Systematic Observations Financing Facility

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GBON National Gap Analysis

[Sierra Leone]

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Weather and climate data for resilience



GBON National Gap Analysis Report
[Sierra Leone]

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1. Country information from the GBON Global Gap Analysis

Located on the west coast of Africa between latitudes 7° and 10° N, Sierra Leone experiences a tropical climate characterized by two distinct seasons: a rainy season from May to October, and a dry season from November to April. The country's weather patterns are strongly influenced by the West African monsoon and the harmattan, a dry, dusty wind that blows in from the Sahara during the dry months.

Annual rainfall varies across the country, with the highest amounts received in the coastal and southern regions. Freetown, the capital city, is situated on the Atlantic coast and is surrounded by hills. It is one of the wettest capitals in Africa, with annual rainfall of between 3,500- and 5,000-mm. Heavy downpours are common during the peak rainy months of July and August, often causing flash floods and landslides due to the city's steep terrain. During the dry season, Freetown experiences hot and humid conditions, which are moderated by sea breezes from the Atlantic Ocean.

As of 2026, Sierra Leone had a population of around 8.9 million, with approximately 46% (around 4.1 million) living in urban areas. The capital and largest city, Freetown, has an urban population of around 1.9 million, making it by far the biggest urban centre in the country.

The Sierra Leone Meteorological Agency (SLMet) is the successor of the Sierra Leone Meteorological Department, which was originally established on 27 April 1961. The Agency was formally established on 28 September 2017 through an Act of Parliament (No. 8 of 2017, amended in 2022), marking the transformation of the Department into an autonomous national institution. SLMet serves as the sole authority for the provision of meteorological and climatological services throughout Sierra Leone. Operating under the Ministry of Environment and Climate Change, the Agency is responsible for monitoring, analysing, and forecasting weather and climate conditions to support national development and safeguard lives and property. It also serves as the country national focal point to the United Nation Framework Convention on Climate Change (UNFCCC).

WMO has conducted a GBON Global Gap Analysis (June 2023) which has resulted in the following results: for the surface observation network, the requirement is two (2) for standard density resolution (200 km). In terms of an upper air site, the GBON requirement calls for a single upper-air station (table 1)

Table 1. 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	2	0	1	1	2
Upper-air stations over land Standard density2 500km	1	0	0	1	1

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

Sierra Leone's Meteorological Service currently operates with considerate financial, technical and manpower constraints. It lacks considerable functional observational network. Currently, almost all meteorological data collected in the country is submitted and processed only at the end of each month after observation (manually) rather than on real-time base.

[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 Small Island States that have a significantly larger EEZ area than land surface area, 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 these Islands have been calculated with 500 km for surface stations and 1000 km for upper-air stations.

Table 2. 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) 1	To improve	Reporting (GBON compliant) 2	To improve
Surface land stations Standard density 2 200km Variables: SLP, T, H, W, P, SD	**0***	**2**	**0**	**0**
Upper-air stations operated from land Horizontal resolution2: 500km Vertical resolution: 100m, up to 30 hPa Variables: T, H, W	**0**	**1**	**0**	**0**
Surface marine stations in Exclusive Economic Zones:3 500 km Variables: SLP, SST	**0**	**1**	**0**	**0**
Upper-air stations operated in Exclusive Economic Zones:[3] 1000 km Vertical resolution: 100m, up to 30 hPa Variables: T, H, W	**0**	**0**	**0**	**0**

*Lungi (Pulsonic station WIGOS-ID: 0-694-0-518237) appears as reporting via WIS 2 in August 2026. It is not green on the GBON compliance tool when checked on 18.08.2026. In addition, the station is not correctly registered – the coordinates are wrong – OSCAR meta data needs to be updated.

[3]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.

Table 3. Assessment of existing GBON stations per station characteristics.

Station name	Station type (S/UA/M[4])	Owner (NMHS/3rd party)	GBON variable measured							Reporting cycle (obs/day)	GBON Compliant (Y/N)
			SLP	T	H	W	P	SD	SST		
Freetown Towerhill Station (0-694-0-518239)	S	SLMet	x	x	x	x	x			24/7 *	N
Lungi International Airport (Adcon) (0-20000-0-61856)	S	SLMet	x	x	x	x	x			24/7 *	N
Lungi (Pulsonic) Lungi Synoptic Station (0-694-0-518237)	S	SLMet	x	x	x	x	x			24/7**	Partially **
Kambia (0-694-0-51823)	S	SLMet	x	x	x	x	x			24/7 *	N
Bo (0-20000-0-61881)	S	SLMet	x	x	x	x	x			24/7 *	N
Bonthe (0-20000-0-61866)	S	SLMet	x	x	x	x	x			24/7 *	N

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 (rainfall in this case); 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).

* The station is performing hourly measurements, however, due to connectivity challenges, the data is not transmitted on a real-time base but rather collected only once a month.

** This station is partially transmitting data via WIS 2. It shows problems with meta data and communication. There are currently two AWSs (Pulsonic) at Lungi Airport which are transmitting data 24/7 which are accessed via dedicated webpage by technical staff at the SLMet Headquater (HQ). Data are frequently (24/7) transmitted to HS machine FRI to different international airports. Monthly climatological data reports are also shared at the end of the months to the HQ. Data from the Pulsonic stations are archived by a dedicated Pulsonic server at the SLMet office at the airport. This station was recently added to the WIS 2 node but is still not transmitting regularly enough to be GBON compliant.

Surface stations

Sierra Leone used to have a dense station network in former days. The old Meteorological Agency was a well-established and developed entity before the civil war. There is still a lot of historical data dating back to 1940. This data is currently only available in paper and would need digitization to secure data and make it available for climate analysis. Unfortunately, observation stations and facilities were destroyed during the civil wars. Several new stations were established with GEF support through UNDP and IFAD and other international project funding in the last years. Between

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

2013 to 2015, SLMet has received two large donations of AWSs through UNDP and IFAD. IFAD donated 8 automatic agro-met stations of which majority requires maintenance and replacement. While UNDP through the GEF early warning project procured 8 AWS that were installed on Cell towers all over Sierra Leone – no data was ever shared with SLMet. So those stations do not belong to the official SLMet network, nor can they be improved/rehabilitated. Other stations were either providing erroneous data or were unable to establish a continuous transmission.

Annex 2 provides a complete overview of all stations being operated by SL Met including rain gauges and their current status.

The authors of this report, together with SLMet, identified six existing stations that are already registered in OSCAR. While none of these stations is currently fully GBON compliant, it is recommended that one of the existing stations be selected for upgrading under the SOFF investment phase.

Based on its strategic importance for the Freetown Peninsula and its role within the national observation network, Freetown/Towerhill (WIGOS-ID: 0-694-0-518239) is recommended as the preferred station for this upgrade (Tables 2 and 3). Freetown also has access to additional observations from the Lungi Synoptic Station (WIGOS-ID: 0-694-0-518237), which can provide complementary observations. It is also noted that Lungi Synoptic Station is currently reporting GCOS Surface Network, however Freetown/Towerhill is easier to access and maintain to sustain the GBON compliance.

In addition, it is recommended to upgrade one existing agro-met station to become an additional GBON station in Makeni (see rational in chapter 3) under the SOFF investment phase. This combination would strengthen both the operational observation network and the long-term institutional and human-resource capacity needed for sustainable GBON implementation.

Sierra Leone is generally in a good position to achieve GBON-compliance with relatively little investment (several stations can easily be upgraded). The more crucial aspect will be to train and build up capacities within SLMet to sustain and maintain the station network in the long run.

Upper-air stations

Sierra Leone does not currently operate any upper-air stations.

Marine stations

Out of existing 5 marine weather stations in Sierra Leone, only three are operational. The main problem for these marine stations is missing internet SIM cards – so the data cannot be transmitted.

3. Results of the GBON National Gap Analysis

Table 4. Results of the GBON national gap analysis.

GBON requirements	Global GBON target	Approved national target	GBON compliant	Gap	
				To improve	New
	[# of stations]				
Surface land stations	2	2	0	**2***	**0**
Upper-air stations operated from land	1	1	0	**0**	1
Surface marine stations in Exclusive Economic Zones:[3] Density 500 km Variables: SLP, SST Observing cycle: 1h	1	1	0	**1**	0
Upper-air stations operated in Exclusive Economic Zones: [3] Density 1000 km Vertical resolution: 100 m, up to 30 hPa Variables: T, H, W Observing cycle: twice a day	0	0	0	0	0

SLP: Atmospheric pressure; T: Temperature; H: Humidity; W: wind; P: Precipitation; SD: Snow depth; SST: Sea surface temperature**.**

*Note: one station is already registered as GBON, the second station is currently an agro-met station which is recommended to be upgraded to become fully GBON compliant during the SOFF investment phase.

Surface stations

According to the GBON standard-resolution requirements (Table 4), Sierra Leone is required to operate at least two surface stations providing hourly observations on a 24/7 basis. The following performance criteria must be met:

- At least 80% of the total reports during the reporting period must be internationally available.
- Delayed reports must not exceed 5% of the total number of reports.
- Reports rejected due to insufficient quality must also not exceed 5% of the total number of reports.

The authors of this report recommend **to upgrade the existing GBON station in Freetown / Towerhill** and upgrade one agro-met station (not yet registered for GBON) in Makeni (to better represent the country's hinterland).

Freetown/Towerhill

In order to represent correctly Sierra Leone's capital city, an improvement of the station in Freetown is required, as the station at the Lungi International Airport (which is partially GBON compliant) cannot represent correctly the weather and climate in Freetown, despite their geographical proximity. The main reason for it is, that their geographical settings result in very different local climates.

Lungi lies on flat coastal plains with open terrain, resulting in lower rainfall, higher temperatures, and contrast, Freetown is built on hilly, coastal areas surrounded by the Atlantic Ocean, which produces orographic rainfall, higher humidity, and frequent cloud cover. These conditions make Freetown one of the wettest capitals in Africa.

The station Freetown/Towerhill is located at the headquarters of the Sierra Leone Meteorological Service (SLMet) in Freetown and could be upgraded to meet GBON standards without major difficulty (figure 1). The place is secure and has regular staff members present to facilitate maintenance and repairs needed.

Makeni

In addition to upgrading one of the existing GBON stations, an upgrade of an agro-met station in Makeni is considered necessary to improve the representativeness and resilience of the observation network in the hinterland. Makeni is particularly suitable for this investment for three main reasons:

(i) the site already serves as a climate station and therefore has an established historical observation record, providing valuable continuity and a basis for comparison with the new AWS observations;

(ii) the station would provide an important backup within the national observation network, increasing its resilience and reducing the risk of data gaps in the event of disruptions at other stations; and

(iii) the site offers a secured location with skilled observers already in place, providing favourable conditions for the reliable operation, monitoring and maintenance of the AWS.

Locating the station alongside existing observation infrastructure would facilitate intercomparison and calibration while benefiting from established logistical and security arrangements. At the same time, locating the station near the university of Makeni could provide an important long-term opportunity for training and capacity development. The establishment of a GBON station in Makeni would therefore strengthen geographical coverage, provide redundancy and continuity within the national network, and support the sustainable operation of the observation system.

This analysis, together with the findings of the Country Hydromet Diagnostics (CHD), demonstrates that the Sierra Leone Meteorological Service has the general technical and logistical capacity to operate and maintain a modern AWS network. One major constraint remains the availability of financial resources for the acquisition and sustainable maintenance of robust automatic weather

stations. In addition, the ITC infrastructure of SLMet is currently not sufficient to support a real-time sharing of data.

However, if further funds will be available, SLMet can strive even towards a high-resolution surface GBON network (as elaborated in annex 1).

Upper-air stations

Sierra Leone does not operate any upper-air stations. However, for a future potential deployment of an upper-air station, the SLMet would be able to use the facilities at the Lungi International Airport (figure 2) as the preferred location, for reasons of locally available staff, safety and accessibility.

SLMet currently has only two technicians with historical experience in operating upper-air stations. Therefore, substantial capacity-building and training activities will be required to support the development and sustainable operation of any future upper-air station.

Marine surface

Currently, SLMet is operating 5 marine stations – but only 3 are transmitting data and being operational. Now, the Sierra Leone maritime authority is volunteering to check the stations, but they are not allowed to execute regular maintenance or repairs. SLMet has not enough resources to do the necessary maintenance work.

The main issue is the missing mobile internet connection – so most of the time the data is not transmitted to SLMet. In case that supporting marine observations will be considered in the future under the SOFF umbrella, in the case of Sierra Leone, it requires just a small continuous investment to assure Sierra Leone to be also marine GBON – compliant.

3.1. Recommended existing surface, upper-air and marine3 stations to be designated to GBON

Table 5. Recommended existing surface, upper-air and marine stations to be designated to GBON.

Station name	Station type (S/UA/M[5])
Freetown Towerhill	S
Lungi Targrin Terminal	M

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



Figure 1. Proposed future GBON surface station network based on the recommended country target of 2 stations (circle representing 200 km diameter coverage of a surface station).



Figure 2. A map with the proposed upper-air station on the location of Lungi International Airport.

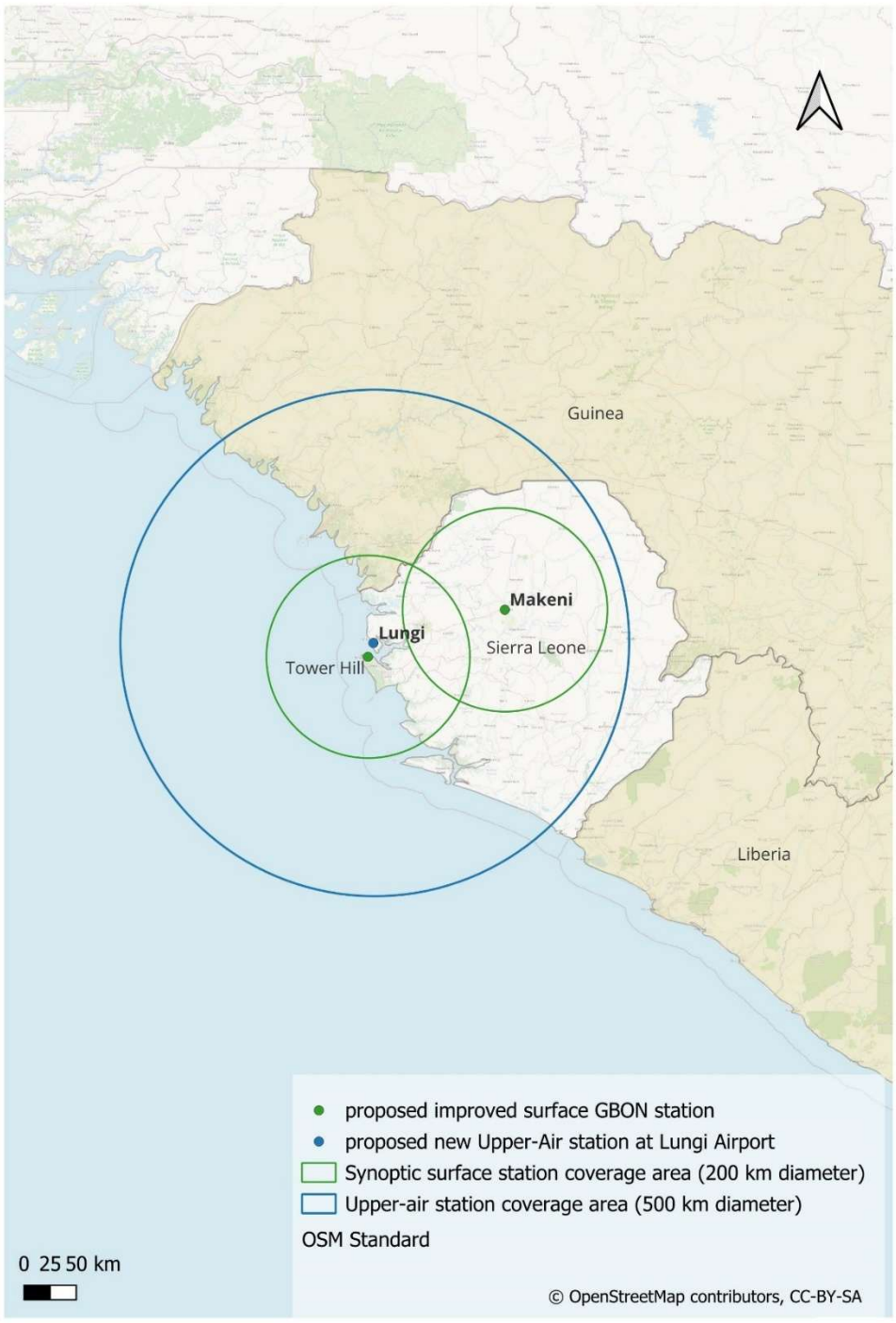


Figure 3. Map of proposed surface and upper-air stations, with a resolution of 200km for surface stations (red and green circles) and 500km for upper-air stations (blue circle). 1 Source: compilation by DWD with QGIS

4. Report completion signatures

Peer Advisor signature Andreas Schaffhauser Unterschrieben von SARAH CATHERINE JONES am 23.10.2026 Dr. Andreas Schaffhauser General Director GeoSphere Austria Dr. Sarah Cathrine Jones General Director DWD
Country signature Ibrahim Kamara General Director SLMet
WMO Technical Authority

ANNEX 1- Rational for the need of 3-4 GBON stations in Sierra Leone

Sierra Leone's topography is predominantly favourable, with approximately 60% flat terrain and 20% plateau, which means nearly 80% of its surface area presents minimal physical obstructions that could affect temperature, barometric pressure, or other meteorological variables. This makes the case, in our perspective, for a minimum of three well-distributed station locations strategically vital for sustainability and data representativeness. Lungi and Freetown location needs to have 2 stations to cover the highly populated area of Freetown and still cover aeronautic needs of the International Airport. Lungi can serve as a back-up GBON station to reduce redundancy.

Therefore, in case that additional funds will be available, the authors of this report would like to recommend considering two easy fixes for two AWS stations which are already existing (and then the country will achieve also a high-resolution GBON Surface Compliance. The additional stations are Lungi International airport and one could be easily upgraded in the south-eastern region (e.g., Bo) to ensure national representativeness.

Such a configuration would enhance the spatial balance and robustness of meteorological observations, supporting more accurate forecasting, climate monitoring, and modelling efforts at both national and regional scales.



Figure 4. Proposed GBON surface station network based on the assessment to reach full coverage of the country - means 4 stations (Lungi, Freetown, Bo and, Makeni)

ANNEX 2- Status of Sierra Leone Meteorological Agency Diverse Automatic Weather Stations as of February 2026

AUTOMATIC RAINFALL STATION

	Station Name	Status	Remark
1	Bunumbu	Functional	Subscriptions
2	Daru	Functional	Subscriptions
3	Kailahun Town	Functional	Subscriptions
4	Kenema Polythenic	Vandalized	Vandalized
5	Koindu (Liberia Border)	Functional	Subscriptions
6	Pendebu	Faulty	Maintenance and Subscriptions
7	ID to be Verified	No RTU	
8	Bongolo Kono	Functional	Maintenance and Subscriptions
9	Jaima Sawefe	Functional	Maintenance and Subscriptions
10	Kayima	Doubtful	Doubtful
11	Yengema	Functional	Maintenance and Subscriptions
12	Bumbuna	Faulty	Subcriptions
13	Makeni	Faulty	Maintenance and Subcriptions
14	Mile 91	Faulty	Maintenance and Subcriptions
15	Yele	Functional	Maintenance and Subcriptions
16	Kambia Town	Functional	Subscriptions
17	Kukuna	Faulty	Maintenance and Subscriptions
18	Kychum	Faulty	Maintenance and Subscriptions
19	Madina	Functional	Maintenance and Subscriptions
20	Rokupr	Faulty	Maintenance and Subscriptions
21	Falaba	Doutful	Maintenance and Subscriptions
22	Kabala	Functional	Maintenance and Subscriptions
23	Kamakwie	Doutful	Doutful
24	Outamba Park	Doutful	Doutful
25	Lunsar	Functional	Subcriptions
26	Masiaka	Functional	Subcriptions
27	Porto Loko Town	Functional	Subcriptions
28	Bumpeh	Functional	Subscriptions
29	CKC BO	Functional	Subscriptions
30	Koribodo	Vandalized	Subscriptions
31	QRS BO	Functional	Subscriptions
32	Sumbuya	Functional	Subscriptions
33	Towama-Njala Campus	Functional	Subscriptions
34	Bonthe Island	Functional	Maintenance and Subscriptions
35	Gbangbatok	Functional	Maintenance and Subscriptions
36	Matru Jong	Functional	Subscriptions
37	Morieba Town	Faulty	Maintenance and Subscriptions
38	Moyamba	Functional	Subscriptions
39	Njala	Functional	Maintenance and Subscriptions

40	Shenge	Faulty	Subscriptions
41	Tomabum	Functional	Maintenance and Subscriptions
42	Bandajuma Sowa Town	Functional	Maintenance and Subscriptions
43	Futa Peje	Functional	Subscriptions
44	Massam Kpaka	Vandalized	New Installations needed
45	Potoeru	Vandalized	New Installations needed
46	Pujehun Town	Functional	Subscriptions
47	Sann Malen	Functional	Subscriptions
48	Sulima Town	Vandalized	New Installations needed
49	Zimmi	Functional	Subscriptions
50	Banana Island	Faulty	Maintenance and Subscriptions
51	FBC	Functional	Maintenance and Subscriptions
52	Freetown (FTC)	Functional	Subscriptions
53	Guma (Major Saminary)	Faulty	Maintenance and Subscriptions
54	Hasting PTS	Functional	Maintenance and Subscriptions
55	Head Office	Vandalized	New Installations needed
56	Mile 13 (Guma)	Faulty	Maintenance and Subscriptions
57	MMCET	Faulty	Doubtful
58	Tokeh	Functional	Maintenance and Subscriptions
59	Tower Hill	Functional	Subscriptions
60	Waterloo District Council	Faulty	Maintenance and Subscriptions
MARINE WEATHER STATIONS			
	Station Name	**Status**	**Remark**
1	Marintine	Functional	Subscriptions
2	Lakka	Faulty	Doubtful
3	Bonthe	Faulty	Subscriptions
4	Shenge	Faulty	Maintenance and Subscriptions
5	Tagrin	Faulty	Subscriptions
	AGROMET STATION		
	Station Name	**Status**	**Remark**
1	Kenema	Functional but data SD card is faulty	Urgent maintenance required
2	*Kpuwabu*	Functional but data SD card is faulty	Urgent maintenance required
3	*Daru*	Damaged	Relocation of station site with new station
4	*Kailahun*	Faulty	Urgent maintenance required
5	*Koidu*	Partly Functional but data SD card is faulty	Urgent maintenance required
6	*Kayima*	Damaged	New station needed

7	*Kabala*	Functional but data SD card is faulty	Urgent maintenance required
8	*Musaya*	Damaged	New station needed
9	Makeni Pulsonic station	Faulty battery	Replacement of battery required
10	Matru Jong	Functional	
11	Myamba Agric Compund	Funational	
	SYNOPTIC AUTOMATIC STATION		
	Station Name	**Status**	**Remark**
1	Lungi Pulsonic station 1	Partially Functional	Subscriptions
2	Lungi Pulsonic station 2	Functional	Subscriptions
3	Tower Hill	Functional	Subscriptions
4	Lungi	Functional	Subscriptions
5	Kambia	Functional	Subscriptions
6	Bo	Functional	Subscriptions
7	Bonthe	Functional	Subscriptions

Subscriptions – the station is set to transmit data through the cellular networks. However, there is a constant issue with funding for these renewals.

Maintenance – the station is lacking basic continuous maintenance, for logistical, accessibility, manpower shortage and other issues.