, other products, and advisories.
- Weaknesses: NMHS does not perform homogenization of data.

Recommendations

- Perform homogenization of data.

Category 3 – Full NMHS functionality Does not meet

Review

- Strengths: The NMHS has produced tailored products for national policy and/or national action plans. It produces some advanced climate information in different tabular and graphical formats.
- Weaknesses: The NMHS should expand the range of climate information products, especially more advanced products tailored to users' needs and improve engagement with users.

Recommendations

- Expand the range of climate information products, especially more advanced products tailored to users' needs;
- Produce analyses and interpretation of climate statements or products for the general public and other users;
- Provide specialized (tailored) climate analysis, prediction and monitoring products, on seasonal to climate change time scale for major sectors on the website.

Pillar 4: User Interface Platform

Summary

The Senegal NMHS partially fulfills the criteria for a Category 2 NMHS for the User Interface Platform pillar. In order to meet the criteria fully, the NMHS would need to improve the engagement

with users, including communication of information on the website and building capacity of staff in climate services/user engagement through the provision of training. In order to move to Category 3, the Senegal NMHS would need to put in place mechanisms to co-produce information with an increased number of sectors (currently co-produces information with the Agriculture and Water sector). Furthermore, it should provide access to national observations and forecast information (for a national interactive media outlet) via website and APIs.

Category 1 – Basic NMHS functionality Meets

Review

- Strengths: Senegal NMHS meets all the User Interface Platform criteria for a Category 1 NMHS with a perfect score. Together with a strategic plan and procedure for user engagement, the Senegal NMHS has one staff member who has been trained to work with users. The NMHS has interacted with users in the past two years, has signed MOUs with multiple sectors, and has procedures in place to co-produce climate information with multiple sectors. The NMHS documents feedback that users provide about climate information products in writing. The NMHS communicates basic climate information through its website.

Recommendations

- None

Category 2. Essential NMHS functionality Partially meets

Review

- Strengths: In the past three years the Senegal NMHS has interacted with and assessed the requirements of climate information users in one or more sectors. This has supported the production of tailored climate information products in response to user's requests and needs. Senegal NMHS is also active in assisting users, through training programs, to interpret and make use of climate predictions and products. The NMHS has mechanisms in place to co-produce climate information products with the Agriculture and Water sector in Senegal. The NMHS has implemented or started the process for National Framework for Climate Services.
- Weaknesses: The NMHS should expand its interaction with the sectors and communicate more advanced climate information on the website. It should also integrate users' feedback into its work. More staff need training in user engagement.

Recommendations

- Integrate feedback from users into a redesign of climate products and improvement of services;
- Train more staff in climate services and user engagement;
- Establish procedures to co-produce information with an increased number of sectors;
- Expand training that explains to users how to access and/or use climate information products;
- Communicate more advanced climate information products via the website.

Category 3 – Full NMHS functionality Does not meet

Review

- Strengths: In the past 5 years Senegal NMHS has produced tailored climate information products for national policy development or national action plans. NMHS has gathered feedback from government departments and ministries about availability, interpretation and usefulness of its forecasts and other information products through surveys. The NMHS

communicates with users of climate information via social media and mobile network platforms.

- Weaknesses: The Senegal NMHS should expand its interaction with sectors and development of tailored advisories. It should also improve the website.

Recommendations

- Establish procedures to co-produce information with an increased number of sectors;
- Post advisories tailored to specific users' needs on website;
- Provide access to national observations and forecast information, via website and API, for use by national interactive media outlets.

Pillar 5: Capacity Development

Summary

The Senegal NMHS partially fulfills criteria for a Category 2 NMHS for the Capacity Development pillar. There are aspects within each of Category 1 and 2 that are not fully met. The NMHS's participation in national climate related policies and plans is limited. It has no staff training protocol, insufficient capacity in software, no high-performance computer and has less than 10 Mpbs internet capacity. In order to move to Category 3 NMHS, the Senegal NMHS would need to further improve its technological capacity.

Category 1 – Basic NMHS functionality Meets

Review

- Strengths: The Senegal NMHS has a formalized governance structure and participates to some extent in climate related policies and plans. The NMHS has an adequate number of senior meteorological technicians with MSc and PhD degrees. Staff have basic training in essential services. The NMHS has staff who have an education in management. Almost all staff have access to basic computing resources and 1 Mbps internet capacity.
- Weaknesses: The NMHS should participate more in national planning. The NMHS has no protocol for the types of training that staff are required to complete. Software needs some improvement.

Recommendations

- Increase participation in national climate related planning and policies;
- Develop a staff training protocol;
- Improve access to software for computation and display of basic climate statistics.

Category 2. Essential NMHS functionality Partially meets

Review

- Strengths: The Senegal NMHS has good governance and a good training program. The NMHS has staff with a range of specializations. It has an adequate number of senior meteorological technicians with MSc and PhD degrees and staff who have an education in management for Category 2.
- Weaknesses: The technological capacity needs improvement.

Recommendations

- Improve access to software tools for weather and climate forecasting, including statistical and dynamical downscaling;
- Invest in high performance computing;
- Invest in higher speed internet, greater than 10 Mbps.

Category 3 – Full NMHS functionality Does not meet

Review

- Strengths: The NMHS has good governance. It has staff who specialize in applications for different sectors. It provides training to other NMHSs.
- Weaknesses: The Senegal NMHS does not meet the IT resource capacity requirements of a Category 3 NMHS.

Recommendations

- There is room to improve formal written partnership and data sharing policies;
- Invest in high performance computing;
- Invest in higher speed internet, greater than 100 Mbps.