8 May 2024

GBON National Contribution Plan of Uganda

Systematic Observation Financing Facility

Weather and climate data for resilience

Table of Contents

List of Abbreviations

AWOS:	Automated Weather Observing System
AWS:	Automatic Weather Station
CAA:	Civil Aviation Authority
CHD:	Country Hydromet Diagnostics report
CSO:	Civil Society Organizations
CREWS:	Climate Risk and Early Warning Systems
DRC:	Democratic Republic of the Congo
EAC:	East African Community
ED:	Executive Director
FTE:	Full Time Equivalent
GBON:	Global Basic Observing Network
GoU:	Government of Uganda
GTS:	Global Telecommunication System
HQ:	Headquarters
HR:	Human Resources
ICAO:	International Civil Aviation Organization
ICT:	Information and Communication Technology
IE:	Implementing Entity
IFRC:	International Federation of Red Cross and Red Crescent Societies
IGAD:	InterGovernmental Authority on Development
IMTR	Institute for Meteorological Training and Research
IsDB:	Islamic Development Bank
KIA:	Kabalega International Airport
KNMI:	Royal Netherlands Meteorological Institute
MARS:	Meteorological Archival and Retrieval System
NARO:	Uganda National Agricultural Research Organisation
NGO:	Non-Governmental Organization
NGA:	National Gap Analysis
NMHS:	National Meteorological and Hydrological Services
NMTS:	National Meteorology Training School
NWFC:	National Weather Forecasting Centre
MQTT:	Message Queuing Telemetry Transport
OSCAR:	Observing Systems Capability Analysis and Review Tool
PA:	Peer Advisor
Ph.D:	Doctor of Philosophy
QA/QC:	Quality Assurance and Quality Control
QMS:	Quality Management System
RCC:	Regional Climate Centre
RIC:	Regional Instrument Centre
RTC:	Regional Training Centre
SFRP:	SSH File Transfer Protocol
SOFF:	Systematic Observation Financing Facility
SOP:	Standard Operating Procedure
UAS:	Upper Air Sounding station
UNMA:	Uganda National Meteorological Authority

URA:	Uganda Revenue Authority
URCS:	Uganda Red Cross Society
WDQMS:	WMO Integrated Global Observing System Data Quality Monitoring System
WIGOS:	WMO Integrated Global Observing System
WIS:	WMO Information System
WMO:	World Meteorological Organization
WB:	World Bank

GBON National Contribution Plan UGANDA

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Module 1 National Target toward GBON compliance

The results of the GBON National Gap Analysis (NGA) indicated the need to rehabilitate and improve nine land surface AWSs to meet the GBON standard 200-km spatial grid resolution and sufficient coverage in Uganda. A minimum 7 stations are indicated based on the country surface area and 200-km spatial grid resolution. In the NGA **it is seriously proposed to increase this list of 7 with two (2) additional stations**.

Arguments to extend the SOFF stations from a minimal seven (7) to nine (9) include the a) challenging social- and political situations in the Republic of Congo (western border, Arua and Kasese stations) and South Sudan (northern border, Arua and Kitgum stations); b) the profound vulnerability of north-western Uganda to prolonged droughts (Kotido station); c) the distinct topography differences between the especially the western border area and central Uganda (Kasese station); and d) the importance of Kasese station for air traffic to Uganda's top tourist attraction, the mountain gorilla reserve.

As it is expected that SOFF activities will face delays and implementing difficulties in South Sudan and the Republic of Congo, it is suggested to intensify SOFF station density at Uganda's northern and western boarders (Kasese, Arua, Kitgum and Kotido stations).

Relative station overlap in the south of Uganda is fully justified considering a. the importance of the micro-climate affected by Lake Victoria, including the provision of early warning services required for Lake Victoria's fishing communities; b. the location of Uganda's main international Airport at Entebbe; c. the facts that Entebbe and Jinja station encapsule Uganda's capital Kampala and its metropolitan area, with high density populations exceeding over 8.5 million people.

Increasing the number of SOFF rehabilitated station from seven (7) to nine (9) is therefore strongly encouraged by PA KNMI.

Irrespective of the final WMO SOFF decision on the number of SOFF supported stations, all nine (9) stations proposed in the NGA, and this NCP, are existing AWS sites, owned and controlled by the

Uganda National Meteorological Authority (UNMA). All nine (9) stations require **full rehabilitation** but no locations for new station sites are required. Out of the proposed 9 stations (figure 1), six (6) are existing OSCAR/WDQMS stations; three (3) are not yet registered.

One (1) Upper-air sounding (AUS) station at ate Entebbe International Airport (located in the south of Uganda) needs to be rehabilitated and improved fully under SOFF, as only the location site and AUS housing are currently present.

In coordination with the SOFF secretariate a second UAS is proposed, in correspondence with UNMA's ambition for two stations, covering the entire country (see Figure 2). UNMA and PA suggest the second station to be located in either Gulu or Lira, to cover the Northern half of Uganda. Both locations have UNMA AWS's (although not included in the SOFF GBON selection) located at the local airstrips. Installation of the second UAS will require land acquisition, housing facilities and additional technical staff for it's operations.

Table 1 summarizes the NGA GBON compliance gaps, and also includes the GBON National Target (see section 1.2).

1.1 Summary of the GBON National Gap Analysis

Table 1: summarizing National Gap Analysis (NGA) report, station requirements and UAS station.

	GBON contribution target				GBON national contribution target	
Station type	**GBON target of stations**	**GBON Compliant stations (#)**	**Stations gap**			
			To improve	**New**	**To improve**	**New**
Surface land stations	7	0	9	0	9	0
Upper-air stations operated from land	1	0	1	1	1	1

Argumentation for number of proposed stations under SOFF
Based on the NGA report, the absolute minimum number of stations for Uganda would be seven (7), when stations would be ideally distributed. UNMA and the PA strongly advise this minimal requirement to extend to 9 (nine) stations, as for the following reasons and arguments:

a. UNMA has two functional stations (Kasese and Arua) very close to the border of the Democratic Republic of the Congo, where armed conflict might disrupt the swift implementation of SOFF, rendering these close-border stations a practical solution to increase at least some data from the conflict area. The same, but to a lesser degree, applies to the Northern border with South Sudan (Arua, Kitgum and Kotido stations)

Table 2: summarizing Gap Analysis report, station requirements and UA station

A. GBON horizontal resolution requirements	Target	Reporting (GBON compliant) [1]	Gap to improve	Gap new	Gap total
Minimum Surface stations Standard density[2] 200 km	7	0	9	0	9
Upper-air stations over land Standard density 500km	1	0	1	1	2

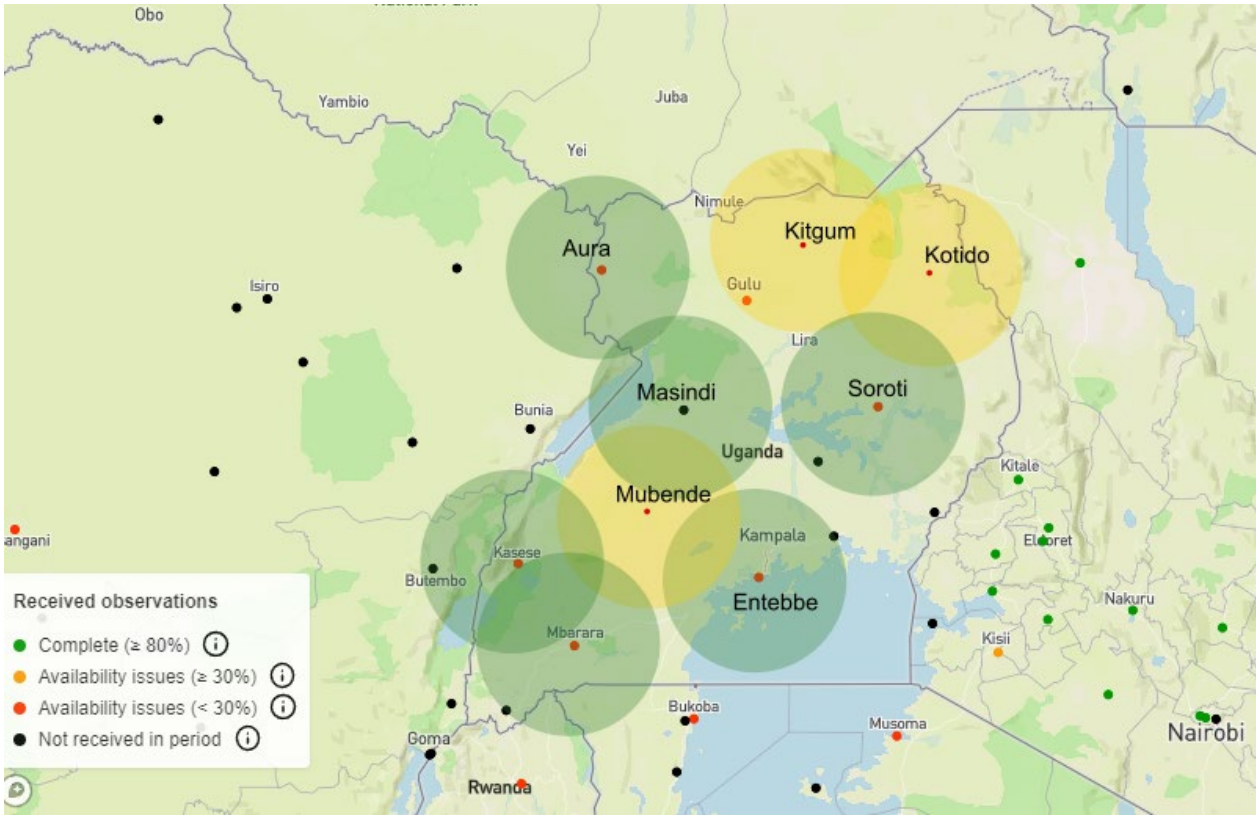

Figure 1: Stations registered with WIGOS ID available in WDQMS and OSCAR/Surface (Arua, Masindi, Soroti, Entebbe, Mbarara and Kasese) and three existing stations that still require OSCAR/WDQMS registration (Mubende, Kitgum, Kotido). GBON affiliated surface stations in Uganda are encircled with a diameter of 200 km as an indication of station coverage, gaps (central west and northeast) and overlap. Source map: OSCAR/Surface, map taken from Uganda NGA report.

[2] The rationale for classifying surface and upper-air stations as reporting is based on the WIGOS Data Quality Monitoring System (WDQMS) for the chosen time period (WMO GBON Global Gap analysis, June 2023). Stations with data availability more than 80% on at least 80% of days, are considered as reporting. Other listed stations are counted as having the possibility to be improved.

b. Kasese station is situated in a mountainous area, quite different from the central highlands, and is located at Kasese Airport that acts as the entry point for Uganda's prime tourist attraction, the mountain gorilla visitors' centre.

c. Overlap between the Entebbe and Jinja stations is noticeable but justified. UNMA and PA consider these stations necessary to cover the climate effects of Lake Victoria, with near shore observations to be important (Entebbe and Jinja) for Early Warnings services to the fishing communities along the Lake. Entebbe station is strategically vital as it not only acts as UNMA's national weather forecast centre (and as such will play a central role in the SOFF GBON activities), it also Uganda's main international airport with meteorological observations. In addition, the Entebbe and Jinja station encapsule Uganda's capital city Kampala and its densest populated areas, with over 8.5 million people living in the Kampala metropolitan area alone. However, to reduce the number of stations to 9 (nine), the Jinja station is excluded from the SOFF GBON list, at least for this first investment phase. PA recommends UNMA to finds additional resources outside SOFF to rehabilitate and upgrade Jinja station.

With these arguments UNMA and the PA strongly encourage SOFF GBON to include 9 (nine) rather than just seven (7) stations in this phase of SOFF.

The primary recommendations by the PA and UNMA for achieving GBON compliance under SOFF in Uganda therefore include:

1) Fully rehabilitating and upgrading the 6 (six) registered WIGOS Automatic Weather Stations (AWS) with GTS/WIS2.0 communication standards.
2) Registering and upgrading three (3) existing AWSs (Mubende, Kotido, Kitgum) in WIGOS/OSCAR to ensure complete national coverage.
3) Compliance with GBON necessitates immediate upgrades of AWS station connectivity to the Regional Telecommunication Hub (RTH) in Nairobi to meet Uganda's data transmission limitations on the GTS.
4) The rehabilitation of the proposed AWS stations should be carried out within the next two to four years.
5) Urgent revamping of the Entebbe UAS by replacing the hydrogen generator, technical hardware and computer hard- and software. Getting this station operational ASAP is essential for training of staff to man the second and new AWS.
6) The installation of a second UAS at either Lira or Gulu in the Northern part of the country, for full UAS coverage of Uganda.
7) Maintaining station capacity and resources, including calibration capabilities, is crucial for ensuring the reliability of data supply under the Systematic Observations Financing Facility (SOFF).
8) UNMA significantly needs to enhance human resource capacity and training, particularly in data and software engineering, station operation and maintenance, and data management.
9) Improving computing power for data integration and weather/climate modelling could be greatly advanced through international cooperation, depending largely on internet facilities at UNMA HQ and the National Weather Forecasting Centre (NWFC).

10) Expanding cooperative efforts with international stakeholders, including development partners, UN agencies, financial institutions, and NGOs active in meteorology, climatology, climate change, early warning systems, and disaster preparedness, is crucial.
11) A data rescue program to digitize and disseminate historical data records is essential to prevent dataset loss and support further research development in climatology for Uganda.
12) It is recommended that SOFF-related efforts and national contribution plans promote and facilitate more intensive regional communication between national hydro-meteorological agencies, and offices, e.g., within the East African Society, especially in areas of data exchange, knowledge sharing, capacity building, hardware provision, and calibration facilities.
13) Additionally, enhancing UNMA's knowledge and capacity chain related to localized weather forecasting and nowcasting, as well as the communication of these products, could significantly improve services and contribute to end-user demands. This includes everything from weather radar products to improved broadcasting techniques.

Module 2: GBON Business Model and Institutional Development

Currently, it is advisable for Uganda's National Meteorological Authority (UNMA) to continue with a fully public business model to bolster its observational capabilities and achieve GBON compliance. The infrastructure for private sector-driven business models in Uganda's meteorological services is not yet established.

At present, UNMA is the single meteorological data provider in Uganda. According to UNMA, lack of private providers is likely to be the effect of restrictions in the legislation and the requirements for a private player to set up an ideal weather observatory.

At present, there are no indications for development of a strong meteorological private sector, neither is UNMA orientating itself to establish private sector relationships, either as data provider or as customer. If such concept is a requirement under SOFF GBON, then this should be established from scratch.

Additionally, the cost-benefit analysis for hydrometeorological services within the weather-sensitive sectors are in the early phase of development. UNMA's direct commercial abilities are restricted by law. The PA advises to concentrate efforts on improving the public service level of UNMA and its focus on implementing SOFF with its requirements in human resources capacity.

PA KNMI is willing to assist UNMA in the exploration of developing (commercial) services for the private sector during the investment phase of SOFF.

2.1. Assessment of national governmental and private organizations of relevance for the operation and maintenance of GBON

The Uganda National Meteorological Authority (UNMA), instituted by an Act of Parliament in 2012, plays a crucial role within Uganda's national policy and governance framework for meteorology. As a semi-autonomous agency under the Ministry of Water and Environment, UNMA is integral to the nation's socio-economic advancement, aligning its strategic plans with Uganda's National Development Plan.

Current policy discussions regarding the potential reintegration of UNMA's functions into the Ministry of Water and Environment pose challenges to its semi-autonomous nature. This re-evaluation must ensure UNMA's agility and effectiveness in meeting Uganda's meteorological needs without compromising its contributions to national development.

Current Functioning

UNMA is pivotal in disaster risk reduction, management, and preparedness, a critical focus given Uganda's vulnerability to climate and weather-related disasters. The nation's reliance on agriculture, fisheries, and tourism underscores the essential nature of UNMA's services for resilience and sustainable development.

Recent assessments have identified a marked increase in demand for accurate weather and seasonal forecasts, especially from the agriculture, fisheries, and disaster preparedness sectors, but at the level of cooperation's, or (semi) governmental agencies. This surge necessitates enhancements in UNMA's service delivery, focusing on predictive accuracy, accessibility, and the customization of forecasts to meet sectoral requirements. At this stage, UNMA is not actively developing products dedicated to the private sector.

Improving communication capacities through innovative technologies and user-friendly outreach, including media partnerships, is imperative for UNMA, starting in the public domain. Establishing strategic partnerships with entities like the Uganda Red Cross Society, and academic institutions is reactively well on its way. Collaborations with international climate resilience and disaster risk management organizations (like UCRS) will fortify UNMA's operational capabilities, extending its impact on public education and disaster readiness. Private sector development will be a completely new domain; demand will have to be identified and actively encouraged. UNMA's ability to undertake such tasks, under commercial conditions, will have to be established as such situation is new to the UNMA management. There is no immediate demand from private actors, at this stage, to jump start such activity.

National noteworthy collaborations

UNMA is not involved in private sector affiliations or contributions. At the non-governmental level collaborations include (taken from CHR Uganda 2024):

- National Agricultural Research Organisation (NARO). NARO, operating under the Ministry of Agriculture, Animal Industry, and Fisheries, hosts several of UNMA's weather stations across its facilities and joins hands with UNMA in pioneering multi-disciplinary research projects.
- Busitema University (BU): Joint initiatives with BU have focused on resource mobilization and the development of a Postgraduate Diploma Course aimed at bolstering human resource capabilities within UNMA.
- International Crane Foundation (ICF)/Endangered Wildlife Trust (EWT): This partnership has been pivotal in mobilizing resources and disseminating weather and climate information to communities coexisting with grey hair cranes.

- Uganda Red Cross Society (URCS): Collaborative efforts during the National Climate Outlook Fora (NCOFs) have enhanced the dissemination of vital weather and climate information and improving URGSs disaster preparedness capacity.
- Lira University: Hosting one of the three weather radars stations, the university has engaged in joint resource mobilization and research projects with UNMA.
- Jane Goodall Institute (JGI): A collaboration aimed at resource mobilization and the dissemination of weather and climate information in the western districts of Hoima and Kikuube.

There are no commercial, or substantial financial arrangements within these collaborations. They are either undertaken under governmental budgets, or without financial transactions. These activities have no representation as UNMA income.

Private sector involvement in operational cooperations
UNMA has no direct affiliations with private sector parties; neither does UNMA provide dedicated services to the private sector parties. In Uganda, UNMA is the single provider of meteorological data. Meteorological services provided to the Uganda Civil Aviation Authorities (UCAA) but current conditions do not allow for financial compensation for these services. UNMA does not cooperate with other, private, governmental, or non-governmental organisations for the collection of data, nor for the operations and maintenance of other observations networks. There are no data-contributions from other national sources. An exception is the collaborations with NARO as AWS sites are located at NARO's territories for security reasons. However, NARO does not contribute data to UNMA's observation network. No financial transactions are included.

For the SOFF program, private sector involvement may be limited to maintenance services and contracts, and possibly involvement calibration services. However, UNMA is very much oriented towards maintaining these capacities within the organisation. At present, no immediate candidates for such services have been identified by PA or UNMA.

As stated earlier, in Uganda, UNMA is the single provider of meteorological data. During the investment phase, and the included training and human capacity activities, the potential of private sector involvement can be further explored and developed.

Partnerships, but no immediate business models
Ensuring the effective functioning and monitoring of stations requires local cooperation, potentially involving government or the private sector for enhanced maintenance and security strategies. While it is critical that the stations are situated at locations with minimum infrastructure requitements (security, electricity) there must be also local cooperation to ensure functioning and tracking of the station. This could be explored through cooperation with governmental and non-governmental partners. UNMA's collaboration with the Uganda National Agricultural Research Organisation (NARO), which hosts weather stations across its facilities, as well as collaboration with Makarere University exemplifies successful partnership models. The ICT infrastructure necessary for the network's operation also demands a strategic approach to maintenance and operations, underscoring the importance of robust local cooperation.

Private sector potential.
Leveraging now-casting and utilizing operational weather radar stations for public information dissemination, particularly through mobile applications based on radar data, could significantly

enhance service delivery. Deciding whether these services should be commercial or public goods necessitates a careful evaluation to ensure both sustainability and universal access to vital weather information.

Earlier attempts by UNMA to cooperate with telecom providers (MTN-Uganda and Airtel-Uganda) in the domain of weather information dissemination has been hampered by the reluctancy of the telecom companies to directly engage with UNMA under mutually acceptable conditions.

PA recommends UNMA to further explore collaboration with private sector parties, including telecom providers. The dissemination of to-be-developed weather radar-based products (like Netherlands "BuienRader", a rainstorm radar application) has real potential for the Uganda market.

Procurement and tendering activities related to SOFF-financed activities via the ISDB will increase the network overview of private sector actors (in the sub-region). The PA will support UNMA in further private sector involvement during the SOFF investments phase.

GBON-Related Insights
As the principal weather and climate data provider in Uganda, UNMA's role is unparalleled. Station exist, and UNMA's structure is perfectly capable to absorb SOFF support and investments. However, enhancing and rehabilitating sensory and data transmission equipment, especially for WIGOS-registered stations, is urgently needed. Human capacity should be brought up to GBON requitements. Collaborations with international stakeholders (including the PA) can augment UNMA's resources in observations, data management, and dissemination. Station maintenance and quality control (station and data sustainability) will be concerns for the medium long-term and require proper addressing in the investment phase.

Training Needs
To meet GBON requirements and maintain WMO standards, focused training on station operation, maintenance, sensor calibration, and data engineering is essential. Increased strategic partnerships and participation in international programs also call for enhanced capabilities in project proposal writing and management.

Additional Needs
UNMA possesses extensive historical weather and climate records, necessitating an internationally supported data preservation and dissemination program. Collaborative efforts in disaster risk reduction, climate adaptation, and food security will bolster UNMA's contributions to national and global initiatives.

2.2 Assessment of potential GBON sub-regional collaboration

Uganda, sharing borders with Kenya, Tanzania, Rwanda, South Sudan and Democratic Republic of Congo (DRC), finds significant potential for sub-regional collaboration in the context of the Global Basic Observing Network (GBON). Documentation for the full preparation phase of the SOFF GBON is available for Rwanda and South Sudan, presenting a framework for collaborative efforts.

UNMA is very much willing to facilitate improved sub-regional collaboration, either for SOFF or weather information collaboration in general. The PA encourages this sub-regional ambition.

Identified potential sub-regional collaborations include:

1. **Regional Training and Capacity Building:** Through WMO Regional Office for Africa or the WMO Regional Climate Centre (RCC) Intergovernmental Authority on Development (IGAD) facilitation, establish cooperation with the Regional Training Centre in Nairobi, optimize a regional training program that should include meteorological background on weather observations (manual and automatic), technical maintenance and data transfer.

2. **Instrument Calibration and Knowledge Exchange:** In partnership with the WMO Regional Office for Africa or IGAD, an exchange mechanism with Nairobi's Regional Instrument Centre could be established. This initiative could facilitate calibration actions across the network and promote the exchange of technical expertise and best practices.

3. **Data Sharing and Network Optimization:** Procedures could be developed to access and share meteorological data available on the Global Telecommunication System (GTS) from neighbouring countries like South Sudan, Rwanda, Kenya, DRC, and Tanzania. Dialogues with these nations and adjacent SOFF countries could include deploying SOFF stations in strategic border areas to enhance network effectiveness.

4. **East African Community (EAC) Engagement:** Intensifying discussions within the EAC, with an emphasis on data availability and sharing, is crucial. For Uganda, optimizing the GBON network in collaboration with Kenya, due to Kenya's dense network along Uganda's western border, may be a priority.

5. **Climate Risk and Early Warning Systems (CREWS) Initiative:** CREWS East Africa, started in early 2023 for a duration of four years, targets EAC members to enhance early warning systems and climate risk management. CREWS is seen as a vital partner in deploying WIS/WIS2-in-a-box, encompassing necessary training for station connectivity and data distribution – key to GBON compliance and international data exchange.

6. **Resource Optimization through Regional Collaboration:**
   Exploring regional collaboration for the procurement and maintenance of GBON stations, including standardizing maintenance procedures and acquiring spare parts, is a novel approach that requires detailed exploration and dialogue with neighbouring SOFF-affiliated countries. Regional discussions and workshops, possibly facilitated by the SOFF secretariat, will focus on joint station purchases, maintenance, and spares.

7. **Special Focus on Lake Victoria Communities:**
   Enhancing forecasting capabilities for Lake Victoria, particularly for the vulnerable fishing communities, involves optimizing near-shore and island-based stations and installing off-shore weather buoys. This targeted improvement could significantly reduce weather-related accidents in the area.

8. **Early Warning for All Initiative:**

The Early Warnings for All (EW4All) initiative, with SOFF's contribution towards hazard detection, observation, monitoring, analysis, and forecasting, aims to address significant GBON gaps in Africa. A specific workshop with EW4All is foreseen to leverage its activities and engage with intergovernmental agencies, regional commissions, and UN entities to support the sustainable operation of the GBON network, laying the groundwork for national early warning systems.

9. **Sub-regional SOFF GBON Network optimalization:**
   Within the scope of SOFF GBON it is encouraged that SOFF AWS site distribution is coordinated at the sub-regional level, especially with Uganda's neighbouring countries. Development paces between countries however may divers. PA has contacted the PA's for Rwanda, South Sudan, and Congo for further coordination of activities. Relation and communications between PA's are in early stages of development and did not result yet in concrete program optimization (at the publication date of this report).

   However, PA KNMI fully recognize the importance of PA coordination within SOFF. In October 2024, KNMI will host the first global SOFF Peer Advisors gathering to underline this importance.

   UNMA is welcoming sub-regional coordination. UNMA is willing to increase observation network density at its borders if socio-political situations in neighbouring countries provide an extra challenge for the current SOFF program. Within the development window of this and corresponding reports under SOFF, UNMA and the PA were not able to establish an optimized sub-regional GBON distribution yet.

2.3. Assessment of a business model to operate and maintain the network

The business model of the Uganda National Meteorological Authority (UNMA) for fulfilling its duties, including operations compliant with the Global Basic Observing Network (GBON), depends on government budgets and limited international cooperation. There are no ongoing private sector or (semi) commercial activities, nor has UNMA plans to develop such services in the immediate future. UNMA, at present, serves as a public utility, under a public governmental budget. Private sector involvement may be explored under SOFF, but the idea is very new to UNMA and should not be pressed upon at this stage.

The annual governmental budget allocation for the fiscal year 2022/23 was 17.656 billion Ugandan Shillings (USh). External domestic and international collaborations and development projects contributed between 1.5 to 2.2 billion USh from 2016-2019, primarily for weather and climate services offered to the Uganda Civil Aviation Authority (CAA, under the Uganda Ministry of Works and Transport). However, since the fiscal year 2019/20, the CAA has ceased its payments, while UNMA has continued to provide services.

The preliminary government budget should align with UNMA's strategic goals. The fiscal year in Uganda runs from July 1st to June 30th of the following year. UNMA especially coordinates its meteorological observation activities with the Ministry of Water and Environment, the Office of the Prime Minister, and the Uganda Civil Aviation Authority.

Currently, there is no continuous financial support from international entities such as the UNDP or WMO, nor are there ongoing (financial) support programs. The maintenance, operational, and development costs of the observation network are solely funded through the government's standard budget.

Governmental budget funding primarily covers staff salaries and other related operational services, such as electricity and infrastructure. Staff salaries have remained unchanged for four fiscal years and have not been adjusted for inflation.

The budget for replacement and investments is minimal, only representing 0.1-0.2%. There is a crucial need for a significant increase in budget and project funding allocations for maintenance, sensor replacement at stations, calibration services procurement, and IT hardware updates. Implementing an AWS rehabilitation and lifecycle plan, ensuring full station connectivity to the GTS/WIS, fully rehabilitating at least one operational radiosonde station, and upgrading related IT hardware for data management are critical for UNMA in the next two to four years.

UNMA currently lacks a cost-recovery mechanism for its services. However, UNMA is in the process of developing such a mechanism to ensure financial flexibility and independently support the organization's activities, including development and meteorological observations. This initiative is strongly endorsed. Nevertheless, operational activities should not solely rely on cost-recovery, as they necessitate a sustainable budget.

Modernizing and improving the UNMA data collection infrastructure is a stated target within the Uganda Governments' National Development Plan II. However, this ambition has not yet been translated to actual strategic financial planning reports that indicate the required investment and potential source and ratio of funding. Improvements of the proposed nine AWS stations and two UAS under SOFF is the first concrete network (AWS, UAS) strategic infrastructure improvement since 2016.

Improving public services first, before private sector adventures

The PA does not advise the immediate development of private sector or commercial services, at this stage of development within UNMA. UNMA has its challenges as it is, requiring assistance in first increase the quality, reliability and effectiveness of its public responsibilities before trying to extent its services to private customers. There are no immediate demands to UNMA for weather products from the private market. In addition, the uncertainty related to the governmental position of UNMA, as an independent authority, or relocating UNMA within the Ministry of Water and Environment is another reason for not pressing such ambition.

However, the PA supports UNMA's ambition to develop more modern communication products for the public domain, as a first step towards dedicated products for a private market. Innovative social media products based on UNMAs weather radar data might be a first step. The KNMI and UNMA will explore such opportunities within their cooperation and peer review relationship.

Incorporating SOFF support within the business plan

The investment plan documentation is being developed between Islamic Development Bank (IsDB) and UNMA, assisted by the PA. No details can yet be provided as the investment plan has not yet been approved by WMO. However, PA is convinced that UNMA can absorb financial support for procurement, instalment of station hardware and find the human resources required for the SOFF

operations and related training and education. The same will apply for the operational phase after installation. UNMA's annual governmental budget is approximately 4.2 million $US per year. SOFF contributions in the rehabilitation and operational phases (total budget) can therefore generate an additional 25-30% increase in activity the next 3 years. Adequate planning is required within UNMA to be able to absorb this increase, e.g. in facilities, management, and administrative capacity. IsDB requires the procurement of a dedicated program management unit (PMU) within UNMA for the duration of the investment phase. IsDB and UNMA will explore establishment of the PMU. PA KNMI will fully support UNMA in the overall process.

2.4. Assessment of existing national strategies and projects related to observing networks

Currently, UNMA has delineated its strategy, operations, and risk management plans within the Second Strategic Plan (SP II). Yet, there's a need for a strategic roadmap backed by adequate financial resources to enhance technical and human capabilities for meteorological observations, including the replacement, maintenance, and calibration of meteorological, limited hydrological, and air quality observation equipment. SOFF is viewed as a suitable framework for organizing and financially supporting these essential components.

UNMA's Automatic Weather Stations (AWS), registered in WIGOS/OSCAR, were set up between 2014-2016. Sensor's failures and instability are frequently reported; dataloggers and energy supply are not optimal. Sensor calibration is lacking. The stations infrastructure conditions are at best adequate but generally suffer from a lack of maintenance and is threatened by development activities in the immediate vicinity.

A comprehensive instrumental rehabilitation program, ensuring full connectivity to the automated GTS/ WIS, is imperative. To ensure a systematically operated and maintained network of observation stations, a lifecycle plan integrated with annual and long-term budgeting is crucial. The SOFF program is anticipated to be an appropriate platform for this, facilitating better coordination between budget allocations, projects, and the strategic objectives of the organization.

Currently, only Climate Risk and Early Warning Systems (CREWS) East-Africa, funded by the WMO, stands out as significant for Uganda. CREWS aims to enhance capacity building for data dissemination through WIS2.0 and address some remaining capacity gaps in the OSCAR database. The CREWS workplan is currently under development. CREWS and SOFF share the same contact person in UNMA. PA has contacted CREWS for information at this stage of development early in the SOFF process. At the date of finishing this report, no specific information (e.g. concept workplan) has been received yet. UNMA and PA seek participation in the dialogue between SOFF and CREWS, but considers coordination between these programs also a responsibility for WMO.

2.5. Review of the national legislation of relevance for GBON

Under the UNMA Act of Parliament (2012), UNMA is mandated to perform meteorological observations and transmit to the GTS, including those pertinent to GBON and SOFF.

Additionally, UNMA is authorized to oversee and collect meteorological observations from third parties. Quality management, including supervision, will ensure that sensors used are sufficient to generate high-quality observations, placing UNMA in a legal position to facilitate such arrangements.

Within the framework of SOFF Uganda, the Islamic Development Bank (IsDB) is appointed and mandated to oversee the investment phase. The IsDB will manage the tender and procurement processes related to the acquisition of hardware or services.

Relevant customs and taxes for imported meteorological items in Uganda include:

- Customs duty (25%)
- Value Added Taxes (VAT; 15-18%)
- Withholding taxes (6%)

IT hardware and AWS sensors may be exempt from VAT in Uganda according to specific laws and provisions. Exemptions for other taxes must be applied for via the Uganda Revenue Authority (URA). Tax policies and rates are subject to legislative updates, policy changes, and economic conditions. Verifying the tax exemption process is advisable. Proactive communication with UNMA and the Government of Uganda (GoU) before initiating any tender process is highly recommended.

The investment, installation, operation, and maintenance of AWSs (both those already registered under WIGOS/OSCAR and those that are not yet registered) are not anticipated to encounter legislative barriers. All stations relevant to the SOFF program are owned and managed by UNMA. No legal or regulatory changes have been reported since the stations were installed. However, land ownership or agreements on land use for AWS installations may need revision or updates. AWS locations must be reassessed for adequate spatial clearance and new housing development in the immediate vicinity.

Special attention is required for the existing, yet non-functional, UAS at Entebbe International Airport. Establishing a second station (in Gulu or Lira) may necessitate legislative procedures and permissions, e.g., related to radio frequency usage.

Furthermore, the rehabilitation of the UAS at Entebbe involves the reinstallation of the Hydrogen / H_2-generator. The generation and storage of hydrogen and the filling of balloons may fall under new legislative and regulatory frameworks concerning safety requirements for workplaces and equipment used in potentially explosive atmospheres.

Module 3: GBON Infrastructure Development

3.1. Design the surface and upper-air observing network and observational practices

The objective of the SOFF investment phase project is to enhance the impact of meteorological observations on global numerical weather prediction by:

- Installing surface weather stations in regions significantly lacking observations.
- Installing or rehabilitating upper-air sounding stations.

- Optimizing the network design on a sub-regional basis.

As highlighted in the Gap Analysis for Uganda and its Annex 1 and further detailed in the Uganda Country Hydromet Diagnostics report (CHD), the current observational network suffers from severely limited maintenance capabilities.

The WIGOS/OSCAR-registered network, comprising twelve (12) stations, is in a state ranging from moderate to poor condition (see Annex 1 for a comprehensive description of station status). Main issues include non-functional sensors (especially wind speed and direction), unstable sensors (such as air pressure), and significant challenges in communication capabilities. Civil infrastructure (including masts, power supply, and station surface vegetation) for potential GBON weather stations is poorly maintained, with encroaching urban development posing additional concerns.

The existing AWS network is burdened with outdated components and features sensors and data loggers from various manufacturers. Some data loggers lack the capability for direct data transfer to the Global Telecommunication System (GTS) or UNMA headquarters, while others face power supply issues.

Currently, no stations identified as relevant for SOFF/GBON are automatically connected to GTS/WIS/WIS2.0. All stations, with the exception of Entebbe Airport, are manned for only 12 hours each day, limiting data collection to daylight hours only. Uganda does not have any stations that report automatically via GTS; all data transfers to the Regional Telecommunication Hub in Nairobi are conducted manually through SMS or email.

All stations are fenced and located at relative secure sites. Theft is not a serious problem that is usually limited to solar panels. The use of data loggers with low power requirements will reduce solar panel sizes, making them unattractive for use in domestic situations.

Office facilities of all 12 existing GBON-affiliated stations is poor to moderate (see Annex 1), with office and computer hardware being main challenges. Security issues are mentioned, related to the fact that all but one stations are only manned 12 hours per day.

Stations under GBON SOFF

To enhance the scope and effectiveness of the GBON initiative in Uganda, a strategic selection and optimization of the meteorological station network has been conducted. The decision to propose three more existing UNMA stations for GBON registration is a calculated move to extend station coverage across Uganda efficiently (see Fig. 1). Concurrently, the choice to exclude two currently WIGOS/OSCAR registered stations from immediate SOFF/GBON efforts is informed by their significant spatial overlap with other stations. See section 1.1 for further clarification.

Consequently, the refined proposal for the SOFF GBON ground station network in Uganda envisions a total of nine (9) Automated Weather Stations.

This number is deemed adequate when considering Uganda's diverse topography and climatological zones, alongside the spatial distribution of the stations (as illustrated in Figure 1). Nevertheless, a meticulous assessment against GBON's stipulated requirements, which advocate for

station spacing of approximately 200x200 km^2 to meet global GBON observational needs, reveals a minimal network of seven (7) *theoretically* fulfil these criteria.

However, the WMO guide no. 1160 states that "*Members should operate surface land observing networks/platforms at horizontal resolutions of 100 km or higher*" and Uganda's topography and microclimate distribution, station backup capacity and concentration of socio-economic relevance in the central south requires at therefore more GBON stations.

In addition, the socio-economic and political stability in countries adjacent to Uganda, in the east and northern border could result in a prolonged and difficult instalment implementation and of SOFF stations in those regions. Uganda's UNMA, with its immediate ability and willingness to absorb SOFF support could intensify its station network in the western and northers regions, as to obtain data relevant for those areas.

Overlap of stations in the south central part of the country is justified as this area not only hosts the highest density of people in Uganda (over 8,5 million), it also hosts the national weather forecasting centre, the Uganda capital of Kampala and Uganda's main international airport (Fig. 1). Although the existing WIGOS-registered station at Jinja is not included in the station list proposed for SOFF (Table 3), UNMA and PA find it important to underline the importance of Jinja station. Rehabilitation under another program then SOFF is highly recommended.

Summarizing, UNMA and the PA opt for 9 stations (see table 3) rather than the minimal seven, with good national coverage, backup capacity in the Kampala area, relevance for data from conflicts areas and good topographical deviation in sites. The PA strongly advises WMO SOFF to honour this ambition.

The challenge now lies in addressing the current non-compliance of the stations registered in WIGOS/OSCAR with GBON standards, primarily due to sensor malfunctions and gaps in the capability for automatic data transmission. Rectifying these issues is imperative for ensuring that Uganda's contributions to the GBON initiative are not only quantitative in terms of station counts but also qualitatively significant, enhancing the global meteorological observation network's overall reliability and utility.

Table 3: List of current nine (9) potential SOFF stations, of which six (6) are already WMO – WIGOS/OSCAR registered AWS stations in Uganda. Three stations (Kotido, Kitgum, Mubende) are not yet registered. All nine stations are proposed to be rehabilitated under SOFF to GBON compliancy.

	Station Name	WIGOS_ID	Owner	Type	Lat	Lon	Required
1	Mbarara	63702	UNMA	AWS	0.6167S	30.6500W	Rehab
2	Masindi	63654	UNMA	AWS	1.6833N	31.7667W	Rehab
3	Kasese	63674	UNMA	AWS	0.1833N	30.1000W	Rehab
4	Soroti	63658	UNMA	AWS	1.7167N	33.6167W	Rehab
5	Entebbe IA	63705	UNMA	AWOS[3]	0.0500N	32.4500W	Rehab
6	Arua	63602	UNMA	AWS	3.0500N	30.9167W	Rehab
7	Kotido	-	UNMA	AWS	3.02N	34.17W	Rehab
8	Kitgum	-	UNMA	AWS	3.30N	21.88W	Rehab
9	Mubende	-	UNMA	AWS	0.58N	21.37W	Rehab

[3] AWOS : Aviation Weather Observing System

Rehabilitation of each of the nine proposed AWS to GBON compliance will involve the procurement, shipping, transportation, and installation of the following components:

- Temperature sensor
- Humidity sensor
- Atmospheric pressure sensor
- Rainfall sensor
- Wind sensor, including both speed and direction.
- Datalogger, complete with a solar panel and battery pack.
- Procurement of 5 spare sensor sets for temperature, humidity, atmospheric pressure, and wind speed and direction.

A critical aspect will be the IT hardware necessary for data transfer via GTS/WIS, or potentially, WIS2.0. This will necessitate corresponding open-access software and capacity building for UNMA staff in data sharing, for which support will be requested from WMO[4].

Additionally:

- Organization of periodic AWS maintenance SOPs (based on the manufacturer's instructions), including capacity, transportation, tools, etc., or alternatively, outsourcing maintenance to an external party.
- Furthermore, UNMA's requirements for updated hardware and software for data and database management, and the minimum system specifications for WIS2.0[5], must be met, potentially through CREWS East-Africa.
- Only Entebbe International Airport station is 24/7-manned stations. Station rehabilitation and upgrading GBON compliancy, including data transmission (to GTS/WIS or WIS2.0) will require new staff, training and updating of special SOP protocols.
- Station security (risks of theft) are minimized

Specific technical specifications will be utilized via UNMA when supporting IsDB in preparing tender documents during investment phase.

Upper air station

UNMA recognises that information of the atmospheric state (temperature, humidity, pressure, and horizontal wind) in the vertical profile is critically important when initializing weather forecast models and for aeronautical navigation. The GBON requirement of spatial resolution for upper-air sounding is 500 km or better with sufficient temporal resolution for observation per location being 1-4 sounding in 24 h.

UNMA has **one** location for a manually operated Upper Air Sounding facility at Entebbe International Airport (see Figure 2). This UAS has been operating since the 1960's until 2016 on a regular basis. The sounding station is currently out-of-operation since 2016. The station housing was rehabilitated in 2022. However, the old hydrogen generator is defect beyond repair, it has inadequate hydrogen storage facility, an incomplete filling facility and no installed communication

[4] WIS2.0 in a box training
[5] WIS2.0 system specifications

and computing facilities. This station was assessed as a present GBON gap. A full rehabilitation and operationalization of the UA sounding facility at Entebbe was recommended in the NGA report.

Two types of upper-air radio sounding systems are available: semi-automatic with manual launching and fully automatic. Both types of systems use the same sonde models (manufacturer specific), and thus, produce equally accurate observations. Daily operation with manual launching is laborious, salary costs are relatively with semi-automatic sounding system. The fully automatic system does not require daily attention from technical staff, but it requires higher initial investments and annual preventive maintenance and the need for advanced skill levels with operational cost implication. Corrective maintenance may also require remote and/or on-site support from the technical team of manufacturer.

The UNMA/KNMI team is confident that the best operational model and way to ensure fulfilling GBON requirements in short-, medium- and long-terms for Uganda is to operate two semi-automatic operated upper-air sounding system for 1) the Entebbe International Airport location, and 2) a location in the north of the country (either Lira or Gulu). See figure 2 for locations and coverage.

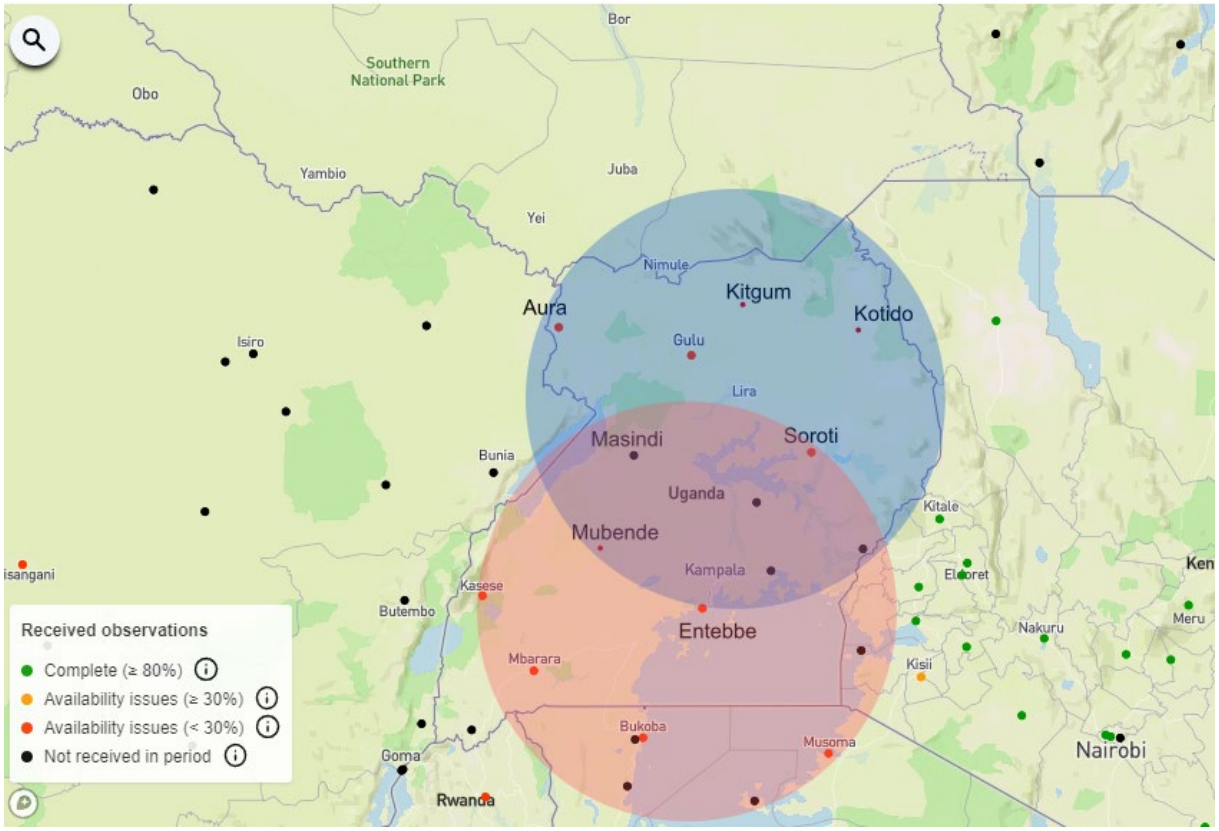

Figure 2: There are no registered Upper Air Stations (UAS) in Uganda registered in WDQMS. An UAS (site and infrastructure) at Entebbe International Airport is inactive and requires rehabilitation. The red circle indicate the 500 km diameter coverage area. A second UAS is proposed at Lira is indicated with the blue 500 km diameter circle. Gulu is an alternative location. Source map: WDQMS, taken from NGA Uganda (2024).

Rehabilitation Entebbe UAS

Renovation and construction work on the current UAS site Entebbe will include:

- Procurement and instalment of a new hydrogen generator
- Inspection, certification, or replacement of hydrogen storage tank/facility
- Rehabilitation of hydrogen filling facility
- Implementation of safety measures (gas storage etc.) related to UAS operation.
- Procurement, instalment of the ground monitoring and communication system, hardware and software
- Procurement of consumables (balloons and radio sondes)
- Sufficient human recourses and skills training will have to be included (ref. Module 4).

Housing and surroundings (launch field) are adequate; old pre-rehab parts will have to be removed. PA recommends making the UAS rehabilitation a priority, working towards operation within the second year of the investment phase. This working station can then be used for training new staff required for the second and new station.

A second UAS station: Gulu or Lira

In coordination with the SOFF secretariate, PA and UNMA propose the installation of a second UAS necessary for adequate UA coverage in Uganda. Airfield AWS locations Gulu or Lira have been identified as potential location for a second UAS. A new station would require land acquisition, full construction of station housing, and full installation of all necessary equipment.

Table 4: Suggestions for two locations for a potential second UAS in Uganda. Both the airfields at Gulu and at Lira are suitable locations.

Station Name	WIGOS_ID	Lat	Lon	Upper-air	Required
Entebbe	08594	16.73146N	22.93077W	UAS	Rehab.
Gulu **or** Lira	No ID No ID	Appr. 2.79N Appr. 2.25N	Appr. 32.28W Appr. 32.91W	UAS UAS	New New

The second and new UAS installed at Gulu or Lira will include:

- Selection and procurement of land.
- Requiring site and site preparations (fencing, ground surface).
- Housing facility for UAS and related office.
- Procurement and instalment of one semi-automated UAS, including hydrogen generator, hydrogen storage tank/facility, and balloon filling facility.
- Implementation of safety measures (gas storage etc.) related to UAS operation.
- Procurement, instalment of the ground monitoring and communication system, hardware and software.
- Procurement of consumables (balloons and radio sondes).
- Sufficient human recourses and skills training will have to be included (ref. Module 4).

Investment in a second UAS will depend on the chosen site and local conditions and can be influenced by regional investments (UAS distribution in neighbouring countries) and national

constraints, including obtaining permissions from authorities, availability of staff, and safety of operations (related to the use of hydrogen).

Given the prolonged period of inactivity at the Entebbe station, it is recommended to undertake a comprehensive review of operational, preventive, and corrective maintenance Standard Operating Procedures (SOPs) for UAS within UNAM. The peer advisor can assist in updating and developing operational procedures during the investment and implementation phase.

UAS operations

Operating UASs during the investment phase will require annual investments in consumable parts, adequate storage, and a budget for annual maintenance. Therefore, the investment phase funding request should account for these costs. It is recommended that UNMA outsources the (annual) maintenance of these stations to the manufacturer.

For operating the renewed and the new upper-air sounding facility, a support training program will have to be defined and developed, and new UAS operations staff to be recruited.

It can be expected that rehab of the Entebbe UAS can be achieved within 1 to 1,5 years after start of the investment phase, after which the station can be fully operational. Building the second and new UAS at Gulu or Lira may require 2 to 3 years before it will be in full operation.

Sensor calibration

Sensor calibration is critically important in Uganda, not just for GBON compliance. Currently, UNMA staff does not perform field calibration of instruments when anomalies or malfunctions are detected. Nearly all sensors at the WIGOS/OSCAR registered stations (Table 3 and Annex 1) tend to be non-sensitive, unstable, not calibrated, or erratic (see overview in Annex 1).

At present, UNMA staff is unable to conduct equipment maintenance and (re)calibration programs due to a lack of resources, materials, replacements, and calibration facilities in Uganda. When necessary, instruments could be sent for inspection and (re-)calibration to the WMO Regional Instrument Centre (RIC) in Nairobi, Kenya. However, financial constraints and the absence of temporary replacement sensors limit this option.

KNMI strongly recommends accompanying any AWS rehabilitation effort under SOFF (or complementary programs) with a robust field program for continuous maintenance and calibration of AWS equipment and sensors.

KNMI and UNMA recommend investing in the following field calibration equipment, required for enhancing operations and maintenance of weather field instruments (Table 5).

Table 5: Field calibration equipment requirement

Field Calibration Test equipment	Sensors	Quantity
Temp/humidity sensor with rad. shield	Temp/humidity	4
Barometric Pres. Transfer standard	Atmospheric pressure	4
Rain gauge calibration device	Precipitation calibration	4
Prop. torque etc.	Wind verification	4

Furthermore, KNMI and UNMA highly recommend equipping the NWFC at Entebbe with a small calibration laboratory featuring a climate chamber for the calibration of temperature and humidity sensors, as well as atmospheric pressure calibrations (Table 6). It is anticipated that all future laboratory calibrations for GBON temperature, humidity, and atmospheric pressure sensors will be conducted at the NWFC in Entebbe.

Table 6: Laboratory calibration equipment requirement

Calibrator	Sensors	quantity
Climate Chamber	Temp/humidity	1
Atmospheric Pressure	Atmospheric pressure	1

The laboratory should be fully equipped and be complemented with repair facilities (adequate workbenches), (power) tools, multi-meters, an oscilloscope, instrumentation, and travel toolsets (including multi-meters). Staff training will be necessary, as well as certification procedures and related costs for calibrators.

Subregional coordination, with National Meteorological and Hydrological Services (NMHSs) of neighbouring countries, as well as SOFF strategic considerations and involvement of WMO RIC Nairobi, may lead to alternative options for the calibration of instruments. However, the necessity for addressing sensor conditions in Uganda should not be underestimated (Annex 1). Short term, regular calibration, is preferred. UNMA considers this component part of its strategic ambition to improve service- and data quality. KNMI endorses this view. Anemometer calibration can be undertaken in the regional centre.
UNMA is very willing to share calibration capacity with neighbouring countries, like either Rwanda or South Sudan. No immediate explorations have yet been conducted.

3.2. Design of the ICT infrastructure, services and the data management system

The UNMA Headquarters in Kampala, alongside the NWFC in Entebbe, hosts the national network infrastructure essential for the storage and dissemination of Uganda's weather and climate data. This infrastructure includes network main servers, switches, cables, and more, which are pivotal in managing the data flow across the country. The primary public network service provider to UNMA, offering a Primary Link speed of mere 14Mbps, is the National Information Technology Authority (NITA). The desired speed would be 100mbps or above.

UNMA manages various data acquisition flows, encompassing airport navigation and safety, alongside other monitoring networks such as agrometeorological automatic weather stations, seismic stations, and more. In light of this, there is an acute need for a modern, efficient Data Management System (DMS) that acts as a critical link in the observation value chain, from measurement stations to the end-user interface. The envisioned ICT infrastructure should facilitate the automatic delivery of data from stations to international bodies and stakeholders, integrating an automated Quality Control (QC) system for observations, a capability that is currently lacking.

At present it is unclear what the technical and budgetary perspectives are for investments that will be made through SOFF or complementary programs, like CREWS East-Africa. Care must be taken to ensure the compliance of any further investments and supplementary implementations with the

Climate Data Management System. This system is responsible for storing, processing, and disseminating climate data and information products, hence the importance of compliance and integration to avoid redundancies and ensure a seamless flow of accurate and timely climate information.

Technical specifications for the data collection system from the observing station to the collection point

The Entebbe International Airport weather data and air navigation services utilize a distinct network and the NetSYS hardware/software system for providing weather forecasts and air navigation information to pilots, including message handling (MHS). The communication system employs OPMET (procured by UCAA) for data transmission.

None of the AWS stations listed in Table 3 are connected to the GTS (see Annex 1). In fact, due to low sensor reliability, only manually obtained reference data is transferred to the NFWC via SMS protocol or email at half-hourly intervals. As AWS stations are manned 12 hours a day, 7 days a week, only daytime data is collected. The AWS typically use their own data loggers.

Incoming station data (at 10-minute or longer time intervals) are centrally stored and managed using specific software. Data quality checks (for anomalies) are not automatically performed. For its manned AWS network, UNMA uses email, SMS and WhatsApp communication protocols and any available cell phone communication provider.

Technical specifications of the data services (compatible with the requirements of WIS 2.0)

Currently, UNMA does not use the GTS, let alone WIS or WIS2.0. Connecting AWS to GTS has the highest priority (after total station rehab and sensor calibration). There is no WIS2.0 protocol in place. The only data communication with the Regional Telecommunication Hub in Nairobi is via half-hourly email updates for an irregular set of stations.
At present, there is little staff capacity for operating WIS2.0-in-the-box, nor are AWS conditions sufficient for the collection of reliably accurate data. The upgrading from a not automatically connected situation (manually connected to GTS) to WIS2.0-in-the-box may be quite a challenging step. However, as WIS2.0-in-the-box installation is well documented (https://github.com/wmo-im/wis2box/discussions) it could be explored that a PA KNMI data communication expert can assist in installing or that an external consultant could be hired (preferably liaised with WMO).

Detailed description of the measures to ensure resilience and continuity of the full data processing chain

Meteorological data acquisition occurs sub-hourly in Uganda at various station locations and lake-based buoys for multiple purposes, including aviation, fisheries, agriculture, civil protection, disaster preparedness and management, environmental monitoring, and more.

However, the data processing chain currently faces significant challenges, as AWS stations are plagued by a lack of maintenance and are not equipped for automated data transfer, as previously mentioned. While the aviation weather services at Entebbe International Airport continue to meet

International Civil Aviation Organization (ICAO) requirements, even the synoptic aviation weather data from this station are not transmitted directly to the WMO – GTS.

Station rehabilitation, GTS connections, and a sustainable maintenance program are deemed essential. Furthermore, the development of a dedicated Data Management System (DMS) for UNMA is considered necessary, along with an overall upgrade of ICT hardware and software across the NWFC, UNMA HQ, AWS offices, and the UAS station at Entebbe.
Such an ICT overhaul will require a comprehensive capacity development (training) program across the entire data value chain. The integration of current (and potential) data flows within a climate data management system may be regarded as a second-phase component.

3.3. Design of the Climate Data Management System

A modern Data Management System (DMS) should leverage open-source technologies and protocols to ensure sustainable, resilient operation, maintenance, and development throughout their lifecycles and beyond. Whether cloud-based or on-premises, the choice depends on national legislation, regulations, staff capacity, and organizational decisions.

UNMA employs the Climsoft data management system/tool for archiving and managing climate datasets. Climsoft can encodes observations into weather messages according the WMO standards of Table Driven Code Forms and is capable of forwarding those encoded messages to the WIS global network. However, this integration is not yet established even though seven staff members have been trained to use this software.

For Uganda, the DMS must be capable of ingesting and storing various types of weather observation data formats, including but not limited to:

- Surface station weather observations
- Buoy-based weather observations
- Upper-air radiosonde observations
- Aviation weather observations
- Radar data observations
- Remote sensing data
- Lightning observation data

The three weather radar stations produce significant data volumes, demanding more storage capacity than UNMA currently possesses. Currently, radar data is only stored for 3 hours, significantly limiting the forecasting capabilities of the existing system. Upgrades in hardware, software, and engineering capacity are highly recommended to enhance UNMA's public service delivery. These aspects, however, may be beyond the scope of this document.

The DMS should serve both as a real-time and long-term (climatological) data repository. It should include modules for calculating value-added parameters and utilizing archived data. Moreover, the system must support standard API interfaces for database content retrieval, potentially including:

- WFS (Web Feature Service)
- EDR (Environmental Data Retrieval)
- WMS (Web Map Service)
- Export to SYNOP & BUFR message formats and delivery to the GTS network
- WIS 2.0 compliance (as per GBON requirements)

The DMS should also manage relevant metadata about stations, networks, and observations, with automatic updates to the WMO/OSCAR system being preferred. GBON hourly observation deliveries should adhere to WMO guidelines (no. 30611) and GBON practices.

Budget considerations must account for the infrastructure required to operate a DMS and data storage, including backup solutions for critical data. A valid support contract with a hardware vendor is advisable for the hardware's lifespan, estimated at 5-8 years before system renewal is necessary.

UNMA's current data storage facilities are limited and require updates. Data ingestion into the database should adopt a modular approach, allowing easy addition of new data feeds with minimal changes to existing components and database structures.

Supported protocols for data transfer and storage should include, at a minimum, Message Queuing Telemetry Transport (MQTT) and SSH File Transfer Protocol (SFTP), in line with GBON specifications. The system must also be capable of receiving and decoding messages from third-party data collection systems. Furthermore, a web-based tool for manual observation entry by stations is essential.

Currently, UNMA's data quality control (QC) capabilities are limited. A compatible QC module, either independent or modular, is crucial for the system upgrade. This QC module must enable real-time quality control and support manual quality checks for non-real-time data. The database system should facilitate time-series queries efficiently.

Resilience hinges on skilled staff and robust IT hardware, supplemented by a comprehensive lifecycle plan and budget. UNMA should oversee the entire data pipeline, necessitating the development of ICT infrastructure for an automated observation network, including GTS data transfer capacity, storage, maintenance, upgrades, and human resources. Enough personnel should be trained in IT skills relevant to meteorological observation and data management. The organization is advised to acquire expertise in meteorological data, data processing tools and principles, data formats, system architecture, software development, databases, APIs, network management, WIS 2.0, web development, and public communication.

3.4. Environmental and sustainability considerations

Apart from the need for immediate station rehabilitation and upgrades for the observation network to meet GBON standards, the sustainability of investments and the efficient operation of the

proposed GBON stations in Uganda hinge on a) securing adequate resources for b) fostering a team of highly competent and motivated management and staff within UNMA.

AWS (Automatic Weather Stations):

It is recommended that thirteen GBON-compliant weather stations be established under the SOFF initiative. For each station, a complete overhaul of sensors and data loggers is essential, although existing civil infrastructure (e.g., electricity supply, wind masts, etc.) can be reused. A robust, scheduled program for preventive maintenance and calibration is necessary to extend the lifecycle of sensors and ensure data reliability. Without such maintenance, calibration, and the capacity for sensor replacement, stations are unlikely to last beyond 5-6 years.

To maintain continuous operation, it is estimated that there should be a surplus of 30% more sensors than stations. For Uganda, this translates to needing four spare sensor sets in the initial investment phase to ensure the sustainable operation of the station network. Data logger replacement is also crucial for enabling efficient data transport and communication with GTS/WIS/WIS2.0 (currently absent in all stations). New dataloggers, for all stations, should have low energy demands, allowing for smaller solar panels and reducing susceptibility to theft.

Since all proposed stations for the SOFF overhaul are currently owned and operated by UNMA, rehabilitation, and the addition of GBON stations will not result in new environmental impacts. However, urban development near existing station locations could pose challenges to station sustainability.

Upper-air Sounding Stations

Establishing a GBON-compliant, semi-automatic upper-air sounding system in Entebbe is feasible with the procurement of a new hydrogen generator and updating ICT hardware and software being critical steps. Existing UNMA staff will require training updates. Proper maintenance is crucial for extending the lifespan of the station.

A new station in Gulu or Lira requires a full investment in a complete upper-air sounding (UAS) system, including land acquisition, housing and facilities. The choice between a semi-automatic or automatic system will depend on the availability of UNMA staff for operations. As with AWS, proper maintenance is crucial for extending the life of the station and equipment, with fully automatic systems being more susceptible to neglect.

Generating hydrogen locally at the station can enhance environmental sustainability and reduce dependence on external hydrogen suppliers, minimizing transportation needs.

Mandate and Public Services

Raising awareness at policy and political levels about the critical importance of improving the availability of essential meteorological data is vital. Discussions on UNMA's semi-independent status and the potential incorporation into the Ministry of Water and Environment are ongoing and represent a pivotal consideration for the agency's future.

The direct positive impact on independent weather forecasts, climate risk management, and the safety and well-being of the population cannot be overstated. UNMA must continue to advocate for its role and ensure the sustainability of its services and operations. Enhancing the availability and quality of forecasting products requires ongoing effort.

To bolster Uganda's climate resilience, UNMA should seek to expand its capabilities in climate data collection, data rescue, analysis, now- and forecasting abilities and product dissemination, ideally supported by explicit government requests.

Currently, the exploration of private sector involvement and the development of public-private partnership schemes for dedicated service delivery are in their infancy. This situation leaves UNMA reliant on government budgets and constrained by limited contributions from international support programs.

Financial support for UNMA is anticipated to be well received, with investments in improving climate services meeting a critical need in Uganda, where the majority of disaster risks (e.g., floods, landslides, drought, hailstorms, high rainfall variability) are directly related to weather conditions.

Module 4: Human Capacity Development

4.1. Assessment of human capacity gaps

Currently, Uganda National Meteorological Authority (UNMA) is experiencing a shortfall of personnel across all essential domains for a comprehensive weather service, including support services. The effective implementation of activities under the SOFF in Uganda is anticipated to increase the demand for skilled staff and enhance overall capabilities. It is crucial to note that current governmental HR regulations restrict UNMA's ability to engage in external recruitment, making the development of internal capacity vital. Consequently, the expansion in labour requirements for a revitalized observation network, ensuring adequate maintenance, calibration, and data management improvements, must be strategically planned, and supported thorough capacity development roadmaps and sufficient resources.

As of the end of the fiscal year 2019/20, UNMA's total workforce numbered 178, falling short of the approved staffing level of 218 across five directorates. By March 2024, 42 positions, which represents 28% of the necessary Human Recources (HR) capacity, remained unfilled, predominantly in support roles. However, critical meteorological and weather observation positions are adequately staffed. In 2023, the staff count at UNMA increased to 185 (refer to Table 7).

Despite the advancements in producing more reliable weather information in Uganda, UNMA lacks a strategic human resources plan for nurturing and providing an expanded suite of weather and climate services to both the public and private sectors.

Table 7: The 2023 overview of UNMA staff, positions, and gender distribution.

Staff information	Total number	
Managers and administrative support staff	15	
Meteo services (forecasters, met applications, data quality control, department managers)	28	
Meteo technicians' observations and (observation officers, supervisors, instrument maintenance, calibration, etc)	70	
Research		
Information technology (ICT services)	7	
Others, specific experts	6	
General support staff (drivers, etc)	59	
Total employees (2023)	185	
Staff disaggregated by gender	**Number**	**Percentage**
Male	126	68
Female	59	32

The operationalisation of aviation meteorological services at the newly developed Kabalega International Airport (KIA) in western Uganda will require additional human resources that are not yet accounted for in UNMA. These would require reskilling/on-job training.

It is important to note that the reactivation of the UAS at Entebbe is important for the operations at KIA. In the same sense, data from the proposed second and new UAS in northern Uganda (Gulu or Lira) would complement operations at KIA. However, at present there is only one person in UNMA with the experience to operate UASs.

Currently, data management represents a significant vulnerability for UNMA, impacting data security, quality of the products, and overall service delivery. There is a critical need for enhancements in software engineering and development capacity to address issues in data management, communications, rescue, and archiving, both from a quantitative and qualitative perspective.

The existing Doppler radar facilities located in three regions, according to UNMA, necessitate additional personnel focused on hardware maintenance and electrical engineering (2 Full Time Equivalents; FTEs) and software engineering (2 FTEs) to unlock the full meteorological and socio-economic potential of these instruments. It's important to note that this requirement may fall beyond the scope of this report and SOFF initiative.

As for the current staffing levels, the number of meteorological experts and technicians is deemed adequate. Nonetheless, the upcoming demands AWS and UAS system rehabilitation, installation, operation, maintenance, and sensor calibration efforts (all in alignment with GBON compliance) have not been fully considered. Given the existing capacity, skill sets, and personnel availability, UNMA anticipates the need for an additional 15-20 meteorological and technical staff to meet the

forthcoming requirements associated with GBON/SOFF, ensuring sufficient human resource capacity (Table 8).

Table 8: First indicative estimation for Human Resource Capacity Requirements as Identified by UNMA for installing, operating, and maintaining a GBON-compliant station network and associated functions.

Staff functions	Actual Numbers	Estimated addition
Hydrometeorology	3	+1
Climate Services	10	+2
ICT specialists & software engineers	7	+2
Meteorological Personnel (Weather Observers and Forecasters)	65	+13
Technician (maintenances and calibration)	3	+2
Managerial and non-technical support staff	5	-
Total numbers:	90	+20

Staff training and education

UNMA has made significant progress through both short-term and long-term capacity-building initiatives to stay abreast of rapidly evolving technologies in the field of meteorology. From 2016 to 2020, training programs were conducted enabling staff to achieve advanced qualifications in meteorology, including four Doctorates (Ph.D.), 14 Master's degrees, 21 Bachelor's degrees, and various specialized certifications in weather, climate, and related sciences from universities both in Uganda and internationally (e.g. United Kingdom, People's Republic of China).

The organization's internal training agenda is steered by a training policy, established in 2020, under the stewardship of the Executive Director and the Director of Training & Research. The revised policy (Training Policy 2024) is currently under review by the UNMA board. Presently, capacity development efforts are being directed by a comprehensive training needs assessment.

Due to the current GoU regulations, UNMA is restricted from externally recruiting specialized talent, thus emphasizing the importance of internal scouting and in-house training programs, enhanced through international collaboration efforts.

The demand for training is notably high, with over 80% of all personnel identified as needing further education, particularly in areas such as meteorological data processing and analysis, development of meteorological products, database and computer network management, and the application and utilization of meteorological radars and satellites. There is a noted absence of training in Uganda for maintaining meteorological sensors, including operating calibration facilities. The enhancement of international collaborations and UNMA's involvement in international research programs are limited by a deficiency in project proposal development skills.

UNMA staff have participated in training programs at the WMO Regional Training Centres (RTC) in Nairobi, Kenya, and other international locations. These centres, including the University of Nairobi

and the Institute for Meteorological Training and Research (IMTR) in Nairobi, can play a crucial role in providing advanced training.
Aviation meteorologists also engage in ICAO-affiliated training at regional centres and additional venues globally.

Currently, weather observers and station technicians receive local training aligned with WMO Class I and Class II syllabi. To align with the enhanced standards set by the WMO's updated Basic Instruction Package for Meteorological Technicians (BIP-MT 2022), it is imperative that staff and technicians involved with GBON stations receive comprehensive refresher training.

A forthcoming challenge for many UNMA staff will be managing the transition to the WIS2.0 system, which utilizes Free and Open-Source Software (FOSS) tools and Python v.3 with software program wis2-in-a-box. This transition necessitates specialized training in these technologies.

Given UNMA's limited internal resources for HR development and training, exploring partnerships and twinning arrangements with other NMHSs, including those involved in peer reviews, and regional training initiatives (such as those under CREWS) at RTCs, for example, in Nairobi, is considered a viable strategy.

Sustainability
To facilitate a more sustainable internal capacity development, UNMA has started communications with the Uganda Ministry of Finance on permanent contracting the additional staff associated with the SOFF program, e.g. after the investment phase. These discussions fall within UNMA's required improvement on its public services as stated in the Uganda National Development Plan II. Discussions have just started, in the slipstream of the NCP and investment plan development. There are not yet available formal strategics reports on the integration of SOFF-related human recourses within an overall long-term HR development plan within UNMA.

4.2. Design capacity development activities for technical staff

The competence-building process and Quality Management System (QMS) at UNMA are in their infancy and necessitate significant improvements. This is particularly crucial for aligning with the SOFF goals, adhering to WMO guidance (no. 1205)[6], and meeting the GBON compliance requirements. This encompasses broad areas including the rehabilitation, operation, and maintenance of the observation network, as well as enhancing the data management system and its associated value chain.

Currently, UNMA's approach to competence building lacks a comprehensive and systematic internal training program. This gap is mainly due to a heavy reliance on the availability of external sources for funding, project opportunities, and the provision of trainers.

To rectify this, UNMA could establish a detailed agenda for both internal and external training initiatives. This would involve the development of specific competence criteria tailored to various functional roles within the organization. Training materials could be compiled from a range of sources, including international capacity-building projects and valuable WMO guides, such as

[6] https://library.wmo.int/viewer/55828

WMO no. 1114[7] and the Guide to the Implementation of Education and Training Standards in Meteorology and Hydrology (WMO no. 1083)[8].

Through the Gap Analysis and the development of the Country Hydromet Diagnostics report, several critical training needs for UNMA have been identified:

1. **Quality Management System (QMS**): There's a need to bolster the QMS to ensure systematic and efficient operation and maintenance of observation networks. Although UNMA possesses a strong foundational knowledge of QMS and has staff trained for internal auditing, there's room for growth in observation process lifecycle planning and execution. It's suggested that UNMA engages in benchmarking exercises for QMS related to AWS and UAS with leading organizations, including the peer-reviewer, to enhance its procedures.

2. **Data Management and Archiving**: The programming skills of staff need to be enhanced to support effective data archiving strategies. UNMA could benefit from benchmarking exercises with institutions that possess advanced data archiving systems, learning best practices. Additionally, an intensive data rescue program would necessitate training in digitization and archiving methodologies.

3. **Data Transfer:** The current lack of capacity for efficient data transfer poses a significant hurdle for achieving GBON compliance. Training for UNMA's programmers on automating data transfer processes from observation stations to the database, and thereafter to Regional telecommunication Hub or the WMO WIS2.0 interface, is crucial. Linking the AWS network to the GTS would mark a significant advancement.

4. **Data Quality Control and Assurance:** There is a pressing need to upgrade the basic programming skills and scientific knowledge of staff to enable them to apply quality assurance and quality control (QA/QC) methods effectively. Capacity building is necessary to equip staff with a comprehensive understanding of the scientific principles underlying different QA/QC methods.

5. **Instrument and Station Maintenance:** To maximize the longevity and effectiveness of SOFF investments, technical training in maintaining AWS setups and various sensor types is vital. This includes adopting good Standard Operating Procedures (SOPs) and competence criteria. Training is also necessary for the operation and maintenance of the UAS (and a potential second station), considering operations were halted in 2016.

6. **Calibration and Sensor Maintenance**: If UNMA decides to reopen or enhance its calibration facilities, training in the use of calibration and testing equipment, both in laboratory and field settings, is essential. Staff should understand the role of calibration in

[7] https://library.wmo.int/viewer/50013
[8] https://library.wmo.int/viewer/35676

the observation value chain and be skilled in analysing calibration results to inform maintenance planning.

7. **Network Monitoring and ICT System Operations:** Staff responsible for ICT systems require an upgrade in their capabilities, including programming skills and technical understanding, to ensure the seamless 24/7 operation of the data pipeline from station to international distribution channels.

This comprehensive approach to capacity development is aimed at addressing the current deficiencies within UNMA's technical staff and equipping them with the necessary skills and knowledge to meet the evolving demands of the meteorological field, against the background of the SOFF/GBON program.

4.3. Design capacity development activities for senior management.

Effective capacity development for senior management at UNMA is pivotal for enhancing the organization's project organization structure, from top management to project contact points and managers. This development aims to improve competencies in portfolio and project management, proposal development and coordination, and aligning project portfolios with the organization's strategic objectives. To achieve these goals, UNMA should pursue training and development in several key areas, including:

- International Development Collaboration: Engaging with international partners can provide UNMA's senior management with insights into global best practices in meteorological services and project management, foster learning and innovation, essential for UNMA's growth, alignment with international standards and an increased potential for international project funds.
- Benchmarking with NMHSs at managerial levels and sub-Regional Cooperation: Comparing UNMA's management practices with those of other NMHSs can reveal areas for improvement and opportunities for cooperation. Sub-regional collaborations can also enhance UNMA's capacity to benefiting from shared knowledge and resources.
- Portfolio and Project Management: Specialized training in portfolio and project management is crucial for senior managers to oversee projects efficiently, from initiation to closure. This includes mastering techniques for risk management, resource allocation, and stakeholder engagement, ensuring projects contribute to the strategic goals of UNMA.
- Strategic and Financial Planning: Senior management should be well-versed in strategic planning processes that define the organization's direction and financial planning to ensure the sustainability of projects and operations.

In addition to these areas, UNMA's senior management and staff could benefit from short courses focused on the dissemination of weather information and enhancing communication and presentation skills. These skills are particularly relevant for public appearances, issuing early warnings for extreme weather events, and effectively communicating weather information to the public and stakeholders.

The peer advisor expresses a willingness to explore further cooperation and knowledge exchange, highlighting the importance of continuous learning and collaboration in strengthening UNMA's capacity to fulfil its mission and strategic goals.

4.4. Gender and CSOs considerations

UNMA currently depicts a gender ratio of 2:1 in its staffing, with no female representation at the director level. However, gender balance is more favourable within the Board, where half of the 6 members are women. The representation of women in middle management requires specific attention as, at present, all managers are male.

The 2020/21 – 2024/25 UNMA Strategic Plan acknowledges gender and equity as critical cross-cutting issues, emphasizing gender-responsive programming as central to its operations. UNMA enforces a merit-based recruitment policy, ensuring no discrimination based on gender, ethnicity, or religious affiliation.

To promote gender and equity actively, UNMA has institutionalized initiatives such as staff training on these topics and affirmative actions to encourage women to pursue studies in meteorology at the National Meteorology Training School (NMTS) and other educational institutions.

Recognizing the unique vulnerabilities of individuals with disabilities and the youth to weather impacts, UNMA has tailored its weather and climate communications to be more inclusive. Seasonal forecasts are translated into 35 local languages, facilitating equitable access to weather and climate services nationwide.

To further embed gender equity in its operations, it is recommended that UNMA conducts a gender assessment at both the start and end of the SOFF Investment Phase to monitor the effectiveness of gender-focused actions. Consideration should be given to establishing an internal quota for the SOFF activities, including training, aiming for at least 50% female participation among staff and ensuring significant female contributions in stakeholder engagement workshops. This commitment to equity should be upheld consistently in all SOFF-related activities, both at the implementing entity and peer advisor levels.

The adverse effects of weather disasters in Uganda disproportionately affect the most vulnerable, with gender, age, and health status being crucial exacerbating factors.
Integrating gender perspectives and engaging civil society organizations (CSOs) in all activities is crucial, especially for a government-based institution like UNMA. This approach should span governance, policy-making, development, dissemination, and response levels, incorporating participative methodologies to amplify the voices of those typically underrepresented.

Encouraging the involvement of CSOs is essential. UNMA's established collaborations with entities such as the Uganda Red Cross Society (URCS) and the International Federation of Red Cross and Red Crescent Societies (IFRC). IFRC provide a solid foundation, as do partnerships with the Uganda National Farmers Federation and the Greater Entebbe Fishers Development Initiative. A further recommendation is to enhance cooperation with the Ministry of Health, acknowledging the growing concern over weather related health phenomena in Uganda. This collaborative approach

will ensure a more inclusive and comprehensive response to the challenges posed by weather and climate variability.

UNMA actively connects with CSO's on increasing public awareness and education on the role and importance of meteorological stations for weather and climate information towards the local communities. Here the CSO functions as intermediate between UNMA and the community, both for information dissemination as well as feedback on information usage. UNMA's experience with such involvement is very positive as communities consider the AWS stations "*as their own*". Worth mentioning is UNMA's MOU with the International Crane Foundation on the community awareness of AWS stations in very remote locations of the country.

Further collaborations with CSO are welcomed at UNMA, from a communications, public awareness, training or disaster responds perspective. At this stage, PA can not concretely suggest immediate new relationships. However, a PA-arranged trainee from the Netherlands will be based for a 6-month period at UNMA, providing capacity for further exploration of CSO involvement.

Module 5: Risk Management

WMO recommends its members to establish a Quality Management System (QMS) to ensure that customer and end user requirements are met (WMO no. 110020). ICAO requires all Aviation Meteorological services to implement a QMS) in its operations**.** UNMA has a ISO9001:2015 certified QMS, and subsequently, comprehensive risk matrixes for AWS and ICT operation and maintenance.

In general, the risk-based thinking (including the risk matrix) is at a high level in the organization. UNMA has a Risk Management Framework Risk Management Office which synthesis risks logs at a monthly basis for reporting to the ED and the Board Audit and Risk committee.

UNMA's position as a semi-independent authority is currently under discussion, with the ongoing discussion of the incorporation of UNMA in the Ministry of Water and Environment as a viable option. Depending on the outcome, risk associated with this transfer need to be revised.

5.1. Recommendations for risk management during SOFF investment implementation and operation period

As stated in the SOFF Operations Manual, the risk mitigation procedures of the Implementing Entity (IE) will be relied upon for SOFF implementation during the Investment phase. The Operational phase is supported by the risk mitigation procedures of the beneficiary.

The following summarises overarching key risks for investment and operation phase to be carefully considered and handled by IE, the beneficiary (UNMA), and peer adviser (PA, here KNMI):

The PA and UNMA distinguished among the following risk categories:

- Contextual: risks related to conflicts, safety, political stability, regional weather, jeopardizing the delivery of the Readiness and Investment phase outputs
- Institutional: risks related to the beneficiary country's institutions participation in the Readiness and Investment phases, including governmental status of UNMA.
- Programmatic: risks related to the country ownership of the Readiness phase outputs and transition to investment and operations.

The identified risks are listed in Table 9 and are assumed to be relevant for the Investments Phase and the Operational Phase of the SOFF Program alike. Please note that the **operational risks** refer to the present situation, indicating the necessity for improvement. When the proposed rehabilitation program will have been completed these risks will have been reduced to a minimum.

Table 9: Overview of identified risk related to GBON implementation in Uganda.

Risk category and description	Probability	Impact	Mitigation action	Monitoring & evaluation
Operational (at present, prior to rehabilitation under SOFF)				
- Location security/theft, and	Low to medium	High	Improve site security (fencing, staff) and reduction of solar panel size (vulnerable to theft)	UNMA to monitor and adjust rehabilitation plans to maximize site security and reduce vulnerability to theft
- Sustainability (technically)	Medium	Moderate	GBON SOFF efforts should guarantee sufficient resources for scheduled maintenance	UNMA to monitor and evaluate; to be considerate the hearth of the SOFF efforts including spare's, calibration capacity, transportation, etc.
- Constant power supply	Medium	High	Grid reliability is insufficient. Station should be solar paneled. Related to security. Low power demand equipment is required to limit solar panel size and battery storage. The bigger the panel, the higher vulnerability to theft.	UNMA to monitor and evaluate power situations; and incorporate solar panel theft vulnerability in rehabilitation plans and design.
- Communication stability	Medium	High	Current station bottle neck (non is automatically GTW/WIS connected); manual data transfer is vulnerable to errors. Automated GTS/WIS connection required. Create rapid repair responds facilities in case of tech failure; explore communication backup systems in rehab design.	UNMA to monitor communication stability, by organizing central 24/7 staff monitoring of the GBON SOFF station functioning.
Contextual				
- Geography (insecure region)	Very low	High	No GBON site is considered considerably insecure. No relocation actions required. UNMA has an MOU with the CSO International Crane Foundation for safeguarding AWS stations in more remote locations of the country.	UNMA to monitor and evaluate situation, including site security and sensor / instrumental functioning
- Site Accessibility issues	Low / very low	High	All sites are UNMA-managed; or owned by trustworthy partners.	UNMA to monitor and evaluate situation, including site security
- Weather Extremes	Medium	Medium	Regular monitoring required; AWS maintenance required	UNMA to monitor and evaluate situation, including site security and repairs
- SOFF-funded investments cause environmental or social impacts	Low	Low	All proposed sites are existing AWS; the new UAS will be located around the Gulu or Lira airfields, both are relatively secure sites.	No mayor impact expected. UNMA management to consider.
Institutional				
- Status UNMA as an semi independent authority	medium	High	Monitoring situation; GoU interval process.	UNMA management to inform SOFF team on status
- Staff availability for implementation (AWS, ICT, DM, UAS)	Medium to high	High	Staff availability is low. Explore synergy with SOFF related programs. Timely initiation of recruitment & training	UNMA management to monitor and evaluate.
- Inadequate human capacity	Medium to high	High	Development of internal training program including the criteria of competence requirements for technical staff.	UNMA management to monitor and evaluate; EA to assist.

- Slow procurement of equipment a/o technical capacity issues	Medium	Medium to high	Support/advice required for certain equipment procurement; timely involvement of GoU	IE, UNMA management and PA to monitor and evaluate;
- Slow implementation of station rehab	Low to medium	Medium	Possibly external capacity to support station rehab	IE and UNMA management to monitor and evaluate; PA to assist.
- Destruction or theft of SOFF financed equipment	Medium	High	AWS sites are secure; solar panels vulnerable to theft; small size panels required	UNMA management to monitor and evaluate
- Slow implementation of training & CD activities	Medium	Medium	Develop fast track, esp, for AWC communication and data transfer (GTS/WIS/WIS2.0), station maintenance and DM	UNMA management to monitor and evaluate; PA to assist.
- Retaining of staff & competences	High	High / Medium	Retirement play role. Implement staff (development) policy, timely coordination with Min of Public Services (recruitment). Staff departure after training is concern.	UNMA management to monitor and evaluate; improve HRM policies (although GoU regulated)
- Slow implementation of data sharing and dissemination	Medium	High	Fast-track capacity development (internal) for ICT hardware/software and capacity and DM	UNMA management to monitor and evaluate; PA to assist. IE support.
- Data accessibility and transport restricted (to RTH or global)	High	High	Fast-track development of GTS/WOS/WIS2.0 infra and capacity	IE, UNAM management to spearhead, both to monitor and evaluate
Programmatic				
- Decrease in funding support for sustainable operations.	Medium/High	High	IE and UNMA management are responsible for taking actions to secure (nat./int'l) funds	IE and UNMA management to monitor and evaluate.
- Lack of support from other Government agencies, incl. central	Medium	Medium	UNMA has sufficient communications to persuade GoU as weather and climate is high in agenda;	UNMA management, with support of IE, monitors partners interest and position GoU
- Lack of synergy with SOFF complimentary programs	Low	Medium	Coordination between SOFF and CREWS seems vital	WMO, UNMA, PA, IE have joint responsibility

Module 6: Transition to SOFF investment phase

The transition to SOFF investment phase is recommended to carry out by following the Uganda Gap Analysis, the Uganda Country Hydromet Diagnostics Report and National Contribution plan (this document). **The peer adviser, the IE and UNMA have not yet been able to complete the funding request for the SOFF implementation phase.**

6.1. Summary of GBON National Contribution Plan

Components	Recommended activities
Module 2. GBON business model and institutional development	1. UNMA relies primarily on government budget allocations and a few international development collaborations to meet its national and international responsibilities, including operations compliant with the GBON. This financial model results in minimal to non-existent funding for essential station maintenance, leading to adverse impacts.
	2. UNMA is in the process of establishing a cost-recovery mechanism to enhance financial stability. This initiative is highly supported. However, it is crucial to recognize that operational activities require a foundation of sustainable budgeting beyond the scope of cost-recovery efforts.
	3. It is advisable to broaden and strengthen partnerships at both national and international levels to ensure GBON compliance and enhance the overall effectiveness of the observation and service provision value chain.
	4. UNMA should develop a comprehensive lifecycle management plan for its AWS and UAS stations slated for rehabilitation. This plan should provide a structured approach to justify budget allocations and funding for maintenance, sensor replacement, and calibration services.
	5. The ongoing policy discussions concerning the potential reintegration of UNMA's functions back into the Ministry of Water and Environment present significant concerns for its semi-autonomous status. These discussions warrant careful consideration to maintain the integrity and effectiveness of UNMA's meteorological services.
	6. PA promotes UNMA's collaboration with the private sector especially in the domain of dissemination of weather information, based on mobile applications (eg. with the use of the modern weather radar data). Private sector involvement (both as service providers and client for custom services) can be explored during the SOFF investment phase.
	1. Following WMO and SOFF guidance, UNMA will have to drastically improve its current AWS stations and the existing UAS and set-up a

Module 3. GBON infrastructure development	new GBON compliant observation infrastructure, with subsequent automatic data transfers with the GTS/WIS or WIS2.0.
	2. Through engagement with SOFF, KNMI, neighbouring country NMHS and regional partners, UNMA aims to set-up a monitoring and evaluation chain, starting from station operations, communication, calibration, maintenance and data management, quality assessment and quality control through engagement with SOFF, KNMI, neighbouring country NMHS and regional partners.
	3. ICT hardware and software abilities should be upgraded, either via on location facilities or cloud-based products.
Module 4. GBON human capacity development	1. UNMA is currently understaffed. SOFF GBON efforts will compete with existing responsibilities. Communications with GoU are recommended to allow for adequate additional recruitment, and retirement replacement
	2. A total re-tooling of UNMA staff related to technical developments and requirements is necessary, especially in the areas of data management, -archiving, -storage and -transfer, QA/QC, station and sensor maintenance, sensor calibration, network monitoring and ICT.
	3. UNMA can benefit from management capacity improvement related to international collaboration, program management, international benchmarking, and strategic and financial planning.
	4. Appropriate efforts related to gender equality in the management in UNMA is highly recommended
Module 5. Risk Management	1. UNMA displays significant risk awareness; further development of its certified QMS is advised upon. Risks related to SOFF involve availability of sufficient capacity; operational procedures and capability related to AWS maintenance; and ability to adequately train exiting staff to operate at higher QMS levels and GBON compliancy
	2. Development of a second international Airport in west Uganda will further increase demand for capacity and staff and is to be taken into consideration.
	3. Capacity risk and training needs rely heavily on international support programs (CREWS). Coordination with SOFF is vital.
	4. UNMA's position as a semi-independent authority is currently under discussion, with the ongoing discussion of the incorporation of UNMA in the Ministry of Water and Environment as a viable option. UNMA, IE and PA should monitor this development carefully.

Module 6. Transition to SOFF investment phase	1. The transition to SOFF investment phase is recommended to carry out by following the Uganda Gap Analysis, the Uganda Country Hydromet Diagnostics Report and National Contribution plan (this document). The peer adviser, the IE and UNMA have not yet been able to complete the funding request for the SOFF implementation phase.

7. Report completion signatures

Peer Advisor signature  Mr Rubert Konijn, Director International Affairs, Royal Netherlands Meteorological Institute (KNMI), The Netherlands
Beneficiary Country remarks and signature  Dr. Bob Alex Ogwang, Executive Director, Uganda National Meteorological Authority (UNMA), WMO PR of Uganda
WMO Technical Authority screening remarks and signature 

ANNEX 1: Current state of UNMA WIGOS/OSCAR-registered and non-registered automatic meteorological weather stations, relevant for GBON-SOFF selection.

This annex provides an UNMA inventory of the status of all eleven (11) under WGOS /OSCAR/SURFACE registered AWSs in Uganda, plus four (4) non-registered, but important UNMA AWSs.
The selection of station for rehabilitation under SOFF is based on this list.
The UAS Station at Entebbe (decommissioned) is also included. Taken from Gap Analysis Report 2024.

ENTEBBE INTERNATIONAL AIRPORT – WIGOS ID: 63705			
Lat : 0.05	**Lon : 32.45**	**Elev : 1155m**	**Date opening: 2016**
TITLE/EQUIPMENT	**PROBLEMS ENCOUNTERED**	**IMPACTS ON OPERATIONS**	**PROPOSED SOLUTIONS**
Surface Measurement Equipment	1) Anemometer: life span 8 years – not sensitive. 2) Wind Vane: life span 8 years – not sensitive 3) Thermometer: life span 5 years – inconsistent 4) Hygrometer: life span 5 years – out of range 5) Atmospheric Barometer: life span 5 years – erratic 6) Rain gauge: life span 8 years – inconsistent 7) Data logger: life span 8 years – power problem 8) Solar panel life span 8 years – charges low	1) Wind data not used/ shared 2) Wind data not used/ shared 3) Temperature data not used/ shared 4) Data is not used and shared 5) Data is not used and shared 6) Data is not used and shared 7) Data not transmitted 8) Data logger not working 24 hours	1) Replace Anemometer 2) Replace wind vane 3) Replace thermometer 4) Replace Hydrometer 5) Replacement of Barometer 6) Replace Rain gauge 7) Replace Batteries (stock batteries) 8) Replace solar panel
Transmission	Data logger does not connect to GTS. Weather data not in table driven format codes.	Weather data not transmitted to GTS weather data not accepted on GTS	Create interface between AWS to Nairobi hub Equip Server with conversion software.
Building	Office accommodation dilapidated.	Reduced commitment to office time.	Renovate office block and adequately furnish it with basic necessities.
Station Environment	insecure office environment	Night work reduced	Provide for office safety measures/facilities.
Work Environment	Poor work environment	Reduced commitment to office time	Enhance working environment by providing necessities like breakfast and launch
Human Resources (Staff)	Capacity low on IT based work	Adoption of new work methods low	periodic Capacity building trainings
Other remarks			In general, a number weather sensors require replacement
Picture site if available			

MASINDI METEOROLOGICAL STATION – WIGOS ID: 63654			
Lat : 1.68	**Lon : 31.72**	**Elev : 1147m**	**Date opening: 2016**
TITLE/EQUIPMENT	**PROBLEMS ENCOUNTERED**	**IMPACTS ON OPERATIONS**	**PROPOSED SOLUTIONS**
Surface Measurement Equipment	1) Anemometer: life span 8 years – not sensitive. 2) Wind Vane: life span 8 years – not sensitive 3) Thermometer: life span 5 years – inconsistent 4) Hygrometer: life span 5 years – out of range 5) Atmospheric Barometer: life span 5 years – erratic 6) Rain gauge: life span 8 years – inconsistent 7) Data logger: life span 8 years – power problem 8) Solar panel life span 8 years – charges low	1) Wind data not used/ shared 2) Wind data not used/ shared 3) Temperature data not used/ shared 4) Data is not used and shared 5) Data is not used and shared 6) Data is not used and shared 7) Data not transmitted 8) Data logger not working 24 hours	1) Replace Anemometer 2) Replace wind vane 3) Replace thermometer 4) Replace Hydrometer 5) Replacement of Barometer 6) Replace Rain gauge 7) Replace Batteries (stock batteries) 8) Replace solar panel
Transmission	Data logger does not connect to GTS. Weather data not in table driven format codes.	Weather data not transmitted to GTS weather data not accepted on GTS	Create interface between AWS to Nairobi hub Equip Server with conversion software.
Building	Office accommodation dilapidated.	Reduced commitment to office time.	Renovate office block and adequately furnish it with necessities.
Station Environment	secure office environment	Commitment to office time is good	Provide for office safety measures/facilities.
Work Environment	Poor work environment	Reduced commitment to office time	Enhance working environment by providing necessities like breakfast and launch
Human Resources (Staff)	Capacity low on IT based work	Adoption of new work methods low	periodic Capacity building trainings
Other remarks			In general a number weather sensors require replacement
Picture site if available			

KASESE METEOROLOGICAL STATION – WIGOS ID: 63654			
Lat : 0.18	**Lon : 30.10**	**Elev : 691m**	**Date opening: 2016**
TITLE/EQUIPMENT	**PROBLEMS ENCOUNTERED**	**IMPACTS ON OPERATIONS**	**PROPOSED SOLUTIONS**
Surface Measurement Equipment	1) Anemometer: life span 8 years – not sensitive. 2) Wind Vane: life span 8 years – not sensitive 3) Thermometer: life span 5 years – inconsistent 4) Hygrometer: life span 5 years – out of range 5) Atmospheric Barometer: life span 5 years – erratic 6) Rain gauge: life span 8 years – inconsistent 7) Data logger: life span 8 years – power problem 8) Solar panel life span 8 years – charges low	1) Wind data not used/ shared 2) Wind data not used/ shared 3) Temperature data not used/ shared 4) Data is not used and shared 5) Data is not used and shared 6) Data is not used and shared 7) Data not transmitted 8) Data logger not working 24 hours	1) Replace Anemometer 2) Replace wind vane 3) Replace thermometer 4) Replace Hydrometer 5) Replacement of Barometer 6) Replace Rain gauge 7) Replace Batteries (stock batteries) 8) Replace solar panel
Transmission	Data logger does not connect to GTS. Weather data not in table driven format codes.	Weather data not transmitted to GTS weather data not accepted on GTS	Create interface between AWS to Nairobi hub Equip Server with conversion software.
Building	Good	Good commitment to office time.	Renovate office block and adequately furnish it with necessities.
Station Environment	secure office environment but no safety gear	Good commitment	Provide for office safety measures/facilities.
Work Environment	Poor work environment	Reduced commitment to office time	Enhance working environment by providing necessities like breakfast and launch
Human Resources (Staff)	Capacity low on IT based work	Adoption of new work methods low	periodic Capacity building trainings
Other remarks			In general a number weather sensors require replacement
Picture site if available			

KABALE METEOROLOGICAL STATION – WIGOS ID: 63726			
Lat : -1.25	**Lon : 29.98**	**Elev : 1869m**	**Date opening: 2016**
TITLE/EQUIPMENT	**PROBLEMS ENCOUNTERED**	**IMPACTS ON OPERATIONS**	**PROPOSED SOLUTIONS**
Surface Measurement Equipment	1) Anemometer: life span 8 years – not sensitive. 2) Wind Vane: life span 8 years – not sensitive 3) Thermometer: life span 5 years – not calibrated 4) Hygrometer: life span 5 years – not calibrated 5) Atmospheric Barometer: life span 5 years – erratic 6) Rain gauge: life span 8 years – inconsistent 7) Data logger: life span 8 years – power problem 8) Solar panel life span 8 years – charges low	1) Wind data not used/ shared 2) Wind data not used/ shared 3) Temperature data not used/ shared 4) Data is not used and shared 5) Data is not used and shared 6) Data is not used and shared 7) Data not transmitted 8) Data logger not working 24 hours	1) Replace Anemometer 2) Replace wind vane 3) Replace thermometer 4) Replace Hydrometer 5) Replacement of calibrated Barometer 6) Replace Rain gauge 7) Replace Batteries (stock batteries) 8) Replace solar panel
Transmission	Data logger does not connect to GTS. Weather data not in table driven format codes.	Weather data not transmitted to GTS weather data not accepted on GTS	Create interface between AWS to Nairobi hub Equip Server with conversion software.
Building	Office accommodation dilapidated.	Reduced commitment to office time.	Renovate office block and adequately furnish it with necessities.
Station Environment	secure office environment but no safety gear	Commitment to work is good	Provide for office safety measures/facilities.
Work Environment	Poor work environment	Reduced commitment to office time	Enhance working environment by providing necessities like breakfast and launch
Human Resources (Staff)	Capacity low on IT based work	Adoption of new work methods low	periodic Capacity building trainings
Other remarks			In general a number weather sensors require replacement
Picture site if available			

MBARARA METEOROLOGICAL STATION – WIGOS ID: 63702			
Lat : -0.60	**Long : 30.68**	**Elev : 1420m**	**Date opening: 2016**
TITLE/EQUIPMENT	**PROBLEMS ENCOUNTERED**	**IMPACTS ON OPERATIONS**	**PROPOSED SOLUTIONS**
Surface Measurement Equipment	1) Anemometer: life span 8 years – not sensitive. 2) Wind Vane: life span 8 years – not sensitive 3) Thermometer: life span 5 years – not calibrated 4) Hygrometer: life span 5 years – not calibrated 5) Atmospheric Barometer: life span 5 years – erratic 6) Rain gauge: life span 8 years – inconsistent 7) Data logger: life span 8 years – power problem Solar panel life span 8 years – charges low	1) Wind data not used/ shared 2) Wind data not used/ shared 3) Temperature data not used/ shared 4) Data is not used and shared 5) Data is not used and shared 6) Data is not used and shared 7) Data not transmitted Data logger not working 24 hours	1) Replace Anemometer 2) Replace wind vane 3) Replace thermometer 4) Replace Hydrometer 5) Replacement of Barometer 6) Replace Rain gauge 7) Replace Batteries (stock batteries) Replace solar panel
Transmission	Data logger does not connect to GTS. Weather data not in table driven format codes.	Weather data not transmitted to GTS weather data not accepted on GTS	Create interface between AWS to Nairobi hub Equip Server with conversion software.
Building	Office accommodation is good.	-	-
Station Environment	secure office environment but not safety gear	Commitment to work	Provide for office safety measures/facilities.
Work Environment	Poor work environment	Reduced commitment to office time	Enhance working environment by providing necessities like breakfast and launch
Human Resources (Staff)	Capacity low on IT based work	Adoption of new work methods low	periodic Capacity building trainings
Other remarks			In general a number weather sensors require replacement
Picture site if available			

SOROTI METEOROLOGICAL STATION – WIGOS ID:63658			
Lat : 1.72	**Lon : 33.62**	**Elev : 1132m**	**Date opening: 2016**
TITLE/EQUIPMENT	**PROBLEMS ENCOUNTERED**	**IMPACTS ON OPERATIONS**	**PROPOSED SOLUTIONS**
Surface Measurement Equipment	1) Anemometer: life span 8 years – not sensitive. 2) Wind Vane: life span 8 years – not sensitive 3) Thermometer: life span 5 years – not calibrated 4) Hygrometer: life span 5 years – Not calibrated 5) Atmospheric Barometer: life span 5 years – erratic 6) Rain gauge: life span 8 years – inconsistent 7) Data logger: life span 8 years – power problem Solar panel life span 8 years – charges low	1) Wind data not used/ shared 2) Wind data not used/ shared 3) Temperature data not used/ shared 4) Data is not used and shared 5) Data is not used and shared 6) Data is not used and shared 7) Data not transmitted Data logger not working 24 hours	1) Replace Anemometer 2) Replace wind vane 3) Replace thermometer 4) Replace Hydrometer 5) Replacement of Barometer 6) Replace Rain gauge 7) Replace Batteries (stock batteries) Replace solar panel
Transmission	Data logger does not connect to GTS. Weather data not in table driven format codes.	Weather data not transmitted to GTS weather data not accepted on GTS	Create interface between AWS to Nairobi hub Equip Server with conversion software.
Building	Office accommodation dilapidated.	Reduced commitment to office time.	Renovate office block and adequately furnish it with necessities.
Station Environment	secure office environment but no safe gear	Risk free work environment	Provide for office safety measures/facilities.
Work Environment	Poor work environment	Reduced commitment to office time	Enhance working environment by providing necessities like breakfast and launch
Human Resources (Staff)	Capacity low on IT based work	Adoption of new work methods low	periodic Capacity building trainings
Other remarks			In general a number weather sensors require replacement
Picture site if available			

GULU METEOROLOGICAL STATION – WIGOS ID: 63630			
Lat : 2.78	**Lon : 32.28**	**Elev : 1147m**	**Date opening: 2016**
TITLE/EQUIPMENT	**PROBLEMS ENCOUNTERED**	**IMPACTS ON OPERATIONS**	**PROPOSED SOLUTIONS**
Surface Measurement Equipment	1) Anemometer: life span 8 years – not sensitive. 2) Wind Vane: life span 8 years – not sensitive 3) Thermometer: life span 5 years – functional 4) Hygrometer: life span 5 years – functional 5) Atmospheric Barometer: life span 5 years – erratic 6) Rain gauge: life span 8 years – functional 7) Data logger: life span 8 years – power problem 8) Solar panel life span 8 years – charges low	1) Wind data not used/ shared 2) Wind data not used/ shared 3) Temperature data not used/ shared 4) Data is not used and shared 5) Data is not used and shared 6) Data is not used and shared 7) Data not transmitted Data logger not working 24 hours	1) Replace Anemometer 2) Replace wind vane 3) Replace thermometer 4) Replace Hydrometer 5) Replacement of Barometer 6) Replace Rain gauge – life span 7) Replace Batteries (stock batteries) Replace solar panel
Transmission	Data logger does not connect to GTS. Weather data not in table driven format codes.	Weather data not transmitted to GTS weather data not accepted on GTS	Create interface between AWS to Nairobi hub Equip Server with conversion software.
Building	Office accommodation too small	Reduced commitment to office time.	Construct bigger office block and adequately furnish it with basic necessities.
Station Environment	secure office environment	Operations risk free	maintain
Work Environment	Poor work environment	Reduced commitment to office time	Enhance working environment by providing necessities like breakfast and launch
Human Resources (Staff)	Capacity low on IT based work	Adoption of new work methods low	periodic Capacity building trainings
Other remarks			In general a number weather sensors require replacement
Picture site if available			

MAKERERE METEOROLOGICAL STATION			
Lat : 0.25	**Lon : 32.63**	**Elev : 1200m**	**Date opening: 2016**
TITLE/EQUIPMENT	**PROBLEMS ENCOUNTERED**	**IMPACTS ON OPERATIONS**	**PROPOSED SOLUTIONS**
Surface Measurement Equipment	1) Anemometer: life span 8 years – not sensitive. 2) Wind Vane: life span 8 years – not sensitive 3) Thermometer: life span 5 years – inconsistent 4) Hygrometer: life span 5 years – out of range 5) Atmospheric Barometer: life span 5 years – erratic 6) Rain gauge: life span 8 years – inconsistent 7) Data logger: life span 8 years – power problem 8) Solar panel life span 8 years – charges low	1) Wind data not used/ shared 2) Wind data not used/ shared 3) Temperature data not used/ shared 4) Data is not used and shared 5) Data is not used and shared 6) Data is not used and shared 7) Data not transmitted 8) Data logger not working 24 hours	1) Replace Anemometer 2) Replace wind vane 3) Replace thermometer 4) Replace Hydrometer 5) Replacement of Barometer 6) Replace Rain gauge 7) Replace Batteries (stock batteries) 8) Replace solar panel
Transmission	Data logger does not connect to GTS. Weather data not in table driven format codes.	Weather data not transmitted to GTS weather data not accepted on GTS	Create interface between AWS to Nairobi hub Equip Server with conversion software.
Building	Office accommodation is good but small.	-	-.
Station Environment	Secure office environment	Security provided	-
Work Environment	Poor work environment	Reduced commitment to office time	Enhance working environment by providing necessities like breakfast and launch
Human Resources (Staff)	Capacity low on IT based work	Adoption of new work methods low	periodic Capacity building trainings
Other remarks			In general a number weather sensors require replacement
Picture site if available			

KOTIDO METEOROLOGICAL STATION			
Lat : 3.02	**Lon : 34.17**	**Elev :1260m**	**Date opening: 2016**
TITLE/EQUIPMENT	**PROBLEMS ENCOUNTERED**	**IMPACTS ON OPERATIONS**	**PROPOSED SOLUTIONS**
Surface Measurement Equipment	1) Anemometer: life span 8 years – not sensitive. 2) Wind Vane: life span 8 years – not sensitive 3) Thermometer: life span 5 years – inconsistent 4) Hygrometer: life span 5 years – out of range 5) Atmospheric Barometer: life span 5 years – erratic 6) Rain gauge: life span 8 years – inconsistent 7) Data logger: life span 8 years – power problem Solar panel life span 8 years – charges low	1) Wind data not used/ shared 2) Wind data not used/ shared 3) Temperature data not used/ shared 4) Data is not used and shared 5) Data is not used and shared 6) Data is not used and shared 7) Data not transmitted Data logger not working 24 hours	1) Replace Anemometer 2) Replace wind vane 3) Replace thermometer 4) Replace Hydrometer 5) Replacement of Barometer 6) Replace Rain gauge 7) Replace Batteries (stock batteries) Replace solar panel
Transmission	Data logger does not connect to GTS. Weather data not in table driven format codes.	Weather data not transmitted to GTS weather data not accepted on GTS	Create interface between AWS to Nairobi hub Equip Server with conversion software.
Building	Office accommodation in a uniport	Reduced commitment to office time.	construct office block and adequately furnish it with basic necessities.
Station Environment	insecure office environment	Commitment to work reduced	Provide for office safety measures/facilities.
Work Environment	Poor work environment	Reduced commitment to office time	Enhance working environment by providing necessities like breakfast and launch
Human Resources (Staff)	Capacity low on IT based work	Adoption of new work methods low	periodic Capacity building trainings
Other remarks			In general a number weather sensors require replacement
Picture site if available			

KITGUM METEOROLOGICAL STATION			
Lat : 3.30	**Lon : 32.88**	**Elev :940 m**	**Date opening: 2016**
TITLE/EQUIPMENT	**PROBLEMS ENCOUNTERED**	**IMPACTS ON OPERATIONS**	**PROPOSED SOLUTIONS**
Surface Measurement Equipment	1) Anemometer: life span 8 years – not sensitive. 2) Wind Vane: life span 8 years – not sensitive 3) Thermometer: life span 5 years – inconsistent 4) Hygrometer: life span 5 years – out of range 5) Atmospheric Barometer: life span 5 years – erratic 6) Rain gauge: life span 8 years – inconsistent 7) Data logger: life span 8 years – power problem Solar panel life span 8 years – charges low	1) Wind data not used/ shared 2) Wind data not used/ shared 3) Temperature data not used/ shared 4) Data is not used and shared 5) Data is not used and shared 6) Data is not used and shared 7) Data not transmitted Data logger not working 24 hours	1) Replace Anemometer 2) Replace wind vane 3) Replace thermometer 4) Replace Hydrometer 5) Replacement of Barometer 6) Replace Rain gauge 7) Replace Batteries (stock batteries) Replace solar panel
Transmission	Data logger does not connect to GTS. Weather data not in table driven format codes.	Weather data not transmitted to GTS weather data not accepted on GTS	Create interface between AWS to Nairobi hub Equip Server with conversion software.
Building	Office accommodation dilapidated.	Reduced commitment to office time.	Renovate office block and adequately furnish it with basic necessities.
Station Environment	insecure office environment	Night work reduced	Provide for office safety measures/facilities.
Work Environment	Poor work environment	Reduced commitment to office time	Enhance working environment by providing necessities like breakfast and launch
Human Resources (Staff)	Capacity low on IT based work	Adoption of new work methods low	periodic Capacity building trainings
Other remarks			In general a number weather sensors require replacement
Picture site if available			

NTUSI METEOROLOGICAL STATION			
Lat : 0.57	**Lon : 31.38**	**Elev :1275m**	**Date opening: 2016**
TITLE/EQUIPMENT	**PROBLEMS ENCOUNTERED**	**IMPACTS ON OPERATIONS**	**PROPOSED SOLUTIONS**
Surface Measurement Equipment	1) Anemometer: life span 8 years – not sensitive. 2) Wind Vane: life span 8 years – not sensitive 3) Thermometer: life span 5 years – inconsistent 4) Hygrometer: life span 5 years – out of range 5) Atmospheric Barometer: life span 5 years – erratic 6) Rain gauge: life span 8 years – inconsistent 7) Data logger: life span 8 years – power problem Solar panel life span 8 years – charges low	1) Wind data not used/ shared 2) Wind data not used/ shared 3) Temperature data not used/ shared 4) Data is not used and shared 5) Data is not used and shared 6) Data is not used and shared 7) Data not transmitted Data logger not working 24 hours	1) Replace Anemometer 2) Replace wind vane 3) Replace thermometer 4) Replace Hydrometer 5) Replacement of Barometer 6) Replace Rain gauge 7) Replace Batteries (stock batteries) Replace solar panel
Transmission	Data logger does not connect to GTS. Weather data not in table driven format codes.	Weather data not transmitted to GTS weather data not accepted on GTS	Create interface between AWS to Nairobi hub Equip Server with conversion software.
Building	Office accommodation is a uniport	Reduced commitment to office time.	Construct proper office block and adequately furnish it with basic necessities.
Station Environment	Insecure office environment	Commitment to work reduced	Provide for office safety measures/facilities.
Work Environment	Poor work environment	Reduced commitment to office time	Enhance working environment by providing necessities like breakfast and launch
Human Resources (Staff)	Capacity low on IT based work	Adoption of new work methods low	periodic Capacity building trainings
Other remarks			In general a number weather sensors require replacement
Picture site if available			

MUBENDE METEOROLOGICAL STATION.			
Lat : 0.58	**Lon : 31.37**	**Elev : 1290m**	**Date opening: 2016**
TITLE/EQUIPMENT	**PROBLEMS ENCOUNTERED**	**IMPACTS ON OPERATIONS**	**PROPOSED SOLUTIONS**
Surface Measurement Equipment	1) Anemometer: life span 8 years – not sensitive. 2) Wind Vane: life span 8 years – not sensitive 3) Thermometer: life span 5 years – inconsistent 4) Hygrometer: life span 5 years – out of range 5) Atmospheric Barometer: life span 5 years – erratic 6) Rain gauge: life span 8 years – inconsistent 7) Data logger: life span 8 years – power problem 8) Solar panel life span 8 years – charges low	1) Wind data not used/ shared 2) Wind data not used/ shared 3) Temperature data not used/ shared 4) Data is not used and shared 5) Data is not used and shared 6) Data is not used and shared 7) Data not transmitted 8) Data logger not working 24 hours	1) Replace Anemometer 2) Replace wind vane 3) Replace thermometer 4) Replace Hydrometer 5) Replacement of Barometer 6) Replace Rain gauge 7) Replace Batteries (stock batteries) Replace solar panel
Transmission	Data logger does not connect to GTS. Weather data not in table driven format codes.	Weather data not transmitted to GTS weather data not accepted on GTS	Create interface between AWS to Nairobi hub Equip Server with conversion software.
Building	Station has no Office accommodation.	Reduced commitment to office time.	Construct office block and adequately furnish it with basic necessities.
Station Environment	Insecure office environment	Staff can't work in bad weather	Provide for office safety measures/facilities.
Work Environment	Poor work environment	Reduced commitment to office time	Enhance working environment by providing necessities like breakfast and launch
Human Resources (Staff)	Capacity low on IT based work	Adoption of new work methods low	periodic Capacity building trainings
Other remarks			In general a number weather sensors require replacement
Picture site if available			

JINJA METEOROLOGICAL STATION – WIGOS ID: 63682			
Lat : 0.45	**Lon : 33.18**	**Elev : 1175m**	**Date opening: 2016**
TITLE/EQUIPMENT	**PROBLEMS ENCOUNTERED**	**IMPACTS ON OPERATIONS**	**PROPOSED SOLUTIONS**
Surface Measurement Equipment	1) Anemometer: life span 8 years – not sensitive. 2) Wind Vane: life span 8 years – not sensitive 3) Thermometer: life span 5 years – inconsistent 4) Hygrometer: life span 5 years – out of range 5) Atmospheric Barometer: life span 5 years – erratic 6) Rain gauge: life span 8 years – functional 7) Data logger: life span 8 years – power problem 8) Solar panel life span 8 years – charges low	1) Wind data not used/ shared 2) Wind data not used/ shared 3) Temperature data not used/ shared 4) Data is not used and shared 5) Data is not used and shared 6) Data is not used and shared 7) Data not transmitted 8) Data logger not working 24 hours	1) Replace Anemometer 2) Replace wind vane 3) Replace thermometer 4) Replace Hydrometer 5) Replacement of Barometer 6) Replace Rain gauge 7) Replace Batteries (stock batteries) Replace solar panel
Transmission	Data logger does not connect to GTS. Weather data not in table driven format codes.	Weather data not transmitted to GTS weather data not accepted on GTS	Create interface between AWS to Nairobi hub Equip Server with conversion software.
Building	Office accommodation is too small.	Reduced commitment to office time.	Acquire more office space and adequately furnish it with basic necessities.
Station Environment	Insecure office environment	Night work reduced	Provide for office safety measures/facilities.
Work Environment	Poor work environment	Reduced commitment to office time	Enhance working environment by providing necessities like breakfast and launch
Human Resources (Staff)	Capacity low on IT based work	Adoption of new work methods low	periodic Capacity building trainings
Other remarks			In general a number weather sensors require replacement
Picture site if available			

TORORO METEOROLOGICAL STATION – WIGOS ID: 63684			
Lat : 0.68	**Lon : 34.17**	**Elev : 1170m**	**Date opening: 2016**
TITLE/EQUIPMENT	**PROBLEMS ENCOUNTERED**	**IMPACTS ON OPERATIONS**	**PROPOSED SOLUTIONS**
Surface Measurement Equipment	1) Anemometer: life span 8 years – not sensitive. 2) Wind Vane: life span 8 years – not sensitive 3) Thermometer: life span 5 years – not calibrated 4) Hygrometer: life span 5 years – not calibrated 5) Atmospheric Barometer: life span 5 years – erratic 6) Rain gauge: life span 8 years – non functional 7) Data logger: life span 8 years – power problem 8) Solar panel life span 8 years – charges low	1) Wind data not used/ shared 2) Wind data not used/ shared 3) Temperature data not used/ shared 4) Data is not used and shared 5) Data is not used and shared 6) Data is not used and shared 7) Data not transmitted Data logger not working 24 hours	1) Replace Anemometer 2) Replace wind vane 3) Replace thermometer 4) Replace Hydrometer 5) Replacement of Barometer 6) Replace Rain gauge 7) Replace Batteries (stock batteries) Replace solar panel
Transmission	Data logger does not connect to GTS. Weather data not in table driven format codes.	Weather data not transmitted to GTS weather data not accepted on GTS	Create interface between AWS to Nairobi hub Equip Server with conversion software.
Building	Office accommodation fair.	Confidence and Commitment to office time.	-.
Station Environment	Uncertain due to upcoming future developments	Fear of station obstruction	Provide for office safety measures/facilities.
Work Environment	Poor work environment	Reduced commitment to office time	Enhance working environment by providing necessities like breakfast and launch
Human Resources (Staff)	Capacity low on IT based work	Adoption of new work methods low	periodic Capacity building trainings
Other remarks			In general a number weather sensors require replacement
Picture site if available			

ARUA METEOROLOGICAL STATION – WIGOS ID: 63602			
Lat : 3.05	**Lon : 30.92**	**Elev : 1280m**	**Date opening: 2016**
TITLE/EQUIPMENT	**PROBLEMS ENCOUNTERED**	**IMPACTS ON OPERATIONS**	**PROPOSED SOLUTIONS**
Surface Measurement Equipment	1) Anemometer: life span 8 years – not sensitive. 2) Wind Vane: life span 8 years – not sensitive 3) Thermometer: life span 5 years – not calibrated 4) Hygrometer: life span 5 years – not calibrated 5) Atmospheric Barometer: life span 5 years – erratic 6) Rain gauge: life span 8 years – inconsistent 7) Data logger: life span 8 years – power problem 8) Solar panel life span 8 years – charges low	1) Wind data not used/ shared 2) Wind data not used/ shared 3) Temperature data not used/ shared 4) Data is not used and shared 5) Data is not used and shared 6) Data is not used and shared 7) Data not transmitted 8) Data logger not working 24 hours	1) Replace Anemometer 2) Replace wind vane 3) Replace thermometer 4) Replace Hydrometer 5) Replacement of Barometer 6) Replace Rain gauge 7) Replace Batteries (stock batteries) Replace solar panel
Transmission	Data logger does not connect to GTS. Weather data not in table driven format codes.	Weather data not transmitted to GTS weather data not accepted on GTS	Create interface between AWS to Nairobi hub Equip Server with conversion software.
Building	Office accommodation is good.	High commitment to work.	Maintain or improve
Station Environment	secure but no safety gear	Risk fatalities, increase of accidents	Provide for office safety measures/facilities.
Work Environment	Poor work environment	Reduced commitment to office time	Enhance working environment by providing necessities like breakfast and launch
Human Resources (Staff)	Capacity low on IT based work	Adoption of new work methods low	periodic Capacity building trainings
Other remarks			In general a number weather sensors require replacement
Picture site if available			

LIRA METEOROLOGICAL STATION			
Lat : 2.25	**Lon : 32.90**	**Elev : 1068m**	**Date opening: 2016**
TITLE/EQUIPMENT	**PROBLEMS ENCOUNTERED**	**IMPACTS ON OPERATIONS**	**PROPOSED SOLUTIONS**
Surface Measurement Equipment	1) Anemometer: life span 8 years – not sensitive. 2) Wind Vane: life span 8 years – not sensitive 3) Thermometer: life span 5 years – inconsistent 4) Hygrometer: life span 5 years – out of range 5) Atmospheric Barometer: life span 5 years – erratic 6) Rain gauge: life span 8 years – non functional 7) Data logger: life span 8 years – power problem 8) Solar panel life span 8 years – charges low	1) Wind data not used/ shared 2) Wind data not used/ shared 3) Temperature data not used/ shared 4) Data is not used and shared 5) Data is not used and shared 6) Data is not used and shared 7) Data not transmitted 8) Data logger not working 24 hours	1) Replace Anemometer 2) Replace wind vane 3) Replace thermometer 4) Replace Hydrometer 5) Replacement of Barometer 6) Replace Rain gauge 7) Replace Batteries (stock batteries) Replace solar panel
Transmission	Data logger does not connect to GTS. Weather data not in table driven format codes.	Weather data not transmitted to GTS weather data not accepted on GTS	Create interface between AWS to Nairobi hub Equip Server with conversion software.
Building	Office spare good	-	
Station Environment	Secure office environment	-	-
Work Environment	poor	Non motivating towards work	Enhance working environment by providing necessities like breakfast and launch
Human Resources (Staff)	Capacity low on IT based work	Adoption of new work methods low	periodic Capacity building trainings
Other remarks			In general a number weather sensors require replacement
Picture site if available			

UPPER AIR STATION ENTEBBE			
Lat : 0.05	**Lon : 32.42**	**Elev : 1155m**	**Date opening:**
TITLE/EQUIPMENT	**PROBLEMS ENCOUNTERED**	**IMPACTS ON OPERATIONS**	**PROPOSED SOLUTIONS**
Surface Measurement Equipment	1) Hydrogen generator (life time 10 years) – not working 2) Hydrogen gas: not under production 3) Sounding system (life time 10 years) 4) Radiosondes (life time 5 years) 5) Balloons old	1) No hydrogen gas produced 2) Weather balloons not released 3) Upper air weather data not captured 4) No exchange of upper weather data 5) No sounding made	1) Repair the hydrogen gas generator. 2) Stock radiosondes 3) Stock Balloons 4) Replace radiosondes 5) Replace balloons
Transmission	Sounding System does not connect to GTS-Nairobi	Upper Weather data not transmitted to GTS Upper Air weather data not accepted on GTS	Equip internet connectivity interface between upper air station and GTS
Building	No Problem-newly rehabilited	-	-
Station Environment	Well maintained and secure	-	-
Work Environment	Poor work environment	Reduced commitment to office time at night	Provide beddings.
Human Resource (Staff)	Capacity low in making upper air soundings	Adoption of new work methods low	Periodic Capacity building trainings Recruit more staff
Other remarks			
Picture site if available			