

NORHED Project on Improving East Africa's Weather Information Management through the Application of Suitable ICTs

Preliminary Status of the Survey Findings in Uganda



Entebbe Meteorology Centre

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National Meteorology Services in Uganda

1.0 Introduction

The National Meteorology Services (NMS) in Uganda are managed by the Department of Meteorology, Ministry of Water and Environment, Uganda Government. Uganda, has 16 climatological zones and a large network of weather stations distributed as shown in Figure 1. According to NMS, the current weather station coverage is only 50%. This is insufficient, presenting the need to have complementing stations particularly in the North, North East and Western parts of Uganda.

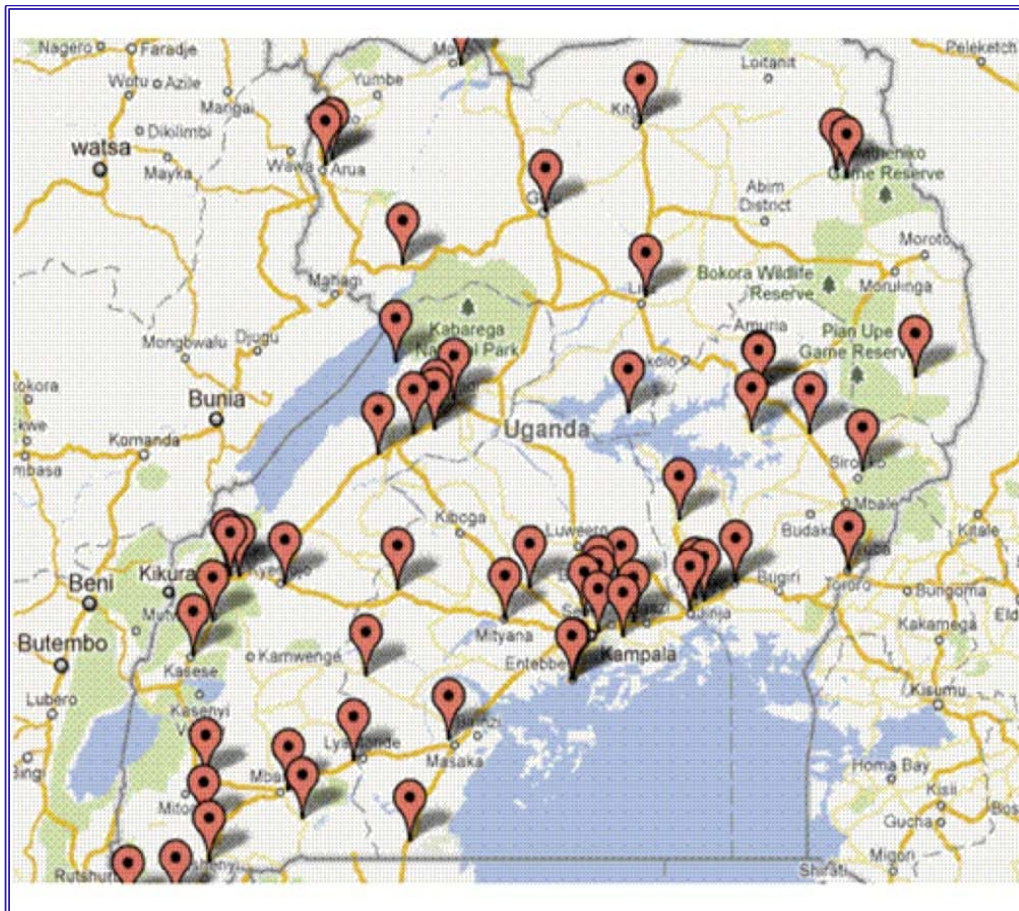


Figure 1: Map showing the weather stations in Uganda

Weather Stations Operated in Uganda

A summary of the types of weather stations that are operated by NMS Uganda is presented in Table 1 and the types of data collected from the weather stations are presented in Table 2 below.

Table 1: Number and Type of Weather Stations operated by NMS

	Type: Purpose of data	Type: Mode of operation		Totals	How often is data collected ?
		Manual	Automatic		
1	Synoptic	12	-	12	Hourly
2	Rainfall	150	-	150	Daily
3	Agromet	9	-	9	Every three hours
4	Hydromet	4	-	4	
5	Upper Air Stations	1		1	Daily
6	Satellite Receiver (MSG – 2 nd Generation)		1	1	Every 15 minutes
7	Weather Radar		0	0	
8	Other(specify) Automatic Weather Station (AWS)		15	15	30 minutes interval

Table 2 Type of Data Collected from the Weather Stations and the Sensors used

Types of Data	Sensors Used
Rainfall Amount	Rain gauge
Rainfall Intensity & Dew Point	--
Humidity	Dry Bulb & Wet Bulb, Slide rule
Atmospheric Temperature	Thermometer
Atmospheric Pressure	Barometer
Wind Direction & Speed	Wind vane and Anemometer/Beaufort Scale
Cloud Cover	Observation
Evapotranspiration	Evaporation pan
Water Temperature	Six's Thermometer
Sunshine Intensity	Sunshine Recorder
Sunshine Duration	Sunshine Recorder
Visibility	Visibility reference point – Back Skirter

2.0 Findings from the Survey

A survey of the national meteorology services in Uganda was done by researchers on the project team. 6 weather stations representing the different areas of Uganda as well as the National Meteorology Centre (NMC) were visited. Table 3 below is a summary of weather stations that were visited and their characteristics. All the stations lacked supplies while some lacked instruments. The general condition of the stations was not impressive and in some instances some instruments has been missing for many years.

Table 3 : Weather Stations visited in the study

Name of Station	Type of Station	Manual	Automatic	• Condition
MASINDI (N)	Synoptic	√		<ul style="list-style-type: none"> • No sunshine card recorders, Min and Max Thermometers
JINJA (E)	Synoptic	√	√	<ul style="list-style-type: none"> • No sunshine card recorders
MAKERERE (C)	Synoptic	√	√	<ul style="list-style-type: none"> • No sunshine card recorders • Stolen evaporation basin • Cut wires on AWS
ENTEBBE (C) (NATIONAL MET CENTRE)	Synoptic Satellite Receiver MSG-2 Upper Air Station Weather Radar	√	√ √ √ √	<ul style="list-style-type: none"> • No sunshine card recorders • Stolen evaporation basin • Cut wires on AWS
MBARARA (W)	Synoptic	√	√	<ul style="list-style-type: none"> • Depressing environment • No means of sending data • Spoilt Wind Vane
NAMULONGE (C)	Agromet	√	√	<ul style="list-style-type: none"> • Only 2 people at station • Site is far away from office • No Soil Thermometer (10yrs)

3.0 Data Management Process

Data from the weather stations is collected by Meteorology Assistants and sent to the NMC by Radio (single side band radios), phone call (landlines), email, post (letter), physical delivery and GPRS as well as other mobile network data services. When data is received by NMC, it is compiled from all stations into required format and coded from Alphanumeric data to binary data. Data is edited to remove any errors and validated using data obtained through automatic weather stations. Data at the NMC is received by the Met Superintendent, processed by Met Officers and then disseminated by Senior Met Supervisors as well as Met Supervisors.

Figure 2 below presents the data management processes that are done before weather information is disseminated to the stakeholders.

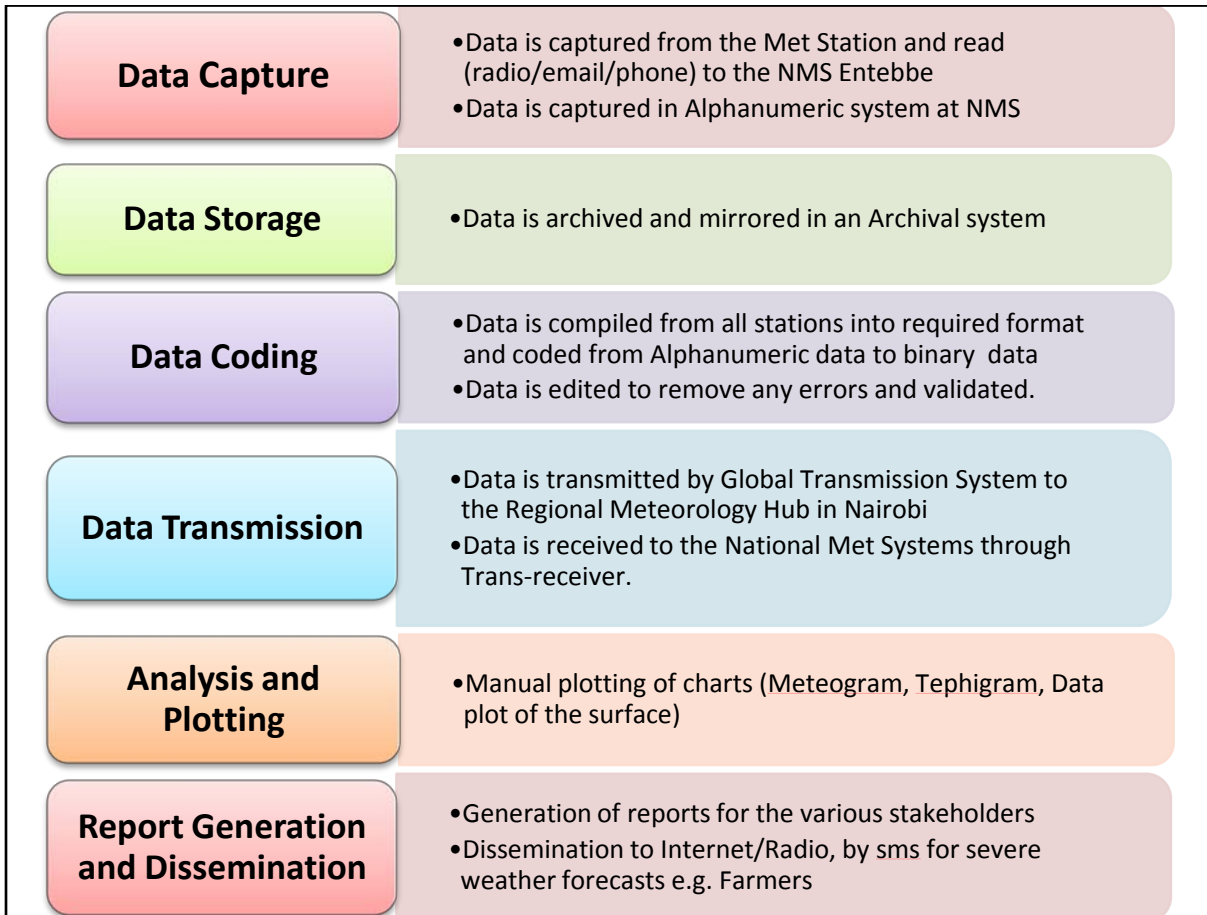


Figure 2: The Data Management Process

4.0 Numerical Weather Prediction Activities

Currently the NMS do not run any Numerical Weather Prediction Models but use ENSEMBLE forecasting (combine several models). Model and products are obtained from the World Forecast centres – AWS-NOAA (American), UK Weather Service, South Africa Weather Service, Regional Met Centre (Nairobi) and Kuwait Met Services. The models generated are based on the following forecasts and are obtained via the Centre’s Websites.

- NOAA (American) – GFS, ETA, WRF
- ECMRW (European Centre for Medium Range Weather forecasting) – Africa Ensemble forecasts
- UK Met office – ALAM

Satellite images are used to complement theplotted charts in order to generate forecasts. The data that is obtained is based on the 8Km spatial, 1 Km High, Temporal 15 min resolutions and the key parameter is rainfall. Approximately 70% of the weather information is accurate and rainfall is the key parameter since Uganda lies in the tropical region.

5.0 Current Status and Gaps in Human Resource

It was reported that there are only 23 meteorologists in Uganda and these are not sufficient to manage the NMS network and the stations all over the country. There is therefore need to train and recruit more meteorologists. Table 4 shows the technology specific skills of the personnel at Meteorology Department. It is evident that the majority of staff are not confident with the skills they have, presenting the need to provide refresher training for staff. The majority of staff in the Meteorology Department are male. In addition, there is only one female member of staff among the senior members. This calls for a conscious effort to encourage and train women in the meteorology field.

Table 4: Summary of Technology Specific Skills

No	Technology	People with related training		Rating of the experience with the technology
		Male	Female	
1	Numerical Weather Prediction Models	2	-	Fair
2	Computer Grid Infrastructures	2	-	Fair
3	Wireless Sensors	1	-	Good
4	Earth Observation Satellite Data	10	1	Very Good
5	Information Dissemination Technologies such as mobile phones	10	2	Good
6	Programming	No experience at all		
7	Databases	Few		Good
8	Hardware maintenance and Systems Administration	Few		Good
9	Sensor configuration and Network Management	Few		Good

It was also noted there was lack of personnel with ICT skills. The ICT related training requirements that would greatly benefit staff are:

- a) Programming- There is a need to have programmers who can develop/design the necessary software needed for the new data capture methods as well as kick start dormant tools on Linux and numerical weather prediction models.
- b) Lack of general ICT skills to collect, process, organise, send, store, preserve data.
- c) Skills for computerised analysis and forecast to replace the manual plotting of charts which is tedious with delays.
- d) Database management – NMS has huge volumes of data presenting the need to improve accessibility and storage of data. Some of the existing software cannot be redesigned to suit the demands because of lack of database designers and developers who are familiar with weather data. This skill is necessary to reduce the time taken to produce the required analysis.
- e) Modeling – Modeling skill will be useful in producing tailored products for the different stakeholders as well as improving the accuracy of forecasting.

- f) Hardware and Systems Maintenance skills for configuring servers for transmission as well as sustaining the Met service operations. Due to shortage of competent staff, NMS has servers for transmission that cannot be configured.
- g) Networks management skills required to ensure that there is communication between the departments for timely reporting.

6.0 Current Status and Gaps in Existing Curriculum

In Uganda, meteorologists are trained at Makerere University while meteorology assistants are trained at the Meteorology School in Entebbe. Currently Makerere University runs two meteorology programmes: Postgraduate Diploma in Meteorology (2 semesters) and BSc of Meteorology (3 years) as shown in Table 5 and Table 6 respectively.

Table 5: Postgraduate Diploma in Meteorology Curriculum

Semester 1		Semester 2	
GMR 6101	Introductory Meteorology	GMR 6201	Synoptic Meteorology
GMR 6102	Thermodynamics and Cloud Physics	GMR 6202	Numerical Weather Prediction
GMR 6103	Tropical Meteorology	GMR 6203	Agro-Meteorology
GMR 6104	Physical Meteorology and Remote Sensing	GMR 6204	Hydrometeorology
GMR 6105	Dynamic Meteorology	GMR 6205	Climate Change and Socio-Economic Implications
GMR 6106	Research Methods and computer Applications in Meteorology	GMR 6206	Research Project

Table 6: BSc Meteorology Curriculum

Year 1			
Sem 1		Sem2	
MET 1101	Introduction to Atmospheric Science	MET 1201	Thermodynamics
MET 1102	Meteorological Instruments and Observation Methods	MET 1202	Climatology
MET 1103	Introduction to computing	MET 1203	Computing and programming in Meteorology
MET 1104	Differential and Integral Calculus	MET 1204	Fundamentals of Matrix Algebra and Vector Calculus
MET 1105	Classical mechanics	MET 1205	Tropical Meteorology
CSK 1101	Communication skills	MET 1206	Cloud Physics
		UNV 1002	Introduction to gender

Year 2			
Semester 1		Semester to	
MET 2101	Atmospheric Dynamics I	MET 2201	Atmospheric Dynamics II
MET 2102	Research Methods in Meteorology	MET 2202	Weather Forecasting Principles I
MET 2103	Synoptic Meteorology	MET 2203	Physical Meteorology
MET 2104	Numerical Methods in Meteorology	ENV 2213	Principles of GIS
Env 2111	Soil conservation and Environment	MET 2205	Oceanography
Env 2110	Gender and Environment	MET 2206	Renewable Energy Resources
MET 2105	Biometeorology		
Year 3			
Semester 1		Semester to	
MET 3101	Remote Sensing in Meteorology	MET 3201	Climate Change, adaptation and mitigation
MET 3102	Meteorology and Human Environment	MET 3202	Weather Forecasting Principles II
MET 3103	Boundary layer Meteorology	MET 3203	Elements of Environmental Pollution and Control
ENV 3110	Geographical Information systems	MET 3204	Project
MET 3104	Hydrometeorology	MET 3205	Aviation Meteorology
MET3105	Agro-meteorology	ENV 3112	Water Resource Management

It was noted that there were very few ICT related courses (shaded) in both curricula. The postgraduate Diploma in Meteorology has only one ICT related course which provides basic literacy skills while the BSc. Meteorology has five related courses. Although both courses have ICT related courses, these do not adequately address the ICT related needs as stated in Section 5.0.

7.0 Current Status and Gaps in the Infrastructure

Table 7 presents the current status and gaps in the infrastructure at the various weather stations and the National Meteorology Centre.

Table 7: Gaps in Infrastructure

A	Lack of instruments & Delayed Maintenance: Barometers, Charts, Sunshine recorder cards, Max and min thermometers, panels
B	Lack of sufficient security at the stations – thefts of property, cutting of wires

C	Difficult to integrate data to uniform standard since each Automatic Weather Station has different data format. (Need an Integrator)
D	Lack of Computers, GPRS Handsets, Radio call at the weather stations
E	Lack of Internet for transmission of data from the weather stations to the national meteorology centre
F	Lack of Software to shift from alphanumeric to binary codes, Software to plot charts, forecasting tools, Out dated Database (Archive system).
G	Delayed delivery of data- Transmission of data (15-30 min)
H	High costs of communication, maintenance and purchasing of equipment
I	Inadequate office structures and furniture

8.0 Current Status and Gaps in any relevant research

The following were identified as key research areas that need to be explored:

- Use of mobile Computing Technologies for communicating MET information
- Modeling and forecasting technologies.

9.0 Key Stakeholders and Target Groups of the Project

The major secondary stakeholders of the project are the National Meteorology Centre whose role is to ensure that weather and climate information is provided to the stakeholders. Other stakeholders include the beneficiaries of weather information as shown in Table 8 below:

Table 8: Secondary Stakeholders of Meteorology Services

		Stakeholders	Consideration
A	Civil Aviation	Civil Aviation Authority	Landing and Take off
B	Agriculture	Ministry of Agric	Farmers- early warning
C	Disaster Preparedness	Office of Prime Minister	Landslides, floods
D	Construction	Private stakeholders	Roads and Buildings
E	Health	Ministry of Health	Flooding – disease outbreaks
F	Fishing Community	Fishermen	Storm warning for fishermen
G	Energy Sector	Water Resources Management	Water, rainfall, dams
H	Defence	Ministry of Defence	Air travel / Security

J	Communication	Media Houses	Broadcast weather forecast
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9.0 How the NORHED Project Relates to National and Institutional Strategic Plans and Priorities

A review of the national and institutional strategic plans and priorities demonstrates that the NMS project is timely and lies within the strategic plans. Below are some of the extracts from the strategic plans:

1) **Makerere University** has the following goals and objectives

- Goal: to enhance the capacity of the university to link with service community, private and public sectors and university
- Objectives : improvement of Government access to knowledge and services
- Community access to knowledge, skills, advice, innovations

Ref:[<http://pdd.mak.ac.ug/sites/default/files/archive/Makerere%20University%20Strategic%20Framework%20Revised%20after%20FPDC.pdf>]

2) **Department of Meteorology, Ministry of Water and Environment** has the following goals :

- To build capacity at central and local government levels for the implementation of the climate and weather programmes;
- To analyse and document climate and weather trends and their implications on socio-economic development;
- To promote collaboration and strategic partnership with government agencies, academic institutions, civil society organizations, cultural and other institutions at various levels in the management of climate and weather programmes and projects;
- To monitor, detect, attribute and predict climate change using scenario models;

Ref:

http://www.mwe.go.ug/index.php?option=com_content&view=article&id=39&Itemid=200

10. Challenges

In the implementation of meteorology services in the country, the NMS is faced with several challenges as explained below:

Challenges hindering Large-Scale Deployment of Modern Technologies

The following were cited as the major hindrances to large scale deployment of modern technologies by the National Meteorological Services:

- Limited budget and expensive acquisition and maintenance costs. Table 9 below shows the estimated acquisition and maintenance costs for the NMS:

Table 9 Estimates of Acquisition and Maintenance Costs

	Cost of Acquisition	Cost in US \$
1	Cost of Equipment and Software	200,000
2	Installation costs	20,000
3	Training costs	50,000
	Maintenance Costs per year	
1	Equipment	30,000
2	Staff	70,000
3	Transport	70,000
4	Equipment Calibration	30,000

- Lack of trained personnel
- Lack of supporting policies
- Lack of maintenance of equipment
- Lack of locally available spare parts

Challenges that hinder effective communication with national communities

The National Meteorology Services listed the following as some of the challenges that hinder effective communication with national communities:

A	Breakdown of communication systems (Network) – making it difficult to send text messages to users
B	Misinterpretation and understanding of weather information by the users
C	Attitude of the users
D	Lack of feedback from the users concerning the information sent
E	Forecasts from the Internet not authorised by MET Dept released to the public. This could be a source of income generation for the department
F	Poor service delivery by the NMS

Other Challenges experienced by NMS

In addition to the technology specific and communication challenges, NMS experiences the following general challenges:

- Vandalism of weather equipment which requires strengthening of the security systems
- High costs of weather equipment
- Low and unmotivated staff.

11. Summary

Despite the goals and objectives of the Meteorology Department, Ministry of Water and Environment, the challenges faced by the NMS, the meteorology services in Uganda are overwhelming. There is still a big gap in the existing human resource, infrastructure and training. It is hoped that the project will assist to find long term solutions to some of the problems, more so now that the NMS is on the way to becoming an authority

12.0 Research Team

Below are the members of the research team that participated in the survey

	Name	Institution
1	Dr. Julianne Sansa-Otim	Makerere University, College of Computing and IS
2	Dr. Agnes RwashanaSemwanga	Makerere University, College of Computing and IS
3	Dr. Richard Okou	Makerere University, College of Engineering, Design Art and Technology
4	Dr. Josephine Nabukenya	Makerere University, College of Computing and IS
5	Dr. Benjamin Kanagwa	Makerere University, College of Computing and IS
6	Ms. Ruth Mbabazi	Makerere University, College of Computing and IS
7	Ms Dora Bampangana	Makerere University, College of Computing and IS
8	Mr. Milton Waisswa	Department of Meteorology, Ministry of Water and Environment
9	Ms. Tazalika	Department of Meteorology, Ministry of Water and Environment