Approved by Roberto Borjabad
on behalf of Jonathan Duwyn
Date: 21/02/2025

Using simple mobile technologies to scale up digital collection & processing of climate observation for adaptation actions in Malawi

UNEP CTCN Project: 2022000048

Updated Equipment & Digital System

February 2025

Draft for review and not for disclosure

ADAPTATION FUND

UN environment programme

CTCN UN Climate Technology Centre & Network

Table of Content

Cover photo: National Coordinator Dr Msadala presents the technology prototype whilst the Working Group validates the software BlueIQ.Africa for observation collection and integration

A. Scope

In the project "Using simple mobile technologies to scale up digital collection & processing of climate observation for adaptation actions in Malawi", supported by UNEP CTCN, this document demonstrates the end of testing and advancing the technology prototype.

The report captures the final updates to the technology and equipment, Activity 4.10 in Output 4 of the project.

The associated deliverables in Output 4 are:

- Deliverable 4.1 Pilot sites: preliminary assessment
- Deliverable 4.2.a Minutes: 1-day workshop
- Deliverable 4.2.b Pilot sites: final selection
- Deliverable 4.3 Detailed pilot work plan/implementation plan
- Deliverable 4.4.a Minutes: meeting
- Deliverable 4.4.b Final Pilot Implementation Plan
- Deliverable 4.5.a Minutes: local workshop
- Deliverable 4.5.b Official community endorsement (written)
- Deliverable 4.6 Report: reception & equipment installation
- Deliverable 4.7 Report: demonstrating start of testing
- Deliverable 4.8 Digital system development & operationalisation
- Deliverable 4.9 Minutes: demonstration workshop (8 people)
- Deliverable 4.10 Report: updated equipment & digital system
- Deliverable 4.11 Minutes: technology validation workshop

In addition to sustained collection of observations, updating equipment etc., the new software platform app.BlueIQ.Africa has been launched. The team has, in the final stages of piloting, modified and adjusted the technology system based on comments received and feedback captured when users and administrators in Government have accessed and validated the system and software.

The methodology for updating equipment and software, was to respond actively to any disruptions and to collaborate across the partnership with government departments. Software updates are being implemented through feedback, adjustment, and bug-fixing.

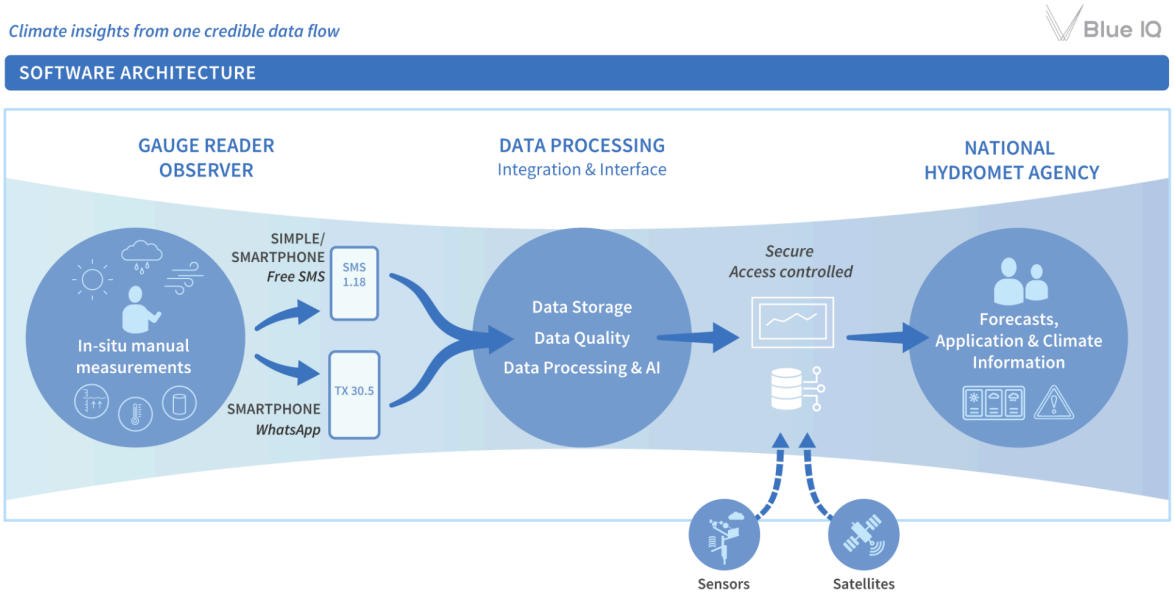
The methodology for piloting and testing was structured into five steps in Output 4. The status of each step is presented in table 1 below, showing that piloting is completed and objectives have been met.

Table 1. Pilot testing in 5 steps

Step	Scope	Status
Step 1. Initial test	To ensure Gauge Readers and Observers can reliably send observations using phones (e.g., SMS/WhatsApp) and the data point is directly accessible to DCCMS and DWR. The test purpose and outcome is to identify and fix any bugs, and to operationalise the proposed technology.	Completed
Step 2. Functionalities established	Efficiency and functionalities of the technology established, approach is used by the Observers and DCCMS and DWR.	Completed
Step 3. Prototype evaluation	Pilot is evaluated for its viability as a technical solution and approach in digitizing near real time manual observations.	Completed
Step 4. Prototype refined and used	Data collection continues and is evaluated for its application and scalability value (particularly for impact modeling and adaptation by synergistically relating the observation data collected to daily time series of climate project modeling).	Completed.
Step 5. Digital system sustained	Digital system accessible to DCCMS and DWR to keep observation data accessible after the testing period in anticipation of the identification and implementation of a sustainable business model.	Completed.

B. Software and Mobile Communication Updates

System overview



Software & User interfaces

The below screenshots demonstrates the following interfaces and functions of the new software:

- The Studio
  Map with interactive stations
  Dashboard for analysis and graphs
  Data tables for easy export

- Stations
  Inventory management interface with station meta-data, photos, performance metrics, maintenance log, graph of observations and location map.

- Chat App
  Chat message function to communicate two-way with individual gauge readers and observers, with information on performance and contact details. Additional Broadcasting function for group messages based on filters or selection of gauge readers and observers (for flood alerts, maintenance reminders etc.).

- Observers
  Personnel management interface to register and manage observers and gauge readers details (gender, age, location, community role etc.).

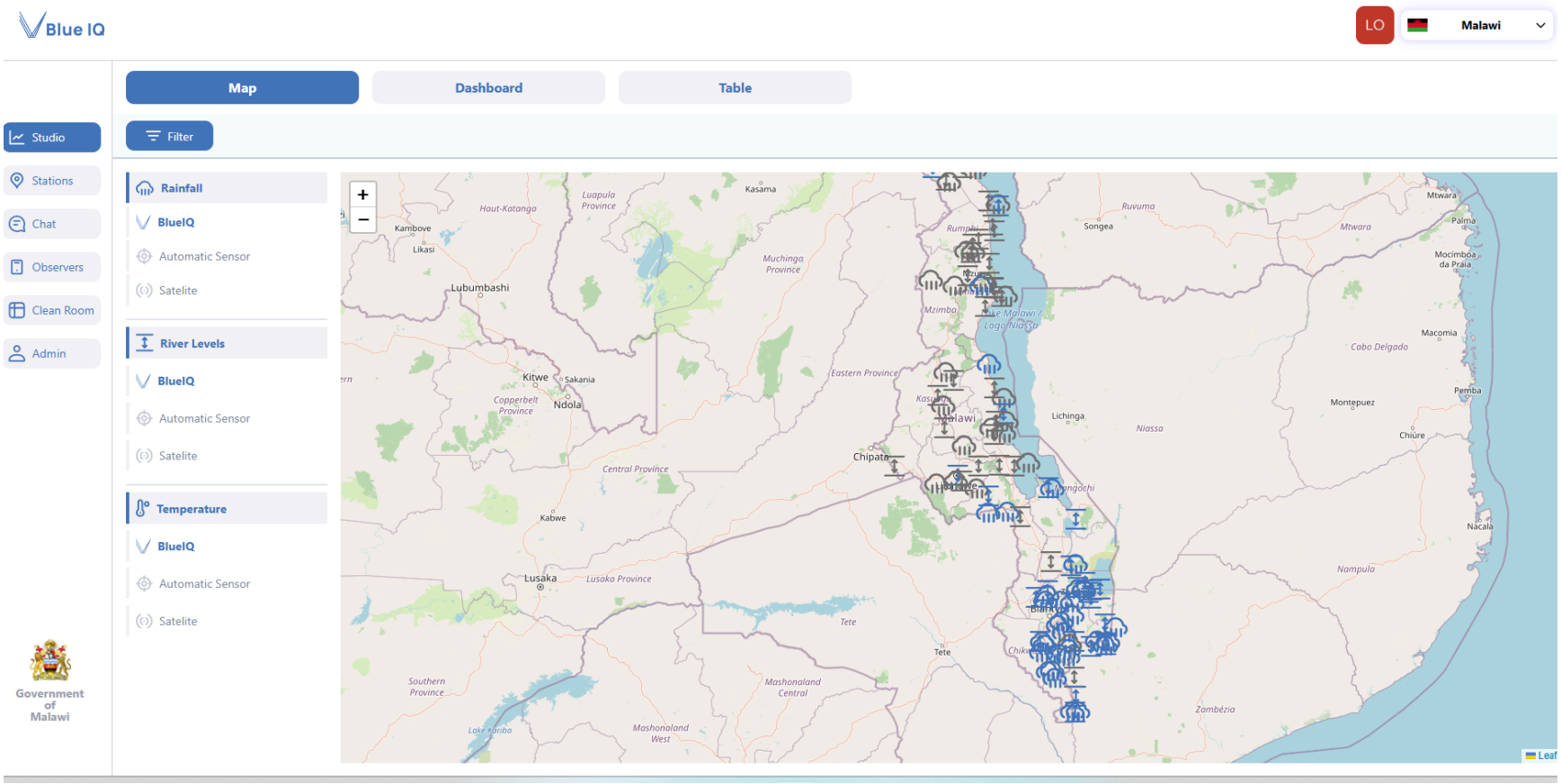
- Clean Room
  Interface for authorized government staff to address and rectify outliers.

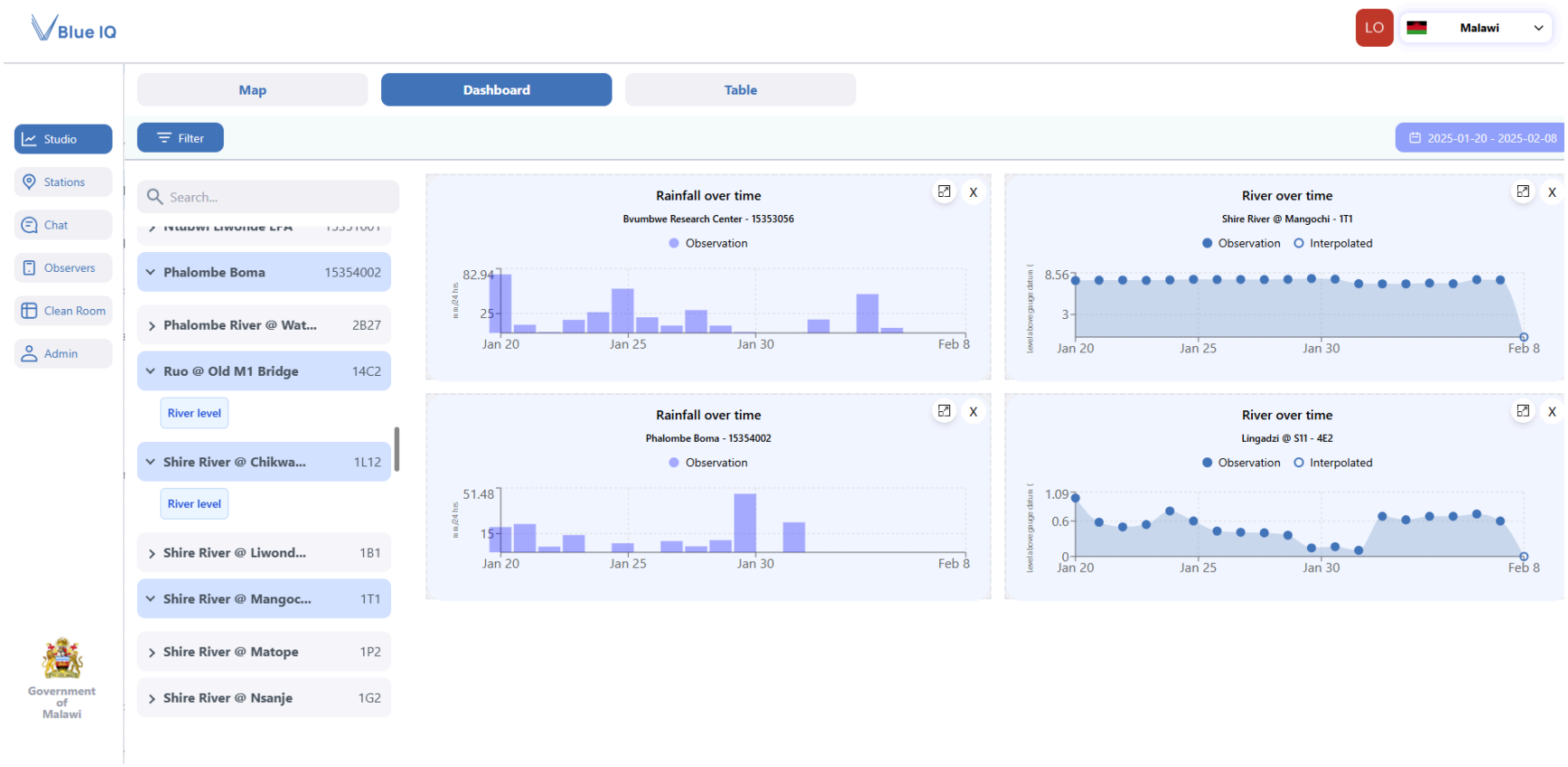
- Admin
  Access profile management interface to manage different users' access and tools in the software.

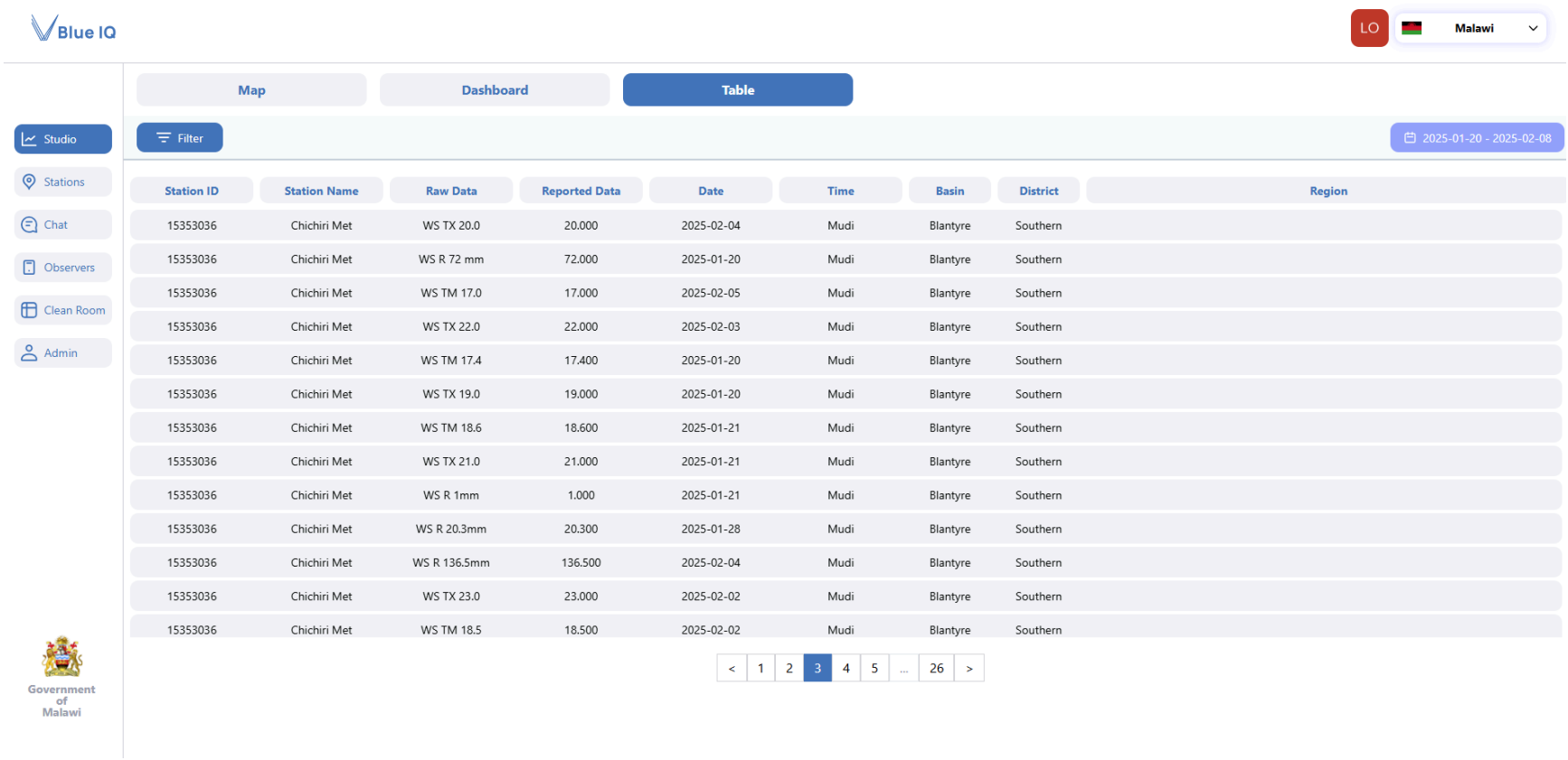
API to government systems

At the end of piloting, the team and government agreed and delivered on enabling API transmission of manual observations from the BlueIQ platform to Hydstra and Climsoft, the two primary water and climate data management systems of the government.

The Water in Sight Ltd has set up access credentials (API keys, tokens) and provided these to the Department of Water Resources and the Department of Climate Change and Meteorological Services. The departments can now extract data based on their use of the API access credential as this is in their purview and not Water in Sight Ltd's.


Blue IQ
LO
Malawi
Map
Dashboard
Table
Studio
Filter
Stations
Chat
Observers
Clean Room
Admin
Rainfall
BlueIQ
Automatic Sensor
Satelite
River Levels
BlueIQ
Automatic Sensor
Satelite
Temperature
BlueIQ
Automatic Sensor
Satelite
Government of Malawi
Kambove
Likasi
Lubumbashi
Kasama
Luapula Province
Haut-Katanga
Muchinga Province
Kitwe
Sakania
Ndola
Copperbelt Province
Chipata
Eastern Province
Central Province
Kabwe
Lusaka
Lusaka Province
Southern Province
Lake Kariba
Mashonaland West
Mashonaland Central
Tete
Songea
Ruvuma
Mtwara
Palma
Mocímboa da Praia
Lake Malawi / Lago Niassa
Mzimba
Lichinga
Niassa
Cabo Delgado
Macomia
Montepuez
Pemba
Chiúre
Nacala
Nampula
Zambézia
Leaf


Blue IQ
LO
Malawi
Map
Dashboard
Table
Studio
Filter
2025-01-20 - 2025-02-08
Stations
Chat
Observers
Clean Room
Admin
Search...
Phalombe Boma 15354002
Phalombe River @ Wat... 2B27
Ruo @ Old M1 Bridge 14C2
River level
Shire River @ Chikwa... 1L12
River level
Shire River @ Liwond... 1B1
Shire River @ Mangoc... 1T1
Shire River @ Matope 1P2
Shire River @ Nsanje 1G2
Government of Malawi
Rainfall over time
Bvumbwe Research Center - 15353056
Observation
82.94
25
mm/24 hrs
Jan 20
Jan 25
Jan 30
Feb 8
River over time
Shire River @ Mangochi - 1T1
Observation
Interpolated
8.56
3
Jan 20
Jan 25
Jan 30
Feb 8
Rainfall over time
Phalombe Boma - 15354002
Observation
51.48
15
mm/24 hrs
Jan 20
Jan 25
Jan 30
Feb 8
River over time
Lingadzi @ S11 - 4E2
Observation
Interpolated
1.09
0.6
0
Jan 20
Jan 25
Jan 30
Feb 8


Blue IQ
LO
Malawi
Map
Dashboard
Table
Studio
Filter
2025-01-20 - 2025-02-08
Stations
Chat
Observers
Clean Room
Admin
Station ID
Station Name
Raw Data
Reported Data
Date
Time
Basin
District
Region
15353036 Chichiri Met WS TX 20.0 20.000 2025-02-04 Mudi Blantyre Southern
15353036 Chichiri Met WS R 72 mm 72.000 2025-01-20 Mudi Blantyre Southern
15353036 Chichiri Met WS TM 17.0 17.000 2025-02-05 Mudi Blantyre Southern
15353036 Chichiri Met WS TX 22.0 22.000 2025-02-03 Mudi Blantyre Southern
15353036 Chichiri Met WS TM 17.4 17.400 2025-01-20 Mudi Blantyre Southern
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15353036 Chichiri Met WS TM 18.6 18.600 2025-01-21 Mudi Blantyre Southern
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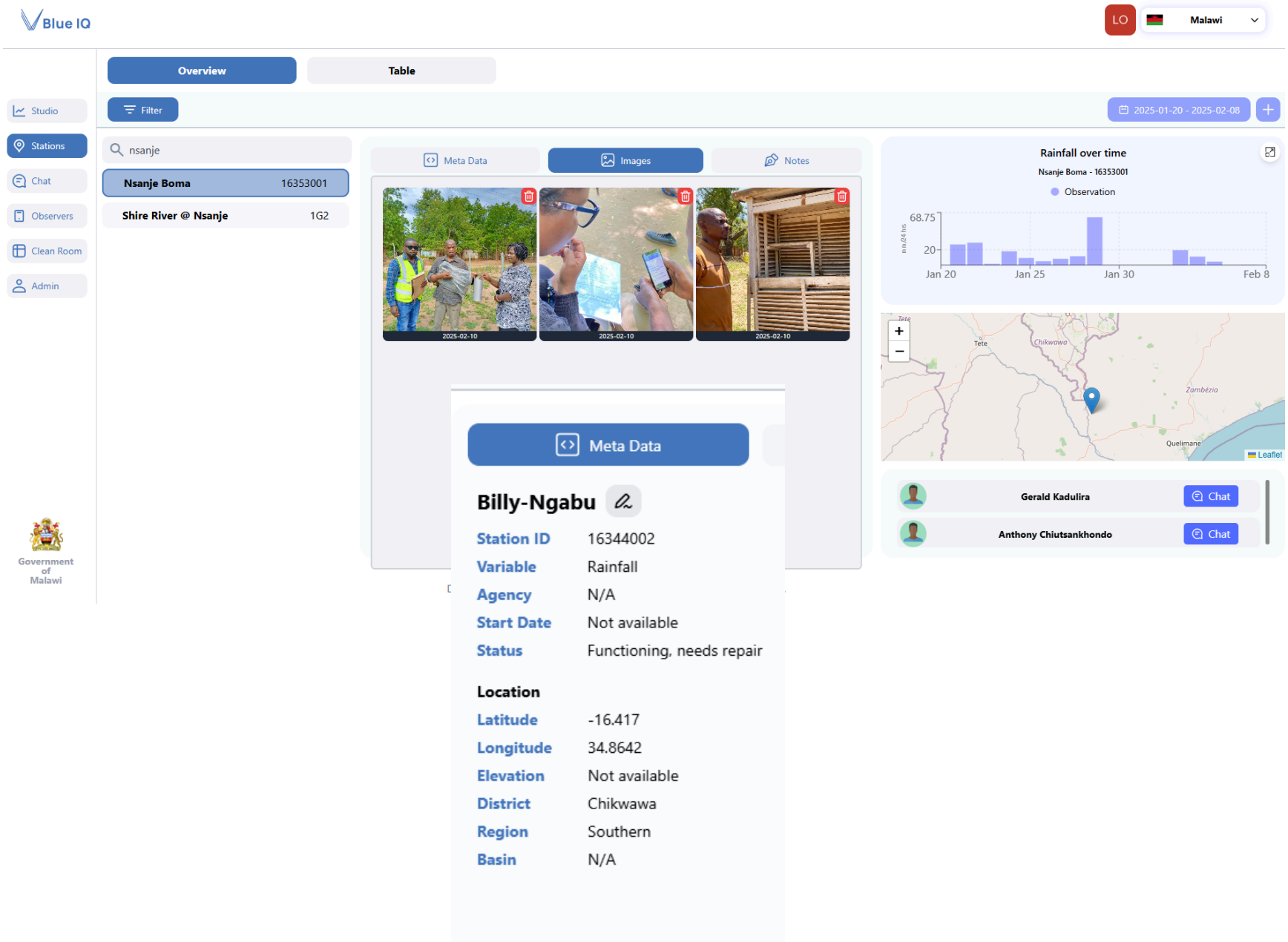
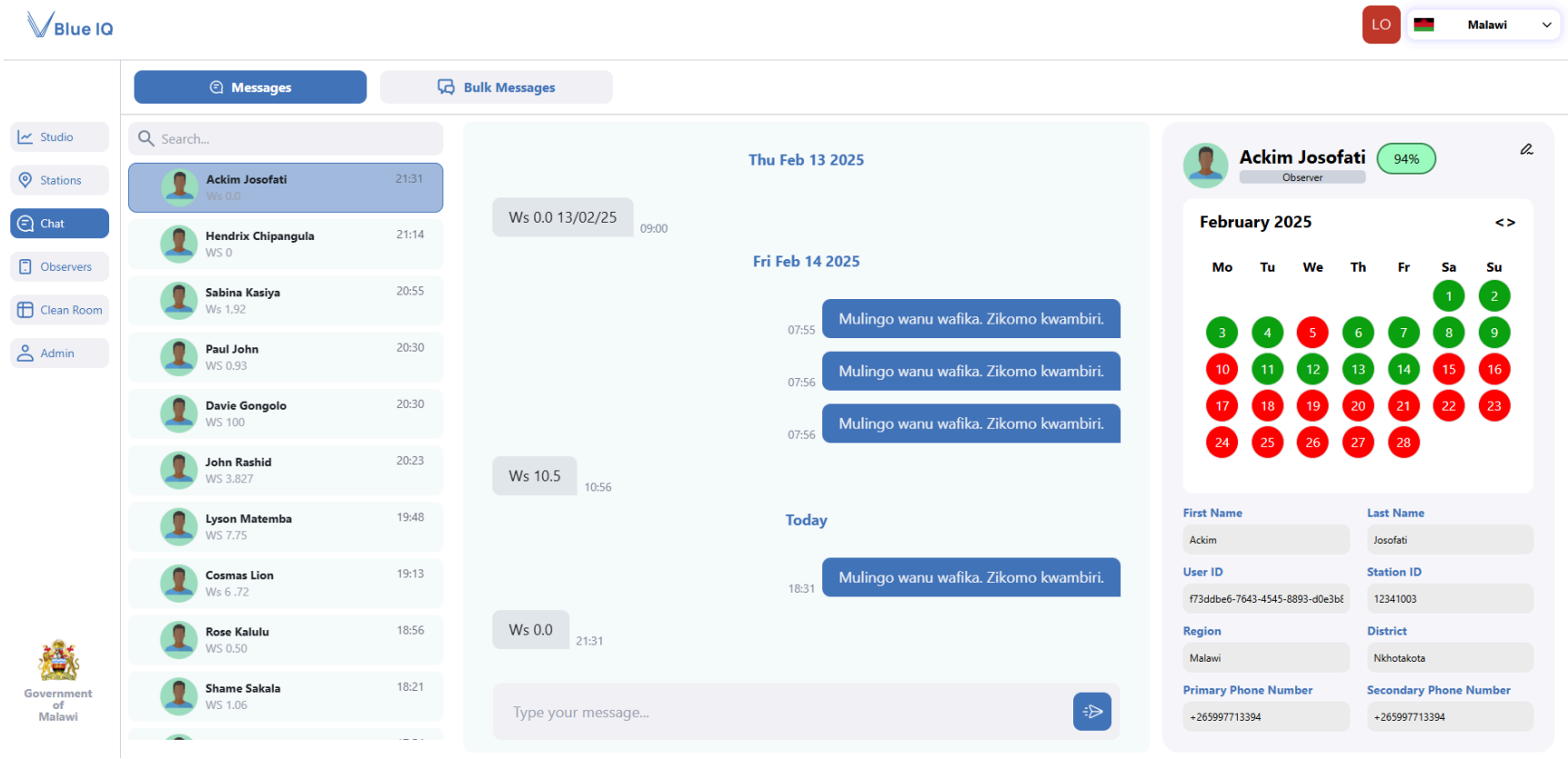
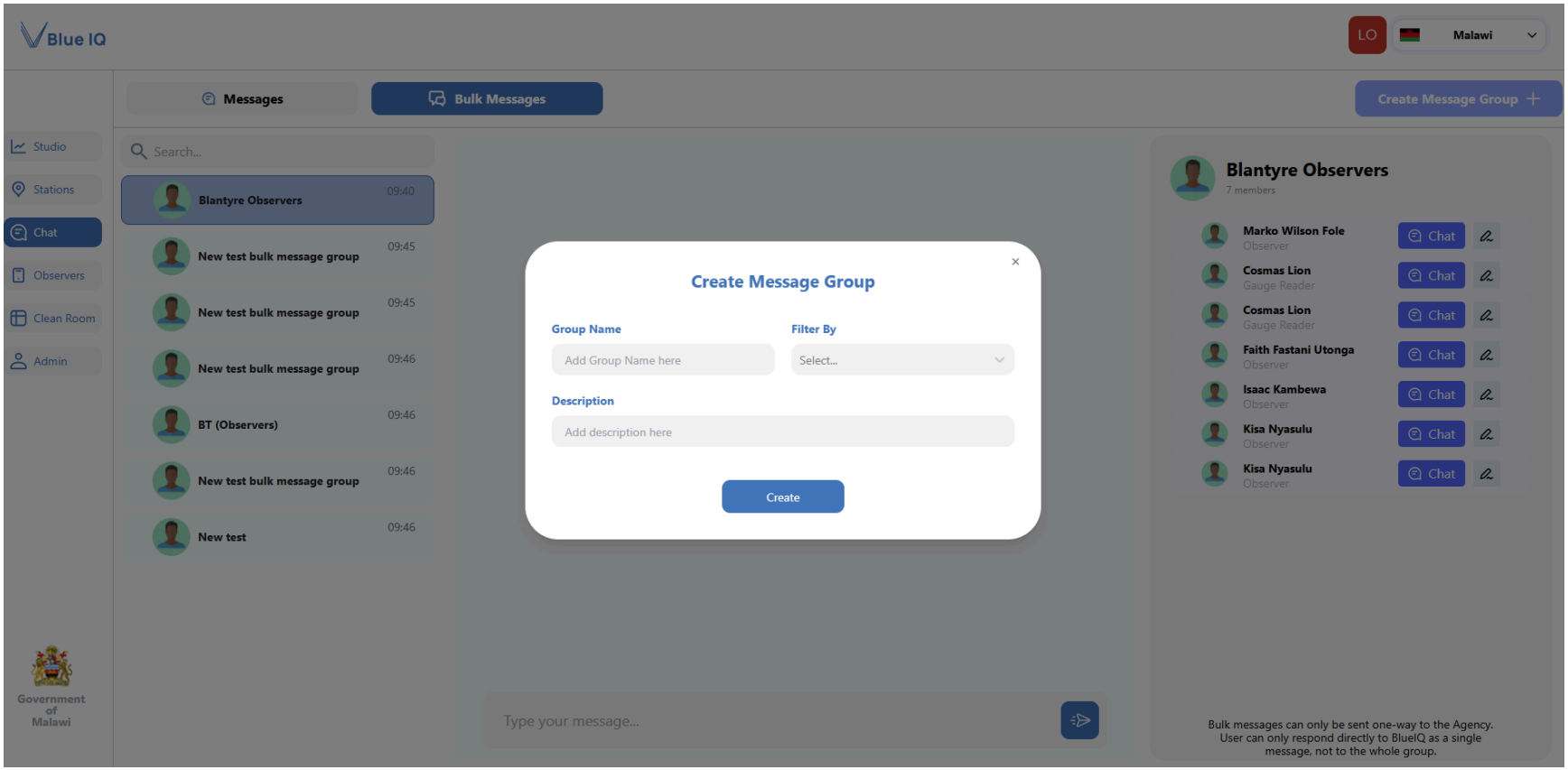
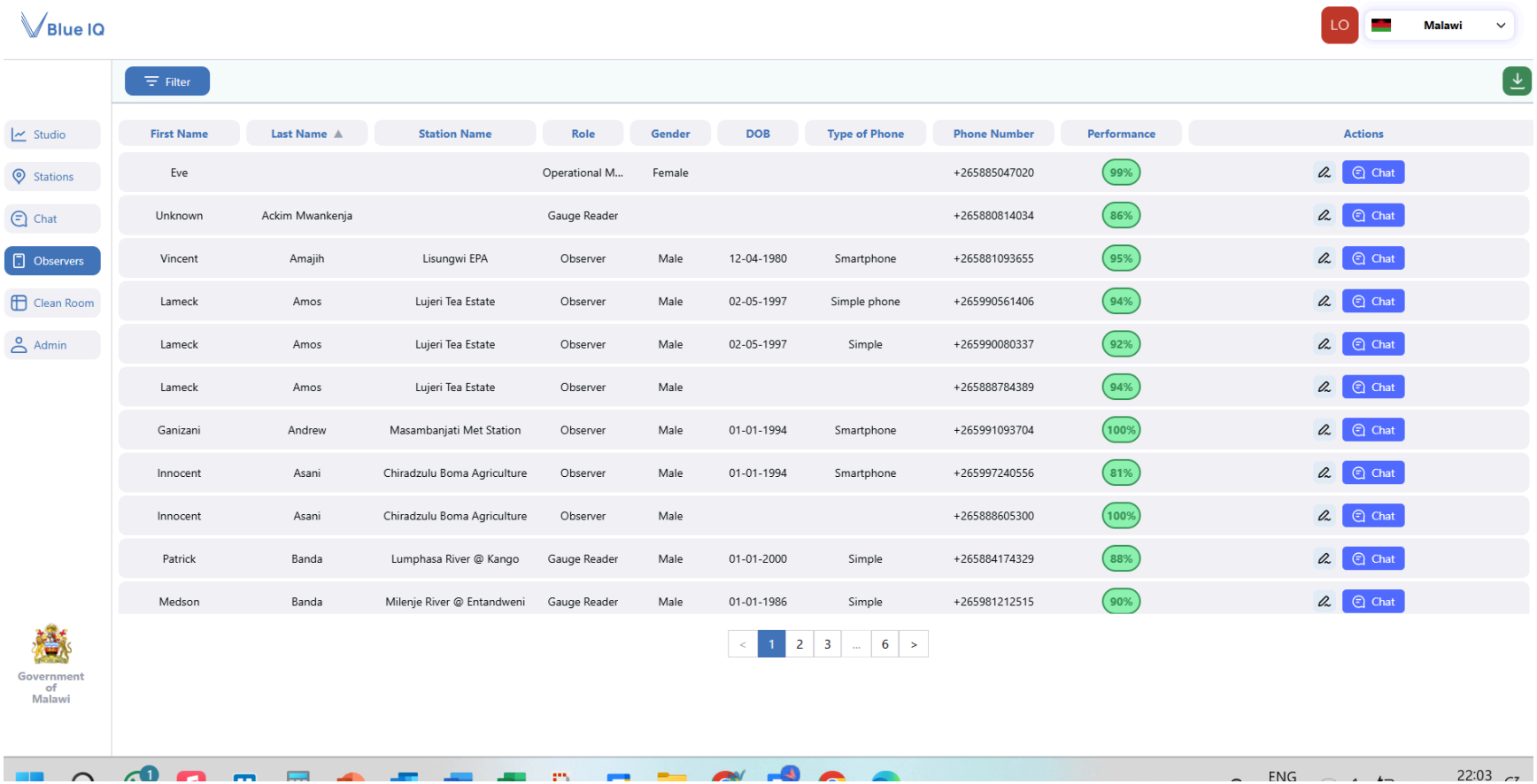
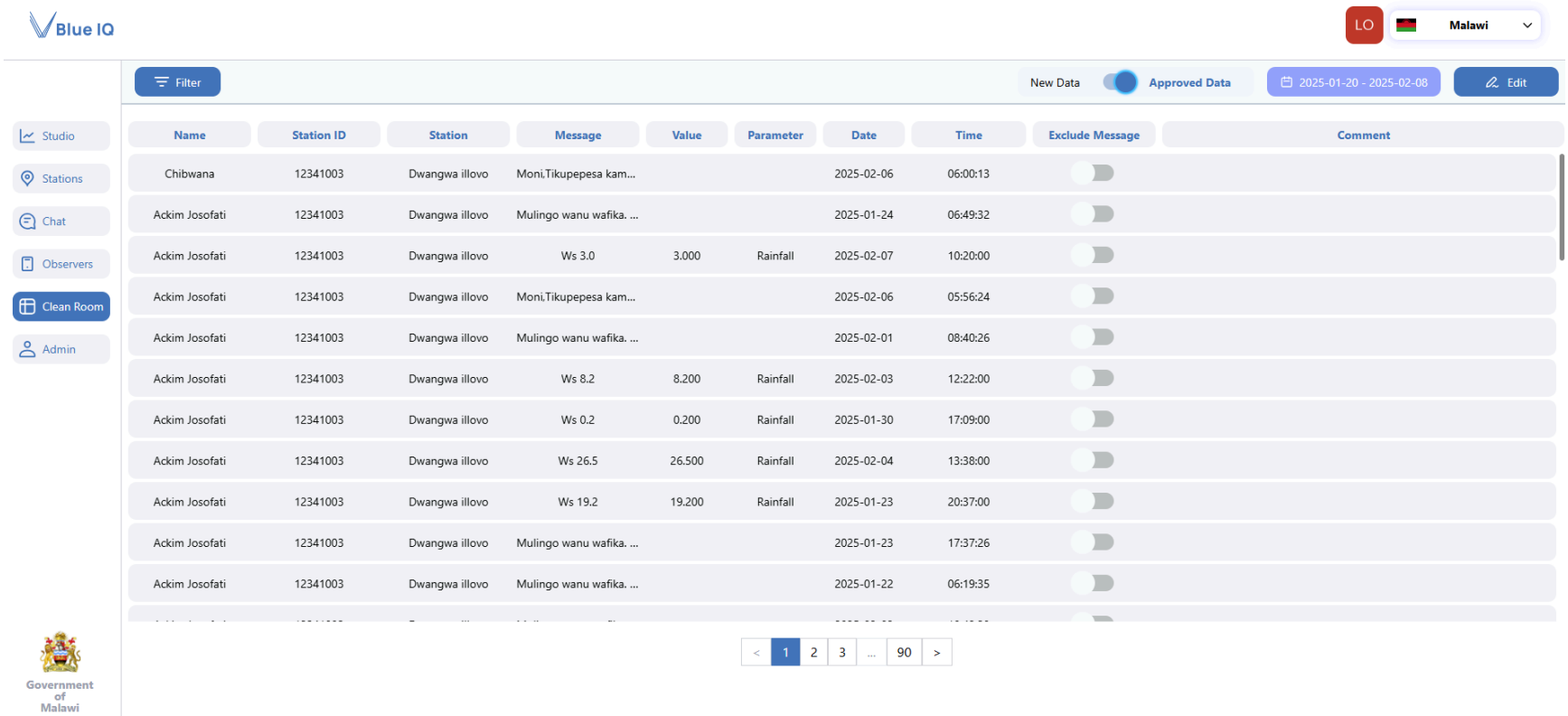
15353036 Chichiri Met WS R 1mm 1.000 2025-01-21 Mudi Blantyre Southern
15353036 Chichiri Met WS R 20.3mm 20.300 2025-01-28 Mudi Blantyre Southern
15353036 Chichiri Met WS R 136.5mm 136.500 2025-02-04 Mudi Blantyre Southern
15353036 Chichiri Met WS TX 23.0 23.000 2025-02-02 Mudi Blantyre Southern
15353036 Chichiri Met WS TM 18.5 18.500 2025-02-02 Mudi Blantyre Southern
Government of Malawi
< 1 2 3 4 5 ... 26 >

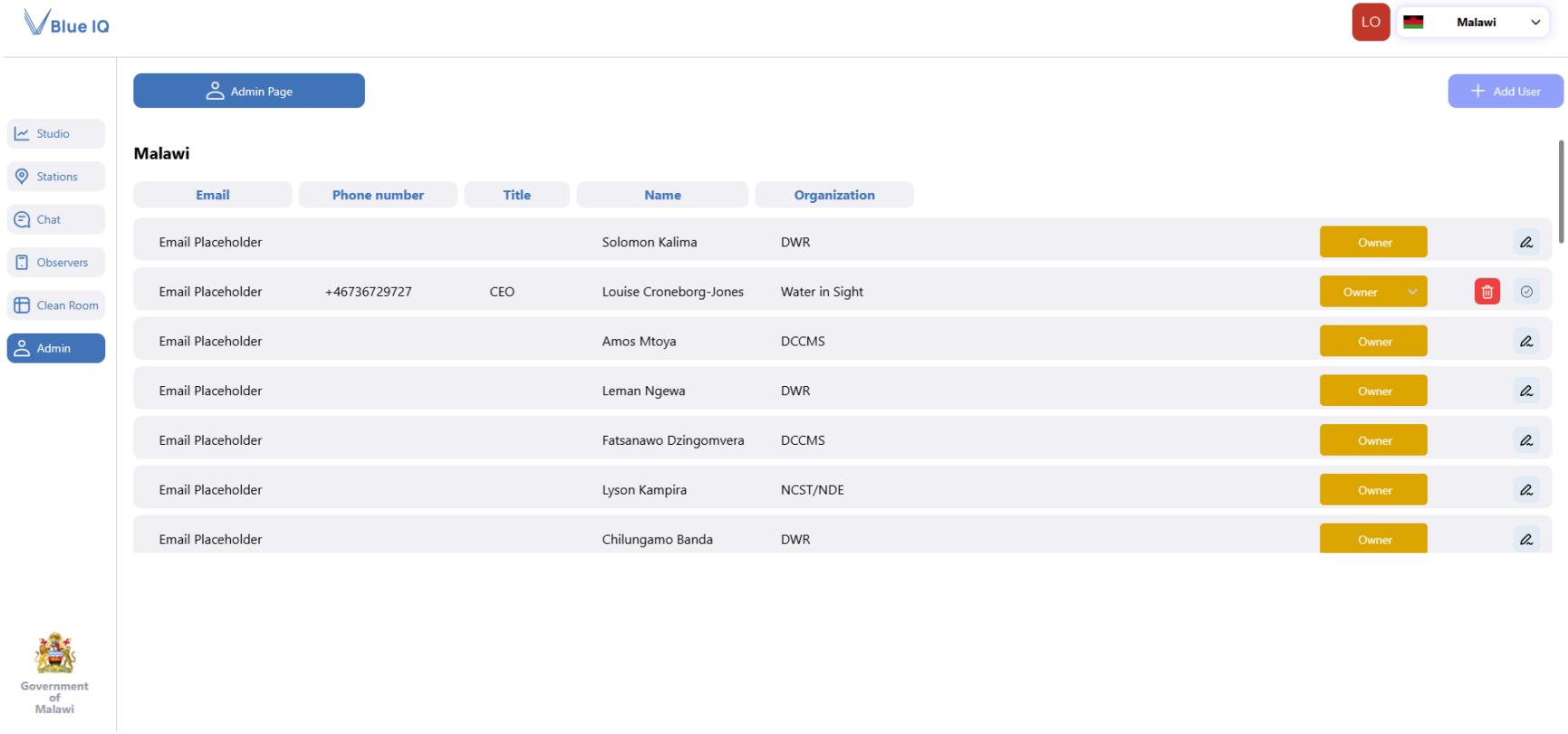

Blue IQ
LO
Malawi
Overview
Table
Studio
Filter
2025-01-20 - 2025-02-08
Stations
Chat
Observers
Clean Room
Admin
nsanje
Nsanje Boma 16353001
Shire River @ Nsanje 1G2
Meta Data
Images
Notes
2025-02-10
2025-02-10
2025-02-10
Rainfall over time
Nsanje Boma - 16353001
Observation
68.75
20
mm/24 hrs
Jan 20
Jan 25
Jan 30
Feb 8
Tete
Chikwawa
Zambézia
Quelimane
Leaflet
Gerald Kadulira
Chat
Anthony Chiutsankhondo
Chat
Meta Data
Billy-Ngabu
Station ID 16344002
Variable Rainfall
Agency N/A
Start Date Not available
Status Functioning, needs repair
Location
Latitude -16.417
Longitude 34.8642
Elevation Not available
District Chikwawa
Region Southern
Basin N/A
Government of Malawi


Blue IQ
LO
Malawi
Messages
Bulk Messages
Studio
Stations
Chat
Observers
Clean Room
Admin
Government of Malawi
Search...
Ackim Josofati 21:31 Ws 0.0
Hendrix Chipangula 21:14 WS 0
Sabina Kasiya 20:55 Ws 1.92
Paul John 20:30 WS 0.93
Davie Gongolo 20:30 WS 100
John Rashid 20:23 WS 3.827
Lyson Matemba 19:48 WS 7.75
Cosmas Lion 19:13 Ws 6 .72
Rose Kalulu 18:56 WS 0.50
Shame Sakala 18:21 WS 1.06
Thu Feb 13 2025
Ws 0.0 13/02/25 09:00
Fri Feb 14 2025
07:55 Mulingo wanu wafika. Zikomo kwambiri.
07:56 Mulingo wanu wafika. Zikomo kwambiri.
07:56 Mulingo wanu wafika. Zikomo kwambiri.
Ws 10.5 10:56
Today
18:31 Mulingo wanu wafika. Zikomo kwambiri.
Ws 0.0 21:31
Type your message...
Ackim Josofati
Observer
94%
February 2025
Mo Tu We Th Fr Sa Su
First Name
Ackim
Last Name
Josofati
User ID
f73ddbe6-7643-4545-8893-d0e3b8
Station ID
12341003
Region
Malawi
District
Nkhotakota
Primary Phone Number
+265997713394
Secondary Phone Number
+265997713394


Blue IQ
LO
Malawi
Messages
Bulk Messages
Create Message Group
Studio
Stations
Chat
Observers
Clean Room
Admin
Search...
Blantyre Observers 09:40
New test bulk message group 09:45
New test bulk message group 09:45
New test bulk message group 09:46
BT (Observers) 09:46
New test bulk message group 09:46
New test 09:46
Government of Malawi
Create Message Group
Group Name
Add Group Name here
Filter By
Select...
Description
Add description here
Create
Type your message...
Blantyre Observers
7 members
Marko Wilson Fole
Observer
Cosmas Lion
Gauge Reader
Cosmas Lion
Gauge Reader
Faith Fastani Utonga
Observer
Isaac Kambewa
Observer
Kisa Nyasulu
Observer
Kisa Nyasulu
Observer
Chat
Bulk messages can only be sent one-way to the Agency. User can only respond directly to BlueIQ as a single message, not to the whole group.


Blue IQ
LO
Malawi
Filter
Studio
Stations
Chat
Observers
Clean Room
Admin
Government of Malawi
First Name
Last Name
Station Name
Role
Gender
DOB
Type of Phone
Phone Number
Performance
Actions
Eve
Operational M...
Female
+265885047020
99%
Chat
Unknown
Ackim Mwankenja
Gauge Reader
+265880814034
86%
Chat
Vincent
Amajih
Lisungwi EPA
Observer
Male
12-04-1980
Smartphone
+265881093655
95%
Chat
Lameck
Amos
Lujeri Tea Estate
Observer
Male
02-05-1997
Simple phone
+265990561406
94%
Chat
Lameck
Amos
Lujeri Tea Estate
Observer
Male
02-05-1997
Simple
+265990080337
92%
Chat
Lameck
Amos
Lujeri Tea Estate
Observer
Male
+265888784389
94%
Chat
Ganizani
Andrew
Masambanjati Met Station
Observer
Male
01-01-1994
Smartphone
+265991093704
100%
Chat
Innocent
Asani
Chiradzulu Boma Agriculture
Observer
Male
01-01-1994
Smartphone
+265997240556
81%
Chat
Innocent
Asani
Chiradzulu Boma Agriculture
Observer
Male
+265888605300
100%
Chat
Patrick
Banda
Lumphasa River @ Kango
Gauge Reader
Male
01-01-2000
Simple
+265884174329
88%
Chat
Medson
Banda
Milenje River @ Entandweni
Gauge Reader
Male
01-01-1986
Simple
+265981212515
90%
Chat
< 1 2 3 ... 6 >
ENG
22:03

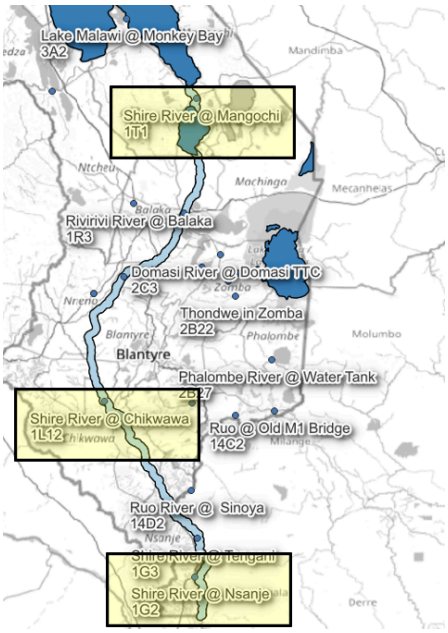

Blue IQ
LO
Malawi
Filter
New Data
Approved Data
2025-01-20 - 2025-02-08
Edit
Studio
Stations
Chat
Observers
Clean Room
Admin
Name
Station ID
Station
Message
Value
Parameter
Date
Time
Exclude Message
Comment
Chibwana 12341003 Dwangwa illovo Moni,Tikupepesa kam... 2025-02-06 06:00:13
Ackim Josofati 12341003 Dwangwa illovo Mulingo wanu wafika. ... 2025-01-24 06:49:32
Ackim Josofati 12341003 Dwangwa illovo Ws 3.0 3.000 Rainfall 2025-02-07 10:20:00
Ackim Josofati 12341003 Dwangwa illovo Moni,Tikupepesa kam... 2025-02-06 05:56:24
Ackim Josofati 12341003 Dwangwa illovo Mulingo wanu wafika. ... 2025-02-01 08:40:26
Ackim Josofati 12341003 Dwangwa illovo Ws 8.2 8.200 Rainfall 2025-02-03 12:22:00
Ackim Josofati 12341003 Dwangwa illovo Ws 0.2 0.200 Rainfall 2025-01-30 17:09:00
Ackim Josofati 12341003 Dwangwa illovo Ws 26.5 26.500 Rainfall 2025-02-04 13:38:00
Ackim Josofati 12341003 Dwangwa illovo Ws 19.2 19.200 Rainfall 2025-01-23 20:37:00
Ackim Josofati 12341003 Dwangwa illovo Mulingo wanu wafika. ... 2025-01-23 17:37:26
Ackim Josofati 12341003 Dwangwa illovo Mulingo wanu wafika. ... 2025-01-22 06:19:35
< 1 2 3 ... 90 >
Government of Malawi


Blue IQ
LO
Malawi
Admin Page
Add User
Studio
Stations
Chat
Observers
Clean Room
Admin
Malawi
Email
Phone number
Title
Name
Organization
Email Placeholder
Solomon Kalima
DWR
Owner
Email Placeholder
+46736729727
CEO
Louise Croneborg-Jones
Water in Sight
Owner
Email Placeholder
Amos Mtoya
DCCMS
Owner
Email Placeholder
Leman Ngewa
DWR
Owner
Email Placeholder
Fatsanawo Dzingomvera
DCCMS
Owner
Email Placeholder
Lyson Kampira
NCST/NDE
Owner
Email Placeholder
Chilungamo Banda
DWR
Owner
Government of Malawi

C. Insights from Satellite Observations

Water in Sight Ltd is a qualified member of the Early Adopter Programs of NASA SWOT and ICESat2. NASA SWOT is the first dedicated satellite launched specifically for observing water levels across the globe whilst ICESat2 is an altimetry mission. Through the programs, the team is able to leverage this collaboration with the expertise of the team's satellite and flood experts at RSS-Hydro SARL (www.rss-hydro.lu).

The experts on the team from RSS-Hydro has been able to undertake correlation analysis with the manual observation, as well as identified a pathway through which NASA SWOT and other satellite data sources could be made available and accessible to government through the BlueIQ.Africa platform developed in the UNEP CTCN project.



Comparative analysis

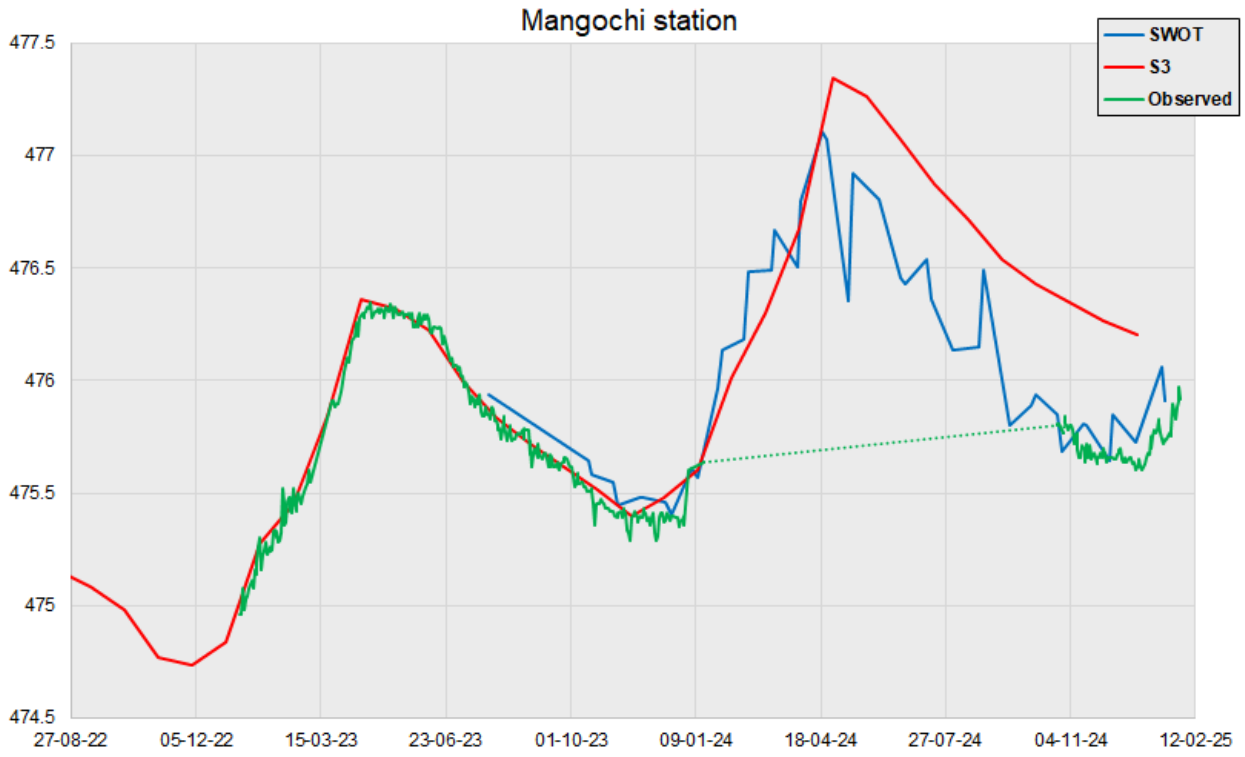
At the technical prototype validation workshop (February 2025), we presented a comparative analysis of observations from different sources and assessed the correlation between them. The preliminary analysis has been performed by comparing different satellite acquisitions and manual observations on several gauge stations along the Shire River (as shown in the figure aside).

All three comparisons showed a good correlation between satellite and manual observations (see following graphs).

The finding is of high value since manual observations are commonly discredited for being inaccurate or falsely reported.

In particular, for the river Gauge station at Mangochi (just south of Lake Malawi on the Shire River), we compared a not continuous time series of manual observations against two satellite missions, SWOT and Sentinel 3. From the analysis of this graph below, we are able to confirm:

- Despite some minor discrepancies, there is a good correlation between the 3 datasets;
- The satellite observations can be used to fill the gaps of missing data;
- Satellite observations can be further used to monitor portions of the river network not equipped with gauges, expanding the consistency of environmental monitoring by exploiting publicly available data (both NASA, SWOT, and Copernicus, S3, data is freely available).

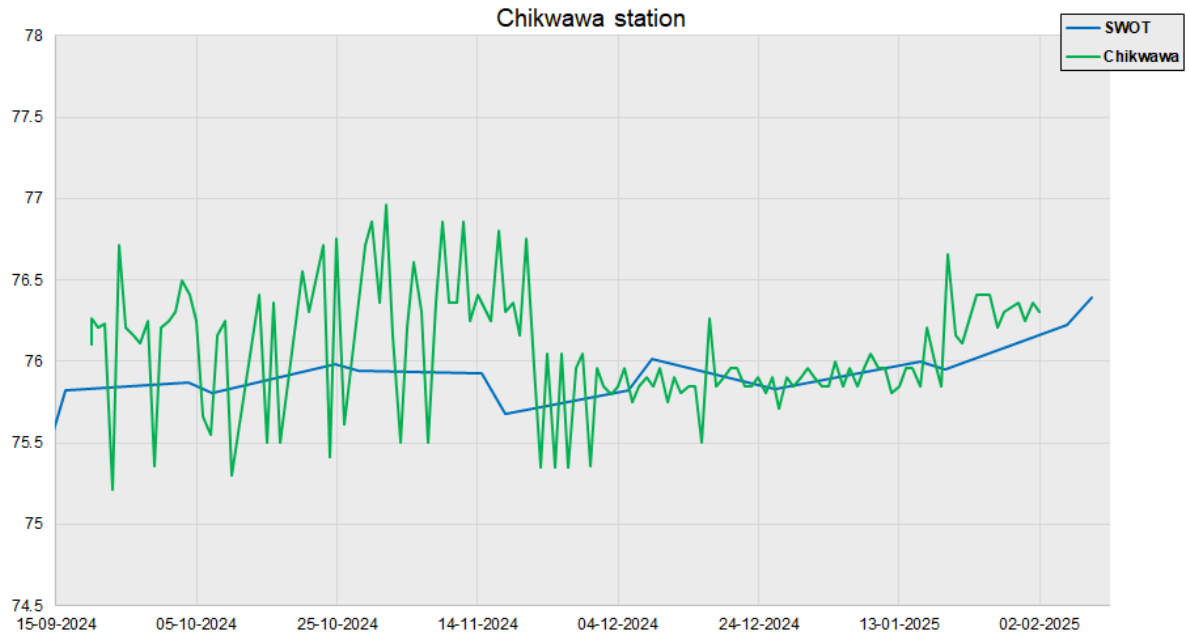


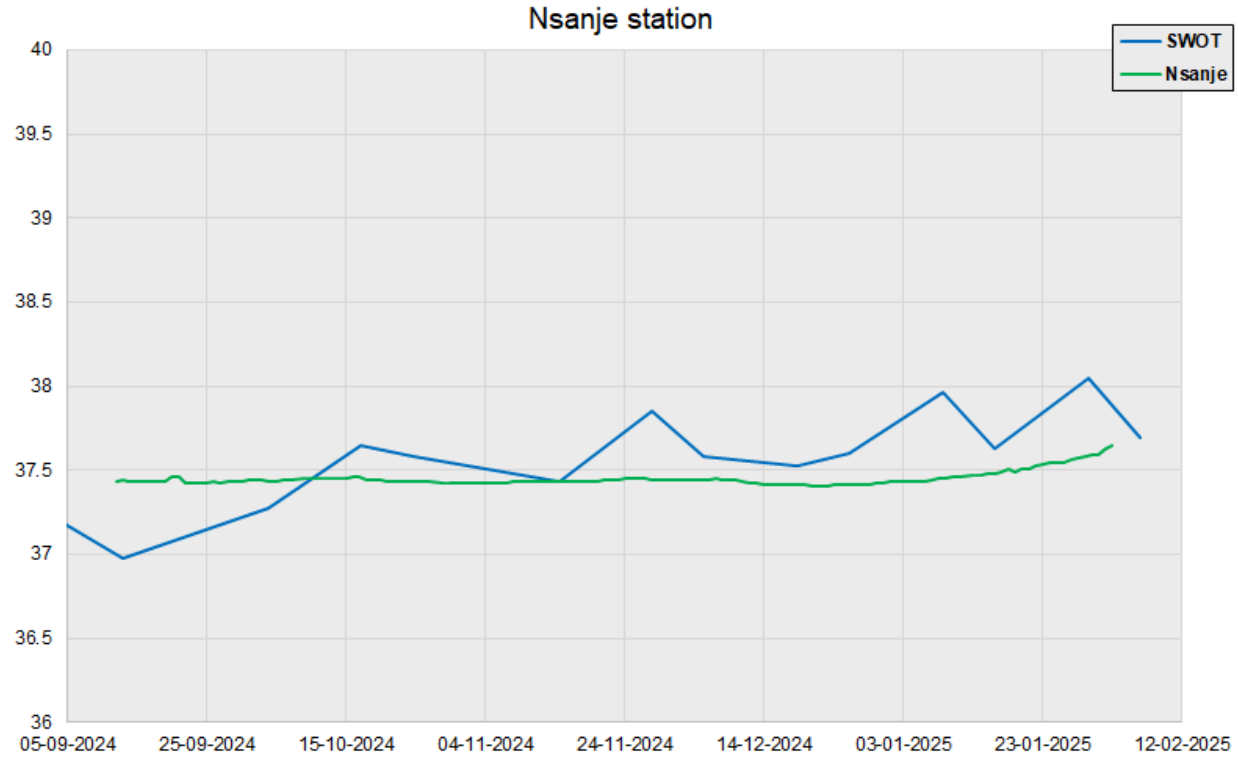
The graph above shows observations of the river level of the Shire River at the Mangochi station from three sources. The red line is those of the combined Sentinel satellite observations. The blue line shows observations from the new NASA SWOT mission (not processed for lower grade observations), and the green line shows observations reported by the Gauge Reader Lyson Matemba.

The green line shows an initial period of reporting between January 2023 and January 2024 by the Gauge Reader, representative of the phase 2 piloting under Water in Sight Ltd with the Swedish Innovation Agency funding. The following period of observation collection is from October 2025 to February 2025, representative of the piloting under the UNEP CTCN project.

Noteworthy, the cost of financing the technology during the 8 month gap of manual observations is approximately US $ 4, and the cost for the compensation of the Gauge Readers work is approximately US $ 36/m (US $ 290 for 8 months).

From the analysis of the Chikwawa station, we were able to detect an inconsistency in the manual observation. Indeed, the first months show a different pattern compared to the rest of the time series. The Chikwawa station is also directly downstream of the Kapichira Hydropower Station that provides over 90% of power in Malawi. The twice daily observations could, therefore be capturing daily fluctuations that satellites do not. This highlights how satellite observations can be used also to compliment or validate the quality of observation or detect an eventual deviation of automatic sensors.





This result paves the road to enhance the exploitation and combination of these data sources. We concluded with a summary of the pros and cons of using satellite data in hydrological studies.

Key points include:

- Pros: satellite measurements often correlate well with in-situ observations, making them useful for cross-checking in-situ observations, filling temporal gaps, and monitoring ungauged basins.
- Cons: limitations such as restricted revisit times and spatial resolution challenges can affect the effectiveness of satellite data, particularly in rapidly changing environments and minor river networks.

D. Equipment updates

After distribution and rehabilitation of the equipment used at river and lake gauging stations, and rainfall monitoring stations, was completed in late 2024, there has been no need for updates apart from two interventions. These are detailed below.

Vandalism at the Mkwakwasi River @ Mangunda Station

Shortly after rehabilitation and installation of new river level gauging posts at the Mkwakwasi River @ Mangunda Station, there was vandalism to one of the metal plates as shown in the photos below. The Gauge Reader and community members did not know who or how it occurred.

Response

The Department of Water's technical team and working group members mobilized rapidly in the early days of January 2025 with the support of the national and international team to travel to the station, bringing replacement materials and welding equipment.

At the same time, it was decided to hold a community consultation with the District Office and the Chief. The community was made aware of the purpose and value of the gauging plates, which they said they did not know before. Together, they travelled to the station to investigate and agree on a way forward. It was agreed that any suspicious activities should be reported to the Chief. No additional damage has occurred at the site since.

Top gauging metal plate cut and bent.

Community consultation and visits the station with the Chief, government staff and team

Plate is fixed and welded to the angle iron.

Retraining at the Ruo River @ Sinoya Station

Since rehabilitating and training the gauge reader at the Ruo River @ Sinyoa Station, there was a stark absence of submitted observation data. The Gauge Reader is an elderly man in his 70s and he admitted that using a phone was a new skill he needed, whilst he also did not have access to electricity to charge his phone.

Response

After failing to reach the Gauge Reader, the team's Project Officer, the Department of Water and its District Officer in Nsanje, agreed to revisit the station.

On arrival, it was agreed to train the Gauge Reader's daughter in how to take and send observation data. However, challenges remain as they need to travel to the trading post to recharge the phone, requiring money for both transport and recharging.

Gauge Reader Fole Penzo with his daughter at the gauging station being trained by government staff

E. Gender and Social Inclusion Updates

A gender-related update to the technology prototype was to provide repeated guidance on where and how to access preventative or reporting on gender based violence (GBV). The team included toll-free phone numbers to access support on GBV in the training materials, and included guidance to several toll-free numbers in mass communication to gauge readers and observers (along with safety guidelines with upcoming rainy season and heightened risk of floods).

The following gender and inclusion lessons and recommendations are being put forward at the stage of final piloting under the UNEP CTCN project.

Lessons and Learnings

- Age variations in community engagement meeting participation: There were variations across communities during participation of community members in community engagement meetings. In some communities, youth participation, especially that of young women was very low, while some communities had good representation of all age groups and genders and some communities had good participation of elderly people in the meetings. Future engagement meetings can strengthen integration of the age, gender and diversity approach during mobilization to ensure that all age groups and people with various intersecting identities are participating in the meetings.

- Disability inclusion: There were no persons with disability who participated in project activities. This is because the project's objective is not to target persons with disability, and the gauge readers and observers enlisted by the government did not report any disability.

- Gender balance: Of the gauge readers and observers engaged in piloting, 78% are men and 22% are women. In Water in Sight's two previous pilots, this proportion remained the same. During community consultations, the division was approximately 60% men and 40% women.

- Age: During piloting, there was diversity in terms of age as there was a combination of youthful, middle aged and elderly gauge readers and observers.

- Safety Concerns: From the surveys, most gauge readers and observers live in close proximity to their monitoring station. However, some men and women live further away. For example, at the station Fortlister the observer is female and she travels long distances to submit the observation. This can involve a higher risk to her safety although this was not documented during piloting. A risk reducing intervention could be to provide bikes, although that also involves a lot of risks in terms of traffic accidents, especially when it is dark.

Recommendations

- Capitalize on youth groups and other existing community structures to disseminate weather information to the communities for their actions. These can also be utilized to

create awareness on the importance of the equipment to prevent vandalism and promote sustainability.

- Communities recommended using local community radio stations and radio listener clubs to disseminate weather related information as they would easily access it in appropriate language.