2nd October 2024

GBON National Gap Analysis

Systematic Observations Financing Facility

Weather and climate data for resilience

WEATHER CLIMATE WATER

Screening of the National Gap Analysis (NGA) of Zambia

WMO Technical Authority screens the GBON National Gap Analysis to ensure consistency with the GBON regulations and provides feedback for revisions as needed. *The screening of the NGA is conducted according to the SOFF Operational Guidance Handbook, version: 04.07.2023 and the provisions in Decision 5.7 of the SOFF Steering Committee.*

Following iterations with peer advisor and beneficiary country, WMO Technical Authority confirms that the National Gap Analysis is consistent with GBON regulations. While the WMO GBON Global Gap Analysis identified the need for 19 surface stations and 4 upper air stations over land to meet the GBON horizontal requirement, the **WMO Technical Authority confirms the NGA results which indicate the need for 21 surface land stations based on specific national circumstances.**

Date: 4 October 2024

Signature:

Albert Fischer

Director, WIGOS Branch, Infrastructure Department, WMO

GBON National Gap Analysis Report
Zambia

Beneficiary Country Focal Point and Institute	Edson Nkonde, Director, Zambia Meteorological Department
Peer Advisor Focal Point and Institute	Tim Donovan, Met Office, UK

1. Country information from the GBON Global Gap Analysis

Table I. WMO GBON Global Gap Analysis (June 2023). Illustration of the information that the WMO Secretariat provides to each country

A. GBON horizontal resolution requirements	B. Target	C. Reporting (GBON compliant)[1]	D. Gap to improve	E. Gap new	F. Gap total
	[# of stations]				
Surface stations Standard density[2] 200 km	19	0	19	0	19
Upper-air stations over land Standard density[2] 500km	4	0	4	0	4

2. Analysis of existing GBON stations and their status against GBON requirements

Table II. Assessment of existent stations per their operational status and network ownership

GBON Requirements	Existing observation stations (# of stations)			
	NMHS network		Third-party network	
	Reporting (GBON compliant) [3]	To improve	Reporting (GBON compliant) [3]	To improve

[1] 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.

[2] For SIDS, for the WMO GBON Global Gap Analysis in June 2023, the EEZ area has been added to the total surface area which is the basis for the target number of stations. The standard density requirements for SIDS have been calculated with 500 km for surface stations and 1000 km for upper-air stations.

[3] 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 during the development of National Gap Analysis 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.

Surface land stations Standard density [4] 200km Variables: SLP, T, H, W, P, SD	0	19	0	0
Upper-air stations operated from land Horizontal resolution[4]: 500km Vertical resolution: 100m, up to 30 hPa Variables: T, H, W	0	1	0	0
Surface marine stations in Exclusive Economic Zones:[7] 500 km Variables: SLP, SST				
Upper-air stations operated in Exclusive Economic Zones:[5] 1000 km Vertical resolution: 100m, up to 30 hPa Variables: T, H, W				

Table III. Assessment of existing GBON stations per station characteristics. Station type: S: Surface, UA: Upper-Air; M: Marine; Owner of the station: NMHS or name of third-party; GBON variables: SLP: Atmospheric pressure; T: Temperature; H: Humidity; W: wind; P: Precipitation; SD: Snow depth; SST: Sea surface temperature; Reporting cycle: Number of observation reports exchanged internationally per day (0-24); GBON compliance: whether the station is GBON compliant or not (see GBON guide on compliance criteria).

Station name	Station type (S/UA/ M[6])	Owner (NMHS/ 3rd party)	Funding source	GBON variable measured							Reporting cycle (obs/day)	GBON Compliant (Y/N)
				SLP	T	H	W	P	SD	SST		
Sesheke - Sesheke MET	Surface	NMHS	Government	Yes	Yes	Yes	Yes	Yes	No	No	>24	N
Nkeyema - Nkeyema Secondary School	Surface	NMHS	Government	Yes	Yes	Yes	Yes	Yes	No	No	>24	N

[4] For SIDS, for the WMO GBON Global Gap Analysis in June 2023, the EEZ area has been added to the total surface area which is the basis for the target number of stations. The standard density requirements for SIDS have been calculated with 500 km for surface stations and 1000 km for upper-air stations.

[5]Although GBON marine stations and stations in EEZ are not part of initial SOFF scope, peer advisors are encouraged to analyze in this step when considered relevant e.g. SIDS, the status of current marine stations for future GBON marine observations investments.

[6] Please see guidance on marine stations in Section 2 on Scope.

Livingstone - Sianzovu/Simwatachela	Surface	NMHS	Government	Yes	Yes	Yes	Yes	Yes	No	No	>24	N
Namwala - Moobola primary School	Surface	NMHS	Government	Yes	Yes	Yes	Yes	Yes	No	No	>24	N
Serenje - Serenje MET	Surface	NMHS	Government	Yes	Yes	Yes	Yes	Yes	No	No	>24	N
Ndola - Fatima Girls Secondary	Surface	NMHS	Government	Yes	Yes	Yes	Yes	Yes	No	No	>24	N
Solwezi - Solwezi MET	Surface	NMHS	Government	Yes	yes	Yes	Yes	Yes	No	No	>24	N
Ikelenge - Kalene Secondary	Surface	NMHS	Government	Yes	Yes	Yes	Yes	Yes	No	No	>24	N
Zambezi - Zambezi MET	Surface	NMHS	Government	Yes	Yes	Yes	Yes	Yes	No	No	>24	N
Chiengi - Mununga Secondary	Surface	NMHS	Government	Yes	Yes	Yes	Yes	Yes	No	No	>24	N
Mpulungu - Niamukolo Day Secondary	Surface	NMHS	Government	Yes	Yes	Yes	Yes	Yes	No	No	>24	N
Mpika - Katibunga Day Secondary School	Surface	NMHS	Government	Yes	Yes	Yes	Yes	Yes	No	No	>24	N
Isoka - Isoka MET	Surface	NMHS	Government	Yes	Yes	Yes	Yes	Yes	No	No	>24	N
Lundazi - Lundazi MET	Surface	NMHS	Government	Yes	Yes	Yes	Yes	Yes	No	No	>24	N
Lusaka - Lusaka City Airport	Surface/ UA	NMHS	Government	Yes	Yes	Yes	Yes	Yes	No	No	>24	N
Nyimba - Kacholola	Surface	NMHS	Government	Yes	Yes	Yes	Yes	Yes	No	No	>24	N
Mongu - Mongu	Surface	NMHS	Government	Yes	Yes	Yes	Yes	Yes	No	No	>24	N
Mansa - Mansa	Surface	NMHS	Government	Yes	Yes	Yes	Yes	Yes	No	No	>24	N
Chipata - Chipata	Surface	NMHS	Government	Yes	Yes	Yes	Yes	Yes	No	No	>24	N
Kasempa - Mukinge girls sec	Surface	NMHS	Government	Yes	Yes	Yes	Yes	Yes	No	No	>24	N
Kasama - Kasama Met	Surface	NMHS	Government	Yes	Yes	Yes	Yes	Yes	No	No	>24	N

3. Results of the GBON National Gap Analysis

Please complete the two tables below and add remarks and technical details in Annexes as needed.

Table IV. Results of the GBON national gap analysis. SLP: Atmospheric pressure; T: Temperature; H: Humidity; W: wind; P: Precipitation; SD: Snow depth; SST: Sea surface temperature**.**

GBON requirements	Global GBON target	Approved national target	Reporting	Gap	
				To improve	New
	[# of stations]				
Surface land stations	19	21	0	**21**	**0**

Upper-air stations operated from land	4	4*	0	**0**	4
Surface marine stations in Exclusive Economic Zones:[7] Density 500 km Variables: SLP, SST Observing cycle: 1h					
Upper-air stations operated in Exclusive Economic Zones: [8] Density 1000 km Vertical resolution: 100 m, up to 30 hPa Variables: T, H, W Observing cycle: twice a day					

*A phased approach to the introduction of Upper Air stations in Zambia is proposed, with 1 station to be established and attain GBON compliance initially and further sites introduced over time – see Appendix A for further details.

3.1 Recommended existing surface, upper-air and marine[10] stations to be designated to GBON

Table V. Recommended existing surface, upper-air and marine stations to be designated to GBON.

Station name	Station type (S/UA/M[16])
Sesheke - Sesheke MET	Surface
Nkeyema - Nkeyema Secondary School	Surface
Livingstone - Sianzovu/Simwatachela	Surface

[7] Although GBON marine stations are not part of initial SOFF scope, peer advisors are encouraged to analyze in this step when considered relevant e.g. SIDS, the need for future GBON marine observations investments according to the GBON requirements.
[8] Although GBON marine stations are not part of initial SOFF scope, peer advisors are encouraged to analyze in this step when considered relevant e.g. SIDS, the need for future GBON marine observations investments according to the GBON requirements.
[9] Although GBON marine stations are not part of initial SOFF scope, peer advisors are encouraged to analyze in this step when considered relevant e.g., SIDS, the need for future GBON marine observations investments according to the GBON requirements.
[10] Although GBON marine stations are not part of initial SOFF scope, peer advisors are encouraged to analyze in this step when considered relevant e.g., SIDS, the need for future GBON marine observations investments according to the GBON requirements.

Namwala - Moobola primary School	Surface
Serenje - Serenje MET	Surface
Ndola - Fatima Girls Secondary	Surface
Solwezi - Solwezi MET	Surface
Ikelenge - Kalene Secondary	Surface
Zambezi - Zambezi MET	Surface
Chiengi - Mununga Secondary	Surface
Mpulungu - Niamukolo Day Secondary	Surface
Mpika - Katibunga Day Secondary School	Surface
Isoka - Isoka MET	Surface
Lundazi - Lundazi MET	Surface
Lusaka - Lusaka City Airport	Surface/U/A
Nyimba - Kacholola	Surface
Mongu - Mongu	Surface
Mansa - Mansa	Surface
Chipata - Chipata	Surface
Kasempa - Mukinge girls sec	Surface
Kasama - kasama Met	Surface
Lusaka - Lusaka City Airport	Upper Air

Figure 1 and 2 below show the locations of the proposed GBON sites for surface and upper air respectively, for further detail see the attached appendix.

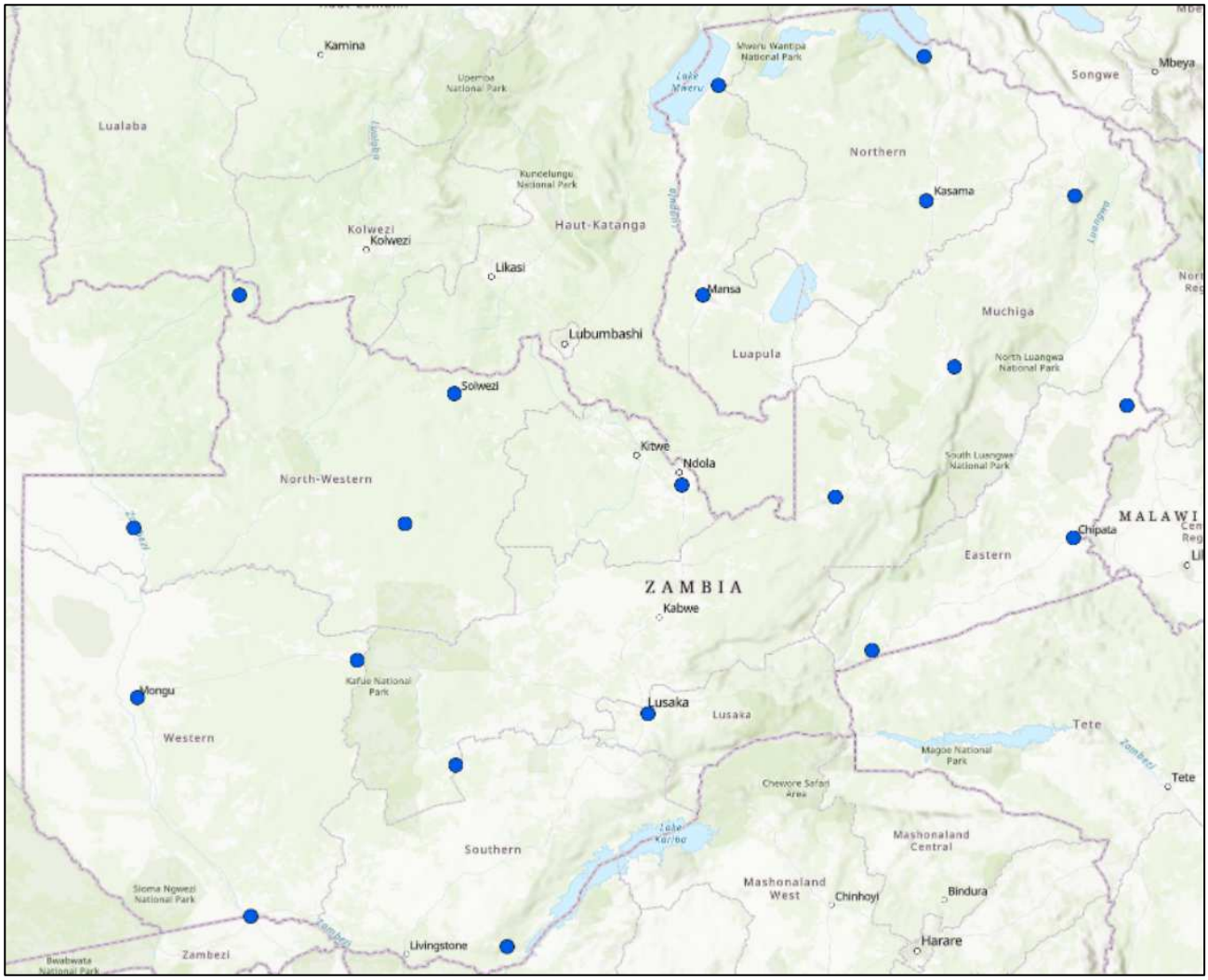

Figure 1 – Location of proposed GBON surface station locations

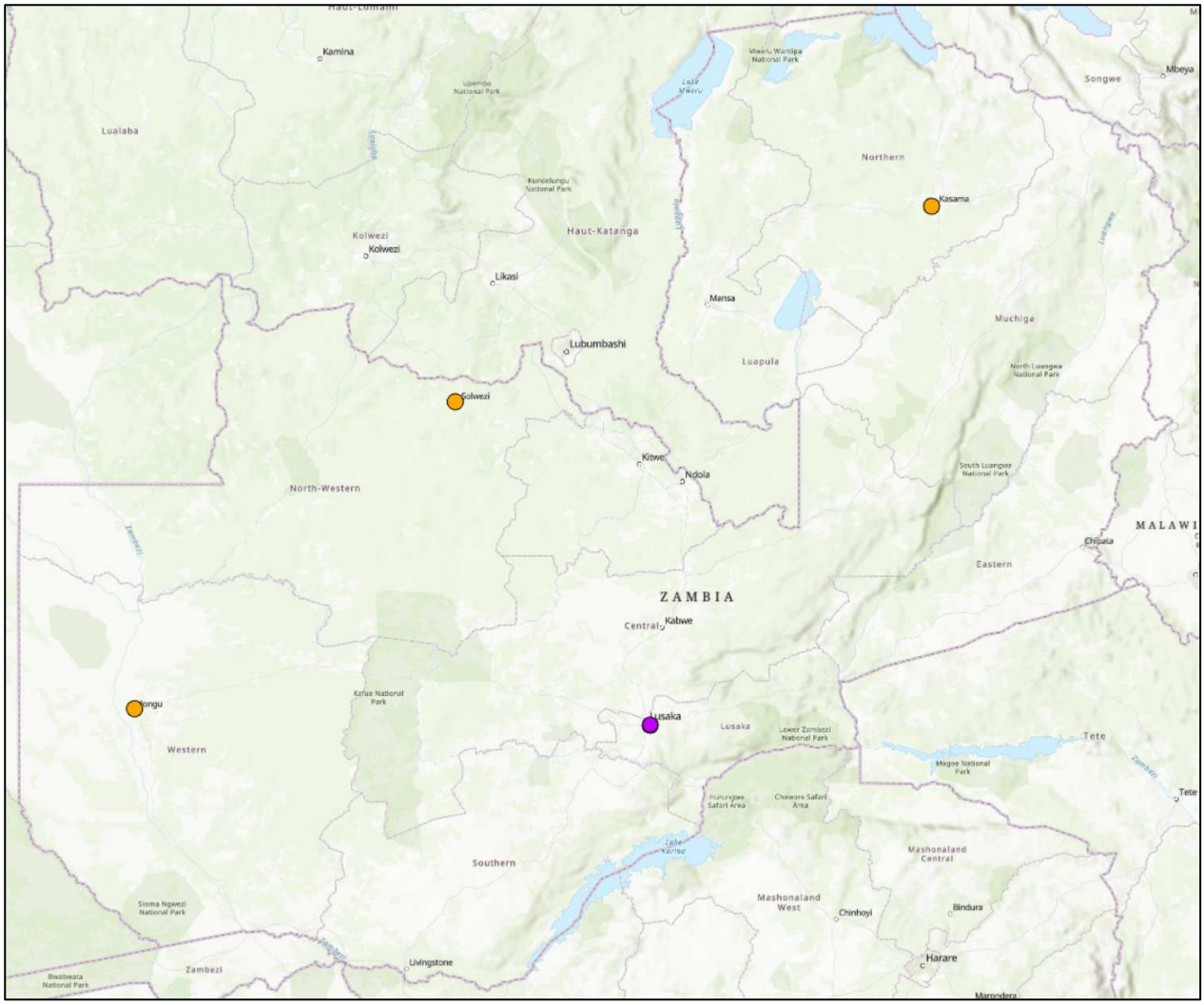

Figure 2 – Location of proposed GBON Upper Air Station locations - initial station shown in purple, later stations shown in orange – see Appendix for further information

4. Report completion signatures

Peer Advisor signature  Helen Bye - Head of International Engagement Met Office 30/09/2024
Beneficiary Country signature  **Edson Nkonde** **Director of Meteorology** **Permanent Representative of Zambia with WMO** 27 September 2024
WMO Technical Authority signature 

Appendices:

Zambia Meteorology Department observing network

A comprehensive network of surface observations has been established across Zambia which is comprised of a mixture of automatic and manual observations using a range of different sensors and funded through a variety of sources. The reliability, quality and longevity of these surface observation sites varies across the country and the infrastructure required to collect, store and transmit data internationally is a significant limitation of the network.

There has been significant investment in establishing a network of Automatic Weather Stations (AWS) across Zambia since 2013. This has included:

- Introduction of the ADCON network between 2013 and 2015 which established 74 ADCON AWS across Zambia. This network was initially established under the Sasscal Weathernet project with research funding from Germany. ZMD report that currently approximately 34 of these stations are still active and recording data. As some stations are currently being replaced through other funding mechanisms, ZMD is seeking to use decommissioned ADCON stations for parts to maintain other stations in the network.
- In 2020 the UNDP Strengthening Climate Resilience of Agricultural Livelihoods in Agro-Ecological Regions I and II in Zambia (SCRALA) project established a new network of 20 Campbell Scientific AWSs which were targeted at the most vulnerable districts in Zambia. The project also provided ZMD with spares which have been used to also install a further 10 Campbell AWSs at Provincial Capital sites.
- ZMD are currently working with World Bank to install a further 120 Campbell Scientific AWS which will provide observations in every single district of Zambia. This is being delivered as a component of the Transforming Landscapes for Resilience and Development in Zambia (TRALARD) project. This project includes provision of spare parts and training for ZMD on the calibration and maintenance of equipment.

ZMD also maintains a network of manual observing sites across the country. These report synoptic measurements to ZMD headquarters via telephone. Where these systems are no longer working, observers report their observations via a What's App Group. These observations are received by a team in Lusaka who manually re-enter the data onto the GTS via a Corobor system. Observations are usually made at synoptic hours (08:00, 11:00, 14:00, 17:00) while observing sites are open. Due to staff availability in Lusaka, these observations are not always transmitted onto the GTS.

Currently the sites that have been nominated for GBON are all manual stations. In order to meet the frequency requirement of GBON, of hourly observations 24-hours per day, it is recommended that only AWS sites are designated as GBON. Data from manual sites should still be shared with the GTS for as long as possible, as this is important for continuity of climate records.

In order to ensure full and uniform coverage of the GBON network in Zambia while ensuring that all sites are located in secure and accessible locations with local staff availability for maintenance, it is considered that 21 surface observation sites are required. This represents an increase of 2 sites above the recommendation of 19 in the WMO global gap analysis from June 2023. Given the substantial number of new AWS made available to ZMD through other funding sources, including

spares, this increase in the number of surface stations represents an easy fix which will enable sustainable coverage of the GBON network in all of Zambia.

The proposed increase in sites from 19 to 21 is made with the following justification:

- The addition of the site at Kasempa ensures that there is good spatial coverage (at 200km resolution) across the country and addresses a couple of small gaps in the network. It also makes sense in terms of the uniform distribution of sites across the country.
- Kasama is also proposed as an additional site as it is also being proposed as a GBON upper air site. From both a practical and scientific perspective it makes sense to have collocated observations at this location.
- Our rationale for proposing these sites is partly influenced by the high number of AWSs that are currently being installed in Zambia. This means that there are no additional installation costs, and only incremental costs associated with sustaining the stations in the network.

The coverage of the proposed GBON surface network in Zambia is show in **Error! Reference source not found.** and the location of the additional 2 stations is highlighted in Figure 4.

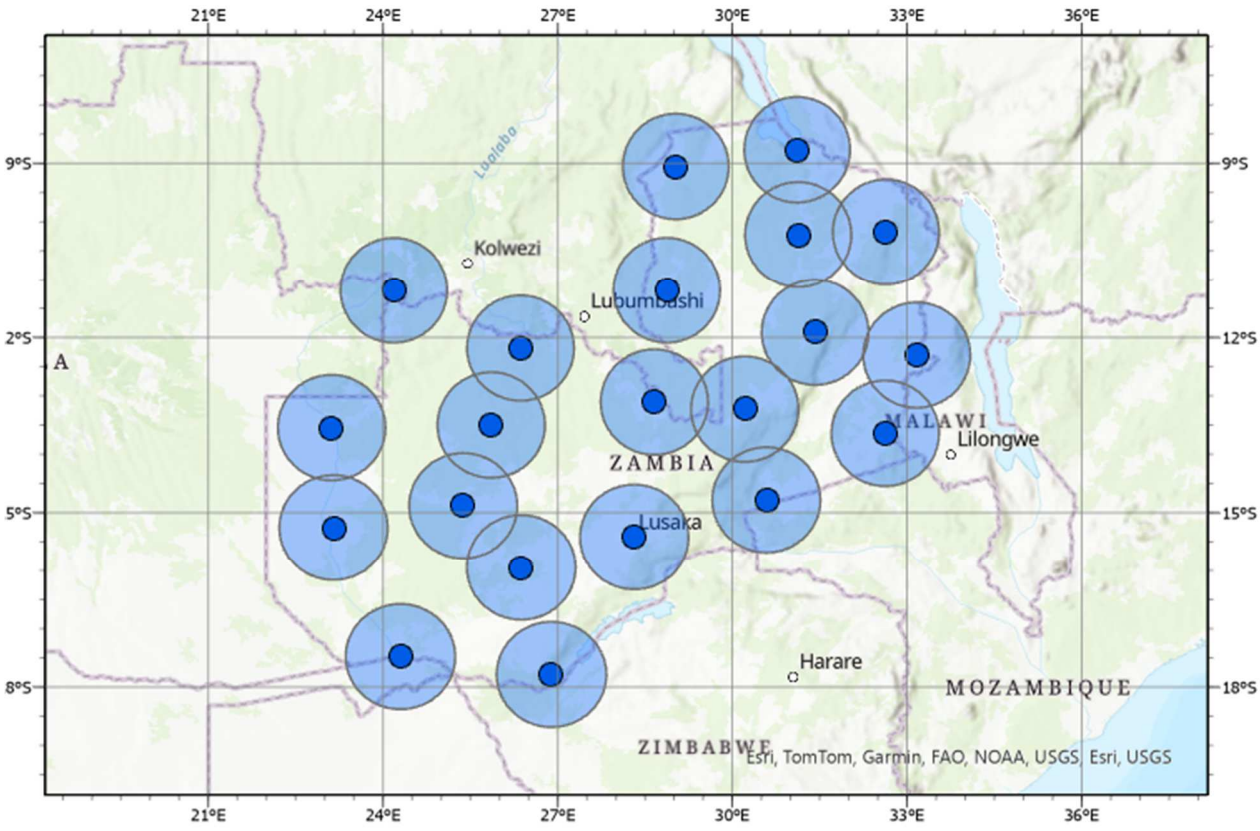

Figure 3 - Proposed GBON surface observation network showing 100km spatial threshold in blue

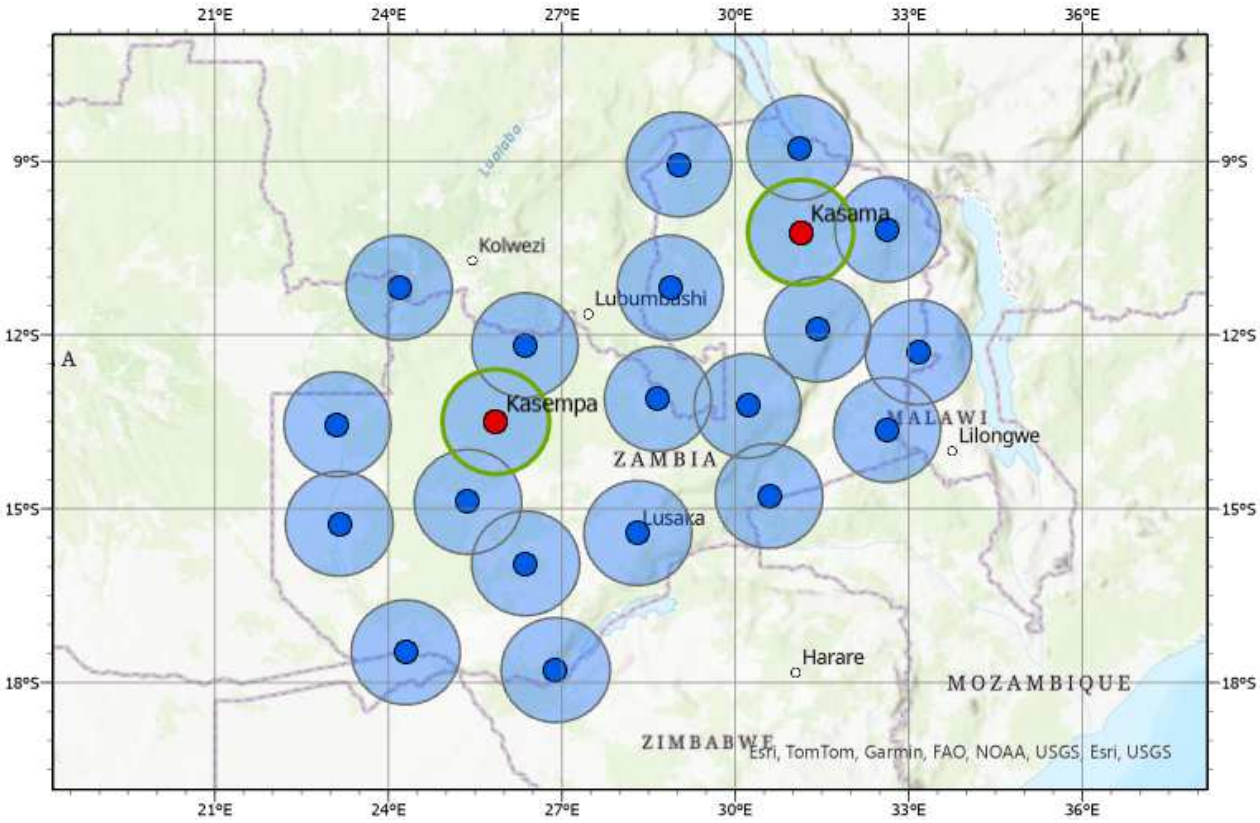

Figure 4 - Proposed GBON surface observation network showing 100km spatial threshold in blue, additional sites at Kasempa and Kasama highlighted in red

There are currently no upper air observations being made in Zambia. The sites listed in WDQMS and OSCAR do not currently undertake any radiosonde launches. One site, in Lusaka, has been operational in the past and has some remaining physical infrastructure (balloon shed) which could possibly be restored, although the previous hydrogen generation and storage equipment is beyond repair and requires total replacement to be operated safely and sustainably. The remaining 3 sites do not currently have any infrastructure or observing equipment to undertake upper air observations.

Given the limited existing infrastructure and the difficulty in staffing and maintenance in the more remote locations, it is proposed that ZMD take a phased approach to the introduction of upper air observations in Zambia. The initial site in Lusaka has been identified as the most viable location to establish upper air observations and it is proposed that this site be rehabilitated, the necessary infrastructure procured and deployed, and the operational practices be implemented in full at this location before the 3 additional sites are established.

It has also been identified that the radiosonde sites should be established where:

i. There is access to secure sites;
ii. Good road transport (sealed road access) for supply of consumables and equipment maintenance; and
iii. Access to suitable staff resources.

These factors need to be considered in addition to the spatial distribution of the stations and the distribution of stations to observe changes to key weather features. For the reasons listed above it is suggested that if four stations are developed in Zambia the proposed Mwinilunga site is moved to

Solwezi. Whilst this is slightly less optimal from a distribution perspective, it is still in a critical location in terms of monitoring of the weather conditions in the build up to rains and how these are tracking across the country.

The timescale for establishment of these 3 sites will be developed, and their locations finalized, in the National Contribution Plan. This represents the most realistic and sustainable manner in which to implement upper air observations in Zambia.

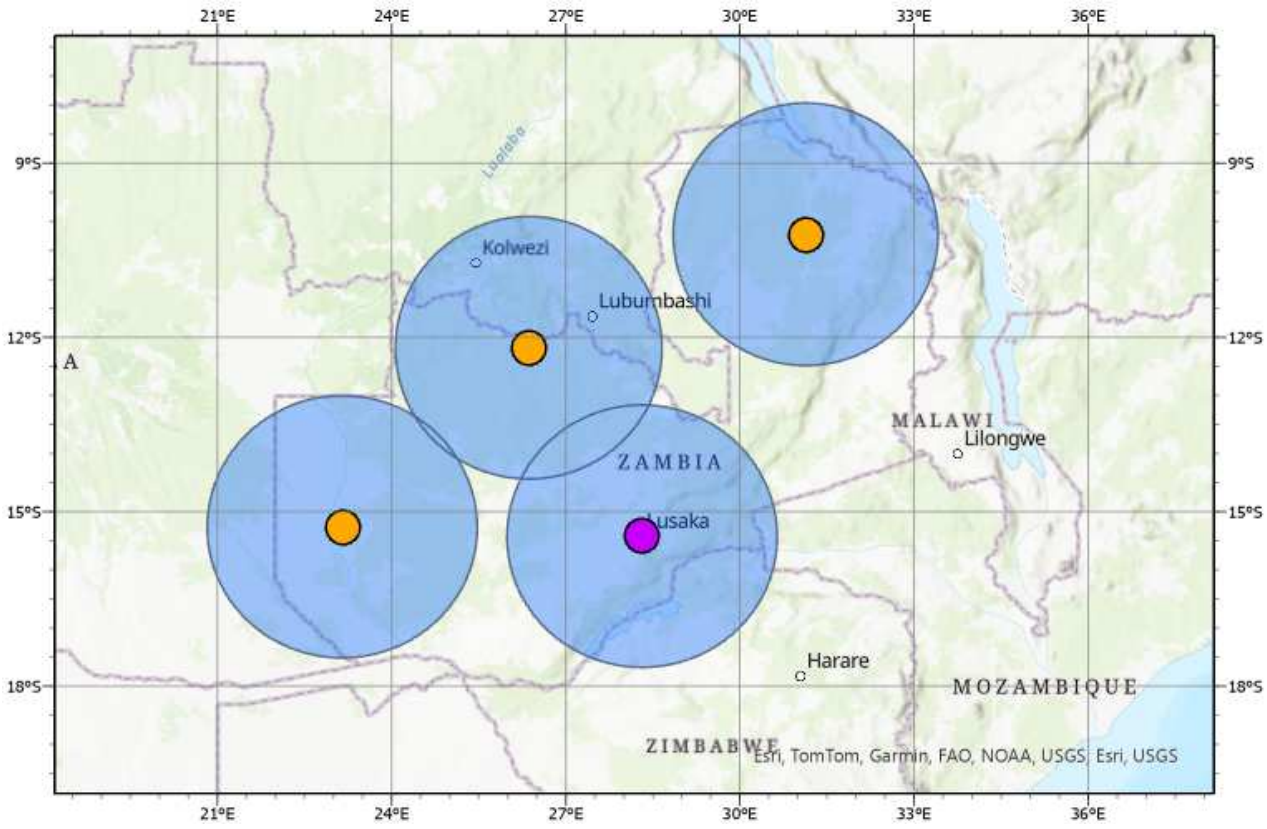

Figure 5 - Proposed final GBON upper air network showing 250km threshold in blue