TITLE: POSSIBILITIES FOR EXPANSION OF SURFACE WEATHER OBSERVING SYSTEMS IN EAST AFRICA

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Abstract

There has been a major challenge, for a long time, of expanding surface observations in the three East African countries namely; Kenya, Uganda and Tanzania. This has been largely because procurement and operational costs of traditional manual meteorological instruments have been too high for the economies of these countries. Other challenges include timely transmission of observed data from the outstations to the National Meteorological Centers (NMCs) and then to other centers via the Global Telecommunications System (GTS) largely due to under-developed communication systems; irregular maintenance as well as non-replacement of both old and obsolete equipment due to inadequate funds. It has not been always possible to adhere to acceptable maintenance and calibration schedules because both Workshop and field calibration systems have also been inadequate.

Recent developments in technology are, however, encouraging. New, more reliable and cost effective automatic weather observing systems (AWOS) have been developed. They are available at a time when there has been a phenomenal growth of Global System of Mobile (GSM) Communication technology. This has helped in two ways: The existing manned weather stations can communicate effectively with the NMCs while the automatic weather systems can automatically send data to the NMCs using the same method. Although this is certainly a positive development, a lot of effort is needed to maintain both the manual and automatic systems.

This paper addresses the need for the NMCs in the East African countries to embrace the idea of adopting new affordable technology in order to deliver quality service in a very competitive, global environment. It proposes simple yet effective processes that can be adopted in order to reduce costly non-value adding activities at the National Meteorological and Hydrological Centres within the East African region.

Introduction

The Meteorological and Hydrological Services of the three East African countries ie the Kenya Meteorological Department (**KMD**), Tanzania Meteorological Agency (**TMA**) and Uganda Department of Meteorology (**UDM**) have a long history of cooperation. The three existed as one service, the **East African Meteorological Department** until 1977 when they split. However, despite the split, they continued to cooperate especially in the areas of training, research and data exchange.

As a result of this relationship, the Modus Operandi of the three Services in regard to design, installation, maintenance and management of observatories has been similar.

A few years after the break up of the East African Meteorological Department, economic conditions of the three countries began to deteriorate. Less and less funds were allocated to the new NMHSs for both recurrent and development expenditure. In Uganda for example, meteorological services became almost non existent until the late 1980s when they had to start afresh. This slowed down or stopped both maintenance and expansion of surface meteorological observations.

Due to factors cited above and World Bank/IMF conditionalities, staff retrenchment followed by a moratorium on recruitment has made the situation worse. The rapidly ageing workforce will be difficult to replace and this will adversely affect observations unless intervention measures are taken.

Kenya has 35 synoptic and agro-Meteteorological stations operated by KMD. Another 15 agro-Meteteorological stations are operated by other institutions through mutual agreement where KMD trains their observers, maintains the instruments and provide stationery. In return the institutions are meant to make observations and transmit data to KMD at regular intervals. However, observation and transmission schedules are not always observed.

Tanzania has a total of 39 synoptic and agro-Meteteorological stations all operated by TMA. Uganda has 25 synoptic and agro-Meteteorological; and 18 hydro-Meteteorological stations. All operated by UDM. These numbers are less than half of the optimum requirements for all the three countries.

Each of the NMHSs has a Networks section that ensures supplies to stations are sustained. They also have Instruments maintenance and calibration units [KMD is a Regional instrument Calibration Centre (RIC) for East and Southern Africa] whose primary role is to repair, service and calibrate workshop and field instruments.

Challenges

Despite the efforts made to sustain credible surface weather observations, there have been several challenges. This is due to a number of factors which include the following:

i. Installation and Operating Costs

One ordinary synoptic Station requires about US $40,000 to install, (exclusive of construction of office and other utilities). This includes procurement and installation of instruments. Another US $ 60,000 is required annually to sustain a staff strength of seven observers, support staff and consumables. Although an agro-Meteteorological station will cost much less to maintain, initial costs are the same or higher. As a consequence, expansion of surface weather observations in the three countries has been extremely slow. On few occasions, external funding for installation has been provided but optimal requirements remain far from being met.

ii. **Maintenance of Instruments**
Repair and routine maintenance of instruments have been a major challenge. Fewer and fewer technical visits were made to the observatories due to inadequate funding. Technicians have been dispatched to the field mainly when breakdowns are reported. Although the technicians take the opportunity to service other instruments, their activities are not scheduled as should be the case. This has been due to improper preparations.
As the instruments became older, some crucial spare parts went out of production. These instruments include automatic rain recorders, thermohygrographs, mercury barometers and cup counter anemometers among others. The rate of replacement of the instruments has been much lower than demand due to procurement costs.

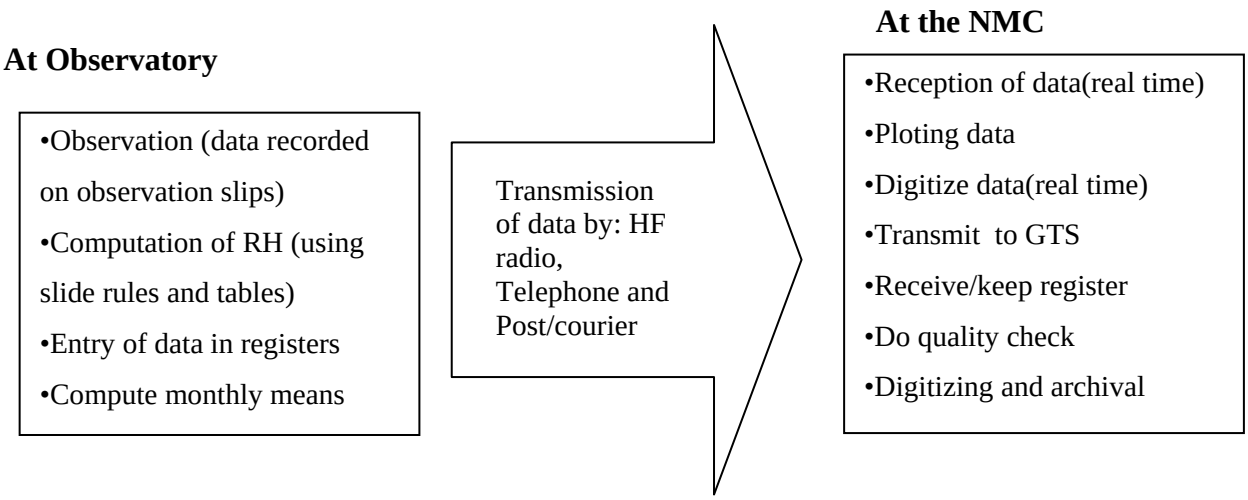
iii. Calibration
Field and workshop calibration has been another problem. Workshop calibration equipment have not been replaced for a long time due to the cost of doing so. Consequently field calibration has been inadequate and data sets from self recording and manual instruments can not be reliably compared.

iv. **Communication**
Communication between observatories and NMCs has been a major challenge. Most of the observatories have been relying on telephone (land lines have been available only within urban centres) and/or High Frequency radios where power is available. The former has been expensive when trunk calls are made. Usage has also been difficult to control and outages are common due to late payment of bills and technical faults.

In the early 1990s, an attempt was made to introduce automatic weather stations and data collecting platforms (DCPs). Both were designed to send data to Meteosat satellite which then relayed the data to Data Reception Stations (DRS) located in NMCs. Although both were initially successful, they soon ran into serious problems of accuracy in transmission time. Their internal clocks were not maintaining required accuracy long enough leading to loss of data. As a result, these observation and communication systems did not last for long.

v. Data management
Standard practice has been to print (offset) synoptic and Metar registers; and observation slips at the NMHS head quarters. The stationeries are shipped by post or courier to the observatories. Once observations are made, data is recorded on the observation slip, and later transferred to the registers. The registers, now containing data are shipped back to climatology sections at the head quarters on monthly basis. Quality checks are done; then the data is prepared for entry into the data base for processing and archival. (see figure 1). The observatories are left without backups of their data and hence no value addition takes place at the observatory level.
Vital data can be lost in case a register is lost during delivery.

Figure 1 "Normal" Processes; Observatory to NMC (HQ)



Useful Technologies

i. Software

With the help of UK Met Office, KMD and Zimbambwe Meteorological Service have been actively involved in development of **Climsoft** software which is appropriate for data transmission, archival and retrieval in WMO recommended format. This software is designed for use both at observatories and data processing/archival sections (see figure 2). Climsoft has embedded formulae that automatically calculate some parameters like relative humidity, generate statistics and plot graphs. It also automatically prepares text files for data transmission. Once in use, Climsoft will make filling of observation registers, use of slide rules and tables have been made redundant. Climsoft is invaluable and has several advantages which include:

■Allows entry of all station parameters during installation.

■Effectively captures data downloaded from Automatic weather Stations

Climsoft is available free of charge to WMO member countries in Africa.

ii GSM Technology

As indicated earlier, there has been a phenomenal growth in GSM technology in the last five years. Large parts of East Africa (about 70% of urban centres) are now accessible through reliable service providers. It is rapidly becoming a common means of voice and data transmission. The observer enters data directly to a PC immediately after observation and sends it to a server at the NMC. Due to the reliability of GSM system, messages are received within seconds at a very low cost (about $0. 005) per message.

A number of observatories in Tanzania and Uganda have been equipped with GSM modems and Personal Computers and are now working reliably.

At the moment, plans are under way to install 25 GSM modems in Kenyan Observatories. This will ensure that all stations are connected (except those that are equipped with VSAT terminals).

iii. Automatic Weather Systems

Recent technological developments have made automatic weather stations cost effective. The communication problem cited earlier can now be solved by incorporating GSM technology in the AWS. The new Ultrasonic wind sensor which is virtually Maintenance

free is now available. Although the AWSs are not cheap, (one system costs about $30,000) maintenance costs are relatively low. Other advantages include:

- •AWSs are more consistent in their measurement
- •They provide data more frequently (some can provide data every minute)
- •They will provide data in all weather, day and night, through out the year
- •They can be installed in sparsely populated/remote areas quite easily
- •Relocating the station is easy
- •The systems are battery/solar powered.

However, there are some notable disadvantages which include:
- •Some elements are difficult to automate (e.g. cloud cover)
- • AWS are less flexible than human observers

KMD has started an ambitious program to install automatic weather stations (AWS) countrywide. GSM technology will be used to send data to NMC at 30 minute intervals (see figure 3). Installation of 12 systems is in progress while plans are under way to install 12 more in the 2006/2007 financial year. UDM has 10 already and plans are under way to install 5 more.
TMA also has 10 in operation but the communication facility through meteosat has been unreliable. Despite this setback, plans are under way for expansion.

Possibilities

The economies of the three East African countries are growing and budgetary allocations for all the three NMHs are steadily increasing. The following opportunities can be exploited for the betterment of meteorological services.

i. Data entry at station

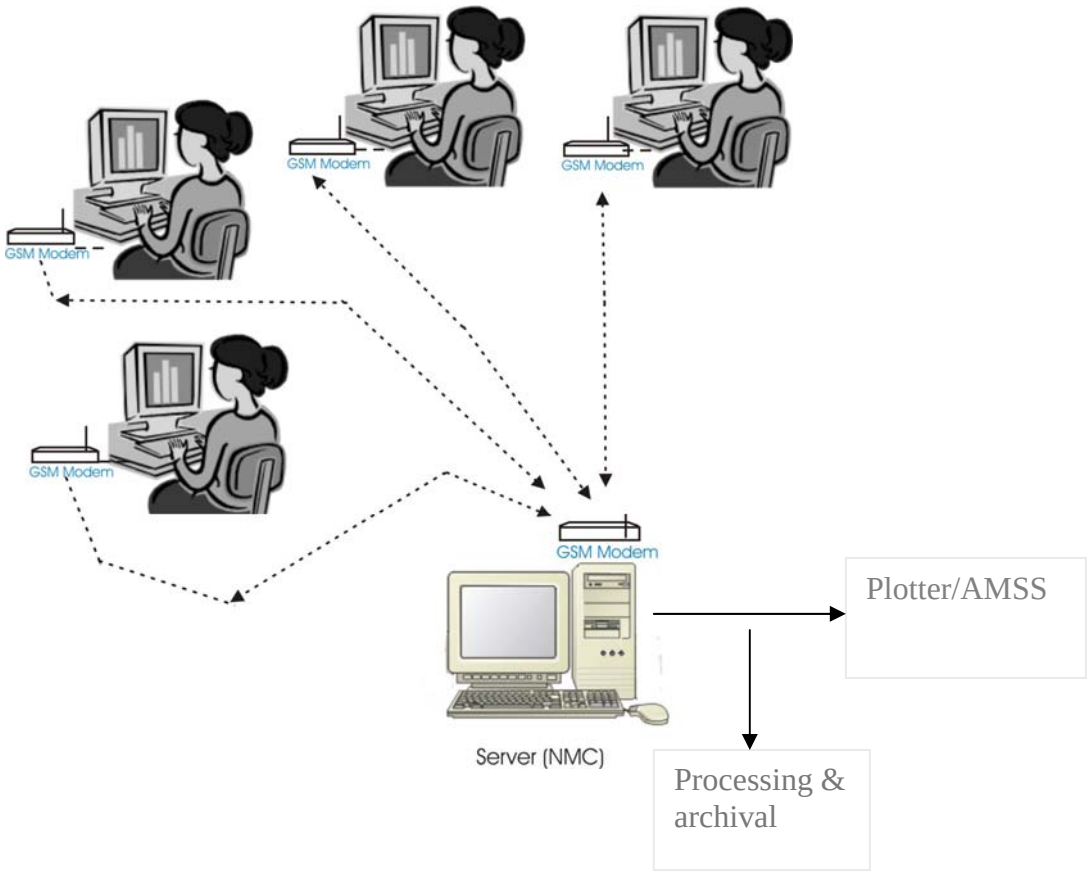
A combination of Climsoft, a GSM modem and a PC at the observatory has several advantages. Data is digitized at the station level and transmitted on time at minimal costs (See figure 2). The hardware is now cheap and Climsoft is free. Once this system is fully operational, the need for registers and other items like slide rules and tables will be eliminated. The observatories can maintain their station data bases for future use unlike the present situation.

ii. Adding value to observed data

Value added products such as trend analyses, statistics of weather parameters etc can be easily produced at the observatory and used for the benefit local communities at no extra costs. Forecasts and service messages can be easily transmitted to the observatories from NMCs and feedbacks sent at an instant.

Climsoft and GSM used to send data and receive value added products

Figure 2



iii. Automation of Observatories

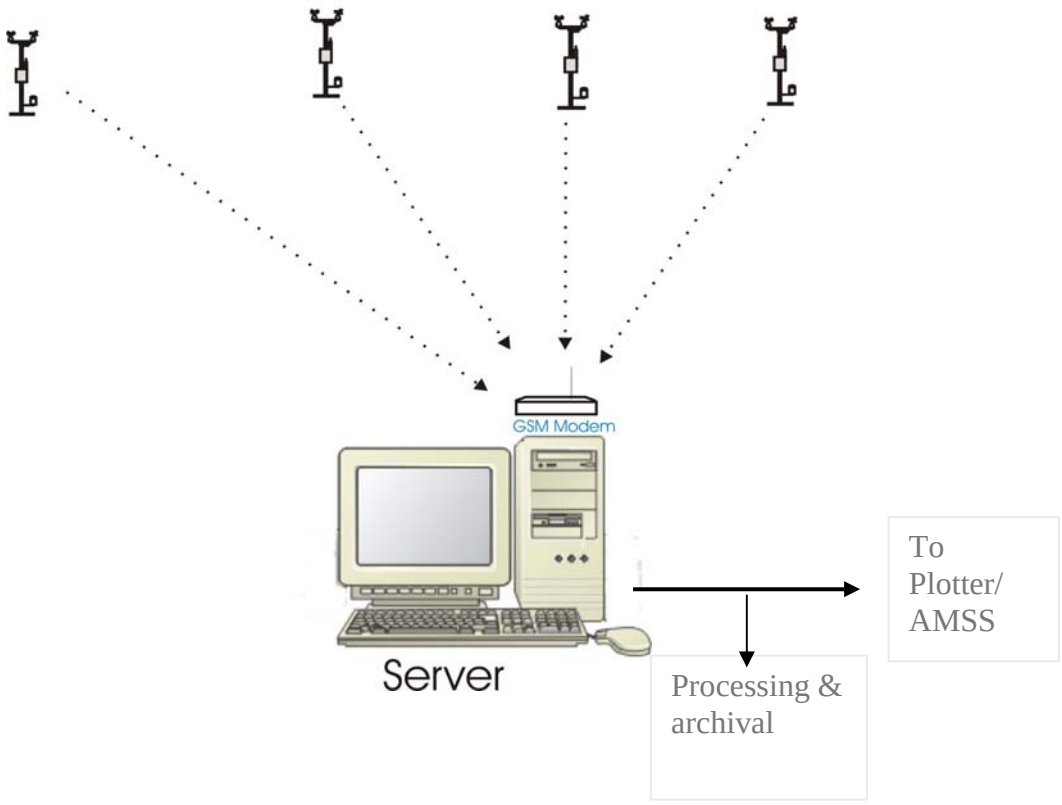
Installation of Automatic Weather Stations at the existing observatories will ensure timely observation and transmission of meteorological data at shorter intervals. The AWS can be equipped with a GSM modem and programmed to send data directly to the NMC. The same data can be down loaded at the observatory for processing and archival using Climsoft. This arrangement requires much fewer personnel to man the station. As a result, more human resources will be available for deployment to other needy areas. The remaining personnel at the station can concentrate on value addition and reaching out to local communities in an effort to popularize meteorological services.

iv. Expansion of observations by increasing AWSs

Automatic weather Stations can be installed as stand alone systems in remote but secure areas (see figure 3). Areas covered by GSM networks are obviously most ideal. AWSs are invaluable in flood and drought prone areas since data obtained would be an important input in the development of early warning systems. If well planned, one of the fundamental problems which is lack of adequate reliable data can be gradually solved.

Figure 3

AWS Network



Conclusions and Recommendations

- GSM technology is currently the most reliable and cost effective way of data transmission between NMCs and observatories in East Africa. It is also available.
- Automatic Weather Observing Systems should form a major component in the future expansion programs.
- Climsoft has the capacity to eliminate a number of non value adding activities such as offset printing and shipping of registers, manual computation of some parameters and saves data entry time.
- Useful value added products can be transmitted to observatories thereby helping in dissemination of meteorological information to the local communities.
- Manual Instruments should be gradually phased out.
- In order to realize full benefits, the three NMHSs must embrace Quality Management Framework(QMF) and work towards it.
- E. A. countries must be ready to fund all necessary activities including calibration and Maintenance of observing and communications systems with some help from development partners.
- Technical staff working at observatories should be trained to produce value added products beyond meteorological observations.