Development of Metrics to Assess National Meteorological Services in Africa

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ACRONYMS AND ABBREVIATIONS

AGRHYMET	Regional Center for Agriculture, Hydrology and Meteorology (Niamey, Niger)
ANACIM	The Sénégal Meteorological Agency, Agence Nationale de l'Aviation Civile et de la Météorologie
API	Application Programming Interface
AWS	Automated Weather Station
CSAG	Climate System Analysis Group (based at the University of Cape Town)
CIS	Climate Information Services
DCCMS	Malawi's Department of Climate Change and Meteorological Services
ENACTS	Enhancing NAtional ClimaTe Services
GDP	Global Domestic Product
GFCS	Global Framework for Climate Services
GCOS	Global Climate Observing System
GTPA	Mali's Groupe de Travail Pluridisciplinaire d'Assistance Agrométéorologique
IPCC	Intergovernmental Panel on Climate Change
IRI	International Research Institute for Climate and Society
NCOF	National Climate Outlook Forum
NMA	Ethiopia's National Meteorological Agency
NMHS	National Meteorological and Hydrological Services
NGO	Non-Governmental Organizations
OSCAR	Observing Systems Capability Analysis and Review
PAC	Partner Advisory Committee
PUMA	Project for Preparing the Use of Meteosat Second Generation data in Africa
SPO	Strategic Planning Office
SSA	Sub-Saharan Africa
SMART	Specific, Measurable, Achievable, Relevant and Time-bound
USAID	United States Agency for International Development
WICOS	WMO Integrated Climate Observing System
WIGOS	WMO Integrated Global Observing System
WMO	World Meteorological Organization

EXECUTIVE SUMMARY

Motivation

Effective Climate Information Services (CIS) provide climate and weather information and related advisory services at temporal and spatial scales relevant to a range of stakeholders, including decision-makers at regional, national, and local community levels such as smallholder farmers and civil society. CIS should meet the immediate needs of agricultural communities as well as serve as the foundation for national and regional information systems to support adaptation to long-term and large-scale climate changes. Developing CIS is part of the mandate of National Meteorological and Hydrological Services (NMHS), though other stakeholders have a growing interest in contributing to the development of CIS to serve their specific needs as well as for the general public. These stakeholders include other public agencies, the private sector (in partnership with public agencies as well as independently), and non-profit, non-governmental organizations (NGOs).

Many African NMHS contend with limited human capital, a lack of financial resources, and obsolete technologies (AMCOMET 2015). Despite covering a fifth of the world's total land area, and having a population of over one billion, Africa has the least developed weather and climate observation network of all continents, and the network is deteriorating (AMCOMET 2015). Thus, developing effective CIS requires considerable investment in the region, and international and bilateral development donors have increased investments to build the capacities of NMHS in Africa. The donors understandably want robust metrics that demonstrate the value gained from these investments. This study builds on prior work to advance an evaluation approach that can assess the capacities that NMHS have, gaps in capacities that investment should address, and changes in capacities over time that can demonstrate the value of investments.

The objectives of this study

This study is part of a larger project, "Assessing Sustainability and Effectiveness of Climate Information Services (CIS) in Africa Sustainable CIS project" (Sustainable CIS project), funded by the United States Agency for International Development (USAID) to better understand how to design and implement sustainable CIS models within and alongside NMHS. The 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 about existing CIS in SSA. The project aims to identify and improve existing CIS programs provided by the public and private sectors, as well as to design and assess potential new models of CIS, which are relevant to local contexts. The project is being implemented by a consortium led by Winrock International, with the International Research Institute for Climate and Society (IRI) at Columbia University, the Climate System Analysis Group (CSAG), the AGRHYMET Regional Center, and the Global Framework for Climate Services (GFCS)[1] as partners.

The project has three work streams:

[1] GFCS is a global partnership of the World Meteorological Organization (WMO) with the UN International Strategy for Disaster Reduction, the World Health Organization, the World Food Programme, the Food and Agriculture Organization of the UN, and others.

1) Sustainability assessment. This includes the development of metrics to assess effectiveness and sustainability of NMHS as providers of CIS, with a baseline assessment of select NMHS, and advice on 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 sustainable financial models for CIS delivery in SSA.
3) Partnership building, synthesis, sharing and uptake of knowledge and lessons learned.

This report describes work conducted under the first component above, the sustainability assessment. This work, led by IRI, has **two objectives**:

1) Propose an evaluation approach to assess capacities of NMHS to implement effective climate information services (CIS) and the change in those capacities over time;
2) Use the evaluation approach to conduct a baseline assessment of current capacity and capacity gaps in seven NMHS in SSA.

This report focuses on the capacity of NMHS to supply CIS. The Sustainable CIS project separates the supply of climate services from the demand for them. A separate effort develops an approach to evaluating the uptake of CIS by users and the associated benefits (Vaughan et. al. 2017; Carr et. al. 2017). The following report presents the NMHS capacity assessment approach, the methodology for applying it, and a summary of the results from assessing the capacity in seven countries. Full results of the capacity assessment are in the companion paper "NMHS Capacity Development Assessment Report" (Lenard et. al. 2018).

The evaluation framework

This study develops an approach to evaluating the capacity of national CIS, which comprises a 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 approach can be used to evaluate continued progress toward the NMHS objectives, though it may evolve over time as the understanding of effective ways of delivering CIS grows and as the vision of sustainable climate services changes.

The study makes three main contributions to the development of an approach to evaluating NMHS:

First, we propose a new evaluation framework that combines two schemas that the WMO developed to guide the NMHS enterprise: the five pillars of the GFCS and WMO's 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 specify criteria that a NMHS must satisfy to be placed within one of four different categories: (1) Basic Climate Services; (2) Essential Climate Services; (3) Full Climate Services; and (4). Advanced Climate Services.

The GFCS specifies broad objectives for each pillar, which do not provide sufficient guidance to assess capacity. The criteria that NMHS must satisfy in order to be placed in each of the categories contain guidance on how NMHS can perform each of their functions, but the WMO does not organize these criteria by the GFCS pillars.

The framework developed through this effort is innovative in that we assign the criteria associated with each NMHS category to the 5 GFCS pillars. The criteria elaborate what a NMHS has to achieve to perform the functions under each of the pillars, and we adopt them as NMHS objectives under each pillar. The framework determines the category in which a NMHS is placed under each pillar depending on the criteria, which the NMHS satisfies. For example, a NMHS may fall into category 1 with respect to functions defined by Pillar 1 (Observations and Monitoring) but fall into category 2 with respect to functions associated with Pillar 4 (User Interface Platform). This approach enables us to provide specific recommendations for investment for each NMHS by identifying the function and capacities that need improvement.

Second, the study generates quantitative metrics that measure the extent to which a NMHS achieves each criterion. The metrics are general enough to evaluate progress towards development of climate services in any NMHS in Africa**.** They may evolve as additional evidence leads to a revision of the framework.

Third, the proposed approach is objective in that the value of each metric can be verified using documentation that most NMHS possess. Verifiability is not an intrinsic property of a metric since metrics can be based on subjective self-assessment, and past assessments rely primarily on questions requiring self-assessment from the staff of the NMHS. Self-assessment introduces potential biases and inconsistencies in evaluations. This study did not have the resources to conduct full verification of metric values. However, the proposed approach allows an objective assessment that enables comparisons between NMHS and within a NMHS over time.

Metrics and Scores

The metrics measure the extent to which a NMHS satisfies each criterion in the evaluation framework. They were developed through a combination of literature review and expert judgment. We assigned values to metrics for each of the seven NMHS included in the study based on data collected through a survey administered at each NMHS. The values are based on responses provided by the NMHS, with some adjustment based on team members' knowledge of individual NMHS and some verification of responses. All responses can be verified in future work.

We assigned a rank of 1-4 to each metric, signifying its importance, with 1 representing the greatest importance and 4 the least importance. The ranking reflects two criteria: (1) the importance of the role that the assessed resource plays in enabling the NMHS to satisfy the criterion, as determined by the expert opinion of the meteorologist on the study team; and (2) the team's expert opinion regarding the quality of data that underlie the metric. We also report what the rank would be in the absence of concerns about data quality. The of inverses of these ranks are used as weights to combine metrics for a given criterion.

Finally, we assigned a score to each category in each pillar, which determines whether the NMHS satisfies the criteria for the given category in the given pillar. These scores are expressed as percentages, and we designate NMHS that receive a score between 80 and 100 as fully satisfying the

criteria for the given category in the given pillar. NMHS that receive weighted scores between 71 and 79 partially fulfill the criteria for a given category. A weighted score below 71 indicates that the NMHS does not satisfy the criteria for the category.

Baseline assessment results

We applied this evaluation approach to assess the baseline capacity of seven NMHSs. The assessment classifies each NMHS within one of the four WMO categories under each of the GFCS pillars. In addition, the assessment produced specific recommendations for investments in capacities that the NMHS may wish to consider to satisfy the requirements of each category within each pillar more fully, and/or to advance to a higher category. The results are presented in Table 1 below and are summarized as follows:

- All NMHS evaluated were found to be more likely to fulfill the criteria for the Basic Climate Service category (category 1) under each pillar than they are to fulfill criteria for the higher categories.
- The three services that have the weakest scores under Capacity Development, (not meeting the criteria for category 1), also have the lowest scores in the Observations and Monitoring and Research, Modeling, and Predictions pillars. This suggests that these NMHS do not have sufficient resources, such as technical capacity and trained staff, to collect data and to deliver basic predictions and forecasts. For example, Cote d'Ivoire would need to establish a protocol for training different types of staff, train them in data rescue, improve access to software for computation and display of basic climate statistics, and improve access to computers connected to the internet to satisfy the requirements for category 1 of the Capacity and Development pillar.
- To meet the criteria for Category 1 of the Observation and Monitoring pillar, the evaluated NMHS should invest in training of station observers and increase the number of surface, upper air, and Class III stations. Together, these investments may begin to enable the country to conduct the research needed to provide basic forecasts.
- Countries can perform the functions defined by the Climate Services Information System and User Interface Platform pillars well even when they do not perform well with respect to functions defined by the other pillars, and vice-versa. For example, Mali has a strong Climate Services Information System and User Interface Platform, but lacks capacity in Observations and Monitoring and Research and Predictions. Malawi also has a strong Climate Services Information System relative to its performance under the other pillars.
- Three out of the four countries that perform well with respect to the Capacity Development pillar, (Senegal, Rwanda, and Ethiopia) also perform well with respect to the Observations and Monitoring and Research, Modeling, and Predictions pillars.

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 1: Scores for seven 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 Service Information System; UIP= User Interface Platform; and, CDV= Capacity Development.) Green and yellow colors indicate that the criteria required for the category have been satisfied or partially satisfied, while red signifies that the criteria have not been satisfied.

Recommendations for using the capacity assessment approach

- The approach developed here provides a yardstick, in the form of WMO NMHS categories, that objectively measures current capacity in and future progress toward performing each of the five basic functions of NMHS defined by the GFCS pillars. This approach can assist strategic and operational NMHS planning since it identifies specific weaknesses in current capacity in order to prioritize investments and resource allocation, and tracks progress over time in relation to goals. Identifying specific gaps and needs also enables NMHS to recognize opportunities for partnerships with the private sector, academia, or others that can fill the gaps.

- Donors can use this approach to target investments designed to address specific weaknesses of NMHS and to measure the impacts of those investments. If used wisely, it can also help donors to prioritize the needs of different NMHS.

- WMO and/or other global or regional CIS institutions may use this approach to evaluate capacities at different NMHS, provide advice on building capacity, and prioritize their investments in NMHS. In particular, WMO could use the approach to conduct their regular assessments of NMHS. A proposal has been made to submit the metrics to WMO's Commission for Climatology for technical review.

Recommendations to improve the evaluation framework

- The GFCS pillars and the criteria attached to WMO categories imply a specific approach to providing CIS. However, different models may be appropriate under different conditions, reflecting particular socio-economic needs, institutions, and national priorities. The evaluation framework would benefit from a collaborative process through which NMHS elaborate and evaluate their own models of providing CIS and refine metrics accordingly. This does not imply that each country would have a different model and metrics. The number of appropriate models for providing CIS is likely to be small. A companion white paper, which is being prepared under this project titled "Approaches to combine technologies for weather observation, storage, and analysis," explores how this might be achieved with regards to weather observation storage and analysis.

- A more complete program theory of NMHS would greatly strengthen the evaluation framework. The GFCS pillars combined with the criteria associated with the WMO categories provide an outline, but they are not sufficiently well defined or specific to fully guide an evaluation. A program theory would specify one or more models of how a NMHS can deliver CIS, with guidance on conditions under which each CIS delivery model is appropriate. Such models would map inputs that NMHS need as well as actions and processes to produce outputs, outcomes, and impacts. These models would serve several purposes:

  (1) Produce metrics that are directly tied to a specific way of providing CIS. These metrics, together with the understanding of how inputs produce outputs, outcomes, and impacts, would enable NMHS to track progress toward desired objectives. Metrics proposed in this paper allow NMHS to track progress, but their relationship to a desired outcome is not well-established in many cases;
  (2) Enable NMHS to assess whether actions are yielding the expected outcomes and impacts, and therefore to learn which parts of the model are working well and which are not, allowing NMHS to improve the model over time; and
  (3) Help build consensus within NMHS about what the organizations should be doing. The program theory should evolve over time as the objectives and nature of the CIS mission change, and as more evidence becomes available about effective approaches to CIS.

- Appropriate metrics are essential for a reliable assessment of capacity at NMHS. The current metrics are based mainly on the expertise of the project meteorologist. Before a new set of metrics based on a program theory is developed, the metrics proposed in this study should be refined through additional consultation with experts from WMO, NMHS, Regional Climate Centers, and other stakeholders. Any refinement of the metrics would require a revision of the survey questions and potentially the approach to implementing the survey.

- This study assigns weights to the metrics that reflect the relative importance of each metric for meeting the criterion and the credibility of the underlying data. The selection of weights is based on the expertise and opinion of the project meteorologist, and as in the previous recommendation, additional consultation and consensus building would provide a stronger basis for the selection of weights. Furthermore, a rigorous sensitivity analysis would be helpful to

examine changes in ranking and final scores that would result from alternative weighting decisions and different choices of cut-off points for scores that signify whether the NMHS meets, partially meets, or does not meet requirements for a given category.

- This study conducted limited verification of survey responses due to time constraints. To fully take advantage of the objective nature of the metrics, further verification should be performed using documents obtained from NMHS, NMHS web pages, previous surveys, and WMO's Country Profile Database. In fact, this process may also be used to expand the information in WMO's Country Profile Database.

- The refinement of all or any part of the evaluation approach, from developing a program theory to reconsidering the metrics within the framework proposed here and/or examining different weights, should take place through a collaborative process, involving all stakeholders, including the NMHS. One possible process is a set of workshops to bring together NMHS, Regional Climate Centers (RCC), WMO, and other relevant institutions.

- Any forum that considers a revision of the evaluation approach may also wish to consider the following issues:
    - This study only evaluated the supply side of CIS, which has pros and cons. If the goal of CIS is to improve adaptation outcomes, then an integrated evaluation should assess the entire process, from supply to ultimate impacts on users. Supply needs to be responsive to both needs and demands, and the demands will depend on how CIS is supplied. The GFCS pillars 3 (Climate Information System) and 4 (User Interface Platform) already consider end users, but further work could be carried out to see how end user needs can be more fully incorporated into the metrics.
    - Examine more fully how NMHS integrate gender considerations in their structures, and how the role of women in NMHS influence the ability of the NMHS to provide CIS services.
    - Address obstacles to collecting good quality data about the financial capacity within the NMHS. The assessment of financial capacity requires both quantitative and qualitative data and therefore it may be beneficial to involve financial analysts in the development of a survey tool to undertake interviews and collect the appropriate data to allow for such an assessment.

1. INTRODUCTION

1.1 Background

The Intergovernmental Panel on Climate Change (IPCC 2014) has identified Africa as one of the most vulnerable continents to climate change due to its high exposure to climate stress and low adaptive capacity. During the last half of the 20th century most of sub-Saharan Africa (SSA) has experienced upward trends in annual mean, maximum, and minimum temperature over large extents of the sub-region, with the most significant warming occurring during the last two decades. The changes affect rain fed agriculture, which generates a significant portion of the GDP of most countries and is a major source of livelihoods (Cervigni et al. 2015). Over the coming decades the situation is likely to be further exacerbated by continuing rapid population growth (United Nations, 2017) and climate change. There is a growing recognition that significant investment in climate and weather information services (CIS) is necessary to strengthen adaptive capacity and mange climate-related risks (Hanen et al.,2014, WMO, 2014a).

CIS can provide climate and weather information and related advisory services at temporal and spatial scales relevant to a range of stakeholders, including decision makers at regional, national, and local community levels, down to smallholder farmers. Successful CIS provide accurate, spatially-resolved daily, ten-day, monthly, and seasonal forecasts and advisories in a timely and accessible manner, as well as historical trends and monitoring products. CIS is attractive because it can address the immediate needs of agricultural communities as well as other sectors, while also building the foundation of national and regional information systems to support adaptation to long-term and large-scale climate change. CIS can also support index insurance products tailored to the needs of small farmers that pay on the basis of defined weather events. Index insurance may facilitate access to credit, allowing farmers to invest in measures that may improve their productivity (Hazel et al., 2010; Helmuth et al., 2009; Seeks and Collier, 2008).

Providing CIS is part of the mandate of National Meteorological and Hydrological Services (NMHS) who commonly serve national needs to observe, forecast, and issue warnings for pending weather, climate and water threats. The development of effective CIS requires access to reliable climate and weather information, which depends on a network of global, regional, and national remote and in situ observations of the atmosphere, oceans, and land. Other stakeholders have also begun to show growing interest in contributing to the development of relevant CIS for specific users and/or the general public. This includes public agencies, private sector - in partnership with public agencies or independently, and non-profit, non-governmental organizations (NGOs). While the private sector is playing an increasing role in the provision of weather information in the developed economies, involvement in lower income countries is still nascent (Usher et. al., 2018).

Despite covering a fifth of the world's total land area, and having a population of over one billion people, Africa has not only the least developed weather and climate observation network of all continents, but also one that is in a deteriorating state (AMCOMET 2015). Many NMHS in SSA contend with limited human capital, inadequate financial resources, and obsolete technologies (AMCOMET 2015), and many lack the capacity to provide even a basic level of services. Therefore,

developing and delivering CIS will require significant investments in capacity building for many years.

There have been efforts to build the capacities of NMHS in Africa, and many international and bilateral development donors have begun to invest in climate services in the region. Most funding agencies understandably want to see robust metrics that demonstrate the value gained from these investments. Understanding current NMHS capacities is essential for guiding future investment and demonstrating its value. This study builds on prior work to advance an evaluation approach that can assess the capacities that NMHS have, the gaps in those capacities that investment should address, and the change in capacities over time.

1.2 Assessing Sustainability and Effectiveness of Climate Information Services in Africa project

The project was implemented by a consortium led by Winrock International, with the International Research Institute for Climate and Society (IRI), the Climate System Analysis Group (CSAG), the AGRHYMET Regional Center, and the Global Framework for Climate Services (GFCS)[2] as partners. The **overall project objective** is to develop models and options for the sustainable delivery of CIS in SSA, and to consolidate and extend knowledge about existing CIS in SSA, with a focus on seven African countries, including Senegal, Ethiopia, Rwanda, Malawi, Niger, Cote d'Ivoire and Mali.

The project has three work streams:

1) Sustainability assessment. This includes the development of metrics to assess effectiveness and sustainability of NMHS as providers of CIS, with a baseline assessment of select NMHS, and advice on 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 sustainable financial models for CIS delivery in SSA.
3) Partnership building, synthesis, sharing and uptake of knowledge and lessons learned.

The Sustainable CIS project focuses on the supply of climate services. A separate effort is being undertaken to evaluate the uptake of CIS by users and the benefits to users.

1.3 Study Objectives and Contributions

This report describes work conducted under the first component of the Sustainable CIS project, the sustainability assessment. The study, led by IRI, has **two main objectives**:

1) Propose an evaluation approach to assess capacities of NMHS to implement effective climate information services and the change in those capacities over time.

[2] GFCS is a global partnership of the World Meteorological Organization (WMO) with the UN International Strategy for Disaster Reduction, the World Health Organization, the World Food Programme, the Food and Agriculture Organization of the UN, and others.

2) Use the evaluation approach to conduct a baseline assessment of current capacity and capacity gaps in seven NMHS.

This study makes three main contributions to the development of an evaluation approach for NMHS:

First, we propose a new framework that combines two schemas, which the WMO developed to guide the NMHS enterprise: the five pillars of the GFCS and the four categories of NMHS. The GFCS defines a system for CIS that consists of five pillars, which identify the essential functions of the NMHS (Section 3). On the other hand, WMO's NMHS Categories specify criteria that a NMHS must satisfy to be placed within one of four different categories.

The GFCS specifies broad objectives for each pillar, which do not provide sufficient guidance to assess capacity within each pillar. The criteria, which NMHS have to satisfy in order to be placed in each of the categories, contain more specific objectives, but the WMO does not organize these objectives by function. The criteria serve to classify NMHS into one of the four categories reflecting all functions combined.

The framework developed through this effort is innovative in that we assign the criteria associated with each category to the 5 GFCS pillars. The criteria elaborate what a NMHS must achieve to perform the functions under each of the pillars, and we adopt them as NMHS objectives under each pillar. In the resulting framework, there are four categories of NMHS (basic, essential, full, advanced) under each of the five pillars of GFCS. The criteria serve to classify the capacity of a NMHS into one of the four categories for the functions represented by each pillar. The classification enables us to provide specific recommendations for investment for each NMHS by identifying the function and capacities that need improvement.

Second, the study develops quantitative metrics that measure the extent to which NMHS achieve each criterion. The metrics are general enough to be applied to evaluate progress towards development of climate services in any NMHS in Africa. The metrics may evolve as additional evidence emerges that necessitates a revision of the framework.

Third, the proposed approach is objective in that the value assigned to each of the metrics can be verified using documentation that most NMHS possess. Verifiability is not an intrinsic property of a metric since metrics can be based on subjective self-assessment, and past assessments rely primarily on questions requiring self-assessment from the staff of NMHS. Self-assessment introduces potential biases and inconsistencies in evaluations. This study did not have the resources to conduct full verification of the metric values. However, the proposed approach allows an objective assessment that enables comparisons between NMHS and within a NMHS over time.

The following steps were taken in the construction of the evaluation approach and capacity assessment of the seven NMHS:

1) Review existing documents on the GFCS objectives and implementation as well as metrics for assessing NMHS that have been applied by WMO/GFCS and others.
2) Construct a framework for evaluating the capacities of NMHS to accomplish the objectives defined by the GFCS.

3) Derive metrics to measure the NMHS progress toward satisfying the GFCS objectives as defined by WMO criteria for the four categories of NMHS.

4) Develop a baseline survey questionnaire to collect data needed to assign values to the metrics.

5) Implement the baseline survey in seven African NMHS – Ethiopia, Rwanda, Malawi, Niger, Senegal, Mali, and Cote d'Ivoire.

6) Analyze the data and prepare the report.

7) Present the metrics and results to the wider community at a side event in Cape Town in June 2018. Elicit feedback to incorporate into this report.

8) Refine metrics and analysis based on feedback.

This report presents the evaluation approach, the methodology for applying it, and a summary of the results from assessing the baseline capacity in seven countries. Full results of the baseline assessment are in "NMHS Capacity Development Assessment Report" (Lenard et. al. 2018).

2. PREVIOUS CAPACITY ASSESSMENTS

Different agencies have performed assessments of some NMHS through different surveys. An exhaustive review of these assessments is beyond the scope of this report. Below is a summary of the work carried out by WMO that informed our methodology.

2.1 Impacts of Achieved Results on Members

WMO regularly conducts surveys and assessments of NMHS worldwide, often carried out by the Strategic Planning Office (SPO). For instance, a survey on the "Impacts of Achieved Results on Members" was undertaken in August-December 2015 where 75 survey questions were sent to 191 WMO members[3]. Similar baseline data were also collected during 2012 and 2013. The latest such survey was conducted in 2017 and is still being analyzed.

2.2 Joint GFCS PAC (Partner Advisory Committee) Baseline Capacity Assessment Tool[4]

This survey tool is designed to assess baseline capacities for the co-production, communication, and use of climate services at the national level. This survey targets NMHS, along with other national stakeholders involved in the production, communication, and use of climate services. It evaluates capacity requirements in three areas 1: National legislation, policy and institutional frameworks and planning; 2: Capacities for production, tailoring and communication of climate services at national level; and 3: Capacities in place for the Use, Mainstreaming and Evaluation of climate services. The metrics presented are distinct for national level and local level requirements.

2.3 WMO Agricultural Meteorology Questionnaire[5]

The WMO Agrometeorology questionnaire includes information requested for the WMO Agricultural Meteorology Database to inform National Progress Reports (2006-2009). The questionnaire includes sections on organization, observations, agrometeorological services for

[3] https://www.wmo.int/pages/about/documents/Fullreport_Survey_Impacts_2015.pdf
[4] www.gfcs-climate.org/sites/default/files/PAC-5-d05-4-Tool_en.docx
[5] www.wmo.int/pages/prog/wcp/agm/documents/questionnaire.doc

agriculture, agrometeorological research, socio-economic benefits, models, drought indices, and societies.

2.4. WIGOS framework self-assessment checklist[6]

The WMO Integrated Global Observing System (WIGOS) is a framework for managing global monitoring systems. It supports the GFCS and other WMO strategic priorities and was developed to assess county readiness to implement WIGOS at the national scale. Sections include: management of WIGOS implementation; collaboration with the WMO co-sponsored observing systems and international partner organizations and programs; design, planning and optimized evolution of WIGOS component; observing systems, observing system operation and maintenance; quality management; standardization, system interoperability and data compatibility; WIGOS operational information resource, data discovery, access and retrieval; capacity development; and communications and outreach.

2.5 GFCS assessment of readiness to implement the National Framework for Climate Services

The GFCS assessment is included in the *Implementation Plan of the Global Framework for Climate Services, Annex II* (WMO 2014) to evaluate countries' state of readiness to create a national level framework for climate services. A guideline for national-level implementation of the framework includes the self-assessment in Phase 1, "Assessing the baseline". It is designed to identify critical gaps and opportunities for improving the delivery of climate services. Phase 1 also includes defining actors involved in the chain of climate information production communication and use, including stakeholders involved in all 5 GFCS pillars and priority sectors, and assessing climate services currently being provided. The *Implementation Plan* also includes a series of questions to assist countries in defining stakeholders, although not in a formal assessment format. This includes questions to identify climate-driven problems that climate services could address as well as stakeholders working across the information chain, from production to use and from national to local scales.

Country assessment reports reflecting GFCS Implementation Plan priorities were available for Côte d'Ivoire, Mali, Niger and Senegal. These reports describe national policies on climate services and existing climate services, identify needs, make investment recommendations based on emerging priorities, and summarize investment options. Each report is based on the National Action Plan for Climate Services, as endorsed by the relevant national authorities, including government representatives for all climate-sensitive sectors. Each report focuses on the GFCS's five priority sectors: (1) Agriculture and Food Security; (2) Disaster Risk Reduction; (3) Health; (4) Water Resources Management; and (5) Energy. The methodology for implementing the National Action Plans is also described in the country reports. The methodology varies between countries, but all include baseline capacity assessments conducted by questionnaires (and sometimes also interviews) and national consultation workshops on climate services with stakeholders, including sectoral partners and end users.

2.6 GFCS Checklist for Climate Service Implementation[7]

The GFCS Checklist is the latest version of the GFCS assessment tools. It was created for NMHS to self-assess progress on climate services implementation and identify areas where support is

[6] www.wmo.int/gfcs/sites/default/files/events/...//Cambodia%20report%202.pdf
[7] https://www.research.net/r/checklist-cs

needed. WMO Members can use it to evaluate the status of climate services implementation and identify gaps. The checklist consists of "YES/NO" questions to assess the degree to which actions have been taken or outputs generated and are grouped into the six categories: (1) Governance; (2) Basic Systems; (3) User Interface; (4) Capacity Development; (5) Provision and Application of climate services; and (6) Monitoring and Evaluation. Within each category (except for governance), suggested actions or outputs are given separately for the four WMO NMHS categories (see next section): (1) Basic, (2) Essential, (3) Full, and (4) Advanced.

The GFCS Checklist Assessment approach is similar to that which was adopted in this study in that it is done across six different categories. The main differences are that some of the six categories do not directly correlate with the five GFCS pillars (Section 3.1), the assessment methodology proposed in our framework is not a self-assessment, and the final results from our assessment are scores that show whether each NMHS meets the criteria for a given NMHS category under a given GFCS pillar.

3. THE EVALUATION APPROACH

The evaluation approach developed in this study includes a framework, set of quantitative metrics, survey questionnaire, and data collection and analysis process.[8] The approach can be used in future rounds of evaluation to compare capacity across time in order to track progress toward the NMHS objectives. The approach may evolve over time as the understanding of effective delivery of CIS grows, and the vision of sustainable climate services changes. As noted in the introduction, we focus on the supply of CIS, setting aside the uptake of CIS by users and their impact on users.

3.1 The framework for the evaluation

The framework that we develop is an outline of a program theory, which should be further elaborated in future work. A program theory is a model of how the program being evaluated, in our case the NMHS, is supposed to work.[9] The model can vary in the amount of detail and elaboration though a complete program theory consists of a theory of change and a theory of action (Funnell and Rogers 2011).

The theory of change specifies the mechanisms through which NMHS can achieve its objectives. The mechanisms transform the inputs the program requires into outputs, expected short-term outcomes, and the longer-term impacts, which should reflect the program objectives. The theory of action specifies the actions that a NMHS should undertake to activate the mechanisms in the theory of change.[10] Metrics should come directly from the program theory and track inputs, actions, outputs, outcomes, and impacts.

[8] Throughout the report, we use the terms evaluation and assessment interchangeably.
[9] The development of a program theory that demonstrates the logic of a program (Rogers et al 2000, White 2009) is an essential component of evaluation in the program evaluation literature (for example Rossi et al 2004, Shadish et al 2002, Patton 2002, Bamberger et al 2006). This literature presents the approaches and methods that are the basis of evaluation practice for social and health programs, though they are not yet being widely applied to the evaluation of CIS.
[10] A common way of depicting a program theory is in a logic model.

The program theory represents a consensus among all relevant stakeholders about the objectives the program is pursuing, what program design achieves those objectives, and under what assumptions. This study relies on frameworks established by the WMO to develop an outline of a program theory because they command consensus.

GFCS Pillars and WMO NMHS Categories

The proposed framework is an outline of a program theory, integrating two existing schemas: the five pillars of the GFCS and WMO's four categories of NMHS[11]. The GFCS is a UN-led initiative spearheaded by WMO to guide the development and application of science-based climate information and services in support of decision-making in climate sensitive sectors (GFCS, 2014b). The GFCS defines five core functions (pillars) that NMHS should perform (WMO, 2014a):

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

WMO's NMHS Categories specify criteria that a NMHS must satisfy to be placed within one of four different categories:

1. Basic Climate Services
2. Essential Climate Services
3. Full Climate Services
4. Advanced Climate Services

The five GFCS pillars (Figure 1) represent a very broad outline of a theory of change. WMO posits that the capacity of a NMHS to deliver effective climate services improves as it becomes better able to perform more of these five functions. Four of the five pillars represent a rough progression in terms of capacities that the NMHS has and outputs that it produces, though the progression is not simple and some of the capacities can be developed out of order. A NMHS needs to have the equipment to be able to collect data on the national environment and needs to maintain the quality of that data, as measured under the Observations and Monitoring pillar. The NMHS also needs to apply research to these data to make predictions about weather and climate variables, as documented under the Research and Predictions pillar. The resulting forecasts and predictions are a necessary input into the Climate Services Information System pillar and the User Interface Platform pillar. However, the latter two pillars also require a rather independent set of investments in two-way communication with users of climate information that is needed to produce information that is useful for applications. The fifth pillar, Capacity Development, documents the resources that are needed to make the work done under the other four pillars possible, and therefore progress under this pillar is likely to be necessary for progress under the other pillars to occur.

[11] https://www.wmo.int/pages/prog/dra/documents/CDSIP-Annex5.doc

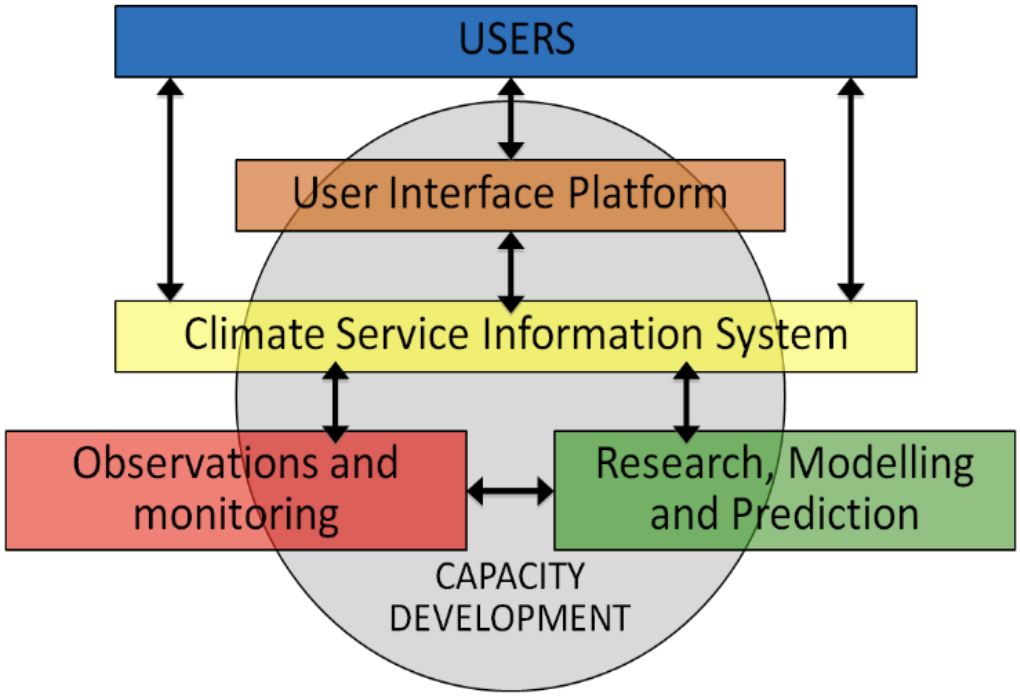

Figure 1: The five pillars of the Global Framework for Climate Services (GFCS)

Yet the GFCS offers limited guidance on the level at which a NMHS should perform each of the functions or how they can acquire capacity to perform them. The criteria that a NMHS must satisfy to be placed into one of the four WMO categories (Figure 2) partially fill this gap, offering more specific guidance. The categories reflect incremental steps toward a more complete climate information service, but are not organized by GFCS pillars.

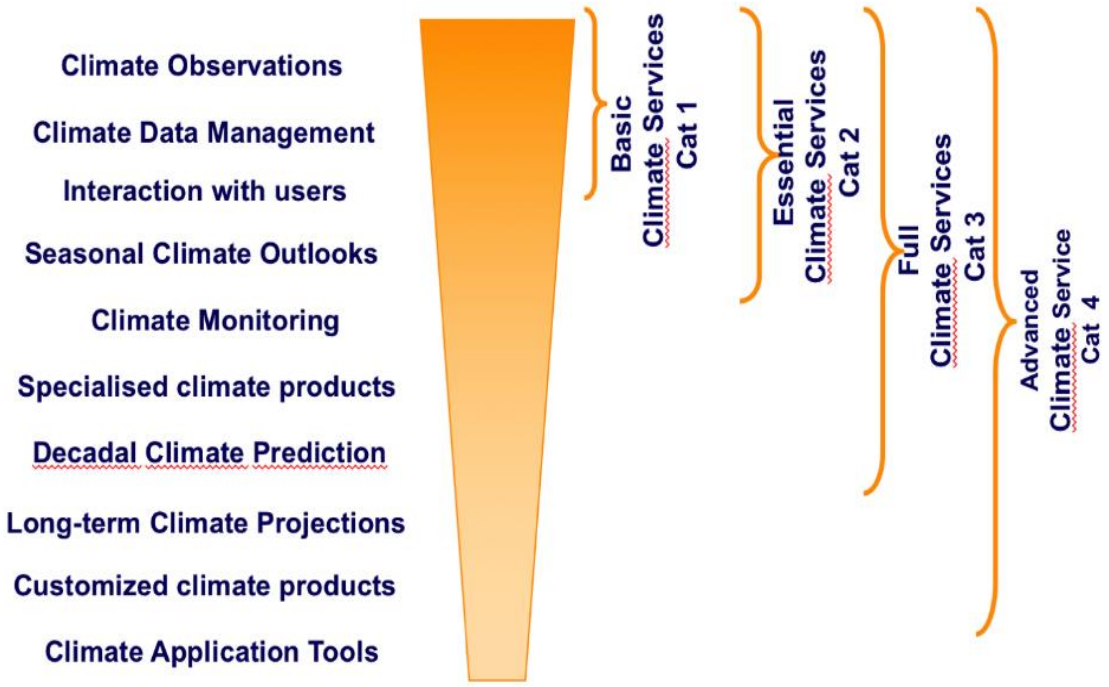

Figure 2: WMO NMHS Categories (Source WMO[12])

The outline of a program theory

In the proposed framework, we consider the WMO criteria applied to classify NMHS into the categories as the objectives that NMHS should strive to achieve, and assign each objective to one of the five GFCS pillars according to the function, which the attainment of each objective helps to perform. For example, the first row in Table 2 lists the criteria that correspond to the Basic Climate Services category (category 1) for each of five GFCS pillars. We assign the criterion that requires an adequate observing system as an objective to be achieved under the Observations and Monitoring pillar. The criterion that requires conducting weather forecasts and warnings is an objective to be achieved under the Research, Modeling, and Predictions pillar, and so on. A NMHS that operates an adequate observing system is placed in category 1 for the Observations and Monitoring Pillar, though it also could be associated with category 2 or 3 under each of the other pillars. A NMHS that operates an expanded observation network is classified in category 2 under the Observations and Monitoring pillar. Note that Table 2 only provides an example.[13] The full framework assigns multiple criteria to each category under each pillar.

[12] WMO Categories of service delivery for NMHSs.docx, document provided by WMO

[13] The full framework is titled "National Meteorological Service Baseline Assessment Tool: Assessing Capacity to Provide Effective and Sustainable Climate Information Services". It can be found on www.climatelinks.org and https://iri.columbia.edu/~acurtis/ilearn/metrics_table_standalone.xlsx

	Observations & Monitoring	Research, Modeling & Predictions	Climate Service Information System	User Interface Platform	Capacity Development
Category 1 Basic	Operate and maintain adequate national observing systems, suitable for basic hydro-meteorological purposes	Conduct weather forecasts and warnings (up to 7-10 days ahead)	Conduct basic climate diagnostics and analysis	Interacts with users, to meet requests (for weather forecasts and information and for basic climatology questions)	Participate in training, as required, for data management, QMF, data rescue, basic analysis (using, e.g., CDMS)
Category 2 Essential	Operates expanded surface climate and weather observation network	Performs national weather and climate research	Conduct advanced statistical analysis (diagnostics; homogeneity testing and adjustment, etc.)	Interact with users in one or more sectors to identify their requirements	Participate in training for specialization in climate services
Category 3 Full	Adopt long- term strategy for managing observing network and its change	Downscale climate prediction and projection products	Develop and/or provide, in a multi-disciplinary context, specialized (tailored) climate analysis, prediction and monitoring products,	Provide climate information relevant to policy development and National Action Plans	Conduct, or provide expertise to, training of climate services and prediction specialists

Table 2: An example of the five GFCS pillars combined with WMO Categories (only three shown) with some of the associated criteria.

The GFCS does not specify inputs, actions, outputs, outcomes, or impacts. The criteria are specific enough to provide guidance with respect to some of the inputs, elucidate some of the actions that the NMHS should take to achieve the functions in the theory of change, and identify some of the outputs that they should be producing. For example, NMHS should "interact with users," as shown in the fifth column and second row of Table 1 to have a User Interface Platform that functions at the category 2 level. NMHS should produce weather forecasts and warnings as part of the Research, Modeling, and Predictions function that operates at the category 1 level. The criteria assigned to the Capacity Development pillar indicate some of the inputs, such as staff qualifications. A more fully developed program theory would begin with broader NMHS objectives and then would integrate the 5 pillars and the criteria into a model of what the NMHS needs to do to deliver climate services, filling in the detail and the connections that are missing in the current framework. The model would specify the needed inputs, actions, outputs, outcomes, and impacts, which would then be measured with metrics.

3.2 Defining Metrics

Metrics are a system of measurement, widely used by industry, academia, and government to evaluate progress towards an objective. Despite broad use, there is no standard definition of the term "metric" and is often used interchangeably with "indicator" and "measure" depending on the

context. In this report, metrics are used to measure specific quantities that indicate the extent to which a NMHS has achieved each criterion. For example, whether a NMHS has signed a Memorandum of Understanding is one metric, which reflects the extent to which the NMHS satisfies the category 1 criterion under the Climate Services Information System pillar that requires a NMHS to interact with users to meet their requests. Table 3 presents all the metrics that the team developed for the two criteria that fall under category 1 of this pillar, as an example of what the framework is. In the absence of a model that fully elaborates how a NMHS can achieve the function in each pillar, the metrics were developed based on a literature search and the expert opinion of the meteorologist on the team.

The metrics are designed to measure progress from one category to the next within each pillar. We measure such progress in one of three ways. First, some metrics impose a progressively higher standard moving from category 1 to category 3. For example, the percentage of observing stations that are staffed by trained observers is one measure of capacity under the Observations and Monitoring pillar. Category 1 under this pillar requires that at least 75% of stations be manned by trained observers. Category 2 requires that at least 90% of stations be manned by trained observers. All stations must satisfy this requirement in category 3. Second, some metrics require increasingly sophisticated capacity from one category to the next. For example, metrics in the Research and Predictions pillar specify different forecast products in different categories, with higher categories requiring more sophisticated products. Third, we consider the extent to which NMHS satisfy the criteria that define lower categories in assessing whether the NMHS satisfies the criteria for higher categories, as we discuss further under "Scores" below.

	Criteria	Metrics	Questions in the survey	Senegal	Cote d'Ivoire	Niger	Mali	Rwanda	Ethiopia	Malawi	Rank	Weight
Category 1 "Basic"	Interacts with users, to meet requests (for weather forecasts and information and for basic climatology questions)	The NMHS has strategic plan and procedures for user engagement	I3	1	1	0	1	1	1	1	2	0.5
		NMHS has mechanisms in place to co-produce climate information products with at least one sector	H12	1	0	1	1	1	1	1	4	0.25
	Get feedback from users on the usefulness and effectiveness of the information and services provided.	Documents user feedback in writing	I10	1	0	0	1	1	0	0	1	1
		Has signed MOU's with at least one sector	H5	1	1	1	1	1	1	1	3	0.3333
		Have website with some basic climate information products	H15, H16 (max 2pts	1	0	0.75	1	1	1	1	1	1
		At least one staff member has training in engagement with users	B16	1	1	0	0	0	0	1	2	0.5
		Has interacted with users over the last two years	I8	1	0.75	1	1	1	1	1	4	0.25

Table 3. A sample of the Metrics table for Category 1 under the Climate Services Information System Pillar.

The team identified metrics, which provide objective, verifiable measures of the extent to which a NMHS satisfies each criterion. The current assessment is based on responses to survey questions provided by NMHS staff in each of the seven countries. The responses can be independently

verified by examining NMHS records. Resources needed to verify all responses were not available in this study. However, verification can be incorporated into future assessments based on this framework.

The value of each metric is derived from answers to one or more of the survey questions. The relevant question numbers are listed in the column next to the metrics in Table 3, and the questionnaire is in Appendix II. There are three types of metrics, two of which elicit binary responses.

Type 1: Any metric based on responses that are either yes or no. If the response is yes, it is assigned a value 1 and if the answer no, it receives a value of 0. For example, the metric "Collects station metadata" for Category 1 of the Observation and Monitoring pillar is based on a question that asks whether the NMHS collects metadata.

Type 2: Metrics based on numerical responses. For example, the first metric in Category 1 of the Observation and Monitoring pillar is "At least 75% of all stations are manned by trained observers". The metric is based on responses to two questions, one of which asks how many stations the NMHS operates and another asks how many stations are manned by trained observers. If the latter is at least 75% of the former, then the metric takes a value of 1, otherwise it takes a value of 0.

Type 3: Metrics based on multiple choice questions and/or several yes/no or multiple-choice questions. These metrics are assigned values between 0 and 1, and the value denotes how many of the conditions are satisfied for the given NMHS. For example, the metric "Maintains electronic backup of data and backed up data at least every month over the past year" in Category 1 of the Observation and Monitoring pillar is based on two yes/no questions and has 2 conditions: that the NMHS maintain electronic backup of data, and that it backed up data at least every month over the past year. The metric takes the value 0 if neither condition is satisfied, 0.5 if one of the conditions is satisfied, and 1 if both conditions are satisfied.

Some of the Type 3 metrics are more complicated. For example, metric "Produces and disseminates seasonal outlooks of rainfall (probability, onset, cessation) and temperature (probability) each season" in Category 2 of Research and Predictions pillar contains 5 categories: whether the NMHS produces each of the 4 listed outlooks and whether it disseminates seasonal outlooks. The question whether the NMHS disseminates seasonal outlooks does not differentiate between different types of outlooks. The resulting value of the metric is the number of conditions that the NMHS satisfies divided by 5.

Ranking and weighting of metrics

We combine the different metrics for a given category and under a given pillar into a single value (score). We assign a rank to each metric, which signifies its importance. A value of 1 reflects the greatest importance and 4 reflects the least importance. The ranking accounts for two criteria: (1) the importance of the role the resource measured by the metric plays in enabling the NMHS to satisfy a given criterion as determined by the expert opinion of the meteorologist on the study team; and (2) expert opinion regarding the quality of data that underlie the metric. Metrics based on data that are considered less reliable receive a lower rank even if the resource measured by the metric is very important to meeting the criterion. The inverses of the ranks are used as weights to combine the metrics into a single score.

We also assign ranks, which reflect only the importance of the resource being measured (Actual Rank). We would use these ranks if the data were reliable. Table 4 presents an example of the rank, which we use to calculate the score (Given Rank) and the Actual Rank. The difference illustrates which data are considered less reliable.

	2: Research, Modeling and Predictions			
	Criteria	Metrics	**Given Rank**	**Actual Rank**
Category 1 "Basic"	Participate in funded research projects and field experiments	Participated in at least two research projects/experiments in the last 5 years	3	1
	Conduct weather forecasts and warnings (up to 7-10 days ahead)	Provides weather forecast for up to 3 days at least twice a week	1	1
		NMHS has access to > 1 Mbps internet capacity	3	2
	Disseminate climate outlooks provided by GPC, RCCs and RCOF	Disseminates seasonal outlooks of rainfall and temperature probabilities each season	1	1

Table 4: An example showing the "actual" and "given" ranks for the different metrics.

Scores

The raw score assigned to each country for each category and pillar is the weighted average of the metric values in that category. However, for category 2, a weighted average of the raw scores from categories 1 and 2 is applied, with a weight of 0.5 on the raw score in category 1 and a weight of 1 on the raw score in category 2. The approach ensures that NMHS performance in category 2 also takes into account its performance in category 1. Without this weighting, in principle it is possible for a NMHS to fail to fulfill conditions for category 1 but satisfy the conditions for category 2. In practice, the problem did not arise for any of the NMHS we evaluated. Similarly, the final score for category 3 is a weighted average of the raw scores in the three categories with a weight of 0.33 on the raw score in category 1, 0.5 on the raw score in category 2, and 1 on the raw score in category 3.

We designate NMHS that receive a weighted score between *80 and 100* as fully meeting the criteria for the given category. NMHS that receive weighted scores between *71 and 79* partially fulfill the criteria for a given category. A weighted score *below 71* indicates that the NMHS does not satisfy the criteria for the category.

These thresholds are subjective. In theory, only NMHS that score 100% for the given category should satisfy the criteria. However, the metrics do not reflect capacities to meet a given criterion perfectly and the data collected through the survey are not perfectly reliable. The range of scores that indicate that the NMHS fully satisfies the criteria accommodates these uncertainties. We introduced a score, which indicates that a NMHS "partially fulfills" the criteria, as an additional way to account for the uncertainties. The score identifies cases in which NMHS are close to fulfilling the criteria, but their score may fall below the threshold for fully satisfying the criteria because of small discrepancies between actual conditions and the data. The thresholds are conservative in that they tend to underestimate the overall performance of the NMHS.

Circumstances differ across countries, and it may not be possible to have a single set of metrics that reflect how well a NMHS meets the climate information needs for each country. The climate service community may wish to tailor the criteria through a collaborative process to account for differences between conditions in different countries. However, until such a process takes place, a range of scores that meet the criteria may partly accommodate differences across countries. The scores are nevertheless useful for assessing the current capacity in each NMHS, the progress made by NMHS over time, and differences in capacity across countries.

3.3 Survey questionnaire and data collection

The team used a questionnaire to collect data needed to assign values to the selected metrics. The questionnaire consisted 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, which was given to relevant NMHS staff who had the necessary expertise to respond. The complete questionnaire is included in Appendix II.

The questionnaires were administered in two different ways. In five of the seven countries, members of the project team visited the NMHS and collected responses in person. The responses were recorded online, using Survey Monkey. In two countries (Ethiopia and Rwanda), NMHS staff filled in the questionnaire online, without a team member present. Project team members followed up to clarify answers afterwards. The way in which the questionnaire was administered did not have any discernible effects on the responses received. Some challenges associated with data collection and the collected data itself are discussed in Section 5.4.

The team also collected additional information through open-ended discussions guided by several questions. These questions focus mainly on training available in the NMHS, types of collaborations, partnerships, and the role of women in the NMHS.

4. ASSESSMENT OF NMHS CAPACITY

The team used the approach described above to assess baseline capacities of seven NMHS in SSA. This section summarizes the results. Full results of the capacity assessment are in the companion paper "NMHS Capacity Development Assessment Report" (Lenard et. al. 2018).

4.1 Overview of the results

We present the categorization of the seven evaluated NMHS for each GFCS pillar in Table 5. As we noted in Section 3, the higher the category for which the NMHS meets the criteria, the greater the capacity to perform the functions specified for the given pillar in that NMHS. There is also an element of progression across the pillars. In particular, progress under the Capacity Development pillar is likely to be necessary to improve performance under the other pillars.

The analyses show that:

- All NMHS evaluated were found to be more likely to fulfill the criteria for the Basic Climate Service category (category 1) under each pillar than they are to fulfill criteria for the higher categories.
- The three services that have the weakest scores under Capacity Development, (not meeting the criteria for category 1), also have the lowest scores in the Observations and Monitoring and Research, Modeling, and Predictions pillars. This suggests these NMHS do not have sufficient resources, such as technical capacity and trained staff, to collect data and to deliver basic predictions and forecasts. For example, Cote d'Ivoire would need to establish a protocol for training different types of staff, train them in data rescue, improve access to software for computation and display of basic climate statistics, and improve access to computers connected to the internet to satisfy the requirements for category 1 of the Capacity and Development pillar.
- To meet the criteria for Category 1 of the Observation and Monitoring pillar, the evaluated NMHS should invest in training of station observers and increase the number of surface, upper air, and Class III and above stations. Together, these investments may begin to enable the countries to conduct the research needed to provide basic forecasts.
- Countries may perform well with respect to the Climate Services Information System and User Interface Platform pillars even when they do not perform well with respect to the other pillars, and vice-versa. For example, Mali has a strong Climate Services Information System and User Interface Platform, but lacks capacity in Observations and Monitoring and Research and Predictions. Malawi also has a strong Climate Services Information System relative to its performance with respect to the other pillars.
- Three out of the four countries that perform well with respect to the Capacity Development pillar, (Senegal, Rwanda, and Ethiopia) also perform well with respect to the Observations and Monitoring and Research, Modeling, and Predictions pillars.

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 5: 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 criteria required for the category have been satisfied or partially satisfied, while red signifies that the criteria have not been satisfied.

There are exceptions to the broad pattern. For instance:

- Mali performs well with respect to the Capacity Development pillar and weakly with respect to the Observations and Monitoring and Research, Modeling, and Predictions pillars, only partially satisfying the criteria for category 1 in both pillars.
- Mali also performs well under the Climate Services Information System and User Interface Platform pillars, being one of only two NMHS in the study, which fully satisfy the criteria for category 2 for the User Interface Pillar.

Mali appears to be directing resources toward establishing communications and partnerships with users of climate information and producing climate information products tailored to users, while its data collection infrastructure and capacity to produce a range of information products are very basic. This may be ascribed, at least partly, to the fact that Mali Meteo is a member of the national multi-disciplinary working group (GTPA: Groupe de Travail Pluridisciplinaire d'Assistance Agrométéorologique) that translates agro-climatic information into useful advice and recommendations. Further research would be needed to assess the path chosen by the Mali NMHS.

4.2 Performance under each of the five pillars of the GFCS

Here we summarize the capacity assessment. A detailed country-by-country report, which includes specific recommendations for investments in capacity for each country, is given in Appendix I.

Observations and Monitoring

The Observations and Monitoring pillar focuses mainly on infrastructure and processes for collecting and maintaining high quality climate data. Three out of the 7 countries met the criteria for category 1 under this pillar, and one country partially met them. One country partially met the criteria for category 2. No country met the criteria for category 3.

The most common weakness for category 1 is the density of upper air observation stations. Only 2 countries have a sufficient number of upper air stations based on the condition in the metric. Other common weaknesses were the frequency with which stations above class 3 report data to the NMHS headquarters and the percentage of rainfall and temperature data that has been digitized.

In category 2, only one country met the condition for the density of surface stations and no country met the condition for the density of upper air observation stations. Further, most countries do not have a sufficient number of stations that are class 3 or above or of automatic weather stations and most NMHS do not have a staff member proficient in WMO/GCOS/WIS data standards and quality management. Most NMHS do not have radar that sufficiently cover the country and none of the NMHS evaluated operate a system for reception, digital processing, and display of satellite data. Thus, common recommendations were that countries should increase the number of upper air and surface stations, including Automatic Weather Stations.

Research, Modeling and Predictions

The Research, Modeling, and Predictions pillar requires producing a range of climate information products and conducting the research needed to generate these products. Three NMHS fully met criteria for category 1, and another three partially met the criteria. Two NMHS partially met the criteria for category 2 and no NMHS satisfies the conditions for category 3.

The main weakness in category 1 was that many NMHS do not provide a seasonal outlook for temperature probability. In category 2, only one country has a sufficient number of staff with a PhD. Specific recommendations were that at least 5% of the NMHS staff should have PhDs for a NMHS in category 2 and at least 10% for a NMHS in category 3. Few NMHS produce monthly rainfall and temperature forecasts, and only one produces ten-day weather forecasts. Most NMHS assess the uncertainty of seasonal forecasts but only one communicates that uncertainty to users of information. All but one could improve access to software tools for weather and climate forecasting, including statistical and dynamical downscaling. The speed of the internet was also a prevalent problem. No NMHS has access to internet with speed greater than 10 Mbps.

Climate Services Information System

The Climate Services Information System focuses on provision of data and a range of climate information products, including those tailored to the needs of specific users of climate information, and communication of those products to users. Five of the NMHS fully satisfy the conditions for category 1, and one partially does. The same five NMHS fully meet the conditions for category 2. Two NMHS partially satisfy the conditions for category 3. All the NMHS that met the criteria for this pillar have implemented ENACTS (Enhancing National Climate Services), which enables NMHS to generate and disseminate (online) an array of climate information products (Dinku et al.,

2017). However, different NMHS have different versions of ENACTS, which means that the number of online climate information products offered is not consistent across the countries.

The main weaknesses in category 1 are that most NMHS in the study do not produce seasonal outlooks for temperature, most could expand the range of basic climate statistics for the major climate variables, and most could improve access to software for computation and display of basic climate statistics.

In category 2, none of the study NMHS perform homogenization of data, and in category 3, most NMHS web pages should provide a greater range of specialized climate analysis, prediction and monitoring products, on seasonal to climate change time scale tailored to the needs of the major sectors. All NMHS should produce seasonal outlooks more often, and most should provide a broader range of outlooks. All should expand the range of advanced climate information products in different tabular and graphical formats.

User Interface Platform

The User Interface Platform pillar comprises criteria designed to ensure that the NMHS has developed procedures, partnership agreements, and the communication infrastructure needed to maintain an engagement with users that includes a two-way flow of communication. Four of the NMHS fully satisfy the conditions for category 1, and one partially meets these conditions. Two NMHS fully meet the criteria for category 2, and one partially satisfies the criteria. Two NMHS partially satisfy the conditions for category 3.

The two main weaknesses in category 1 are that most NMHS do not train their staff in engaging with users to learn about users' needs, to produce climate information to meet users' needs, and to obtain feedback regarding the usefulness of that information. Most NMHS do not document feedback from users of climate information in writing.

In category 2, most NMHS could expand the training that they conduct to explain to users how to access and use climate information products. Only two NMHS have written procedures for incorporating feedback from users into the redesign of climate information products. Most NMHS could expand the range of advanced climate information products on their websites.

In category 3, most NMHS do not post advisories tailored to specific users' needs on their websites. Most should expand their partnerships for providing climate information products tailored to the needs of the major sectors through MOUs. None of the NMHS fully provide website and API (Application Programming Interface) access to national observations and forecast information for use by any national interactive media outlet.

Capacity Development

The Capacity Development pillar specifies criteria for human and technical capacity that the NMHS need to deliver climate information services in each of the categories. The study added metrics in two additional dimensions considered essential to the delivery of CIS, which were not present in the WMO criteria: institutional and technical capacity. Four NMHS fully satisfy the conditions for category 1 while the same four partially satisfy the conditions for category 2. None of the NMHS meet the criteria for category 3.

In category 1, most NMHS should broaden their participation in national climate-related policies and plans. Most NMHS do not have a protocol that governs what types of training staff should undergo and how frequently and should expand training to include data rescue. Further, most could

improve access to software for computation and display of basic climate statistic and improve basic access to computers connected to the internet.

In category 2, most services have limited corruption safeguards, such as independent auditing of appropriation, procurement and expenditure policies. Many NMHS should expand their training to include training of mid-level meteorological technicians and all but one should improve access to software tools for weather and climate forecasting, including statistical and dynamical downscaling.

Significant gaps remain in category 3 in institutional and technical capacity. Most services do not have the status of an independent body under a ministry and none have adequate access to high-speed internet or high-performance computers to satisfy the conditions for category 3.

One general finding with respect to financial capacity is that there appears to be significant growth in executive remuneration compared to that of other categories of employees. This may be an indication that NMHS are diversifying and strengthening the executive to provide better overall leadership, or it could suggest an increasingly unequal reward structure. Qualitative data would help to clarify the reasons for the pattern.

We analyzed the role that women play in the NMHS staff capacity. The findings show that approximately 25% of entry-level meteorological technicians are female, and that across the seven countries, a total of 528 entry-level staff are currently employed in this capacity. Comparatively, a similar percentage of women are employed at the mid-level, but at the senior level the proportion of women drops to approximately 18%, with executive representation of females even lower. Full time technical staff constitute approximately 73% of the total NMHS employees in the seven countries. The Ethiopian NMHS employs the most staff (296 people) of all countries, and Malawi employs the fewest (17 people). Four out of the seven countries, Ethiopia, Mali, Cote d'Ivoire, Rwanda, have a gender policy in place.

5. CHALLENGES AND GAPS

The study proposes an evaluation approach based on extensive work undertaken by the WMO and other agencies to develop and implement the GFCS. In this section, we provide an overview of the challenges and gaps so that future work can elaborate and improve the different components of the approach.

5.1 Developing the metrics

The proposed evaluation framework builds on the five pillars of the GFCS and the WMO criteria. The GFCS pillars were not intended to serve as an evaluation framework and thus do not serve that purpose well. The objectives defined for each GFCS pillars are very broad. Assigning the WMO criteria to each pillar is not the ideal approach to clarifying how NMHS can perform the functions under each pillar. The pillars are not independent. Capacity in Observations and Monitoring contributes to capacity in Research, Modeling, and Prediction and Climate Services Information Systems, and capacities measured in the Capacity Development pillar are integral to the functions performed under the other pillars. Therefore, criteria and the resulting metrics do not belong neatly under one pillar and neither do they clarify the connections between the pillars. The criteria, while more specific than the objectives for the pillars, are not sufficiently well defined for the purposes of measuring performance, and some very similar criteria appear under different categories. The incomplete specification of how a climate service should or can look in the resulting framework

complicates the development of metrics, and the connection between the selected metrics and the goal of providing a climate service is not fully established.

The development of metrics should begin with the elaboration of a program theory, or at least a logic model, as discussed in Section 3, which specifies how a NMHS can achieve each criterion, how the criteria result in the functions envisioned under each pillar, and how the functions combine to deliver a climate service. For example, a criterion for a Category 1 NMHS in the Observations and Monitoring pillar states that the NMHS should "Operate and maintain adequate national observing systems," while in category 2 the more demanding criterion states that the NMHS should "Operate expanded surface climate and weather observation network." The study proposes metrics for both criteria. However, the metrics should be derived from a model of an observation network that specifies what an "adequate" observation network looks like and what an "expanded" network looks like and why.

Similarly, a model of an observation network should specify how sufficient maintenance of a network can be attained. What staff capacity and procedures result in sufficient maintenance? The models would specify the outputs of the observation and maintenance processes and their outcomes. These would translate directly into metrics, which would serve to monitor whether the observation and maintenance processes are on track to achieve the intended objectives. Such elaboration of mechanisms for attaining the criteria is needed for the other criteria and other pillars. The final product should specify the outputs, outcomes, and the ultimate socio-economic impacts that the climate service intends to achieve.

The pillars and the criteria imply a particular NMHS structure, in which the NMHS themselves operate and maintain the observation network and interact directly with users of climate information. However, the functions may be performed through alternative arrangements. For example, under some circumstances, a public-private partnership may deliver a more complete and better-maintained observation network than one built through public investment alone. A NMHS that does not have sufficient resources may attain better performance under the Climate Services Information System pillar if it forms a partnership that allows it to rely on the research capacity in other NMHS or in a regional climate information center. The range of alternatives may be particularly broad for the User Interface Platform. The pillar requires appropriately trained individuals who can perform the boundary work of identifying the decisions that users make that should be guided by climate information; what climate information can meet these needs; and feedback about how well any climate information provided is meeting the needs; as well as can guide the process of improving the climate information in response to feedback. Such individuals do not have to be employed by the NMHS but could be engaged through other mechanisms.

A more effective evaluation framework could allow NMHS and other stakeholders to elaborate the model that best suits their circumstances and develop metrics that measure progress toward that model. This does not mean that each NMHS has a different model and different metrics. The number of possible alternative models is likely small, and the resulting metrics are likely to overlap considerably since they will measure the outputs, such as data, forecasts, and other information products in addition to process, and the desired outputs, outcomes, and impacts are likely to be similar for all. Allowing for alternative arrangements is particularly important, because different NMHS face widely differing circumstances in terms of environmental conditions, available resources, institutions, national priorities, and socio-economic needs. Regional Climate Centers,

which support provision of climate services by NMHS, may also need to be integrated into the framework.

5.4 Metrics

The team strove to develop SMART (specific, measurable, achievable, relevant and time-bound) metrics that measure the current status of each NMHS with respect to each criterion under each GFCS pillar, and that will indicate future progress toward the criterion. This was a challenging task mainly because, as described above, the criteria defined for the different categories were not specific enough for defining SMART metrics. The team has referred to WMO's standards and guidelines on observations, products and services yet most of these standards and guidelines were not specific enough to define appropriate metrics. Thus, the choice of many of the metrics was based on expert opinions rather than defined standards. For example:

- One of the metrics for Category 1 under the Observation and Monitoring is "Coverage of surface stations is at least one station for every 50 km." This is based on the minimum requirement by WMO's OSCAR (Observing Systems Capability Analysis and Review)[14] specifically for agricultural applications. This requirement could be different for other applications. The agricultural requirement is used here because agriculture is the most important economic activity in Africa. The other caveat is that this metric does not take topography and population into account.

- Under the same pillar, one metric is the percentage of observing stations that are staffed by trained observers. The requirement for category 1 is that at least 75% of stations should be manned by trained observers weighs the classification of the NMHS toward category 1. Category 2 requires that at least 90% of stations should be manned by trained observers. All stations should be manned by trained observers under category 3. The thresholds used here (75%, 90%, and 100%) are based on expert intuition and would need to be verified.

The identification of metrics that rely less on expert opinion requires that the climate service community develop more detailed models of how NMHS can achieve agreed upon objectives, as discussed in Section 5.1 above. Such models would provide a more solid basis for the selection of metrics.

5.5 Data Collection (survey)

The assessment is based on answers provided by the NMHS staff to a survey. Several challenges arose regarding data collection through the survey. First, NMHS staff have already responded to several questionnaires designed to assess baseline capacity in recent years, making the task onerous. A baseline capacity questionnaire is necessarily lengthy due to the amount of information that is needed. However, this issue was mitigated by dividing the questionnaire into sections, which focused on different topics. Each section was given to a different person in the NMHS to ensure that the person responsible for responding had the necessary expertise. Each section was not particularly long. In cases in which the same person was responsible for responding to more than one section, each section could be completed separately at different times. Experience with similar length questionnaires in other contexts suggests that the data collection should not be onerous if it is part

[14] https://www.wmo-sat.info/oscar

of a process that is well understood, agreed upon, and accepted by all participants. However, frequently repeated surveys that request similar information do result in survey fatigue.

Another challenge was lack of clarity in some questions, either due to lack of a common understanding of technical terms or lack of sufficiently detailed instructions in the question. For example, one of question asks: "How many observing stations of each of the following types does the NMHS operate today?" There were two issues with this question. First, respondents did not necessarily share the same definition of the different types of stations as was intended by the authors. Second, the question did not specify whether stations that the NMHS "operates today" include stations that may not be reporting because of, say, instrument failure. The team followed up with some the NMHS to confirm how they understood the questions. Future assessments should allocate sufficient time to identify and correct problems during piloting of the questionnaire. Also, building consistency checks into the data collection tool can help to identify problematic questions.

A pilot survey also can help to identify and change questions that are too sensitive to answer. Most of the NMHS did not answer at least some of the questions related to finances. Most NMHS were reluctant to share financial data because they considered the data sensitive. In other cases, the financial aspects of the institutions were handled by a higher authority, for example a ministry, and the NMHS either did not have access to the information or felt that they were not authorized to share it.

The combination of the questions, collection method, and collection tool did not result in adequate data to assess the financial capacity of the NMHS. The problem may be the low level of finance capability within the NMHS or a poor approach to the assessment. Financial questions may have been poorly understood and/or difficult to answer. Questions that compare expected and actual revenues, designed to gauge the NMHS ability to predict the political situation and plan the budget accordingly, may be misunderstood or poorly answered due to low administrative capacity. There were inconsistencies in the data, such as revenues from different sources that add up to more than 100%, which suggests poor record keeping. In order to improve the financial assessment, the approach should include collection of quantitative and qualitative data, preferably by professionals who have a background in finance. Finance professionals should participate in refining the metrics. Engaging finance professionals has budgetary implications, but financial data is not likely to be adequate without the investment.

Metrics are only as good as the data on which they are based. Instead of relying on finance metrics, a qualitative assessment of the strengths and weaknesses of NMHS finance departments may be a more effective approach. This assessment could strengthen financial management, record keeping, and collection of financial data by the NMHS, thereby improving the usefulness of metrics. Another component of the Sustainable CIS project is developing a NMHS Financial Planning tool and guidance document that should help with financial planning. The tool builds on the results of the metrics, and should capture data that will be useful for the metrics in the future.

The final challenge arose mainly due to the method that the team used to administer the questionnaire. We programmed the questionnaire into Survey Monkey because electronic data collection offers many advantages with respect to ensuring data quality. As respondents began the survey, they often had to stop to search for information needed to answer the questions. In some cases, they provided temporary answers to some questions and then revised answers. In Survey

Monkey, the revisions created new entries, resulting in multiple entries for some countries with different answers to the same question. In most cases, the simple solution was that the last entry was the correct one. However, in some cases, different answers had to be reconciled. The problem did not outweigh the advantages of electronic data collection, but future assessments should use a different platform that allows responses to be revised without creating multiple entries.

5.6 Ranking

As described earlier, ranks were assigned to each metric to signify the importance of that metric in order from greatest importance, 1, to least importance, 4. The ranking takes into account the importance of the metric in meeting the criterion it is assigned to, as well as the quality of the question used to collect the data and the responses obtained. The rankings were used to compute weights (inverses of the ranks), which were used to combine the different metrics in a given category into a score. The main gap is that the ranks rely heavily on the expert opinion of the meteorologist on the project team. Another expert may assign different ranks. Resource and time constraints limited the extent to which the team could analyze how sensitive the results were to different choices of ranks.

The meteorologist modified the values of some of the metrics based on specific knowledge about the capabilities of the NMHS. For instance, one of the metrics for Category 3 under the Climate Information System pillar is "NMHS web page provides specialized (tailored) climate information products for the agriculture, water, health, and energy sectors". Implementation of certain version of ENACTS (Enhancing National Climate Services) would ensure a high value for this metric, but the staff member who responded to the survey may not know that. The expert on the team, who implemented ENACTS in some of the countries, changed the values of the metric based on his knowledge of what version of ENACTS the NMHS implemented. This is an example in which the team verified responses given to the survey against objective documentation. Future applications of the framework should develop a protocol for conducting such verification in a systematic way, which should not depend on the identity of the individuals who are conducting the study. This study could not conduct a full verification or develop the needed protocol.

5.7 Scores

The raw score assigned to each NMHS for each category and in each pillar is a weighted average of the values of the metrics in that category. The scores for Categories 2 and 3 are the weighted averages of the scores of that category and the previous category(ies). These scores are used to determine whether a given NMHS meets the criteria for the specific category. Depending on scores, the NMHS may fulfill the criteria fully, or partially or not at all. The main issue with the ranking is that the thresholds used to determine if a NMHS fulfills the criteria or not is determined subjectively, though intuitively. As in the case of the weights, the score would also need rigorous sensitivity analysis, which was only partly performed[15] and needs further work.

5.8 Verification

Verification of the responses obtained from the participating NMHS is very important to ensure the validity of the analysis. There are different ways to verify the responses. The web pages of the NMHS could be checked for the types of information products offered online and documentation may be obtained for some of the yes/no questions. Examples of such questions include: Does the

[15] The sensitivity analysis carried out indicated the "partly met" window may need to be wider, but further analysis is needed to make a more complete determination.

NMHS have written guidelines that govern access to climate data? Does the NMHS have a written strategic plan for engaging with users? Is there a recognized procedure for incorporating user feedback into the design and recalculation of existing and developing products? The other verification would be comparing NMHS responses to those they provided to WMO's Country Profile Database. However, the verification done by the team has been very limited, mainly checking webpages, due to time and resource constraints. Future applications of the framework should develop a protocol for conducting such verification.

6. SUMMARY AND RECOMMENDATIONS

This study builds on the GFCS and past WMO assessments to develop an evaluation approach that can assess NMHS readiness to implement functional National Frameworks for Climate Services. The approach consists of a framework that integrates the five GFCS pillar with the WMO categories for NMHS, a set of objective metrics that measure progress toward attaining various capacities as defined in that framework, a survey questionnaire designed to collect data needed to calculate the metrics, and a data collection and analysis process.

The study uses the approach to demonstrate current NMHS capacities to develop and deliver cost-effective CIS, and gaps in those capacities in seven countries in SSA. It also provides specific recommendations for investments that each NMHS may wish to consider to bridge the gaps. The assessment of baseline capacity is particularly relevant in light of current efforts underway at WMO to converge on standard methods for evaluating countries' baseline capacities to implement the GFCS at national level.

Future rounds of evaluation may use this assessment to assess continued progress toward the objectives laid out in the evaluation. The approach may evolve if stakeholders who are involved in this process decide to change the framework to better suit the vision of sustainable climate services, which may evolve over time, and as evidence accumulates about effective approaches to achieving the objectives.

To our knowledge, this approach is the first of its kind. It offers several strengths compared to existing evaluation tools, including integrating the GFCS pillars and WMO Categories and identifying objective, verifiable metrics. The approach categorizes NMHS capacity to perform the functions defined by each of the five GFCS pillars, identifying specific strengths and weaknesses of each NMHS, and hence which capacities need more investment. However, the approach has limitations, identified in the previous section. The five GFCS pillars provide a strong and flexible scaffolding. The challenge is to develop more clearly elaborated models of how NMHS can deliver climate services that yield well-founded metrics. The areas that need further work are summarized in the following recommendations.

Recommendations for using the capacity assessment approach

- The approach developed here provides a yardstick, in the form of WMO NMHS categories, that objectively measures current NMHS capacity toward performing each of the five basic functions defined by the GFCS pillars. This approach can assist strategic and operational NMHS planning

since it identifies specific weaknesses in current capacity in order to prioritize investments and resource allocation, and tracks progress over time in relation to goals. Identifying specific gaps and needs also enables NMHS to recognize opportunities for partnerships with the private sector, academia, or others that can fill the gaps.

- Donors can use this approach to target investments designed to address specific weaknesses of NMHS and to measure the impacts of those investments. If used wisely, it can also help donors to prioritize the needs of different NMHS.

- WMO and/or other global or regional CIS institutions may use this approach to evaluate capacities at different NMHS, provide advice on building capacity, and prioritize their investments in NMHS. In particular, WMO could use the approach to conduct their regular assessments of NMHS. A proposal has been made to submit the metrics to WMO's Commission for Climatology for technical review.

Recommendations to improve the evaluation framework

- The GFCS pillars and the criteria attached to WMO categories imply a specific approach to providing CIS. However, different models may be appropriate under different conditions, reflecting particular socio-economic needs, institutions, and national priorities. The evaluation framework would benefit from a collaborative process through which NMHS elaborate and evaluate their own models of providing CIS and refine metrics accordingly. This does not imply that each country would have a different model and metrics. The number of appropriate models for providing CIS is likely to be small. A companion white paper, which is being prepared under this project titled "Approaches to combine technologies for weather observation, storage, and analysis," explores how this might be achieved with regards to weather observation storage and analysis.

- A more complete program theory of NMHS would greatly strengthen the evaluation framework. The GFCS pillars combined with the criteria associated with the WMO categories provide an outline, but they are not sufficiently well defined or specific to fully guide an evaluation. A program theory would specify one or more models of how a NMHS can deliver CIS, with guidance on conditions under which each CIS delivery model is appropriate. Such models would map inputs that NMHS need as well as actions and processes to produce outputs, outcomes, and impacts. These models would serve several purposes:

  (1) Produce metrics that are directly tied to a specific way of providing CIS. These metrics, together with the understanding of how inputs produce outputs, outcomes, and impacts, would enable NMHS to track progress toward desired objectives. Metrics proposed in this paper allow NMHS to track progress, but their relationship to a desired outcome is not well-established in many cases;
  (2) Enable NMHS to assess whether actions are yielding the expected outcomes and impacts, and therefore to learn which parts of the model are working well and which are not, allowing NMHS to improve the model over time; and

(3) Help build consensus within NMHS about what the organizations should be doing. The program theory should evolve over time as the objectives and nature of the CIS mission change, and as more evidence becomes available about effective approaches to CIS.

- Appropriate metrics are essential for a reliable assessment of capacity at NMHS. The current metrics are based mainly on the expertise of the project meteorologist. Before a new set of metrics based on a program theory is developed, the metrics proposed in this study should be refined through additional consultation with experts from WMO, NMHS, Regional Climate Centers, and other stakeholders. Any refinement of the metrics would require a revision of the survey questions and potentially the approach to implementing the survey.

- This study assigns weights to the metrics that reflect the relative importance of each metric for meeting the criterion and the credibility of the underlying data. The selection of weights is based on the expertise and opinion of the project meteorologist, and as in the previous recommendation, additional consultation and consensus building would provide a stronger basis for the selection of weights. Furthermore, a rigorous sensitivity analysis would be helpful to examine changes in ranking and final scores that would result from alternative weighting decisions and different choices of cut-off points for scores that signify whether the NMHS meets, partially meets, or does not meet requirements for a given category.

- This study conducted limited verification of survey responses due to time constraints. To fully take advantage of the objective nature of the metrics, further verification should be performed using documents obtained from NMHS, NMHS web pages, previous surveys, and WMO's Country Profile Database. In fact, this process may also be used to expand the information in WMO's Country Profile Database.

- The refinement of all or any part of the evaluation approach, from developing a program theory to reconsidering the metrics within the framework proposed here and/or examining different weights, should take place through a collaborative process, involving all stakeholders, including the NMHS. One possible process is a set of workshops to bring together NMHS, Regional Climate Centers (RCC), WMO, and other relevant institutions.

- Any forum that considers a revision of the evaluation approach may also wish to consider the following issues:
    - This study only evaluated the supply side of CIS, which has pros and cons. If the goal of CIS is to improve adaptation outcomes, then an integrated evaluation should assess the entire process, from supply to ultimate impacts on users. Supply needs to be responsive to both needs and demands, and the demands will depend on how CIS is supplied. The GFCS pillars 3 (Climate Information System) and 4 (User Interface Platform) already consider end users, but further work could be carried out to see how end user needs can be more fully incorporated into the metrics.
    - Examine more fully how NMHS integrate gender considerations in their structures, and how the role of women in NMHS influence the ability of the NMHS to provide CIS services.
    - Address obstacles to collecting good quality data about the financial capacity within the NMHS. The assessment of financial capacity requires both quantitative and

qualitative data and therefore it may be beneficial to involve financial analysts in the development of a survey tool to undertake interviews and collect the appropriate data to allow for such an assessment.

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APPENDIX I: CAPACITY ASSESSMENT BY COUNTRY

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, and does not meet the criteria for a Category 1 NMHS for the User Interface Platform pillar.

Pillar 1. Observation and Monitoring

Summary
Ethiopia's National Meteorological Agency (NMA) comfortably fulfills 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 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 by about 1500, including AWS;
Increase the number of AWS by at about 200;
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 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 possesses 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 has led research grant proposals in the past 5 years. The staff evaluates and communicates the performance of forecasts, run climate models and organize at least one 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 produces basic climate statistics for major climate variables and produces and disseminates 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 Does not meet

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 does not fulfill the criteria for a Category 1 NMHS for the User Interface Platform pillar. In order to meet the criteria for Category 1, the NMHS should have at least one staff member who is trained in engagement with users, and should establish a practice of documenting the feedback that users provide about the usefulness and effectiveness of climate information products and services. The NMHS would need to enhance its capacity to train users of climate information in the use of the climate information products, and improve the documentation and integration of user feedback into product redesign and development in order to meet the criteria for Category 2.

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 MOUs and has procedures in place to co-produce climate information with at least three 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 and documentation of feedback provided by users.

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;

Document feedback provided by users about the climate information products and services in writing.

Category 2. Essential NMHS functionality Does not meet

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 Does not meet

Review

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

Recommendations

None

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 has 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 has 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 by at least 27;
Add at least one upper air station;
Increase the number of Class III and above stations by at least 13.

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 by at least 700, of which most of these should be Class III and above;
Increase the number of AWS (currently zero) by at least 20;
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 (Climate Data Tools);
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 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 participates 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 has 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 specializations of climate, seasonal prediction, agromet, hydromet and 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 center with backup power and power protection as well as increasing internet bandwidth to greater than 10Mbps.
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 by at least 123, and these should be Class III and above;
Increase number of upper air stations by at least 9 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 uses 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 produces 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 National Framework for Climate Services (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 establish a formalized governance structure, 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 has basic training in essential services. Most staff have access to basic computing resources and 1 Mbps internet capacity.
Weaknesses: The Malawi NMHS has no formalized governance structure. Human, and technological capacities are limited.

Recommendations

Establish a formalized, written governance structure;
Expand participation in national policy processes;
Recruit more staff with MSc and PhD degrees;
Establish a protocol for training required of different staff members;
Train staff in data rescue;
Recruit more highly qualified management staff.

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 straining 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

Improve corruption safeguards, including independent auditing of appropriation, procurement and expenditure policies

Strengthened IT resources

Establish a protocol for training required of different staff members, including further staff training, staff qualifications

Recruit more highly qualified management staff.

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. It also operates the PUMA system for reception and display of satellite data.

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 by over 90 and number of upper air stations by about 100;
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 has participated in at least 5 research projects in the last 5 years. Specialist technical functions in different forecasting disciplines are present. The staff produces 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 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 has 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 National Framework for Climate Services (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 is some staff with education in management. All staff has 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 has 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 that specializes in applications for different sectors. The NMHS provides training to other NMHS. At least 3 staff members 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 by at least two stations;
Increase the number of Class III and above stations by at least 13;
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) by over 150;
Increase the number of upper air stations by about 90;
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 has 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 10Mbps 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 10Mbps

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 has 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.

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 has 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 has 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 is 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 center 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 specializations. 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 10Mbps
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 by 3;
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 has 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 produces and disseminates 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 takes 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 uses 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 produces 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 is 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 is 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 has 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 has 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 specializes in applications for different sectors. A sufficient number of senior meteorological technicians have MSc or PhD degrees. Staff has 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) by at least 137;
Increase the number of upper air stations by at least 18 stations;
Enhance existing satellite data reception and processing system.

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 has adequate access to the internet.
Recommendations
None

Category 2. Essential NMHS functionality Does not meet

Review
Strengths: Five percent of the staff has PhDs, and the staff represents 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 produces 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 needs 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 are 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 has basic training in essential services.

The NMHS has staff that has an education in management. Almost all staff has access to basic computing resources and 1 Mbps internet capacity.
Weaknesses: The NMHS should perhaps 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 specializes in applications for different sectors. It provides training to other NMHS.
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.

APPENDIX II: QUESTIONNAIRE FOR ASSESSING THE CAPACITY OF NATIONAL METEOROLOGICAL AND HYDROLOGICAL SERVICES TO PROVIDE CLIMATE INFORMATION SERVICES

Introduction

While investments in climate information services (CIS) are on the rise, the guidance and delivery of CIS in Sub-Saharan Africa is significantly underfunded. To advance understanding of how to bridge the funding and investment gap for National Meteorological Services (NMHS/NMHS), the USAID-funded project entitled *"Assessing Sustainability & Effectiveness of Climate Information Services in Africa*" aims to develop quantitative baseline metrics as one of its outputs. This is a research initiative and involves experts from the Global Framework for Climate Services (GFCS), the International Research Institute for Climate and Society (IRI) at Columbia University, Climate System Analysis Group, AGRHYMET Regional Centre, and Winrock International. The methodology for building the baseline metrics employs five functional components of GFCS and WMO's Categories for NMHS. Essentially, the metrics are designed to evaluate how ready NMHS in Africa and beyond are today to implement each of the five pillars of the GFCS. The metrics have been informed by and build on existing WMO instruments such as the questions outlined in the recently issued Country Profile Database (CPDB) and the Checklist. However, the metrics are different from these instruments because they aim to be quantitative and objective rather than serve as a self-assessment.

The attached questionnaire is part of this effort and we would like to kindly request your support in undertaking the baseline assessment within your service. We are excited at the opportunity to better assess your needs in meeting user demand for climate services, and your needs and priorities in mainstreaming investment and services.

Thank you very much in advance for providing the information requested in this questionnaire. The data will help to develop a process for ongoing future data collection needed to help grow the capacity of climate information services.

Instructions

The questionnaire is divided into 11 sections, which address different functions of the NMHS. Each section is designed to stand alone as a separate questionnaire, and each can be given to the person(s) who has the necessary expertise to answer the questions. We kindly request that any person who does not have the information needed to answer any of the questions pass the question along to someone who can provide the information.

The 11 sections are: Governance, NMHS staff capacity, Observing stations, Computing infrastructure, Data, Remote sensing, Climate services, Communication of data and information products, Interaction with users, Research, Financial questions.

National and NMHS governance

Country:
Ethiopia
Rwanda
Niger
Mali
Cote d'Ivoire
Malawi

List the position of each respondent in the NMHS
Respondent 1 Name _____
Position_____

Respondent 2 Name _____
Position_____

Respondent 3 Name _____
Position_____

Does legislation (law, decree or other legislative) exist that frames the mandate of the NMHS?
Yes
No

What is the placement of the NMHS in the government structure? (Select only one response.)
Directly under the President's or Prime Minister's office
An independent body under a ministry
A semi-independent body under a ministry
A department/unit under a ministry
Other (please specify)

Which of the following strategy/plans are available at the national level? (Select all that apply.)
Nationally Determined Contribution to the Paris Agreement (NDC)
National Adaptation Plan (NAP)
Disaster risk management (DRM)
Other (specify)
None

In which of the following strategy/plans has the NMHS participated/contributed? (Select all that apply.)
Nationally Determined Contribution to the Paris Agreement (NDC)
National Adaptation Plan (NAP)
Disaster risk management (DRM)
Other (specify)
None

Is there a Quality Management System (QMS) program in use as part of NMHS's management practices?
Yes
No
Do not know

Has the NMHS implemented or started the process for a National Framework for Climate Services?
Yes
No

Do the senior management of the NMHS believe that the NMHS has a sufficient budget?
Yes
No

Do the senior management of the NMHS believe that the NMHS personnel are properly trained?
Yes
No

Do the senior management of the NMHS believe that the NMHS has an adequate amount of office equipment?
Yes
No

Do the senior management of the NMHS believe that the NMHS has an adequate amount of office space?
Yes
No

Are personnel decisions, including recruitment, subject to regular internal and external audits?
Yes
No

Are budget decisions subject to regular internal and external audits?
Yes
No

NMHS staff capacity

Some questions allow you to choose the option "Information needed to answer the question is not available." Choose this option only if there is no one in the NMHS who has the information. Otherwise please obtain the information from the relevant person.

Country:

Ethiopia
Rwanda
Niger
Mali
Cote d'Ivoire
Malawi

List the position of each respondent in the NMHS
Respondent 1 Name _____
Position_____

Respondent 2 Name _____
Position_____

Respondent 3 Name _____
Position_____

How many staff who are currently employed at the NMHS are in the following age categories?
Less than 20 years
20-30 years
30-40 years
40-50 years
Over 50 years

What is the retirement age for NMHS staff? (In years.)
_____

How many staff are currently employed at the NMHS who specialize in each of the following functions?
Meteorological technicians at entry level (Observers)_____
Meteorological technicians at mid-level (Assistant forecasters)_____
Meteorological technicians at senior level (Forecasters)_____
Forecasters specializing in Numerical Weather Prediction (NWP)
Climatologists_____
Agrometeorologist_____
Hydrometeorologists_____
Remote Sensing (radar, satellite, other)
IT personnel including telecommunication specialists_____

How many female staff are currently employed at the NMHS who specialize in each of the following functions?
Meteorological technicians at entry level (Observers)_____
Meteorological technicians at mid-level (Assistant forecasters) _____
Meteorological technicians at senior level (Forecasters)_____
Forecasters specializing in Numerical Weather Prediction (NWP)
Climatologists_____

Agrometeorologist_____
Hydrometeorologists_____
Remote Sensing (radar, satellite, other)
IT personnel including telecommunication specialists__
___
How many staff at the NMHS perform technical functions?
_____
Information needed to answer the question is not available.

How many of the staff who perform technical functions are full-time, permanent employees?
_____
Information needed to answer the question is not available.

How many staff who perform technical functions are female?
_____
Information needed to answer the question is not available.

How many of the female staff who perform technical functions are full-time, permanent employees?
_____
Information needed to answer the question is not available.

How many staff who are currently employed in the NMHS have each of the following degrees in fields related to meteorology?
PhD_____
MSc_____
PGD _____
BSc_____
Information needed to answer the question is not available.

How many female staff who are currently employed in the NMHS have each of the following degrees in fields related to meteorology?
PhD_____
MSc_____
PGD _____
BSc_____
Information needed to answer the question is not available.

How many people are involved in producing the seasonal forecasts?
_____

How many of the ICT staff have each of the following qualifications?
Computer science to school leaver competency_____
Degree/diploma in computer science_____
Other – please specify_____
Information needed to answer the question is not available.

How many personnel are qualified to operate and maintain the hardware - satellite dish, modem and associated software?
_____

How many staff have received a total of at least a month of training in the following? (The total can be composed of more than one training course.)
Climate data management, including Climate Data Management Systems (CDMS)
_____
WMO Quality Management Framework _____
Data rescue _____
Using/interpreting internationally available weather forecasts, e.g. ECMWF, GFS etc.
Seasonal prediction _____
Statistical downscaling techniques _____
Dynamic downscaling techniques _____
Installation, configuration and management of Numerical Weather Prediction (NWP) systems
_____
Statistical data analysis _____
Satellite and/or radar meteorology
GIS (Geographic Information Systems) _____
Web administration and content development_____
OSCAR/Surface
Engagement with users of climate information
Information needed to answer the question is not available.

Which of the following trainings does the NMHS itself offer for its staff?
Meteorological technicians at entry level (Observers)_____
Meteorological technicians at mid-level (Assistant forecasters) _____
Meteorological technicians at senior level (Forecasters)
Other(specify)_____
Information needed to answer the question is not available.

Has the NMHS provided training to NMHS staff from other countries during the last 5 years?
Yes
No
Information needed to answer the question is not available.

Does the NMHS have written guidelines that specify ongoing training required for staff in various positions, after they have been hired by NMHS?
Yes
No

If yes
Do the training guidelines specify the frequency with which staff should undergo training? (Select only one response.)
Yes

No

What was the total number of staff (executives, non-executive management, and other employees) in each of the past 5 years?
Last year _____
2 years ago _____
3 years ago_____
4 years ago _____
5 years ago_____
Information needed to answer the question is not available.

How many of the total number of staff were full-time, permanent employees in each of the past 5 years?
Last year _____
2 years ago _____
3 years ago_____
4 years ago _____
5 years ago_____
Information needed to answer the question is not available.

What is the total current staff in Full Time Equivalents (FTE)?
_____
Information needed to answer the question is not available.

How many of the total number of staff are female currently?
_____

How many of the female staff are permanent, full-time employees?
_____

What was the total number of employees in the executive management team[+] in each of the past 5 years?
Last year _____
2 years ago _____
3 years ago_____
4 years ago 5 years ago_____
Information needed to answer the question is not available.

[+]The executive team refers to the highest leadership team within the organization such as CEO, CFO, CIO, CTO, DG, or other executive management. Probably 4-5 individuals.

How many members of the current executive management team are female?
_____

What was the total number of employees in the non-executive management team[**] in each of the past 5 years?

Last year _____
2 years ago _____
3 years ago_____
4 years ago 5 years ago_____
Information needed to answer the question is not available.

**The management team refers to the next level of management below the executive team that is responsible for managing technical or other staff employed by the NMHS.

How many members of the current non-executive management team are female?
_____
Do any of the NMHS management staff have three months or more of training in management?
Yes
No

Does the NMHS have a gender policy?
Yes
No

How many staff have financial management and accounting education?
1 year of financial management and accounting education? _____
2 years of financial management and accounting education? _____
3 or more years of financial management and accounting training? _____
Information needed to answer the question is not available
Information needed to answer the question cannot be shared

How many staff have on the job experience with financial management and accounting?
1 year of on the job experience? _____
2 years of on the job experience? _____
3 or more years of on the job experience? _____
Information needed to answer the question is not available
Information needed to answer the question cannot be shared

How many staff who are engaged in financial management, hold the following qualifications?
Certified Public Accountant (CPA) _____
Certified Management Accountant (CMA) _____
Certified Internal Auditor (CIA) _____
Other please specify. _____
Information needed to answer the question is not available
Information needed to answer the question cannot be shared

Observing stations

Some questions allow you to choose the option "Information needed to answer the question is not available." Choose this option only if there is no one in the NMHS who has the information. Otherwise please obtain the information from the relevant person.

Country:
Ethiopia
Rwanda
Niger
Mali
Cote d'Ivoire
Malawi

List the position of each respondent in the NMHS
Respondent 1 Name _____
Position_____

Respondent 2 Name _____
Position_____

Respondent 3 Name _____
Position_____

How many observing stations of each of the following types does the NMHS operate today?
Synoptic _____
Principal _____
Agromet _____
Hydromet_____
Climate reference_____
Ordinary (Class 3) _____
Rain gauge only (Class 4) _____
AWS_____
Upper Air

How many observing stations of each of the following types did the NMHS operate in 2007?
Synoptic _____
Principal _____
Agromet _____
Hydromet_____

Climate reference_____
Ordinary (Class 3) _____
Rain gauge only (Class 4) _____
AWS_____
Upper Air

How many of each of the following types of stations are manned by trained observers?
Synoptic _____
Principal _____
Agromet _____
Hydromet_____
Climate reference_____
Ordinary (Class 3) _____
Rain gauge only (Class 4) _____
Upper air observing _____

How many stations are manned by staff who are not regular NMHS employees?
_____
Information needed to answer the question is not available.

How many of the observing staff who are not regular NMHS employees are paid for the work?
_____
Information needed to answer the question is not available.

How many of the observing staff who are not regular NMHS employees have received relevant training?
_____
Information needed to answer the question is not available.

How many manual stations sent data to NMHS headquarters over the last year with the following frequency? (Enter 0 if none.)
Every day _____
Once a week _____
Once a month _____
Only annually_____
Information needed to answer the question is not available.

Has the NMHS undertaken a needs assessment to determine the number of stations needed?
Yes
No

Has the NMHS undertaken a needs assessment to determine the density and type of stations needed for different applications?
Yes
No

Does the NMHS have a written strategic plan for expanding the station network and observed climate variables? (Select only one response.)
For expanding the station network but not climate variables
For expanding both
Neither

Does the NMHS have a manual that details procedures for station inspections and maintenance?
Yes
No

How often does the NMHS inspect each manual station? (Select only one response.)
More than twice a year
Twice a year
Once a year
Only once in a while
Never

Do inspections of manual stations include instrument calibrations?
Yes
No

How often does the NMHS inspect every automatic station? (Select only one response.)
More than twice a year
Twice a year
Once a year
Only once in a while
Never

How many manual stations did the NMHS inspect over the last year?

_____
Information needed to answer the question is not available.

How many automatic stations did the NMHS inspect over the last year?

_____
Information needed to answer the question is not available.

How many days were there station outages that resulted in gaps in the data in the last year? Please report the sum over all the stations of the number of days of outages for each station, so total number of station-days.

_____
Information needed to answer the question is not available.

Would NMHS staff be able to repair and/or replace an AWS? (Select all that apply.)
Repair
Replace
Neither

Has a National WIGOS Implementation Plan been adopted/approved?
Yes
No
Do not know

Is there a National WIGOS partnership agreement for integration and open sharing of observations from NMHSs and non-NMHS sources in place?
Yes
No
Do not know

Computing infrastructure

Some questions allow you to choose the option "Information needed to answer the question is not available." Choose this option only if there is no one in the NMHS who has the information. Otherwise please obtain the information from the relevant person.

Country:
Ethiopia
Rwanda
Niger
Mali
Cote d'Ivoire
Malawi

List the position of each respondent in the NMHS
Respondent 1 Name _____
Position_____

Respondent 2 Name _____
Position_____

Respondent 3 Name _____
Position_____

How many computers does the NMHS have in the following categories?
Laptops _____
Desktops_____
Servers_____
High Performance _____

How many of these computers are connected to a UPS?
_____

How many computers at the NMHS are connected to the internet at each of the following bandwidths? (Enter 0 if none.)
Less than 1Mbps (Megabits per second) _____
1 to 10Mbps_____
Greater than 10Mbps_____

Does the NMHS have a backup power generator?
Yes
No

Are the spaces that contain computer equipment climate controlled (air conditioned)?
Yes
No

Are there times of the year during which electricity outages are common?
Yes
No

If yes
During how many months of the year are electricity outages common?
_____

If yes
Is the backup power generator capacity sufficient to provide power during all of the electricity outages?
Yes
No

Data

Country:
Ethiopia
Rwanda
Niger
Mali
Cote d'Ivoire
Malawi

List the position of each respondent in the NMHS
Respondent 1 Name _____
Position_____

Respondent 2 Name _____
Position_____

Respondent 3 Name _____
Position_____

Does the NMHS have a climate data base management system (CDMS)?
Yes
No

If yes,
Please specify the CDMS system:
_____

Is there a backup copy of the climate data?
Yes
No

How often has the NMHS been making a backup copy of the data over the last year? (Select only one response.)
Daily
Weekly
Monthly
Less often than once a month

Does the NMHS collect and archive station metadata? (Select all that apply.)
Collect
Archive
Neither

Does the NMHS integrate observations from other national sources/agencies into its database? (Select only one response.)
Yes
No
No other agency in the country collects climate data

Has the NMHS used data quality control tools over the last year?
Yes
No

If yes
Which data quality control tools has the NMHS used over the last year?
_____
__

Does the NMHS perform homogenization of climate data?
Yes
No

Has the NMHS conducted data rescue over the last 5 years?
Yes
No

If yes:
How many years of rainfall data have been digitized?
_____

How many years of temperature data have been digitized?
_____

How many years of rainfall data remain to be digitized?
_____

How many years of temperature data remain to be digitized?
_____

Does the NMHS develop and manage regional and/or global specialized climate databases and archives? (Select only one response.)
Develops and manages
Only manages
Neither

Has the NMHS implemented ENACTS (Enhancing National Climate Services)?
Yes
No

Which of the following communication systems does the NMHS use to access data and products? (Select all that apply.)
WIS dedicated networks (World Weather Watch GTS)
GTS via Internet
Internet (other than GTS links)
Private or dedicated lines to centers (other than GTS links)
Other (please specify)
None

Remote sensing

Some questions allow you to choose the option "Information needed to answer the question is not available." Choose this option only if there is no one in the NMHS who has the information. Otherwise please obtain the information from the relevant person.

Country:

Ethiopia
Rwanda
Niger
Mali
Cote d'Ivoire
Malawi

List the position of each respondent in the NMHS
Respondent 1 Name _____
Position_____

Respondent 2 Name _____
Position_____

Respondent 3 Name _____
Position_____

How many radar does the NMHS operate?
_____

If more than 0
How many days was one or more of the radar not functional last year?
_____
Information needed to answer the question is not available.

What systems does the NMHS have for receiving and processing satellite data? (Select all that apply.)
PUMA
SYNERGY
GEONETCast
Other, please specify _____
None

Does the NMHS operate a lightning detection network?
Yes
No

Climate services

Some questions allow you to choose the option "Information needed to answer the question is not available." Choose this option only if there is no one in the NMHS who has the information. Otherwise please obtain the information from the relevant person.

Country:

Ethiopia
Rwanda
Niger
Mali
Cote d'Ivoire
Malawi

List the position of each respondent in the NMHS
Respondent 1 Name _____
Position_____

Respondent 2 Name _____
Position_____

Respondent 3 Name _____
Position_____

Does the NHMS have a strategic work plan?
Yes
No

If yes
Does the NMHS periodically review whether it is meeting targets with respect to the strategic work plan?
Yes
No

How often does the NMHS review whether it is meeting targets with respect to the strategic work plan? (Select only one response.)
Annually
At least every 5 years
On an ad hoc basis
Never

G.1 Forecasting

How do NMHS staff produce weather forecasts? (Select all that apply.)
Numerical Weather Prediction (NWP)
Quantitative
Qualitative
Other – please explain _____

For how many days ahead does the NMHS issue weather forecasts? (Select only one response.)
Fewer than 3 days
3 days

more than 3 days but fewer than 7days
7 days or more

How often has the NMHS issued the weather forecast in each of the past 5 years? (Select only one response for each year.)
Past year
Every day
2 -3 times per week
once per week
less often than once per week
2 years ago
Every day
2 -3 times per week
once per week
less often than once per week
3 years ago
Every day
2 -3 times per week
once per week
less often than once per week
4 years ago
Every day
2 -3 times per week
once per week
less often than once per week
5 years ago
Every day
2 -3 times per week
once per week
less often than once per week

Which seasonal forecasts does the NMHS provide every season? (Select all that apply.)
None
Total rainfall amount
Total rainfall probability
Onset
Cessation
Rainfall frequency
Temperature
Temperature probability
Other – please specify _____

What software does the NMHS use to produce seasonal forecasts? (Select all that apply.)
CPT
geoCOF
Click

Scopic
Other, please specify_____
None

How often does the NMHS issue seasonal forecasts? (You may select more than one response if the frequency is different for different forecasts.)
Every month (rolling forecast)
Once every three months
Less than once every three months
NMHS does not produce seasonal forecasts

Which monthly forecasts does the NMHS produce? (Select all that apply.)
None
Total rainfall
Rainfall frequency
Temperature
Other – please specify _____

How many seasonal and monthly forecasts has the NMHS issued in total in each of the past 5 years?
Past year _____

2 years ago _____
Information needed to answer the question is not available.

3 years ago_____
Information needed to answer the question is not available.

4 years ago_____
Information needed to answer the question is not available.

5 years ago_____
Information needed to answer the question is not available.

Does the NMHS perform quantitative verification of seasonal forecasts?
Yes
No

Does the NMHS run a climate model for weather and climate forecasts?
Yes
No

Does the NMHS access and use monthly to seasonal and longer climate predictions provided by RCCs, RCOFs, and/or GPCs?
Yes
No

If yes
How does the NMHS use these products? (Select all that apply.)
Quantitatively (in a statistical or dynamical model)
Qualitatively (just visual inspections)

G.2 Other climate information products and services

Has the NMHS produced a national climate atlas?
Yes
No

If yes, how many years ago was the climate atlas produced?
_____

Which basic climate statistics has the NMHS produced over the last 2 years? (Select all that apply.)
Frequency and intensity of extremes events
Spatial means
Anomalies
Long term trends
Other-please specify _____
None

Which climate variables have the basic climate statistics included over the last 2 years? (Select all that apply.)
Rainfall
Temperature
Relative humidity
Evapotranspiration
Thunder days
Sunshine duration
Other – please specify _____

What statistical software do staff use to produce climate statistics? (Select all that apply.)
Excel
Instat/R-Instat
R
Python
GrADS
geoCLIM
CDT
Other – please specify
None

Which of the following climate information products has the NMHS produced during the last 2 years? (Select all that apply.)
Gridded/interpolated station data
Products derived from satellite data for monitoring activities
Products derived from climate model data such as reanalysis products
Climate statistics and graphical products (including maps, analysis and graphs of precipitation, temperature, relative humidity, evapotranspiration, sunshine duration, etc.)
Probable maximum precipitation, frequency of extreme temperature, probable maximum floods, intensity duration frequency, etc
Analyses on climate extremes, maps, graphs, images (e.g. satellite)
Assessment of current climate conditions in terms of averages, variance, thresholds, percentiles at weekly or 10-daily, time scales.
Assessment of climate conditions in terms of averages, variance, thresholds, percentiles at monthly and/or seasonal time scales.
Impact-based forecast
ENSO, SST and intra-seasonal variability products
None of the above

Does the NMHS produce advisories or early warnings? (Check all that apply.)
Advisories
Early warnings
Neither

Communication of data and information products

Some questions allow you to choose the option "Information needed to answer the question is not available." Choose this option only if there is no one in the NMHS who has the information. Otherwise please obtain the information from the relevant person.

Country:
Ethiopia
Rwanda
Niger
Mali
Cote d'Ivoire
Malawi

List the position of each respondent in the NMHS
Respondent 1 Name _____
Position_____

Respondent 2 Name _____
Position_____

Respondent 3 Name _____

Position_____

Does the NMHS have written guidelines that govern access to climate data?
Yes
No

To which of the following national institutions/originations does the NMHS provide climate data free of charge? (Select all that apply.)
Governmental
Non-governmental
Academic
Private/Commercial
Other, please specify_____
None

With which of the following sectors has the NMHS signed an MOU? (Select all that apply.)
Agriculture
Water
Health
Energy
Transport
Other, please specify_____
None

How often does NMHS send weather forecasts to the media? (Select only one response.)
Multiple times per day
Once per day
Once every 2 – 3 days
Once a week
Less than once a week
Never

Does the NMHS disseminate seasonal forecasts?
Yes
No

Does the NMHS publish documentation of forecast verification/uncertainties?
Yes
No

Does the NMHS contribute to the national Early Warning System (EWS)? (Select only one response.)
Yes
No
EWS does not exist

Is there a national committee or platform composed of ministries, agencies and other stakeholders that coordinates Disaster Risk Reduction activities at the national to sub-national levels?
Yes
No

If yes
Is your NMHS a member of this national committee?
Yes
No

Does the NMHS have mechanisms in place to co-produce climate information products with the following sectors? (Select all that apply.)
Agriculture
Water
Health
Energy
Transport
Other, please specify_____
None

Does the NMHS disseminate advisories?
Yes
no

Does the NMHS disseminate early warnings?
Yes
no

Does the NMHS have a dedicated website?
Yes
No

If yes
What information is available on the website? (Select all that apply.)
Weather forecasts
Ten-day forecasts
Monthly forecasts
Seasonal forecasts
Reports of basic climate statistics
Bulletins (Agromet, Hydromet, other)
Climate maps/graphs
Remote sensing products (RFE, NDVI, …)
Advisories tailored to specific users' needs
Other – please specify_____

How many times did users access the NMHS website each year in each of last 5 years?
Past year _____
Information needed to answer the question is not available.

2 years ago _____
Information needed to answer the question is not available.

3 years ago_____
Information needed to answer the question is not available.

4 years ago_____
Information needed to answer the question is not available.

5 years ago_____
Information needed to answer the question is not available.

Does the NMHS have a public relations or press office?
Yes
No

Does the NMHS use social media (such as Facebook and/or Twitter) to communicate with users?
Yes
No

Has the NMHS used or does it plan to use mobile platforms (such as mobile phones) to communicate with users? (Select only one response.)
Has used mobile platforms
Plans to use mobile platforms
Neither

Interaction with users

Some questions allow you to choose the option "Information needed to answer the question is not available." Choose this option only if there is no one in the NMHS who has the information. Otherwise please obtain the information from the relevant person.

Country:
Ethiopia
Rwanda
Niger
Mali
Cote d'Ivoire
Malawi

List the position of each respondent in the NMHS
Respondent 1 Name _____
Position_____

Respondent 2 Name _____
Position_____

Respondent 3 Name _____
Position_____

Does the NMHS have a written strategic plan for engaging with users?
Yes
No

How often does the NMHS review whether it is meeting the targets established in this plan? (Select only one response.)
Annually
Less often than annually
On an ad hoc basis
Never

Has the NMHS undertaken an assessment of user needs in any sector in the last 3 years?
Yes
No

If yes,
Has the NMHS undertaken an assessment of user needs in more than one sector in the last 3 years?
Yes
No
Information needed to answer the question is not available.

Are there focal persons in the NMHS assigned to lead interactions with different sectors in the country?
Yes
No

Did the NMHS staff interact with any of the following users over the last 2 years? (Select all that apply.)
Government agencies
Private for-profit organizations (businesses)
Private non-profit organizations
General public
Do not interact with users

Does the NMHS have written procedures that govern provision of products and services to users of climate information?
Yes
No

Does the NMHS maintain written documentation of user feedback?
Yes
No

If yes
When the NMHS captures user feedback, does it disaggregate the data by gender, e.g. women, women-led businesses or organizations, etc.?
Yes
No

If yes
Is there a recognized procedure for incorporating user feedback into the design and recalculation of existing and developing products?
Yes
No

Has the NMHS conducted surveys that ask the following users about availability, interpretation and usefulness of its forecasts and other information products in the last 2 years? (Select all that apply.)
Public
Other government departments and/or ministries
Non-government organizations
Academic users
Private, commercial users
Do not conduct surveys of users

Has the NMHS conducted surveys that ask other government ministries about the usefulness of its data?
Yes
No

What are most common requests from users that the NMHS has received in the last 3 years?

_____

_____

How many National Climate Outlook Forums has the NMHS organized in the last 2 years?

_____

Has the NMHS produced climate summaries, bulletins or reports specifically for users in the last 2 years?
Yes

No

Has the NMHS produced manuals for users of climate information that explain how to access and/or use climate information products in the last 2 years?
Yes
No

How many training sessions has the NMHS conducted in the last 2 years that explain to users how to access and/or use any climate information products?

_____
Information needed to answer the question is not available.

Has the NMHS produced interpretations of climate statements or products for the general public or for specific users in the last 2 years? (Select all that apply.)
For the general public
For specific users
Do not produce interpretations of climate statements or products

Has the NMHS produced any tailored climate information products that respond directly to requests from users in the last two years?
Yes
No

Does the NMHS receive specialized requests for weather/climate information from women and/or organizations that serve women and/or businesses or organizations run by women?
Yes
No

Has the NMHS produced or tailored any climate information specifically to inform the development of a national policy or a National Action Plan in the last five years?
Yes
No

Research

Some questions allow you to choose the option "Information needed to answer the question is not available." Choose this option only if there is no one in the NMHS who has the information. Otherwise please obtain the information from the relevant person.

Country:
Ethiopia
Rwanda
Niger
Mali
Cote d'Ivoire
Malawi

List the position of each respondent in the NMHS
Respondent 1 Name _____
Position_____

Respondent 2 Name _____
Position_____

Respondent 3 Name _____
Position_____

Does the NMHS require staff in any positions to participate in research?
Yes
No

Does the NMHS offer staff incentives to participate in research?
Yes
No

Do staff at the NMHS have access to online research literature sources, e.g. e-libraries, e-journals?
Yes
No

How many research projects and/or field experiments have NMHS staff participated in over the last 5 years?
_____
Information needed to answer the question is not available.

Have NMHS staff led any research projects and/or field experiments over the last 5 years?
Yes
No

Have any NMHS staff been listed as lead authors on any peer-reviewed publications in the last 5 years?
Yes
No

How many NMHS staff have been principal investigators on research proposals submitted in the last 5 years?
_____
Information needed to answer the question is not available.

Financial questions for all NMHS

If responses to financial information cannot be provided please clarify if the information is available but cannot be shared or does not exist. If the information is available and the respondent does not have access to the information, please direct the survey to the relevant individual.

Country:
Ethiopia
Rwanda
Niger
Mali
Cote d'Ivoire
Malawi

List the position of each respondent in the NMHS
Respondent 1 Name _____
Position_____

Respondent 2 Name _____
Position_____

Respondent 3 Name _____
Position_____

What financial accounting system does the NMHS use?
_____

What organization audits the NMHS's financial reports?
_____

Does budget control allow adaptive management and re-allocation of funding within the year?
Yes
No

Are budget summaries or full budgets publicly available? (Select all that apply.)
No
On NMHS website
On the controlling agency website
Other, please specify _____

What is the total remuneration* of the executive+ team paid each year over each of the last 5 years? (In local currency. Please be sure to include the complete number without any abbreviation e.g. 1,200,000 rather than 1.2 million)
Past year _____
2 years ago _____
3 years ago_____
4 years ago_____

5 years ago_____
Information needed to answer the question is not available
Information needed to answer the question cannot be shared

What is total remuneration* of the non-executive management** team paid each year over each of the last 5 years? (In local currency. Please be sure to include the complete number without any abbreviation e.g. 1,200,000 rather than 1.2 million)
Past year _____
2 years ago _____
3 years ago_____
4 years ago_____
5 years ago_____
Information needed to answer the question is not available
Information needed to answer the question cannot be shared

What is the total remuneration* of all staff paid each year over each of the last 5 years? (In local currency. Please be sure to include the complete number without any abbreviation e.g. 1,200,000 rather than 1.2 million)
Past year _____
2 years ago _____
3 years ago_____
4 years ago_____
5 years ago_____
Information needed to answer the question is not available
Information needed to answer the question cannot be shared

+The executive team refers to the highest leadership team within the organization such as CEO, CFO, CIO, CTO, DG, or other executive management. Probably 4-5 individuals.
*Remuneration includes salary and other staff overheads such as medical and pension benefits, employment related taxes, and other staff related costs. Individual remuneration is not needed – just totals for the relevant groups.
**The management team refers to the next level of management below the executive team that is responsible for managing technical or other staff employed by the NMHS.

Do the procurement processes satisfy any of the below conditions? (Please check all that apply.)
Competitive
Subject to public review
Non-discriminatory
None of the above

Is the NMHS able to incur debt?
Yes
No

If yes

What is the total current debt? (In local currency. Please be sure to include the complete number without any abbreviation.) _____
Information needed to answer the question is not available
Information needed to answer the question cannot be shared

How much did the NMHS over-spend or under-spend compared to its budget in each of the past 5 years? (Please indicate by how much the amount spent exceeded the budget as positive number and by how much the amount spent was under the budget as a negative number in local currency. Please be sure to include the complete number without any abbreviation.)
Past year _____
2 years ago _____
3 years ago_____
4 years ago_____
5 years ago_____
Information needed to answer the question is not available
Information needed to answer the question cannot be shared

What percentage of the annual budget was spent on forecasts in each of the past 5 years?
Past year _____
2 years ago _____
3 years ago_____
4 years ago_____
5 years ago_____
Information needed to answer the question is not available
Information needed to answer the question cannot be shared

What is the annualized number of observations made over the last year?
_____
Information needed to answer the question is not available

Does the NMHS have audited financial accounts?
Yes
No

If yes
Does the NMHS have at least 5 years of audited financial accounts?
Yes
No

If yes to #16
Could the NMHS share any financial accounts that it has with this research team?
Yes
No

IF YES TO 17 AND 18, THEN INTERVIEWER PLEASE COLLECT 5 YEARS OF AUDITED ACCOUNTS FROM THE NMHS AND THE SURVEY IS FINISHED.

IF YES TO 16, NO TO 17, AND YES TO 18 THEN COLLECT ANY AVAILABLE AUDITED FINANCIAL ACCOUNTS FROM THE NMHS AND GO ON TO Q 19.

If no to 16 or to 17
Are there financial data available for any of the past 5 years for which there are no audited accounts?
Yes
No – data do not exist
No – data are confidential and cannot be released
No - data are held by another staff member or department

IF YES, THEN CONTINUE TO QUESTION 1 IN THE NEXT SECTION.

IF B THEN SURVEY IS FINISHED.

If C
Can the data be released if a confidentiality agreement were signed?
Yes
No

IF ANSWER TO Q 19 WAS C THEN SURVEY IS NOW FINISHED.

IF D THEN PLEASE DIRECT THE QUESTIONNAIRE TO THE RELEVANT STAFF MEMBER OR DEPARTMENT.

If answer to q18 was no
Why the financial accounts cannot be shared?
A. Data are confidential and cannot be released
Data are held by another staff member or department
Other – please explain _____

If A
Can the data be released if a confidentiality agreement were signed?
Yes
No

IF ANSWER TO Q 21 WAS A THEN SURVEY IS NOW FINISHED.

IF B, CAN YOU PLEASE DIRECT THE QUESTIONNAIRE TO THE RELEVANT STAFF MEMBER OR DEPARTMENT

IF C THEN THE SURVEY IS FINISHED.

Additional financial questions for those NMHS who cannot share audited financial accounts for the past 5 years.

How much have actual expenditures varied from budgets for the last 5 years? (Difference between expenditure and budget as percentage of budget in each year.)
Past year _____
2 years ago _____
3 years ago_____
4 years ago_____
5 years ago_____
Information needed to answer the question is not available
Information needed to answer the question cannot be shared

Does the NMHS have control over its budget?
YES
NO
Information needed to answer the question is not available
Information needed to answer the question cannot be shared

If no to q2
How much annual revenue does the NMHS directly control (as a percent of annual budget)?
_____
Information needed to answer the question is not available
Information needed to answer the question cannot be shared

If no to q 2
How much of the annual expenses are directly attributable to the NMHS (as a percent of annual budget)?
_____
Information needed to answer the question is not available
Information needed to answer the question cannot be shared

What has been the frequency of budget overruns over the past 5 years?
Every year
1 in 2 years
1 in 3 Years
1 in 4 years
once
never
Information needed to answer the question is not available
Information needed to answer the question cannot be shared

Over what period are budgets forecast?
1 year
2 years
3 years or more

Information needed to answer the question is not available
Information needed to answer the question cannot be shared

Please provide a revenue breakdown for the NMHS for each of the last 5 years. How much of your revenues came from: (In local currency. Please be sure to include the complete number without any abbreviation).
Government payments.
Past year _____
2 years ago _____
3 years ago_____
4 years ago_____
5 years ago_____
Information needed to answer the question is not available
Information needed to answer the question cannot be shared

Donor payments.
Past year _____
2 years ago _____
3 years ago_____
4 years ago_____
5 years ago_____
Information needed to answer the question is not available
Information needed to answer the question cannot be shared

From aviation.
Past year _____
2 years ago _____
3 years ago_____
4 years ago_____
5 years ago_____
Information needed to answer the question is not available
Information needed to answer the question cannot be shared

Other, please specify _____
Past year _____
2 years ago _____
3 years ago_____
4 years ago_____
5 years ago_____

What were actual total revenues in each of the last 5 years? (In local currency. Please be sure to include the complete number without any abbreviation e.g. 1,200,000 rather than 1.2 million)
Past year _____
2 years ago _____
3 years ago_____
4 years ago_____

5 years ago_____
Information needed to answer the question is not available
Information needed to answer the question cannot be shared

What were actual expenditures in each of the last 5 years? (In local currency. Please be sure to include the complete number without any abbreviation.)
Past year _____
2 years ago _____
3 years ago_____
4 years ago_____
5 years ago_____
Information needed to answer the question is not available
Information needed to answer the question cannot be shared

What were budget revenues in each of the last 5 years? (In local currency. Please be sure to include the complete number without any abbreviation.)
Past year _____
2 years ago _____
3 years ago_____
4 years ago_____
5 years ago_____
Information needed to answer the question is not available
Information needed to answer the question cannot be shared

What were the budget expenditures for each of the last 5 years? (In local currency. Please be sure to include the complete number without any abbreviation.)
Past year _____
2 years ago _____
3 years ago_____
4 years ago_____
5 years ago_____
Information needed to answer the question is not available
Information needed to answer the question cannot be shared

What percentage of total remuneration is spent on female staff?
_____
Information needed to answer the question is not available
Information needed to answer the question cannot be shared

What are the total capital asset values accounting for depreciation and amortization over each of the last 5 years? (In local currency. Please be sure to include the complete number without any abbreviation.)
Past year _____
2 years ago _____
3 years ago_____
4 years ago_____

5 years ago_____
Information needed to answer the question is not available
Information needed to answer the question cannot be shared

What is the highest single capital expense over each of the last 5 years? (In local currency. Please be sure to include the complete number without any abbreviation.)
Past year: Expense: _____ Amount:_____
2 years ago: Expense: _____ Amount: _____
3 years ago: Expense: _____ Amount:_____
4 years ago: Expense: _____ Amount:_____
5 years ago:_____
Information needed to answer the question is not available
Information needed to answer the question cannot be shared

What are the total meteorological Equipment asset values accounting for depreciation and amortization over each of the last 5 years? (In local currency. Please be sure to include the complete number without any abbreviation.)
Past year _____
2 years ago _____
3 years ago_____
4 years ago_____
5 years ago_____
Information needed to answer the question is not available
Information needed to answer the question cannot be shared

What are the repair and maintenance expenses in each of the last 5 years? (In local currency. Please be sure to include the complete number without any abbreviation.)
Past year _____
2 years ago _____
3 years ago_____
4 years ago_____
5 years ago_____
Information needed to answer the question is not available
Information needed to answer the question cannot be shared

What are the total radar asset values accounting for depreciation and amortization over each of the last 5 years? (In local currency. Please be sure to include the complete number without any abbreviation.)
Past year _____
2 years ago _____
3 years ago_____
4 years ago_____
5 years ago_____
Information needed to answer the question is not available
Information needed to answer the question cannot be shared

What are the computer and software expenses in each of the last 5 years? (In local currency. Please be sure to include the complete number without any abbreviation.)
Past year _____
2 years ago _____
3 years ago_____
4 years ago_____
5 years ago_____
Information needed to answer the question is not available
Information needed to answer the question cannot be shared

What are the consumables and spares expenses in each of the last 5 years? (In local currency. Please be sure to include the complete number without any abbreviation.)
Past year _____
2 years ago _____
3 years ago_____
4 years ago_____
5 years ago_____
Information needed to answer the question is not available
Information needed to answer the question cannot be shared

What are the travel expenses over each of the last 5 years? (In local currency. Please be sure to include the complete number without any abbreviation.)
Past year _____
2 years ago _____
3 years ago_____
4 years ago_____
5 years ago_____
Information needed to answer the question is not available
Information needed to answer the question cannot be shared

What are the communications expenses in each of the last 5 years? (In local currency. Please be sure to include the complete number without any abbreviation.)
Past year _____
2 years ago _____
3 years ago_____
4 years ago_____
5 years ago_____
Information needed to answer the question is not available
Information needed to answer the question cannot be shared

What are the electricity expenses over each of the last 5 years? (In local currency. Please be sure to include the complete number without any abbreviation.)
Past year _____
2 years ago _____
3 years ago_____
4 years ago_____

5 years ago_____
Information needed to answer the question is not available
Information needed to answer the question cannot be shared

What are the total operating expenses over each of the last 5 years? (In local currency. Please be sure to include the complete number without any abbreviation.)
Past year _____
2 years ago _____
3 years ago_____
4 years ago_____
5 years ago_____
Information needed to answer the question is not available
Information needed to answer the question cannot be shared

THANK YOU VERY MUCH FOR YOUR TIME!