Status of Climate Database at UNMA (Uganda National Meteorological Authority)

Introduction

From September 30 to October 4, 2024, IDEMS collaborated with the Uganda National Meteorological Authority (UNMA) to conduct an audit of their climate database. The audit aimed to assess the completeness of station records and the quality of data in the database.

This work was carried out as part of IDEMS's terms of reference outlined in a Letter of Agreement (LoA) with the World Meteorological Organization (WMO). Specifically, IDEMS was tasked with "conducting a full 5-day on-site training in Uganda as soon as possible to kick-start data rescue activities." To support UNMA in launching data rescue efforts, it was agreed during an inception meeting that the audit would be instrumental in identifying gaps in historical climate records. This would enable UNMA to work towards completing and updating the records. Additionally, the audit would help UNMA identify necessary corrections to enhance the quality of the climate data.

The overarching goal of the LoA was to strengthen data rescue implementation as part of the United Nations' Early Warnings for All initiative. A complete and high-quality climate database is essential for helping Uganda understand its climate variability and estimate climate risks. Uganda, along with Liberia and Bangladesh, was selected to receive this support in 2024.

This report summarizes the findings of the database audit and provides recommendations, as agreed with UNMA, to maintain a comprehensive and high-quality database. The document also outlines how the week's activities were structured to achieve this objective.

The Working Group and Schedule

The work involved a small core group of staff in the data lab in UNMA. These are mainly staff involved in entering and managing data into the database. Due to an ongoing restructuring of the UNMA, only 2 staff from the data lab were available during the week. It was agreed that these two staff would aim to be trainers of the new staff who may join the lab after the restructuring is completed.

For this reason, the sessions in the week were structured as hands-on, practical sessions where the data lab staff used R-Instat to conduct the audit and inventory analysis of the data in the database. R-Instat is a front-end to R with a special climatic menu which makes it

simple and easy to import data in a tidy format from Climsoft - the database used by UNMA - .In addition, R-Instat has special facilities for checking, examining and analysing climate data. This was the first time the staff were interacting with R-Instat but they were able to quickly learn the tool and focus on the data work at hand. A detailed schedule of the activities completed on each day of the week is provided in the Appendix.

The work-in sessions also enabled IDEMS to gain insights about the data processes at UNMA. IDEMS was therefore able to offer practical recommendations for improving these processes to enhance data completeness in the database.

Status of Climate Database

Database

As already indicated, UNMA uses Climsoft version 4 to digitize and manage the country's climate data. The Climsoft server is set up in the IT department while the workstation is set up in the data lab office. Recently UNMA received technical support where the Climsoft database was updated and maintained and hence the data lab staff were confident that the database has no set up issues with regard to managing station data. The data lab staff were also further trained on Climsoft processes at the same time.

Station Information in the database

The database is currently configured to manage data from a total of 163 manual stations. These include 20 main stations with the rest being mainly volunteer stations. The stations are set up in Climsoft with details about their locations i.e. longitude and latitude information. However, it was established this information has not been verified in a long time despite there being known instances of stations changing locations. The lack of updating was blamed on delayed transmission of the new longitude and latitude information by the network and stations department. The audit, therefore started with checking the accuracy of the longitude and latitude information for the stations in Climsoft.

It was also noted the Climsoft is not currently set up to receive data from 20 automatic weather stations which were set up 10 years ago to complete the main stations in collecting climate data on a sub-daily basis.

Climate data in the database

Only rainfall and temperature have been entered into Climsoft. Data for other elements have not been entered. The data are entered into Climsoft by the data lab staff after the monthly data recording sheets are received at the headquarters. The entry of the data is not timely as

such the rainfall and temperature data are not upto date. Rainfall digitization was estimated at 80% while temperature was far behind at 60%.

Data Utilization

We sought to determine the extent to which Climsoft records are utilized internally by the data lab team and other departments. Specifically, we aimed to establish whether a feedback mechanism exists through which data users provide insights on data quality. Our premise was that data quality improves when the data are actively used.

It was established that the primary consumers of Climsoft records are external users. While a few internal users also access the records, most departments requiring climate data rely on alternative methods to obtain the information rather than using Climsoft. Due to time constraints, we were unable to visit the departments to explore their practices in detail. However, it appears that Climsoft records may not be widely used internally because they are often not up to date.

There is a clear need to encourage more departments to utilize Climsoft records. Greater internal usage would serve as an incentive to ensure the timely entry of data and regular quality checks, ultimately making the database more useful and reliable.

Paper Archive

UNMA maintains a well-organized and spacious physical archive of paper records as part of the climate database. The paper copies are securely stored in fire-proof cabinets. These cabinets are systematically organised by station, with the records within each station further sorted by year and month, enabling easy retrieval of paper records for data verification. The

The paper archive section also oversees the scanning and storage of photo images of the paper recording sheets, a critical step in climate data management within Climsoft. These scanned images are stored on a dedicated server. The status of paper copies scanned and stored in the server could not be determined as the task is done in a random manner which makes it difficult to track progress. In addition, the paper archive module in Climsoft is not linked to the server hence inaccessible via Climsoft.

Other Databases

Besides Climsoft, there exists separate systems at UNMA that store and manage other types of data. These include:-

- Synoptic data (3-hour basis) is handled separately at the Entebbe station. The data are managed using Excel and are entered on time. The data are used by the airport and also other sections of the authority.

- Data from 20 automatic weather stations installed at close proximity with the 20 synoptic stations in the country are stored in a dedicated server which is not linked to Climsoft hence managed separately.
- There also exists remote-sensed hydroclimatic data stored in yet another dedicated server.

Results of Inventory and Gap Analysis of Climate Data in Climsoft

Only Climsoft database was accessible to the data lab staff during the week and so our work did not include the other databases. The other databases are managed by IT staff who were not available during the week mainly because of the restructuring.

In this section, we demonstrate the outputs of the inventory and gap analysis. We do not present the whole set of results because UNMA preferred that they remain internal documents for now.

Verifying Station Location Details

Examination of station information revealed that 56 stations did not have longitude or latitude information or both. The list was put together to be shared with the network and stations office to provide this information.

To verify the longitude and latitude information, a map of stations was produced showing the location of the stations in Uganda. The map was also shared with the field office who will then try and verify whether the stations are correctly located in the country. We had not received feedback by the end of the week. The task was ongoing at the time of writing this report

Inventory of Climate data

A bar plot that highlights periods with gaps in red within each station's records was produced. This was done for rainfall and temperature records where applicable. This visualization provided a quick overview of data availability for each station. The plots were compiled in a document that remained with the data lab staff.

Gaps in Station Data

A table showing months without data for each station was also produced as part of the audit task. The period under review was from the year the station was established until June 2024. An example of the table is shown below for Mbarara station. The results of the entire analysis were compiled and presented to UNMA data manager for the next steps which involve searching for the records and digitizing them into Climsoft.

	station_name	Element	From	To	Count	Level
1	MBARARA MET STATION	rain	1916-04-01	1916-07-31	4	Month
2	MBARARA MET STATION	rain	1917-11-01	1917-11-30	1	Month
3	MBARARA MET STATION	rain	1933-11-01	1933-12-31	2	Month
4	MBARARA MET STATION	rain	1938-12-01	1938-12-31	1	Month
5	MBARARA MET STATION	rain	1940-08-01	1940-08-31	1	Month
6	MBARARA MET STATION	rain	1942-01-01	1943-04-30	16	Month
7	MBARARA MET STATION	rain	1957-12-01	1957-12-31	1	Month

Recommendation and Next steps

At the end of the week, IDEMS made a presentation to the UNMA leadership about the work accomplished collaboratively with the data lab team. The presentation also included proposals for next steps, informed by the findings and progress made during the week as follows:

- UNMA requires additional Climsoft support to reconfigure the database installation to eliminate the cause of duplicate records. The data team to request this support from the Climsoft team in Nairobi and UK Met. IDEMS will support UNMA to prepare the request
- Climsoft should serve as a one-stop “shop” for all climate data at UNMA. The data team will submit a request for technical support to configure the database and ingest data from automatic weather stations (AWS) and other remotely sensed sources into Climsoft. IDEMS will support UNMA to prepare the request if needed.
- Climsoft records, particularly rainfall and temperature data, should be complete. The data team agreed to prioritize gap-filling efforts, focusing on recent years where records are more easily accessible, and ensure this data is entered into Climsoft.
- Rainfall and temperature records in Climsoft should be up to date for each station. The data lab will prioritize the digitization of these records through December 2024, starting with the main official stations before extending the efforts to other stations.
- The digitization of data needs to be immediate and quickly as possible. UNMA agreed to explore data entry at the stations. IDEMS suggested that UNMA considers the use of new Climsoft web application which is currently under testing. Uganda could become a test country. Other suggestions provided included the use of WhatsApp, ODK, the Climsoft App, and other tools. IDEMS available to support UNMA
- UNMA will explore the use of satellite data and AWS data to fill gaps in station records that cannot be recovered. While UNMA expressed interest in this approach, they

emphasized the need for technical support to implement it effectively. It was agreed that this advanced training may be possible after a basic time series analysis training which will follow this exercise.

Conclusion

The week was successful as the objectives were met. Following the audit, UNMA is now able to The Climsoft records in Uganda require significant improvement to become exemplary within the region. Many stations have gaps in their data, particularly for recent years, and both rainfall and temperature records are not up to date. Addressing these gaps by prioritizing the entry of missing data, especially from recent years, would substantially enhance the database's usefulness.

In addition, substantial technical support may be needed to help UNMA integrate additional data currently stored outside the Climsoft database. Furthermore, advanced training for UNMA staff may be necessary to enable them to effectively leverage existing records to fill gaps where data has been lost or is unrecoverable. With these improvements, the Climsoft database has the potential to become a robust tool for climate data management in Uganda.

Appendix - The Schedule

Day 1: Monday 30th September 2024

- Presentations about past data rescue initiatives
- Presentation and discussions about the scope of the current initiative
- R-Instat installations
- Ratified initial plan for the rest of the week

Day 2: Tuesday 1st October 2024

- Presentations of the different datasets that are in custody of the department i.e. Climsoft, AWS servers, hydrological data servers etc
- Presentation of data transfer process and discussions on how to improve the processes
- General introduction to R-Instat and its facilities for tidying, checking and summarizing data

Day 3: Wednesday 2nd October 2024

- Importing daily rainfall data including from Climsoft
- Tidying the data and identifying issues with the data in Climsoft
- Investigating and eliminating duplicates cases found in the Climsoft records
- Analysis of gaps in rainfall records per station

Day 4: Thursday 3rd October 2024

- Analysis of gaps in rainfall records per station continued
- Preparing a report of the inventory analysis for rainfall
- Extracting temperature records from Climsoft into R-Instat
- Analysis of gaps in temperature records per station

Day 5: Friday 4th October 2024

- Presentation of the inventory reports to management
- Discussions on next steps in addressing gaps in data especially in recent times
- Planning for second workshop on basic time series analysis