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Systematic Observations Financing Facility

GBON National Contribution Plan of United Republic of Tanzania

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Weather and climate data for resilience

GBON National Contribution Plan

United Republic of Tanzania

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Module 1: National Target toward GBON compliance

Table 1. GBON National Contribution Target from Nationalgap analysis

Type of station	Baseline (Results of the GBON National Gap Analysis)				GBON National Contribution Target	
	Target (# of stations)	GBON-compliant stations	Gap		New	To improve
			New	To improve		
Surface	27	0	9	18	9	18
Upper-air	5	0	4	1	4	1

Out of the 18 stations to be improved, the Tanzanian Government has procured equipment to improveeleven (11). Therefore, the project will improve seven (7) stations. Further, out of the four (4) new Upper-air stations to be procured, the Tanzanian Government will procure one (1). The project will therefore procure three (3) upper-air stations.The SOFF project will procure nine surface stations to fill the gap of required new stations. The SOFF project will also upgrade the Upper Air station in Dar es Salaam to become GBON compliant.

The distribution of proposed stations is shown in **Figure 1 and 2.**

Table 2: Compliance criteria for GBON Surface land stations

Mark	Name	Description	Criteria
S_{SL} 1	**Monthly Availability (%)**	No. of received monthly reports / (Days per month * 24) Monthly	**≥ 80%**
S_{SL} 2	**Timeliness (%)**	No. of late reports/ (Days per month * 24)	**< 5%**
S_{SL} 3	**Monthly Quality (%)**	No. of rejected monthly reports/ (Days per month * 24)	**< 5%**

Table 3: Compliance criteria for GBON Upper-air stations.

Mark	Name	Description	Criteria
S_{UA} 1	**Monthly Availability (%)**	No. of received monthly profile (to 30hPa) reports/ (Days per month * 2)	**≥ 80%**
S_{UA} 2	**Vertical Resolution(Y/N)**	Vertical resolution is at least 100 m	**Yes**
S_{UA} 3	**Timeliness (%)**	No. of late reports/ (Days per month *2)	**< 5%**
S_{UA} 4	**Monthly Quality (%)**	No. of rejected monthly reports/ (Days per month*2)	**< 5%**

Table 4. GBON National target for Tanzania based on phased approach (%)

Geographical depiction of locations for new and improved Surface and Upper Air Stations

The United Republic of Tanzania has a territory of 947,323 km^{2,} which makes it the 13th largest country in Africa and the 31st largest country in the world. It is surrounded by; the Indian Ocean to the east, Lake Victoria to the North, Lake Tanganyika to the west, and Lake Nyasa to the southwest. Tanzania has unique orographic features starting from Mean Sea Level (MSL) to approximately 6000m above MSL. According to the gap analysis conducted, a total of 27 surface stations for GBON minimum resolution of 200km by 200km and five (5) upper air stations for 500km by 500km are required to cover the territory of the country as detailed in

Table 1. The National Contribution Plan proposes the below distribution for new and improved stations.

Type of station	Baseline (Results of the GBON National Gap Analysis)				GBON National Contribution Target		GBON Implementation National target based on phased approach (%)			
	Target (# of stations)	GBON-compliant stations (#)	Gap		New	To Improve	31.12 2024	31.12 2025	31.12 2026	31.12 2027
			New	To improve						
Surface	27	0	9	18	9	18	20%	50%	≥80%	≥80%
Upper-air	5	0	4	1	4	1	N/A	20%	≥80%	≥80%

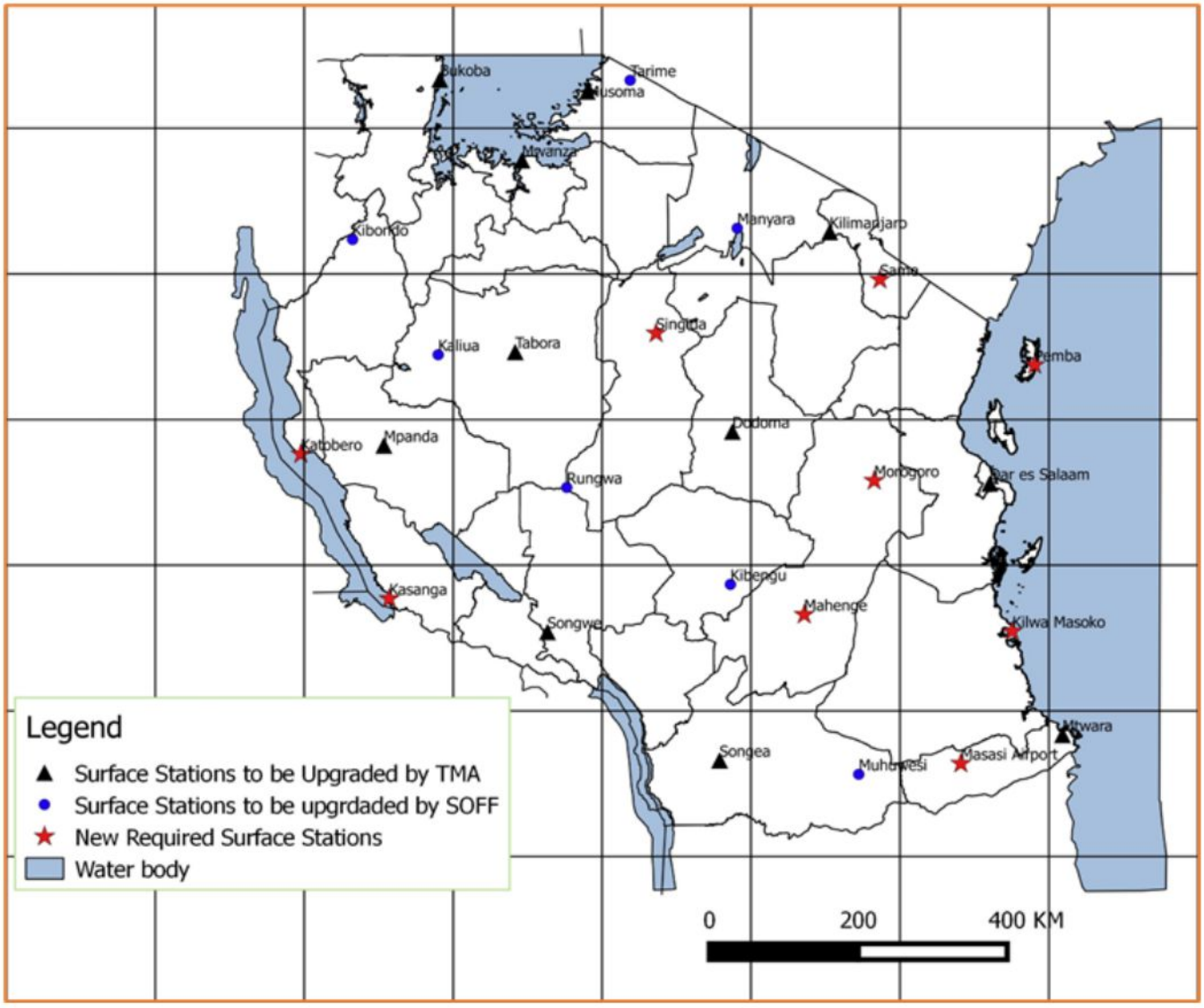


Figure 1: *Map of Tanzania showing existing and proposed surface stations at 200km by 200km resolution*

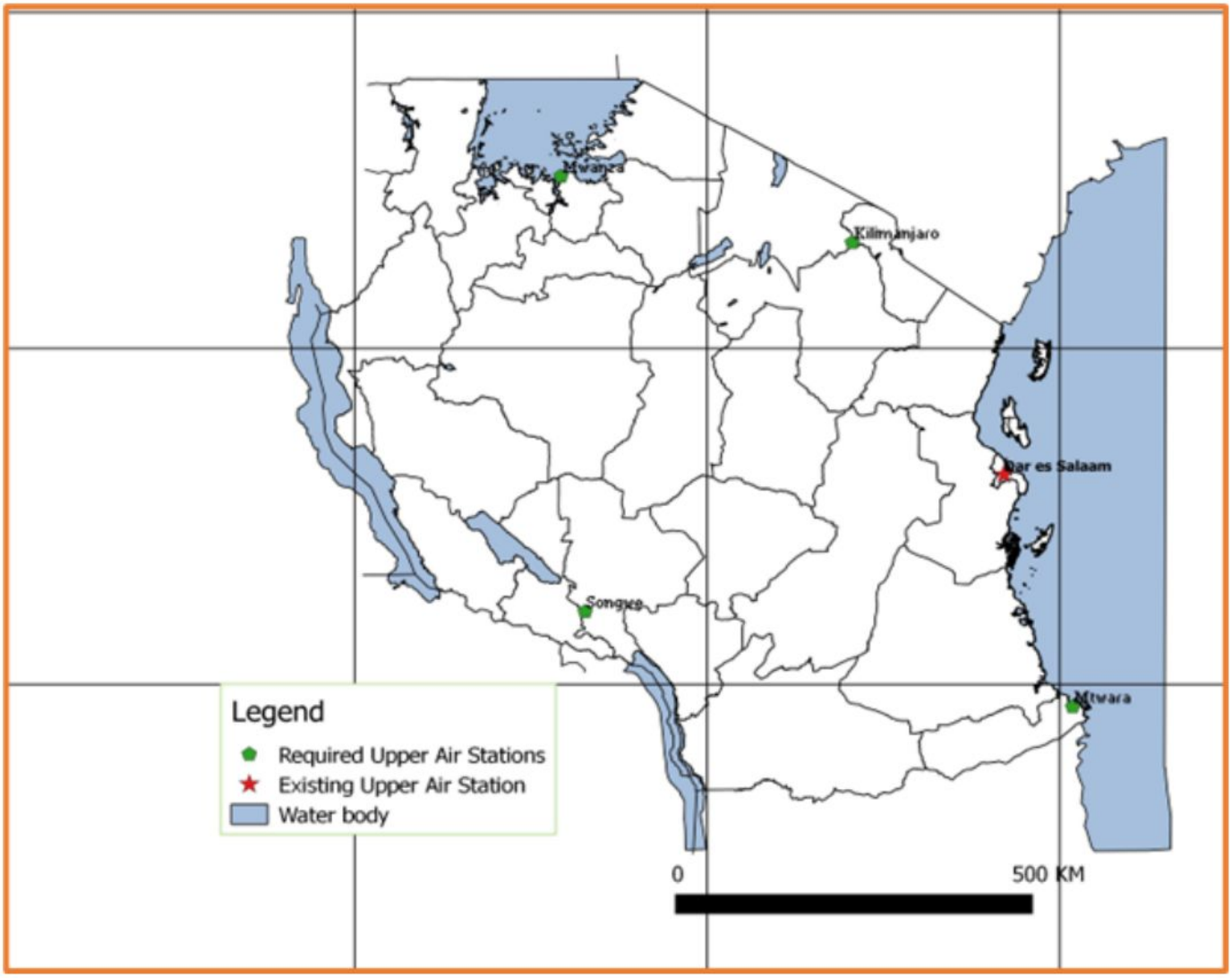


Figure 2: *Map of Tanzania showing Existing and proposed Upper-Air Stations at 500km by 500km resolution*

Module 2:GBON Business Model and Institutional Development

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

TMA is the government institution mandated to provide weather and climate services through The Tanzania Meteorological Authority Act No. 2 of 2019. The institution is responsible for regulating, coordinating and provision of meteorological services to the general public, institutions, and individual users for socio-economic development, including weather forecasts, and severe weather warnings for the safety of life and properties. The Tanzanian Meteorological Authority Act also mandates TMA to approve and regulate all meteorological operators in Tanzania. The law describes that all meteorological operators are required to share meteorological data with TMA. The Act indicates opportunities for further engagement and cooperation between TMA and the private sector.

In Tanzania, several Government institutions (such as the Ministry of Water, the Ministry of Agriculture, the Ministry of Energy, and the Ministry of Natural Resources and Tourism) own and operate meteorological stations for the aim of supporting specific sector needs. The mode of operation (frequency of observation and data format) of these stations and sensors used do not meet the required standard for use to support GBON network. Several climate sensitive Government entities are showing interest to mainstream climate services into their operations by investing in weather observations. Partnership with these institutions will highly contribute to Tanzania Meteorological Authority (TMA) data bank and increase the availability of weather data to be exchanged internationally for contributing to GBON Network.

There are no private sector operators providingmeteorological observations and data services to the public in Tanzania. Theavailable private entities are those who gather meteorological observations for their own purposes, such as larger scale agricultural entities and mining companies.Collaboration with the private sector could enhance the use of meteorological data and information and it is a priority of TMA to strengthen private sector cooperation across the meteorological value chain. As part of its ongoing work TMA will continue toassessment the potentiality of private sector and other public operators to contribute tothe GBON network.

Proposed activities for the investment phase:

i. Continuous engagement with Government Stakeholders operating meteorological stations and their potential to support GBON.

2.2 Assessment of potential GBON sub-regional collaboration

Tanzania has bilateral relations in weather and climate services with countries in the Eastern and Southern Africa Sub-Regions whereby TMA has been providing technical support to some National Meteorological and Hydrological Services (NMHSs) in the sub-regions. Furthermore, Tanzania collaborates with neighbouring countries in the Eastern and Southern Africa Sub-Regions under WMO, East African Cooperation (EAC) and South African Development Community (SADC) programmes and projects. Such collaboration include implementation of WMO projects like HIGH impact Weather LakeSystems (HIGHWAY) project under which TMA was requested to provide technical support. Tanzania is also participating in the implementation of Climate Risk Early Warning Services (CREWS)project which is seeking to establish a regional Early Warning Project for the countries surrounding Lake Victoria basin. TMA and the CREWS project team are currently exploring relevant national level activities for Tanzania.

Furthermore, Tanzania is currently serving as WMO Regional Specialized Meteorological Centre (RSMC) providing guidance on severe weather for countries around Lake Victoria Basin (Rwanda, Burundi, Kenya and Uganda). Tanzania is also serving as a Regional WIGOS Centre responsible for data availability and quality in the EAC region.Since the collaboration is already established, therefore establishment of sub-regional collaboration under SOFF project is viable. This may include activities like cross learning, maintenance, and calibration of the instruments. However, the main challenge for establishing the sub-regional network is that some neighbouring countries are currently not part of SOFF.

Proposed activities for investment phase:

i. Map potential (existing) forums for sub-regional collaboration;
ii. Establish a coordination team among the Sub-regional Countries (including peer advisors and Implementing Entities) which will meet regularly to maximize coordination and resources across the borders.
iii. Attend and coordinate sub-regional meetings;
iv. Identify and implement activities for regional collaboration which will enhance and strengthen the implementation of GBON (e.g. Maintenance and calibration of meteorological instruments); and
v. Establish sub-regional network and data sharing mechanism among the neighbouring countries.

2.3 Assessment of the most effectivebusiness model to support network operations

Being a government institution, the funding source for all TMA operations is through annual government budget allocations. The 2023 annual budget of TMA was 17 million US Dollars.This includes budget for procurement, operation, and maintenance of meteorological infrastructure, employment, and development of human capacity.Of the total budget, the budget for meteorological infrastructure was 5 million US Dollars (including procurement and maintenance of meteorological infrastructure; construction and maintenance of buildings). The government's

current initiatives to enhance weather and climate services, managed by the TMA, include the modernization of meteorological infrastructure through the procurement of weather Radars and Automatic Weather Stations, rehabilitation of existing stations and human capacity development. The Government has also invested in improvement of its National Meteorological Training Centre (NMTC) to improve training services for TMA staffs and other trainees from outside TMA.

In addition, TMA gets financial and technical support from external development partners through implementation of donor-funded programmes and projects. Among the projects that supported TMA is the "Climate Information and Early Warning System"project, which was implemented by UNDP with funding from global Environment Facility (GEF) in 11 African nations, including Tanzania, through its "Climate Information for Resilient Development in Africa (CIRDA)" programme. This support realized the procurement of 36 Automatic Weather Stations integrated into the TMA observation network. However, as many of these stations are nearing the end of their life span, SOFF will address this challenge by either improving or replacing some of these stations with new ones.

Since currently the known stakeholders operating weather stations are from government organizations, TMA appears to have very strong relationship with the Tanzania government stakeholders and have been successful in advocating for the importance of a strong public National Government meteorological institution. Meanwhile, the cooperation with private sector stakeholders in operating meteorological stations is at development stage and the contribution of private sector to the GBON is unlike to be significant during investment phase.

The conclusion from the above analysis is that the most appropriate set up for Tanzania is the SOFF business model 1: a fully funded National Meteorological Institution. This means that the current outlook for financing of the compliance phase will likely be through the SOFF project, possibly in combination with funding from the Tanzania government budget.

Based on the gap analysis for Tanzania to be GBON compliant, a total of 27 surface stations are required of which 9 new stationsto be funded by SOFF, 7 stations to be upgraded by SOFFand 11 stations funded by the government of Tanzania. Moreover, five (5) upper air stations are required, out of which are:four (4) new stations and 1 station to be upgradedOut of the 4 new upper-air stations required, procurement and installation ofone (1) will be funded by the government of Tanzania. O&M for all five stations has been budgeted under the SOFF project.Currently there are no other donors supporting operationalization of the meteorological infrastructure at TMA.

Based on the budget breakdown for all activities as indicated in the funding request, the total budget for project outputs is **USD 13,926,170**. The funding requested from SOFF project is **USD 9,026,278**. The in-kind contribution by TMA will be**USD 4,899,892**. Therefore, the ratio of Tanzania contribution is 0.35 (see table on **annex 5** to the Funding request).

2.4 Assessment of existing national strategies and projects for developing and improving observing networks

Various Tanzania national strategies related to development and improvement of the observing networks have been assessed during the Readiness Phase. The assessed policies and strategic documents include the following:

i. TMA Medium Term Strategic Plan (2021/ 2022 - 2025/26);
ii. National Framework for Climate Services (NFCS 2018-2025);
iii. National Disaster Management Policy (2004);
iv. National Agriculture Policy (2013);
v. National Climate Change Response Strategy (2021-2026);
vi. Nationally Determined Contribution for Tanzania (NDC) (2021);
vii. National Disaster Management strategy (2022-2027; and
viii. The National Five-Year Development Plan (2021/22 - 2025/26).

Among the priority interventions indicated in the above-named documents related to development and improvement of observing networks are:

i. Enhancement of observation stations - National Climate Change Response Strategy;
ii. To modernize the real time data monitoring, data exchange, processing and forecasting systems (TMA strategic Plan);
iii. To strengthen the capacity for calibration and maintenance of instruments and equipment (TMA strategic Plan);
iv. To develop the human resources capacity of TMA for efficient provision of services (TMA strategic Plan); and
v. Warning systems for all disasters to be developed and strengthened so as to ensure timely dissemination of information (National Disaster Management Policy).

Implementation of SOFF project activities aligns well with the highlighted policies and strategies, all of which call for enhancing observation and monitoring of weather and climate and modernization of meteorological observation network. The government of Tanzania is implementing an initiative to modernize meteorological infrastructure at TMA, including meteorological observation equipment such as weather radars.

TMA collaborates with other stakeholders through the implementation of programmes and projects related to enhancement of observation and monitoring in the country. The only ongoing project, which is related to capacity building,is supported by the Finnish Meteorological Institute through its regional project in Kenya, Rwanda, and Tanzania (FINKERAT). There is no ongoing project related to procurement of weather stations or data exchange.

Previously, TMA has also worked with both national and international organizations such as the Red Cross, UNDP, and World Food Program. At the stakeholder meeting carried out as part of the Readiness Phase, it was clear that

there is potential to expand these partnerships to support the Early Warning for All initiative with a focus on creating value at the latter part of the meteorological value chain. It requires that the partners continue to organize meetings and share experiences on how best to utilize and strengthen each organizations expertise.

Proposed activities:

To ensure consistent and smooth implementation of SOFF project, including eventual aligning to changes in policies and strategies, the following activities will be undertaken:

i. Close monitoring of policies and strategies and their effect on project implementation and take appropriate actions;
ii. Continuous engagement with government and other Ministries on policy and strategy development; and
iii. Continuous engagement with Early Warning For All (EW4All) stakeholders, incl. civil society, UN and other INGO's.

2.5 Assessment of the national legislation of relevance for GBON

Assessment of national legislation relevantfor GBON has been done for the following:

i. Tanzania Meteorological Authority Act No. 2 of 2019 and its regulations;
ii. Disaster Management Act No. 7 of 2015;
iii. Environmental Management Act, 2004;
iv. Public Procurement Act, 2011; and
v. Income Tax Act.

Generally, the assessed legislations show no major constrains that can impede the project. However,the Income Tax Act has indicated tax charges for importation of infrastructure. Such taxation will cause significant increase of the cost of meteorological equipment that will be procured (imported).

This constraintwill be addressed by preparing a Letter of Agreement (LoA) between TMA and UNDPto be submitted to the Planning Commission and Ministry of Finance requesting for tax exemption.

Proposed activities:

i. Develop agreements and documentation to facilitate tax exemption and clearance of procured infrastructure.

Module 3: GBON Infrastructure Development

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

3.1.1 Surface Observing network

TMA operatessurface observing network consisting of 27 manned synoptic weather stations and 41Automatic Weather Stations (AWSs).The GBON resolution for surface stations requires a 200km spatial resolution. According to this resolution and Tanzania's territory, the minimum number of stations required to meet the GBON spatial resolution is 27 stations. To fulfil the GBON requirement, nine (9) new stations will be established, and 18 stations will be improved. The United Republic of Tanzania Government (URT) has initiatedimprovement of eleven (11) stations. Theimprovement ofthe remaining 7 stations is planned to be covered by the SOFF project. **Figure 1** presents the map of proposed surface stations.

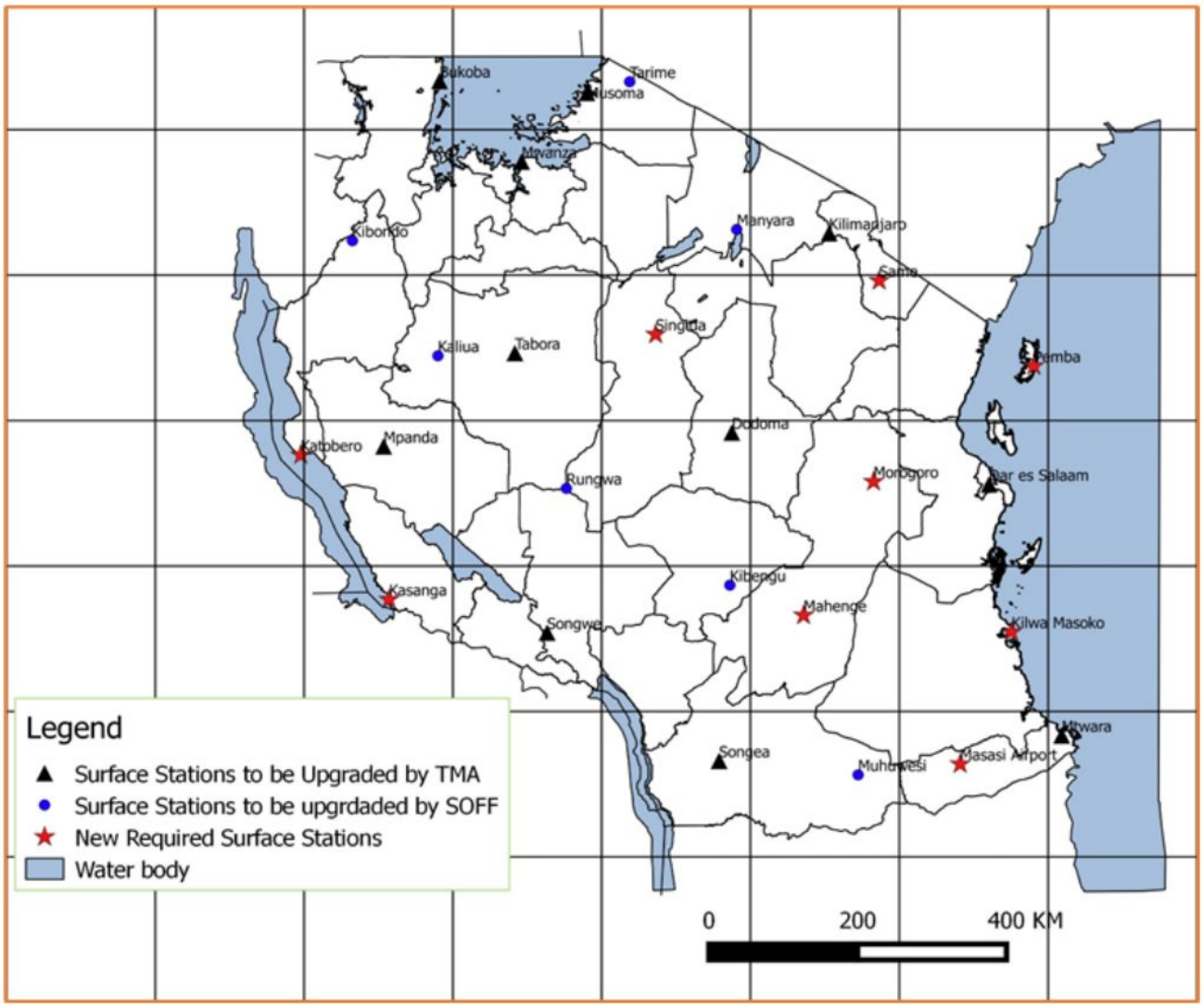


Figure 1: *Map of Tanzania showing existing and proposed surface stations at 200km by 200km resolution*

A list of the proposed 27 stations action required per station and source of fundsis indicated in **Table 5.**

Table 5: List of new stations and stations to be improved

S/N	Station name	Action Required	Source of fund
1	Bukoba	Upgrade	URT
2	Musoma	Upgrade	URT
3	Tarime	Upgrade	SOFF
4	Kibondo	Upgrade	SOFF
5	Mwanza	Upgrade	URT
6	Manyara	Upgrade	SOFF
7	KIA	Upgrade	URT
8	Kaliua	Upgrade	SOFF
9	Tabora	Upgrade	URT
10	Singida	New	SOFF
11	Same	New	SOFF
12	Pemba	New	SOFF
13	Katobero	New	SOFF
14	Mpanda	Upgrade	URT
15	Rungwa	Upgrade	SOFF
16	Dodoma	Upgrade	URT
17	Morogoro	New	SOFF
18	Dar es Salaam	Upgrade	URT
19	Kasanga	New	SOFF
20	Songwe	Upgrade	URT
21	Kibengu	Upgrade	SOFF
22	Mahenge	New	SOFF
23	KilwaMasoko	New	SOFF
24	Songea	Upgrade	URT
25	Muhuwesi	Upgrade	SOFF
26	Masasi	New	SOFF
27	Mtwara	Upgrade	URT

Most of the existing stations, which will be improved, measure the required five parameters (air pressure, air temperature, relative humidity, horizontal wind and precipitation). However, some of these stations need to be replaced with new ones to automate themsince some of them are close to the end of their lifespan. The listof the proposed 27 stations and the parameters measured per site are shown in **Table 6.**

Table 6: List of proposed 27 stations and the parameters measured per site

S/N	Station name	Atmospheric Pressure	Air Temp	Humidity (RH)	Horizontal Wind Direction	Horizontal Wind Speed	Precipitation Amount/ Intensity	Data Logger: Data transfer protocol	Remarks
1.	Bukoba	✓	✓	✓	✓	✓	✓	*Manual*	*Upgrade for automation*
2.	Musoma	✓	✓	✓	✓	✓	✓	*Manual*	*Upgrade for automation*
3.	Tarime	✓	✓	✓	✓	✓	✓	*FTP*	
4.	Kibondo	✓	✓	✓	✓	✓	✓	*FTP*	
5.	Mwanza	✓	✓	✓	✓	✓	✓	*Manual*	*Upgrade for automation*
6.	Manyara	✓	✓	✓	✓	✓	✓	*FTP*	
7.	KIA	✓	✓	✓	✓	✓	✓	*Manual*	*Upgrade for automation*
8.	Kaliua	✓	✓	✓	✓	✓	✓	*FTP*	
9.	Tabora	✓	✓	✓	✓	✓	✓	*Manual*	*Upgrade for automation*
10.	Singida	✓	✓	✓	*X*	*X*	✓	*Manual*	*New station as*
11.	Same	✓	✓	✓	*X*	*X*	✓	*Manual*	
12.	Pemba	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*New station. No station exist at the location*
13.	Katobero	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*New station. No station exist at the location*
14.	Mpanda	✓	✓	✓	*X*	*X*	✓	*Manual*	*Upgrade for automation*
15.	Rungwa	✓	✓	✓	✓	✓	✓	*FTP*	
16.	Dodoma	✓	✓	✓	✓	✓	✓	*Manual*	*Upgrade for automation*
17.	Morogoro	✓	✓	✓	*X*	*X*	✓	*Manual*	
18.	Dar es Salaam	✓	✓	✓	✓	✓	✓	*Manual*	*Upgrade for automation*
19.	Kasanga	*X*	*X*	*X*	*X*	*X*	*X*	*X*	
20.	Songwe	✓	✓	✓	✓	✓	✓	*Manual*	*Upgrade for automation*
21.	Kibengu	✓	✓	✓	✓	✓	✓	*FTP*	
22.	Mahenge	✓	✓	✓	*X*	*X*	✓	*Manual*	
23.	KilwaMasoko	✓	✓	✓	*X*	*X*	✓	*Manual*	
24.	Songea	✓	✓	✓	✓	✓	✓	*Manual*	
25.	Muhuwesi	✓	✓	✓	✓	✓	✓	*FTP*	
26.	Masasi	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*No station exist at the location*
27.	Mtwara	✓	✓	✓	✓	✓	✓	*Manual*	*Upgrade for automation*

3.1.1.1 Sensors for measuring the required weather parameters

The availability of sensors for measuring the required weather parameters at each station is indicated in **Table 7.** Evaluation of the sensors at each existing stations indicated that there is no station with the horizontal wind speed in extended range (0-100m/s). The possible achievable horizontal wind speed is the normal range of 0-75m/s.

Table 7: Availability of sensors for measuring the required weather parameters at each station

S/N	Station name	Atmospheric Pressure	Air Temperature	Humidity (RH)	Horizontal Wind Direction	Horizontal Wind Speed		Precipitation Amount/ Intensity
		500 – 1080 hPa	-80 °C to +60 °C	0-100 %RH	0-360 degrees	Max: 0-75 m/s	Extended : 0-100 m/s	0-500mm/hr
1.	Bukoba	✓	✓	✓	✓	✓	X	✓
2.	Musoma	✓	✓	✓	✓	✓	X	✓
3.	Tarime	✓	✓	✓	✓	✓	X	✓
4.	Kibondo	✓	✓	✓	✓	X	X	✓
5.	Mwanza	✓	✓	✓	✓	✓	X	✓
6.	Manyara	X	X	X	X	X	X	X
7.	KIA	✓	✓	✓	✓	✓	X	✓
8.	Kaliua	✓	✓	✓	✓	✓	X	✓
9.	Tabora	✓	✓	✓	✓	✓	X	✓
10.	Singida	X	X	X	X	X	X	✓
11.	Same	✓	✓	✓	X	X	X	X
12.	Pemba	X	X	X	X	X	X	X
13.	Katobero	X	X	X	X	X	X	X
14.	Mpanda	✓	✓	✓	X	✓	X	✓
15.	Rungwa	✓	✓	✓	✓	✓	X	✓
16.	Dodoma	✓	✓	✓	✓	✓	X	✓
17.	Morogoro	X	X	X	X	X	X	X
18.	Dar es Salaam	✓	✓	✓	✓	✓	X	✓
19.	Kasanga	✓	X	X	X	X	X	✓
20.	Songwe	✓	✓	✓	✓	✓	X	✓
21.	Kibengu	✓	✓	✓	✓	✓	X	✓
22.	Mahenge	✓	✓	✓	X	X	X	✓
23.	KilwaMasoko	X	X	X	X	X	X	✓

24.	Songea	✓	✓	✓	✓	✓	X	✓
25.	Muhuwesi	✓	✓	✓	✓	✓	X	✓
26.	Masasi	X	X	X	X	X	X	X
27.	Mtwara	✓	✓	✓	✓	✓	X	✓

3.1.1.2 Auxiliary components

An evaluation was conducted to ascertain the physical condition of various components at each station to establish their worthiness to sustain operations for a long time. The assessment indicated that all AWSs use solar power and thus include batteries. None of the stations have bird cages for the protection if the ultrasonic wind sensors. It was further noted thatsome components such as lightning protection, grounding and cables need to be improved. None of the stations have radiation shields capable of holding two probes for filed comparison. The analysis for auxiliary components is summarized in **Table 8.**

Table 8: Analysis of Auxilliary components

Station name	AWS cabinet	Power / mains	Solar panel	Battery	Lightning Protection	Grounding systems	Radiation Shield	Cables, wires, connectors	Commu-nication	Bird Cage
Bukoba	✓	✓	✓	✓	✓	✓	✓	✓	✓	X
Musoma	✓	✓	✓	✓	✓	✓	✓	✓	✓	X
Tarime	X	N/A	✓	✓	✓	✓	X	✓	✓	X
Kibondo	X	N/A	✓	✓	✓	✓	X	✓	✓	X
Mwanza	✓	X	✓	X	X	X	X	X	X	X
Manyara	X	N/A	X	X	X	X	X	X	X	X
KIA	✓	✓	✓	✓	✓	✓	✓	✓	✓	X
Kaliua	✓	N/A	✓	✓	✓	✓	X	✓	✓	X
Tabora	✓	X	✓	✓	X	✓	X	✓	V✓	X
Singida	X	X	X	X	X	X	X	X	X	X
Same	X	X	X	X	X	X	X	X	X	X
Pemba	X	N/A	X	X	X	X	X	X	X	X
Katobero	X	N/A	X	X	X	X	X	X	X	X
Mpanda	✓	X	✓	X	X	X	X	X	X	X
Rungwa	✓	N/A	✓	✓	✓	✓	X	✓	✓	X
Dodoma	✓	✓	✓	X	X	✓	X	✓	X	✓
Morogoro	X	X	X	X	X	X	X	X	X	X
Dar es Salaam	✓	✓	✓	✓	X	✓	X	✓	✓	X
Kasanga	✓	N/A	✓	✓	✓	✓	✓	✓	✓	X
Songwe	✓	✓	✓	X	X	X	X	X	X	X
Kibengu	✓	N/A	✓	✓	✓	✓	✓	✓	✓	X
Mahenge	X	X	X	X	X	X	X	X	X	X
Kilwa Masoko	X	X	X	X	X	X	X	X	X	X
Songea	✓	X	✓	✓	✓	✓	✓	✓	✓	X
Muhuwesi	✓	X	✓	✓	✓	✓	✓	✓	✓	X
Masasi	X	X	X	X	X	X	X	X	X	X
Mtwara	✓	✓	✓	✓	✓	✓	✓	✓	✓	X

The assessment also indicated that, temperature and humidity shields, rain gauge stand, fencing and security are not available at some of the stations, hence required. A summary of the assessment is provided in **Table 9.**

Table 9: Assessment on Stands, Fencing and Security to be put in place/ installed

S/N	Station name	Temperature/Humidity stand/ shield	Rain gauge stand	Fencing	Security
1	Bukoba	✓	✓	✓	✓
2	Musoma	✓	✓	✓	✓
3	Tarime	X	✓	✓	X
4	Kibondo	X	✓	✓	✓
5	Mwanza	✓	✓	✓	✓
6	Manyara	X	X	X	X
7	KIA	✓	✓	✓	✓
8	Kaliua	X	✓	✓	✓
9	Tabora	✓	✓	✓	✓
10	Singida	X	X	X	X
11	Same	X	X	X	X
12	Pemba	X	X	X	X
13	Katobero	✓	✓	✓	✓
14	Mpanda	✓	✓	✓	✓
15	Rungwa	✓	✓	✓	✓
16	Dodoma	X	✓	✓	✓
17	Morogoro	X	X	X	X
18	Dar es Salaam	✓	✓	✓	✓
19	Kasanga	X	X	X	X
20	Songwe	✓	✓	✓	✓
21	Kibengu	X	✓	✓	✓
22	Mahenge	X	X	X	X
23	KilwaMasoko	X	X	X	X
24	Songea	✓	✓	✓	✓
25	Muhuwesi	X	✓	✓	✓
26	Masasi	X	X	X	X
27	Mtwara	✓	✓	✓	✓

3.1.1.3 Activities to be performed during establishment of new stations

TMA has already identified potential sites for the new surface stations. The sites are on government owned property and are easily accessible for constructing the upper air stations.

A summary of activities to be performed during establishment of new stations is indicated in **Table 10.**

Table 10: Activities needed for establishment of new stations

S/N	Station	Activity	Reason
1.	Singida	i. Transportation of new AWS to sites ii. Fence construction iii. Casting of foundations iv. Installation of New AWS	Automation required as the station performs Manual observation
2.	Same	i. Transportation of new AWS to sites ii. Fence construction iii. Casting of foundations iv. Installation of New AWS	Automation required as the station performs Manual observation
3.	Pemba	i. Transportation of new AWS to sites ii. Fence construction iii. Casting of foundations iv. Installation of New AWS	No station exist at the location
4.	Katobero	i. Transportation of new AWS to sites ii. Fence construction iii. Casting of foundations iv. Installation of New AWS	No station exist at the location
5.	Morogoro	i. Transportation of new AWS to sites ii. Fence construction iii. Casting of foundations iv. Installation of New AWS	Automation required as the station performs Manual observation
6.	Kasanga	i. Transportation of new AWS to sites ii. Fence construction iii. Casting of foundations iv. Installation of New AWS	End of station lifespan,
7.	Mahenge	i. Transportation of new AWS to sites ii. Fence construction iii. Casting of foundations iv. Installation of New AWS	Automation required as the station performs manual observation
8.	KilwaMasoko	i. Transportation of new AWS to sites ii. Fence construction iii. Casting of foundations iv. Installation of New AWS	Automation required as the station performs Manual observation
9.	Masasi	i. Transportation of new AWS to sites ii. Fence construction iii. Casting of foundations iv. Installation of New AWS	No station exists

3.1.1.4 Activities needed for stations requiring upgrade

Summary of activities needed for stations requiring upgrade is indicated in **Table 11**

Table 11: Activities needed for upgrading stations

Station	Activity	Reason
Tarime	i. Replacing Temperature / RH radiation shield ii. Replacing AWS Cabinet iii. Upgrading data logger, wires and cables) iv. Replacing solar battery v. Rehabilitation of fence vi. Upgrade of precipitation amount/intensity sensors vii. Installing bird cage for ultrasonic sensor protection	End of station lifespan, Station installed in 2016
Kibondo	i. Replacing Temperature / RH radiation shield ii. Replacing AWS Cabinet iii. Upgrading data logger, wires and cables) iv. Replacing battery v. Replacing grounding vi. Replacing lightning protection vii. Rehabilitation of fence viii. Installing bird cage for ultrasonic sensor protection	End of station lifespan, Station installed in 2016
Manyara	i. Replacing Temperature / RH radiation shield ii. Replacing AWS Cabinet iii. Upgrading data logger, wires and cables) iv. Replacing solar panel and battery v. Replacing grounding vi. Replacing lightning protection vii. Rehabilitation of fence	Station installed in 2017
Kaliua	i. Replacing Temperature / RH radiation shield ii. Replacing AWS Cabinet iii. Upgrading data logger, wires and cables) iv. Replacing solar battery v. Replacing grounding vi. Replacing lightning protection vii. Rehabilitation of fence viii. Replacement of wind sensor	End of station lifespan, Station installed in 2017
Rungwa	i. Replacing Temperature / RH radiation shield ii. Replacing AWS Cabinet iii. Upgrading data logger, wires and cables) iv. Replacing solar battery v. Replacing grounding vi. Replacing lightning protection vii. Rehabilitation of fence viii. Replacement of wind sensor ix. Installing bird cage for ultrasonic sensor protection	Nearing its lifespan, Station installed in 2016
Kibengu	i. Replacing Temperature / RH radiation shield ii. Replacing AWS Cabinet iii. Upgrading data logger, wires and cables) iv. Replacing solar panel and battery v. Replacing grounding vi. Replacing lightning protection vii. Rehabilitation of fence viii. Installing bird cage for ultrasonic sensor protection	Nearing its lifespan, Station installed in 2016

Muhuwesi	i. Replacing Temperature / RH radiation shield ii. Replacing AWS Cabinet iii. Upgrading data logger, wires and cables) iv. Replacing solar panel and battery v. Replacing grounding vi. Replacing lightning protection vii. Rehabilitation of fence viii. Installing bird cage for ultrasonic sensor protection	End of station lifespan, Station installed in 2017

3.1.1.5 Investment activities for surface observation stations

Investment activities will be required for new stations and the stations to be improved. The activities will involve procurement of infrastructure and systems.The GBON standard tender specification document will be used as reference during procurement.The partners will also ensure that it is specified in the tender that all new sensors comply with WMO No. 8 document (CIMO guide). Investmentactivities needed are summarized in **Table 12.**

Table 12: Investment activities for surface observation stations

Activity No	Activity description	Quantity	Estimated Cost(USD)
	a. preparation of tenders		
1	Establish technical specification for each station		
2	Site survey at new station locations;		
3	Tender document preparation, advertisng of tender		
	b. Installation of New nine (9)Surface stations		
1	Procurement of New AWSs	9	639,000
2	Transportation of new AWSs to installation sites	9	10,000
3	Installation of New AWSs	9	81,000
4	Supervision and inspection	9	38,000
	Sub-total		**768,000**
	a. Upgradingseven (7) surface stations		
1.	Rehabilitate/modernize/replace data loggers to meet MQTT and SFTP data transfer protocol requirement. This will include replacement of the following: i. AWS 310 base structure; ii. Radiation shield iii. Standard AVI configuration iv. Mains Power (90-260VAC) + Solar panel (70W orhigher) v. Backup battery (12 VDC / 26 Ah) vi. RS-485 (2-wire) local serial data output vii. TERMBOX-1200 for mains power and one data line viii. Ultrasonic wind sensor WMT703, ix. Barometer PTB330, Class A with 3 transducers x. TU probe HMP155E (RS485) + DTR13	7	210,000

	shield xi. RG13 pedestal, 1.14m high xii. AWS installation kit for non-frangible DKP200 Mast xiii. Sensor support arm for DKP200, up to 4 sensors xiv. Upgrade of precipitation amount/intensity sensors that do not meet required measurement range xv. Bird cage for wind sensors protection xvi. Upgrade communication at all sites including SIM cards and data/air-time		
2.	Replacing grounding	7	350
3.	Replacing lightning protection	7	5,950
4.	Procurement of material for rehabilitation of fence	7	36,000
5.	Installation of parts for upgrading AWSs	7	31,100
6.	Replacement/rehabilitation of fences	7	10,500
	Sub-total		**293,900**
	b. **Procurement of welding equipment for fences fabrication.**		
1	Weldingmachine	2	3,000
2	Angle grinder	2	1,000
3	Drill machine	3	800
4	Bench vice	2	500
5	Ironworktoolkit	3	1,500
6	Metal Cutting Machine	2	2,000
7	Welding Shield	10	120
8	Set of Gloves	10	150
9	Welding Googles	10	2,000
	Sub-total		**11,070**
	Grand Total		**1,072,970**

3.1.2 Recommended maintenance plan for improved/new stations, including calibration practices to be undertaken during SOFF implementation:

The planned maintenance intervals and activities of TMA is defined for each observing system, individual sensors and components in accordance with WMO and TMA manuals, guides and Standard Operating Procedures (SOPs) or as recommended by the manufacturers or suppliers.

TMA plans to implement a quarterly preventative maintenance schedule for GBON stations. The preventive maintenance may include field calibration/verification activities. Apart from preventive maintenance, corrective maintenance activities are carried out to repairnon-functional instrument/equipment. It is anticipated to attend

the system breakdowns within 3 days to ensure that the station meets the WMO and National monthly data availability performance target.

In order to achieve this maintenance plan, TMA has divided Tanzania into seven (7) cluster zones. Each zone will be manned with a residential engineer who will oversee maintenance in the zone of operationin order to facilitate fast response to restore stations operations in the event of malfunction or failure. Apart from zonal engineers, other technical personnel are based at TMA HQ in Dodoma and Central Forecasting Office in Dar es Salaam with the capacity to support meteorological infrastructure where all infrastructure to receive data from stations and exchange globally are installed. Each cluster zone has an office, which will have a store. Crucial spare parts are stored at the store of each cluster zone. In order to facilitate fast response to restore stations operations in the event of failure, a vehicle is needed to support each residential engineer.The SOFF project has budgeted funds for the procurement of five vehicles to be placed in each cluster zones. TMA through funds from the Tanzanian governmentwill procure vehicles for the remaining two cluster offices. **Table 13** shows Cluster zones and stations within each zone.

Table 13: Cluster zones and stations within each zone

Zone No.	Cluster Zones	Stations within the cluster zone
1	LAKE ZONE	Bukoba
		Musoma
		Tarime
		Mwanza
2	WESTERN ZONE	Kibondo
		Tabora
		Kaliua
		Katobero
		Mpanda
3	CENTRAL ZONE	Singida
		Dodoma
		Rungwa
4	NORTH-EASTERN HIGHLANDS	Manyara
		KIA
		Same
5	EASTERN	Dar es Salaam
		Pemba
		Morogoro
		Mahenge
6	SOUTHWESTERNHIGHLAND	Songwe
		Kibengu
		Kasanga
7	SOUTHERN	Kilwamasoko
		Mtwara
		Masasi
		Muhuwesi
		Songea

In order to ensure they continue to meet the GBON criteria, stations must undergo preventive maintenance, routine calibration and corrective maintenance whenever necessary. The interval and cost for those activities are established in **Table 14** and **15** respectively.

Table 14: Maintenance type and interval

Maintenance type	Location	Responsible person	Interval (Days)
Preventative maintenance	On site	Zone Engineer	Quarterly
Field Calibration	On site	Zone Engineer	As per instrument requirement
Corrective maintenance	On site	Zone Engineer	Within three (3) days

Table 15: Maintenance cost

Items	Number of Visit/year	**Unit price (USD)**	**No. of stations (27 stations)**	**No. of years**	**Total Cost (USD)**
Preventive maintenance	4	1,250	27	3	405,000
Field Verification/ calibration (conducted parallel with preventive maintenance)	1	250	27	3	20,250
Corrective maintenance	N/A			3	30,000
APN Internet Connectivity	12	10	27	3	9,720
Spare parts			27	3	284,500
Total operational and maintenance cost					**749,470**

3.1.3 Calibration

There are two types of calibration of measuring instruments of GBON station namely laboratory calibration and field calibration. Laboratory calibration performed in a laboratory operated in accordance with IEC/ISO 17025. The national or international measurement and traceability standards should be used to perform the required calibrations. Field calibrations are conducted for certain sensors by

using the field calibration equipment. All field calibration equipment should be calibrated in a laboratory defined intervals for ensuring measurements and traceability.TMA maintains a number of laboratory calibration equipment and field calibration equipment. In order to efficiently serve the 27 surface stations, quantitative and qualitative improvement of calibration equipment is required. A list of the available calibration equipment and the proposed calibration equipment to be procured is indicated in Table 16 and 17 respectively.

Table 16a: Laboratory calibration equipment (available at TMA calibration laboratory)

Calibrators	Sensors	Date of Purchase	Date of last calibration	Condition (Poor/medium/Good)
Climate Chamber	Temperature and Relative humidity	2015		Medium
Barometric Pressure Calibration chamber	Digital Barometer	2006	2022	Medium
Wind speed generator	Wind anemometer	2017	2021	Good

Table 16b: Laboratory calibration equipment (to be procured)

Equipment	Test equipment	Sensors	Quantity	Estimated cost (USD)
1 Rain gauge laboratory calibration device	Rain gauge calibrator	Raingauge	2	29,000
Climate Chamber	Thermometer and Hygrometer	Temperature generator Humidity generator	1	To be procured by TMA
Wind tunnel	Anemometers	Wind speed and wind direction	1	To be procured by TMA
Pressure generator	Barometers	Air pressure	1	To be procured by TMA
Grand Total				**29,000**

Table 17: Field Calibration Equipment

Equipment	Test equipment	Sensors	Quantity	Estimated cost (USD)
1	Mobile temperature calibrator	Temperature sensor	7	280,000
2	Mobile pressure generator	Temperature sensor	7	210,000
3.	Mobile humidity generator	humidity sensor	7	105,000
4.	Barometric Pressure Transfer standard	Atmospheric pressure sensor	7	56,000
5.	Rain gauge field calibration device	Precipitation sensor	7	35,000
Total				**686,000**

3.1.4 Upper Air stations

TMA is operating one Upper Air Station located at Julius Nyerere International Airport (JNIA) in Dar es Salaam. The station performs daily ascent at 1200 GMT. The station consists of a hydrogen gas generating plant and a radio sounding station for tracking radiosondewhenreleased into the space.

The plant generates hydrogen for filling the weather balloons. The balloons currently on use at TMA weighs 350g. To perform two ascents a day as per GBON requirement, TMA will have to automate sounding process as currently the release is manually. Moreover, more consumables (radiosondes and balloons) are also required.

For the Upper Air observation, GBON requires a 500km spatial resolution. According to this requirement, the minimum number of upper air stations required to meet the GBON spatial resolution for Tanzania is 5 stations. Therefore, in addition to the existing one (1) Upper Air Station to be improved, four (4)new Upper Air Stations are required**[Figure 2]**of which TMA will procure one (1) upper station (Mtwara) with funding from the Government of Tanzania. Therefore, SOFF funding will be required for three (3) new upper air stations.

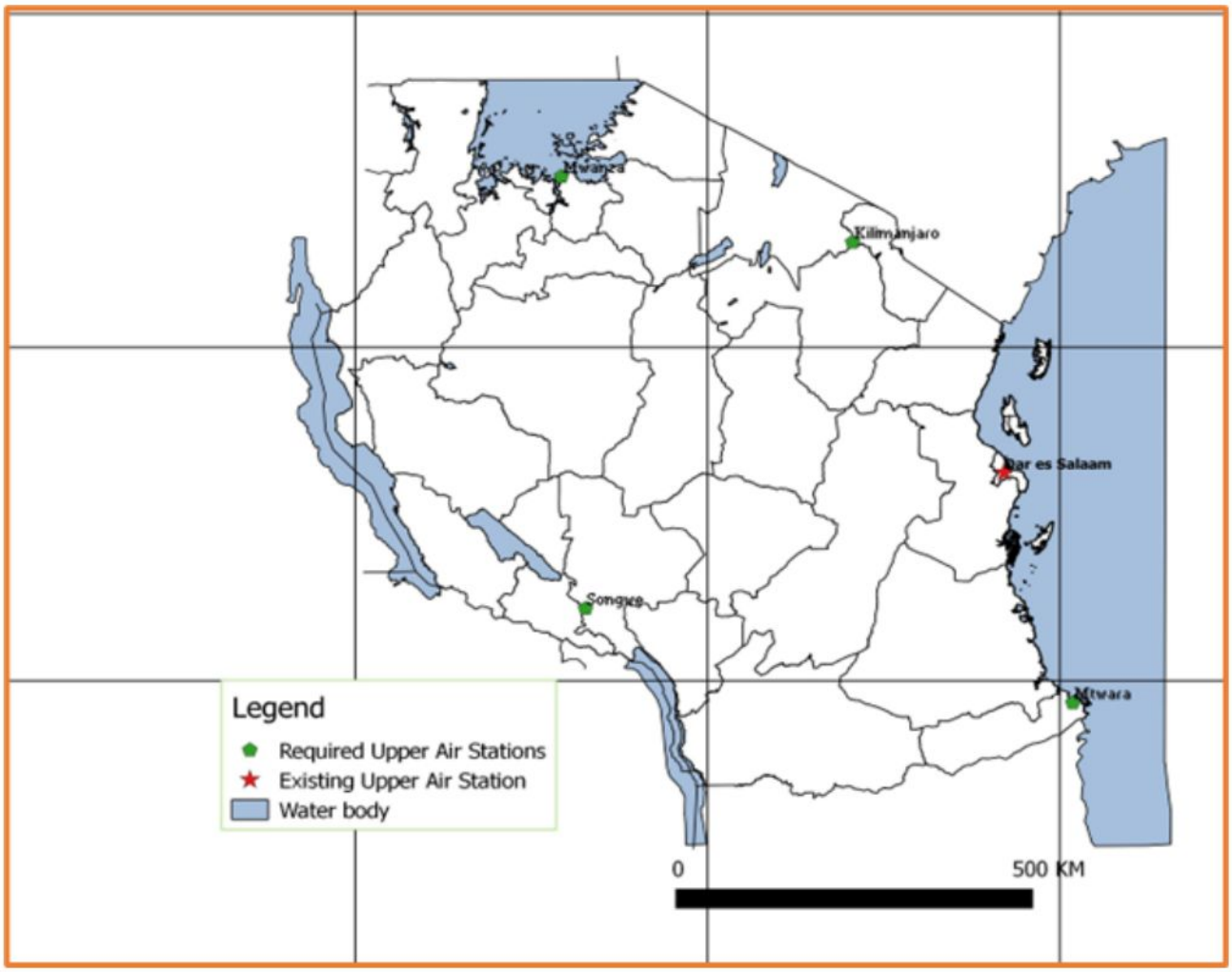


Figure 2: Map of Tanzania showing Existing and proposed Upper-Air Stations at 500km by 500km resolution

3.1.4.1 Investments and activities needed for the installation of new upper air stations and the improvement of existing stations

TMA has already identified sites for the new upper air stations. The sites are on government owned property and are easily accessible for constructing the upper air stations.

Table 18: List of upper Air stations (existing and proposed new) and parameter measured

Station name	Site Coordinates	Temperature	Humidity (RH)	Horizontal Wind Direction	Horizontal Wind Speed
Mwanza	Lat :02°26′31.0′′s Long: 32°55′29.0′′e Alt: 1146m	X	X	X	X
Kilimanjaro	Lat :03°25′38.0′′s Long: 37°03′29.0′′e Alt: 894m	X	X	X	X
Songwe	Lat :08°55′22.0′′s Long: 33°16′06.0′′e Alt: 1340m	X	X	X	X
Dar es Salaam	Lat :06°52′34.0′′s Long: 39°12′27.0′′e Alt: 51m	✓	✓	✓	✓
Mtwara	Lat :10°20′05.0′′s Long: 40°11′04.0′′e Alt: 114m	X	X	X	X

The list of activities per new Upper Air site and the reason for their establishment is indicated in **Table 19.**

Table19: List of sites for proposed Upper Air stations

S/N	Station	Site Coordinates	Activity	Reason
1	Mwanza (to be procured by SOFF)	Lat :02°26′31.0′′s Long: 32°55′29.0′′e Alt: 1146m	i. Construction of upper air building ii. Installation of upper air station	No upper station exist
2	Kilimanjaro (to be procured by SOFF)	Lat :03°25′38.0′′s Long: 37°03′29.0′′e Alt: 894m	i. Construction of upper air building ii. Installation of upper air station	No upper station exist
3	Songwe (to be procured by SOFF)	Lat :08°55′22.0′′s Long: 33°16′06.0′′e Alt: 1340m	i. Construction of upper air building ii. Installation of upper air station	No upper station exist
4	Mtwara (to be procured by URT)	Lat :10°20′05.0′′s Long: 40°11′04.0′′e Alt: 114m	i. Construction of upper air building ii. Installation of upper air station	No upper station exist

3.1.4.2 Activities needed for installing new Upper air station

The start-up investment activities for the establishment of the new upper-air stations are as follows:

i. Establish technical specification for new upper air stations;
ii. Conducting site survey for the upper air station (Sites for upper air stations will be at the airport locations where TMA surface observations exists hence land and access for building of upper air infrastructures are easily accessible).
iii. Construction of the hydrogen generator building, ensuring that the building design is in accordance with national standards and codes of practice concerning the risks presented by explosive gas;
iv. Installation of lighting, power/mains and water supply including back-up solutions
v. Procure Hydrogen generation systems, ground systems and hardware, procure consumables, Fire protection (extinguishers and adequate warnings according to national regulations) and first aid kit; Personal Protective Equipment (PPE) i.e. special garments; and Hydrogen presence detecting tools/ Gas leak detection units.

3.1.4.3 Activities needed for upgrading Upper air station at JNIA

Activities needed for upgrading Upper air station at JNIA are indicated in Table 20.

Table 20:Activities needed for upgrading Upper Air station

S/N	Station	Activity
1	Dar es Salaam	i. Renovation of existing upper air building ii. Replacement of gas storage tank gauges iii. Replacing Filters iv. Replacing valves v. Replacing electrolytic cell vi. Procurement of Hydrogen detecting tools/ Gas leak detection units. vii. Procurement of autosonde system and accessories viii. Procurement of consumables and maintenance parts

3.1.4.4 Budget for construction and installation of new Upper Air stations

The budget for construction and installation of new Upper Air stations is indicated in **Table 21.**

Table 21: Budget for construction and installation of new Upper Air stations

Items	Unit cost (USD)	No of Units	Total Cost (USD)
Building /Facilities			
Water and static proof building (Balloon room)	85,000	3	255,000
Lighting and earthing	4,500	3	13,500
Power/Mains power supply	6,500	3	19,500
Direct water supply,Water tank (2000litres) and water pump	1,000	3	3,000
Hydrogen Generation System			
Hydrogen generator (0.5 Nm3/hr (20SCF/hr/500l/hour)	150,000	3	450,000
Hydrogen storage vessel 1000 litre water capacity (7m3)including inlet/outlet isolating valve, purge valve, pressureindicator and safety relief valve (set of piping, fitting,accessories for connection of the electrolyser to the tankand from the storage tank to draw-off panel)- Three (3) storage tanks per station	45,000	3	135,000
Cost for installation and commissioning of the hydrogen generator system	36,000	3	108,000
Uninterruptable Power Supply (UPS)	30,000	3	90,000
Auto-sondesystem for auto launching of meteorological balloon and accessories	220,000	3	660,000
Ground System Hardware installation			
Upper-air ground system and installation	45,000	3	135,000
Backup power (Solar power and UPS)	15,000	3	45,000
Workstation	5,000	3	15,000
Network connectivity (network switch and cabling) / mobile network connection	2,000	3	6,000
Total Cost			**1,935,000**

3.1.4.5 Budget for Upgrading Upper Air station at Dar es Salaam

The budget for upgrading Upper Air station is indicated in **Table 22.**

Table 22: Budget for upgrading Upper Air station

Items	Unit cost (USD)	No of Units	Total Cost (USD)
Upgrading the Upper air station which will include: • Replacement of gas storage tank gauges • Replacing Filters • Replacing valves • Rehabilitation of the hydrogen generation system • Procurement of Hydrogen detecting tools/ Gas leak detection units. • Procurement and installation of autosonde system and accessories	**100,000**	**1**	**100,000**
Procurement and installation of autosonde system and accessories	**220,000**	**1**	**220,000**
Grand total			**320,000**

Table 23: Cost of consumablesfor five stations for two years

Items	Unit price (USD)	No of Units per year (five stations)	No.of years	Total Cost (USD)
Radiosonde (daily sounding + spares) incl. ballons + valves for five stations	165	Calculation for Radio sondes is 2 per day*2 years*5 stations + 100 spares per station = 7800.	2	1,287,000
Spare parts	5,000	5	2	50,000
Operational Cost (electricity, water, chemicals, data transmission, internet, Maintenance of the equipment)	600	60	2	72,000
Total				**1,409,000**

3.1.4.6 Observational practices for the upper-air network

According to experience of operating an upper air station in Tanzania, at least two (2) technical personnel and two (2) operators are required to maintain one (1) upper air station. To facilitate a network of five upper air stations, at least ten (10) qualified technical personnel and ten (10) operators are required. This will require a specialized training for eight technicians and eight(8) operators as currently TMA has two (2) qualified personnel.

a) Recommended maintenance plan for improved/new upper air stations, including calibration practices to be undertaken during SOFF implementation.

It is recommended that daily safety checks should be done for the balloon room/shed and the hydrogen generating system. Furthermore, regular training, at least every 2 years, should be conducted to ensure that all staffs are updated on standards and practices, benefits and requirements for upper-air observations, technology improvements, and system maintenance and quality management. The Hydrogen Generating Systems must be serviced and recertified by the manufacturer every 5 years to ensure its safety and reliability while regular maintenance shall be conducted every year under consultation with the manufacturer.

3.2 Design of the ICT infrastructure and services

a) Detailed description of the Telecommunication infrastructure and services design

TMAoperates surface observing network consisting of manned synoptic weather stations and AWSs. The real time observations from manned stations are sent at the CFO, communication section every three (3) hours through email, GPRS and telephone. Received observations at CFO are then manually submitted to the Automatic Message Switching System (AMSS) for international exchange. Weather parameters observed at stations are also sent through email and hardcopies to the climate data section for long term storage.

The current ICT infrastructure is old and outdated. To efficiently comply with the GBON criteria the current system must be renewed and upgraded to a fully automatic system (observation, transmission and exchange of meteorological information and data).

The recommended telecommunication infrastructure will consist of a Network of observing stations, Communication from the observing stations, Data collection system, and nodes for GTS, WIS 2.0, Climate Data Management, In-house Numerical Weather Prediction (NWP) nodes etc. Data flow starts with collection of data from observing station and sending data to the Data Collection System. The data collection system then performs data quality check. The data must follow WMO standards and the data presentation system and other users of the data collected

must have ways to ingest the collected data - The network topology is shown in **Figure 3**.

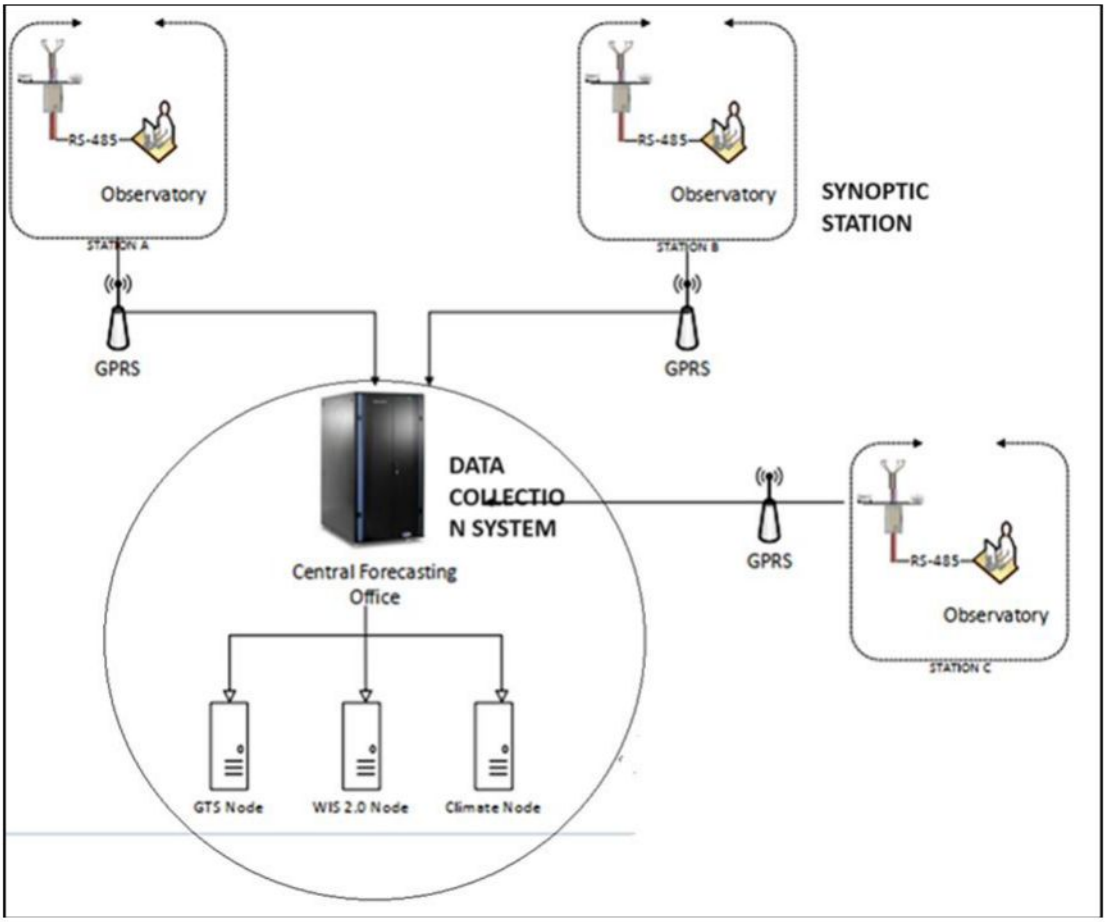


***Figure 3**: The network topology of recommended telecommunication infrastructure*

a. The Data Control System Functions

i. Receive data from stations

ii. Quality Control

- Perform quality controls by checking/monitoring:
- Instrumental or physical limits
- Climatological limits
- Maximum allowed temporal variability
- Consistency checks between variables

iii. Monitoring sub-system

Monitor the station operating status

iv. Perform Data processingConfiguration sub-system

i. Configuration of monitoring indicators
ii. Configuration of station's metadata

v. Sending data to other users

- GTS

- WIS 2.0
- Real time data display (Forecasting)
- National Meteorological Data bank (Climate Data Management)
- NWP etc.

To ensure resilience and continuity of the full data processing chain, a number of actions will be undertaken, including:

i. Establishment of a reliable data collection system;
   a. This will include a secondary system, identical to the primary system. In case of downtime of the primary system, the secondary system takes over, until the primary system is back up and running. This resolves to an active/passive setup.
ii. Backup power:
   a. Ensure availability of observations at stations by providing power backup to stations.
   b. At the stations batteries can function as power backup.
   c. UPS and Solar power system for server room.
   d. UPS and Generator for main building.
iii. Stations should be able to store data in case of connection issues totheheadquarter and ability to resendwhen the connection is restored.

Proposed activities:

i. Design an effective data collection system taking into consideration all meteorological platforms with ability to convert and disseminate collected meteorological information into various thematic applications such as NWP, GTS, WIS 2.0 and climate data management system (refer **Figure 3**);
ii. Prepare appropriate technical specification for the data collection system;
iii. Procure data collection and dissemination system;
   a. System should include visualization and monitoring tools for real time monitoring of the observing platforms; and
iv. Put in place reliable telecommunication connectivity (backup system for telecommunication and power).
v. Technical and users receive training on managing and using the data collection system.

3.3 Design the data management system

The current system of climate data management uses input data from stations (manned weather stations, Automatic Weather Stations, rainfall stations and climate stations). However, the system does not have the capability to receive data automatically without human intervention. Instead, the observed data from weather and rainfall stations is sent to the data section daily at 0600GMT through email and/or telephones and entered manually. Data from some of the stations is received in form of hard copies on rainfall cards or forms, whereby it is archived in hard copies before it is entered manually into the system. Also the system has limited

capability to perform data quality control, data processing and analysis, product generation and quality check of the data is done manually. This option is labour intensive, time consuming and jeopardizes the quality of the data due to human intervention in recording the data at the station and entering the data into the system. Furthermore, the approach jeopardizes data safety as the cards and forms may get lost on the way before they reach the data section for archiving.

In view of the existing challenges and risks related to data quality and loss, there is a need to invent another system with the capability of automating all the processes, including data receiving, quality control, data processing, data analysis (including big data processing and analysis) and product generation. The partners propose that the system should include a climate-data collection system node, which will receive data and store automatically from weather stations, in addition to the GBON prioritized elements.

Update for Data Base Management System (DBMS)through SOFF will add a significant value in the implementation of this project as it will enhance the ability of TMA to perform quality control to information received from the station before archived and shared across the world.

Proposed activities:

i. Design in consultation with Peer Advisor an effective Data Management System for data archiving and prepare appropriate technical specifications;
ii. Supplying, installing and commissioning an effective database management system for data archival, data quality control, product generation and data processing including big data processing.
iii. Industrial and onsite training for users and Technical personnel on the data Management system (shall be included in ii above);
iv. Factory Acceptance test of DBMS (shall be included in ii above); and
v. Monitor performance of the system and report accordingly.

The data management system can becommercial software or open source.Itshall be hosted in-house at TMA whereby TMA will be responsible for its operations after training.

The cost for activities under sections 3.2 and 3.3 is indicated in **Table 24**

Table 24: Cost for activities under sections 3.2 and 3.3

S/N	TYPE OF EQUIPMENT	FUNCTION	COST(USD)
1	Data Collection System	To receive data from station and distribute to various nodes. The partners will, during the	750,000

		tendering process, explore if the budget for DCS could include Database Management System (DBSM) for short and long term archiving of meteorological data	
2	Put in place reliable telecommunication connectivity.	Backup system for telecommunication facilities and power	50,000
3	Station Monitoring System	To monitor the status of remote stations for quick fault detection and maintenance	50,000
Total			**850,000**

3.4 Environmental and sustainability considerations

The observing networks will be designed, implemented, and operated with the aim of having a sustainable weather and climate observing systems. The instruments/system will comply, at a minimum, with Tanzania and/or any recognized Environmental regulations. This will apply to the instrument itself, all its sub-systemsand associated consumables where applicable. Where packaging material selection allows, without degradation of the instruments' performance or shelf life, only recyclable materials must be used.The project partners shall also adhere to both WMO recommendations and Tanzanian environmental and sustainability requirements for the procurement, shipping, installation, and operation forboth surface and upper air stations.

Recommended pragmatic approaches and measures for environmentally responsible design and evolution of the national networks to achieve GBON requirementsinclude:

i. Carrying out Environmental Impact Assessment (EIA)as required by Tanzania law;
ii. Ensuring technical specifications for equipment comply with environmental requirements;
iii. Integration of sustainability considerations for the management of operations of GBON stations, including installation, calibration, and maintenance;
iv. Selectionofenvironmental friendly material for the development, shipping and day-to-day operations of GBON stations.

Module 4. GBON Human Capacity Development

4.1 Assessment of human capacity gaps

TMA is led by the Director General who is assisted by five (5) Directors; Director of Forecasting Services, Director of Infrastructure and Technical Services, Director of Research and Applied Meteorology, Director of Cooperate Services and Director of Meteorological Regulation and Quality Assurance. Currently TMA has approximately 520 staff. Among them are 400in the meteorology cadre and 120 are supporting staff. Among the staff in the meteorology cadre, 79% are males and are21% females. TMA operates at 76%staff capacity compared with its estimated optimal number of staff.

Currently, TMA has 15 Meteorological engineers and 10 ICT experts. The estimated optimum number of engineers to maintain TMA observation infrastructure, including GBON network is 34.

In Tanzania, recruitment of staff for government institutions takes place at central level by the Public Service Recruitment Secretariat. Upon recruitment staff are assigned to the specific institutions. Recruitments are based on submission of annual budgets and human resource requests from each government institution. TMA has submitted a proposal for employment of more Meteorological Engineers to the Public Service Recruitment Secretariat the institution which is responsible to hire government employees. While waiting for new engineers to be employed by the Government, the clustering of stations in zones and assigning engineers and vehicles to each zone will enable timely attendance to any station downtime and therefore the project has not budgeted for employment of new engineers specific for this project.

This project is considered asa high priority projectfor TMA. In that consideration, all personnel working on the implementation of this project will be considered as in kind contribution from TMA except for expenses incurred for field travel and per Diemsin implementing activities of the project which will be compensated as per Tanzania government regulation and TMA incentive package, which will be covered by the project.

Proposed activities:

i. Conduct continuous assessments of capacity gap in area of installation, calibration, fabrication, maintenance of meteorological instruments.
ii. In collaboration with peer advisorexplore areas of collaboration to address identified capacity gap.

4.2 Design capacity development activities for technical staff

TMA exchanges observed meteorological observation through WMO Global Telecommunication System (GTS) on behalf of the government of the United

Republic of Tanzania. To ensure smooth operation on observation activities, TMA through Directorate of Infrastructure and Technical Services ensures all meteorological instruments conducting observation are in good order and have a valid calibration certificate. However, with modernization and coping with changing in technologies,it is critical to build capacity on site Instrument maintenance, fabrication of modern meteorological instruments (Assembling, integration and configuration), calibration of modern meteorological equipment (laboratory and onsite)and monitoring and maintenance of crucial telecommunication facilities (such as AMSS, Satellite receiving stations and NWP data reception). In ensuring smooth and sustainable operations of the GBON infrastructure, the project will build the required capacity to existing experts (engineers) to maintain the GBON infrastructure. Capacity building with involve training for 13 engineers in Instrument maintenance, fabrication of modern meteorological instruments (Assembling, integration and configuration), calibration of modern meteorological equipment (laboratory and onsite), monitoring and maintenance of crucial telecommunication facilities (such as AMSS, Satellite receiving stations and NWP data reception). The project will also train 10 ICTstaff in monitoring and maintenance of telecommunication facilities.

Proposed activities:

i. Train TMA engineers to fabricate/assemble, integrate and configure modern meteorological equipment in collaboration with peer advisor.
ii. Training of 8 TMA engineers in daily safety checks and basic maintenance of an upper-air system.
iii. Training of TMA ICT staff in new data collection and data base management systems

4.3 Design capacity development activities for senior management

For a strategic organization like NMHS, every senior executive requires superior skills to manage every resource within the organization in an effective manner.
Hence capacity development for senior management should include but not limited to

- Understand and use strategic planning tools;
- Initiate a strategic planning process;
- How to react speedily to technological changes within the organization;
- Analytical tools at hand to help identify the cause of problems;
- Develop appropriate strategies for greater personal, team and organizational effectiveness and
- Project management skills

To equip members of senior management with the required skills, the project will train ten (10) members of senior management in the above-named aspects.

Proposed Activities

i. Identify consultant to provide training on the identified needs (DMI/WMO).
ii. Training of 10 TMA senior Management on identified needs.

4.4 Gender and Civil Society Organizations (CSOs) considerations

4.4.1 Gender

TMA has continued to make efforts to ensure gender equality in the provision of weather and climate services. In Tanzania there is a clause in the law governing public tenders, which requires government institutions to ensure that where possible 10% of public tenders go to companies, which are operated by special/minority groups. The act is not applicable for highly specialized tenders such as meteorological equipment, but the act will be sought applied to smaller procurement and booking of venues where possible.

TMA will work with the project partners and stakeholders to promote gender equality in meteorology to ensure gender involvement. In line with the recommendations from the WMO Technical Commission for Infrastructure (INFCOM[1]) and the eight focus areas for gender balance that INFCOM has identified, the project partners will work towards developing strategies for the promotion of gender balance in project activities. The partners will particularly take active steps to ensure that capacity development opportunities are gender inclusive.This includes training and educational opportunities, participation in coordination activities, and promoting the visibility of gendercontributionsand to encourage young scientiststotake interest in meteorology and the climate sciences. Gender indicators have been included in the Result Framework to ensure that there is at least a 50% female representation in capacity building activities. Gender consideration has been addressed right from the beginning of SOFF project implementation, including SOFF Readiness Phase activities whereby the project team and participants in the organized activities considered participation of men and women as well as different age groups.

4.4.2 Civil Society Organizations (CSOs)

TMA and UNDP have existing relationship with CSOsin Tanzania. In this project TMA will work together with UNDP to engage CSOs to identify their potential in contributing to GBON and create awareness as relevant in different aspects of GBON with aim of strengthening partnerships with CSOs and Private Sector.

Through the SOFF initiative, efforts will be made to extend the partnership with TMA and private sector to explore mechanisms to support the delivery of the SOFF Investment Program where appropriate. Particularly, the implementation of SOFF will also ensure the involvement of CSOs through the continuous engagement on

[1] INFCOM-2-d09-GENDER-ISSUES-approved_en.docx (wmo.int)

Early Warning For All and on how to translate strengthened weather data to improved provision of last mile services.

Proposed Activities

i. Ensure 50% participation of females in capacity building activities
ii. Conduct Gender monitoring to ensure accomplishment of the gender indicators in the result framework
iii. Organize stakeholders' workshop for awareness raising on the role of CSOs in the implementation of SOFF and their contribution to GBON.

Module 5: Risk Management Framework

Table 25: Risk Management Framework

No	Risk	Risk level	Likelihood	Impact	Risk Mitigation Measures
		Please indicate: Low, Medium, High, Very high	Please indicate: Rare, Unlikely, Possible, Likely, Very likely	Please indicate: Insignificant, Minor, Moderate, Major, Extreme	*Please indicate risk mitigation measures the project will undertake.*
1.	Failure to comply with legal requirements (e.g. TMA Act No.2 of 2019, Procurement Act, Revenue Act, Finance Act, and associated Regulations etc)	Medium	Unlikely	Major	• Initiate MoU/agreement among parties to have sections signifying necessity for compliance. • Having implementation flow chart(s)/ matrix with clear responsibilities descriptions
2.	Late disbursement of funds	Medium	Possible	Minor	• Close follow up on Funds flow and schedule
3.	Ineffective international data sharing	Medium	Unlikely	Major	• Ensure effective telecommunication system is in place. • Ensure regular inspection and maintenance of infrastructure. • Ensure availability of skilled personnel in maintenance and conducting

					meteorological observations.
4.	Destruction/ Theft/Vandalism of SOFF infrastructures	High	Possible	Major	• Employ security personnel. • Engage the Civil Society Organizations (CSOs) and all relevant local authorities from the beginning of the project. • Enter into MoU with Local Government Authorities and Religious Organizations.
5.	Inability to access meteorological data and forecast products	Medium	Possible	Moderate	• Ensure reliable telecommunication facility. • Provide access to data and products. • Ensure relevant expertise to access the data from global/regional sources.
6.	Price escalation	Medium	Possible	Moderate	• Ensure budget allocation addresses exchange rate fluctuations • Timely procurement.
7.	Damage of infrastructure by natural hazards	Low	Possible	Moderate	• Locating stations at places not prone to natural hazards like flooding, landslides, etc

Risk monitoring will be an integral part of the project management and the TMA project manager will be tasked with maintaining an updated risk management framework. Risk analysis will be a topic on the agenda during the project partner meetings where the partners together will assess if there have been significant changes to the risk management framework. A particular risk is the security at the four new AWS sites. The project will support construction of guards houses to avoid theft of equipment. If a risk materializes, the project team will ensure that all relevant stakeholders receive swift communication about the situation and the planned mitigating actions.

Module 6.Transition to SOFF investment phase

The partners (TMA, UNDP, DMI) will work together to prepare the funding request for the Investment phase based on the recommendations provided in the Plan. Furthermore, UNDP and DMI will support TMA to organize preparatory activities to the Investment Phase Funding Request. Such preparatory activities are to organizing a working session to prepare Letter of Agreement between TMA and UNDP and project documents to request for exemption of custom and importation tax of meteorological infrastructure.

Summary of GBON National Contribution Plan

Provide summary of GBON National Contribution Plan by filling this table

This is a summary of the proposed project activities. The detailed activities and sub-activities are indicated in **Annex 2.**

Components	Recommended activities
Module 2. GBON business model and institutional development	**2.1 Assessment of national governmental and private organizations of relevance for the operation and maintenance of GBON**
	2.1.1 Continuous engagement with Government entities operating meteorological stations and their potential to support GBON.
	2.1.2 Conduct a survey to assess the potential and readiness of private sector operating meteorological stations to support GBON implementation.
	2.2 Assessment of potential GBON sub-regional collaboration
	2.2.1 Mapping of potential (existing) forums for collaboration.
	2.2.2 Establish a coordination team among the Sub-regional Countries (including peer advisor and Implementing Entity) which will meet regularly to maximize coordination and resources across the borders.
	2.2.3 Attend and coordinate sub-regional meetings
	2.2.4 Identify activities for regional collaboration, which will enhance and strengthen the implementation of GBON (e.g., Maintenance and calibration of meteorological instrument).
	2.2.5 Establish sub-regional network and data sharing mechanism among the neighbouring countries.
	2.3 Assessment of the most effective business model to support network operations
	2.4 Assessment of existing national strategies and projects for developing and improving observing networks
	2.4.1 Close monitoring of policies and strategies and their effect on project implementation and take appropriate actions.
	2.4.2 Continuous engagement with government and other ministries on policy and strategy development.
	2.4.3 Continuous engagement with Early Warning For All (EW4All) stakeholders, incl. civil society, UN and

	other INGO's.
	2.5 Assessment of the national legislation of relevance for GBON
	2 2.5.1 Develop agreements and documentation to facilitate tax exemption and clearance of procured infrastructure.
Module 3. GBON infrastructure development	**3.1 Design the surface and upper-air observing network and observational practices**
	a) Surface observation stations
	3.1.1 Establish technical specification for each station to be procured.
	3.1.2 Conduct site survey for installation of stations at new locations.
	3.1.3 Procurement of new equipment for new stations and stations to be upgraded (Supply, Install and Commission for one new station. For other stations – supply. Installation will be conducted by TMA Engineers). Tender document preparation, advertisement of tender document, evaluation and tender board decision will be determined by UNDP and TMA (*The procurement shall include cost of equipment, industrial training and FAT*)
	3.1.4 Port and custom clearance.
	3.1.5 Inspection of procured items.
	3.1.6 Shipment from TMA warehouse to site.
	3.1.7 Installation of new nine (9) stations.
	3.1.8 Upgrade of seven (7) stations.
	3.1.9 Supervision and inspection of stations
	b) Maintenance plan for Surface Observation Stations
	3.1.10 Cluster stations into Zones.
	3.1.11 Prepare technical specification of required laboratory and mobile calibration equipment.
	3.1.12 Procure mobile and laboratory calibration equipment (Including industrial, On-site training for Engineers and Factory Acceptance Test (FAT)).
	3.1.13 Establish and implement calibration and maintenance plan.
	3.1.14 Perform annual laboratory calibration as per requirement.
	a) Upper Air stations
	3.1.15 Establish technical specification for new upper air stations.
	3.1.16 Conduct site survey for installation of new stations;
	3.1.17 Procurement of 3 upper air stations - supplying,

	installation and commissioning (the procurement shall also include cost for Factory acceptance test, Industrial and on-site training for Engineers and operators, Annual maintenance and consumables supply contract, cost for construct building offices for three (3) upper air stations and cost of vehicles (5) to facilitate rapid operations and maintenance of upper air stations).
	d) Maintenance plan for Upper Air Stations
	Cluster stations into Zones.
	3.1.18 Prepare the estimate annual operation cost (Radiosondes, balloon, other running costs like electricity, water and internet)
	3.1.19 Establish and implement maintenance plan.
	3.1.20 Monitor the implementation of the plan.
	3.2 **Design of the ICT infrastructure and services**
	3.2.1 Design an effective data collection system taking into consideration all meteorological platforms with ability to convert and disseminate collected meteorological information into various thematic applications such as NWP, GTS, WIS 2.0 and climate data management system (refer diagram under 3.2).
	3.2.2 Prepare appropriate technical specification for the data collection system.
	3.2.3 Procure data collection and dissemination system;
	3.2.4 Procure visualization and monitoring tools for real time monitoring of the observing platforms.
	3.2.5 Put in place reliable telecommunication connectivity.
	3.2.6 Technical and users receive training on managing and using the data collection system.
	3.3 **Design the data management system**
	3.3.1 Design in consultation with Peer Advisor an effective Database Management System (DBMS) node for data archiving and prepare appropriate technical specifications.
	3.3.2 Supplying, installing and commissioning an effective database management system for data archival, data processing and product generation including big data processing.
	3.3.3 Industrial and onsite training for users and ICT personnel on the database Management system (shall be included in ii above).
	3.3.4 Factory Acceptance test of DBMS (shall be included in ii above).
	3.3.5 Monitor performance of the system and report accordingly – in kind contribution.

	3.4 **Environmental and sustainability considerations**
	3.4.1 Carry out Environmental Impact Assessment (EIA).
	3.4.2 Ensuring technical specifications for equipment comply with environmental requirements;
	3.4.3 Integration of sustainability considerations for the management of operations of GBON stations, including installation, calibration, and maintenance;
	3.4.4 Selection of environmental friendly material for the development, shipping and day-to-day operations of GBON stations.
Module 4. GBON human capacity development	**4** Module 4: Human Capacity Development
	4.1 Assessment of human capacity gaps
	4.1.1 Conduct continuous assessments of capacity gap in area of installation, calibration, fabrication, maintenance of meteorological instruments
	4.1.2 In collaboration with peer advisor explore areas of collaboration to address identified capacity gap.
	4.2 Design capacity development activities for technical staff
	4.2.1 Train TMA engineers to fabricate/assemble, integrate and configure modern meteorological equipment in collaboration with peer advisor
	4.2.2 Training of 8 TMA engineers in daily safety checks and basic maintenance of an upper-air system.
	4.2.3 Training of TMA ICT staff in new data collection and data base management systems
	4.3 Design capacity development activities for senior management
	4.3.1 Identify consultant to provide training on the identified needs (DMI/WMO).
	4.3.2 Training of 10 TMA senior Management on identified needs.
	4.4 Gender and CSOs considerations
	4.4.1 Organize stakeholders' workshop for awareness raising on the role of CSOs in the implementation of SOFF and their contribution to GBON.
	4.4.2 Organize sensitization seminars to students to pursue engineering studies.
Module 5.	5.1 Construct 4 guard houses in the premises of AWS at

Risk Management	remote areas.
Module 6. Transition to SOFF investment phase	6.1 Develop agreements and documentation to facilitate tax exemption and clearance of procured infrastructure. This activity will be implemented under section 2.5 (i). 6.2 Prepare funding request for SOFF investment phase

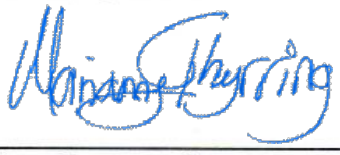
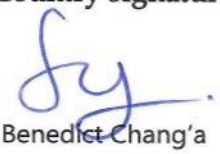
Annex 2: Detailed implementation plan

Activity number	Activity – description	Year 1				Year 2				Year 3 - Commission Period			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
	Module 2 - Business Model and Institutional Development												
2.1	Assessment of national governmental and private organizations												
2.1.1	Survey on Government Stakeholders				x								
2.1.2	Survey on Private Sector Stakeholders				x								
2.2	Assessment of potential GBON sub-regional collaboration												
2.2.1	Mapping of potential (existing) forums for sub-regional collaboration;			x									
2.2.2	Establish a coordination team among the Sub-regional Countries				x								
2.2.3	Attend and coordinate sub-regional meetings					x			x				x
2.2.4	Identify and implement activities for regional collaboration					x			x			x	
2.2.5	Establish sub-regional network and data sharing mechanism									x			
2.3	Assessment of the most effective business model												
2.4	Assessing national strategies for developing observing networks												
2.4.1	Continuous monitoring of policies and strategies	x	x	x	x	x	x	x	x	x	x	x	x
2.4.2	Continuous engagement with government and other Ministries	x	x	x	x	x	x	x	x	x	x	x	x
2.4.3	Continuous engagement with EW4A stakeholders, incl. civil society, UN	x	x	x	x	x	x	x	x	x	x	x	x
2.5	Assessment of National legislation related to GBON												
2.5.1	Develop agreements and documentation to facilitate tax exemption and clearance of procured infrastructure	x		x									
	Module 3 - Infrastructure Development												
3.1	Designing surface and upper-air observing network												
	Surface stations installation												
3.1.1	Establish technical specification for each station to be procured	x											
3.1.2	Conduct site survey for installation of stations at new locations	x											

Activity number	Activity – description	Year 1				Year 2				Year 3 - Commission Period			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
3.1.3	Tender document preparation	x											
3.1.4	Procurement of new equipment for new stations and stations to be upgraded		x	x									
3.1.5	Port and custom clearance.			x									
3.1.6	Inspection of procured items			x									
3.1.7	Shipment from TMA warehouse to site			x									
3.1.8	Installation of new nine (9) stations				x	x							
3.1.9	Upgrading of seven (7) stations				x	x							
	Surface stations maintenance												
3.1.10	Cluster stations into Zones	x											
3.1.11	Technical specification of laboratory and mobile calibration equipment	x											
3.1.12	Procure mobile and laboratory calibration equipment		x	x									
3.1.13	(a) Establish calibration and maintenance plan				x					x			
	(b) Implement calibration and maintenance plan					x	x	x	x	x	x	x	x
3.1.14	Perform annual laboratory calibration as per requirement								x				x
3.1.15	Purchase vehicles (5) to facilitate rapid operations and maintenance		x	x									
	Installation of Upper Air Stations												
3.1.16	Establish technical specification for new upper air stations (including buildings)	x											
3.1.17	Conduct site survey for installation of new stations	x											
3.1.18	Procurement of equipment (consumables) to upgrade existing UA station		x	x									
3.1.19	Procurement of 3 upper air stations		x	x									
3.1.20	Construct building offices for three (3) upper air stations and installation of upper air stations			x	x	x							
3.1.21	Construction of guard houses in new station locations				x	x							
	Maintenance of Upper Air stations												
3.1.21	Prepare the estimate annual operation cost		x										
3.1.22	Establish and implement maintenance plan					x	x	x	x	x	x	x	x
3.1.23	Monitor the implementation of the plan						x	x	x	x	x	x	x
3.2	Design of the ICT infrastructure and services												
3.2.1	Design an effective data collection system		x	x	x			x				x	
3.2.2	Technical specification for the data				x	x	x						

Activity number	Activity – description	Year 1				Year 2				Year 3 - Commission Period			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
	collection system												
3.2.3	Procure data collection and dissemination system						x	x x	x				
3.2.4	Put in place reliable telecommunication connectivity				x	x	x	x	x	x	x	x	x
3.3	Design the data management system												
3.3.1	Design Data Management System node		x	x									
3.3.2	procurement and installation of database management system				x	x	x						
3.3.3	Industrial and onsite training on the data Management system							x	x				
3.3.4	Factory Acceptance test of Database Management System							x	x				
3.3.5	Monitor performance of the system and report accordingly							x	x	x	x	x	x
3.4	Environmental and sustainability considerations												
3.4.1	Carry out Environmental Impact Assessment		x	x									
	Module 4 - Human Capacity Development												
4.1	Assessment of human capacity gaps												
4.1.1	Capacity gap assessment for installation, calibration, fabrication, and maintenance	x	x					x					
4.1.2	Explore peer advisor capacity to address identified capacity gap		x	x				x					
4.2	Design capacity development activities for technical staff												
4.2.1	Training of TMA engineers on fabricate/assemble, integrate and configure equipment				x				x				x
4.3	Design capacity development activities for senior management												
4.3.1	Identify consultant to provide training on the identified needs	x						x					
4.3.2	Training of TMA senior Management on identified needs				x				x				x
4.3.3	Training of project team in project management		x										
4.4	Gender and CSO considerations												
4.4.1	Organize annual stakeholders' workshop				x				x				x
	Module 5 - Risk Management Framework												
5.1.1	Project Management Meetings where risk matrix will be assessed and updated	x	x	x	x	x	x	x	x	x	x	x	x
5.1.2	Progress reports containing risk analysis	x	x	x	x	x	x	x	x	x	x	x	x

Report completion signatures

Peer Advisor signature 
Beneficiary Country signature  Dr. Ladislaus Benedict Chang'a **Acting Director General of Tanzania Meteorological Authority (TMA) and Permanent Representative of Tanzania with WMO**
WMO Technical Authority signature