WMO International Conference on Automatic Weather Stations (ICAWS-2017)

Experiences in Rolling out an Automatic Weather Stations Network at KMD

by

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Table of Abbreviations

AWOS	Automatic Weather Observing System
AWS	Automatic Weather Station
AYII	Area Yield Indexed based crop Insurance
CDMSs	County Directors of Meteorological Services
GOES	Geostationary Operational Environmental Satellite
GPRS	General Packet Radio Service
GSM	Global System for Mobile Communications
GTS	Global Telecommunication Network
GTS	WMO Global Telecommunication System
IMTR	Institute for Meteorological Training and Research
KARI	Kenya Agricultural Research Institute
KMD	Kenya Meteorological Department
OiCs	Officers in Charge
WIGOS	WMO Integrated Global Observing System
WII	Weather Index based crop Insurance
WMO	World Meteorological Organisation

1. Introduction

The mandate of the Kenya Meteorological Department (KMD) is observing and understanding weather and climate, and in providing meteorological, hydrological and related services in Kenya.

KMD and other organizations have established and maintain a network of different types of meteorological observatories, distributed all over Kenya. Over the years, KMD has relied more on the manual observations of surface data. This involves physical observation of weather parameters by an observer and then relaying the observed weather parameters to the National Meteorological Centre (NMC) for further analysis and re-transmission.

To modernize operations and to improve its observational network, KMD has established a number of automatic observatories. This is essential in the provision of accurate and timely climate information and reliable weather forecasts. KMD is therefore continuously expanding its automated observational network, by deploying Automatic Weather Stations (AWSs) all over the country.

The Kenya Meteorological Department (KMD) started rolling out Automatic Weather Stations (AWSs) in the early 1990s, in collaboration with the Kenya Agricultural Research Institute (KARI). The data was beamed through the GOES satellite to Europe and then channelled back to KMD through the World Meteorological Organization Global Telecommunication System (WMO GTS). Since then, newer more cost effective AWSs have been developed with the ever advancing computer technology. The introduction of Global System for Mobile Communications (GSM) technology has made data communication more affordable and extensive to cover most of the country. Almost all the current AWSs in Kenya now use the GSM platform for data transmission and control.

KMD now owns and operates over 100 AWSs, deployed in various parts of the country. The Government of Kenya has supported KMD acquire the bulk of these systems through one of the flagship projects titled “Modernization of Meteorological Services” of the county’s development framework of Vision 2030. KMD is also collaborating with other weather and climate monitoring public and private organisations, in areas such as climate data sharing, specifications and standards. The Institute for Meteorological Training and Research (IMTR), the training arm of KMD, and a WMO regional training centre, continues to train and develop training courses not only on AWS technology but also in instruments and methods of observations, repair, calibration and maintenance. This paper discusses the history of AWSs at KMD, the challenges and the lessons learnt the current situation and the strategies being put in place to build and maintain a sustainable AWSs network.

2. History of AWSs at Kenya Meteorological Department (KMD)

The very first instances of automation, started with the introduction of thermo-hygrographs and automatic rain gauges that can still be seen at most KMD weather observatories. These systems used mechanical technology of wind-up mechanical clock, ink pen system and a paper chart. Due to their mechanical nature, they proved to be difficult to maintain. They required highly trained technicians and precision equipment for their maintenance. They eventually proved unsustainable and were finally all abandoned. Few of them are operational today.

Figure 1 Early Automated Mechanical Systems

KMD started rolling out Automatic Weather Stations (AWSs) in the early 1990s, in collaboration with the Kenya Agricultural Research Institute (KARI). The data was beamed through the GOES satellite to Europe and then channelled back to KMD through the World Meteorological Organization Global Telecommunication System (WMO GTS).

A special time slot on the GOES satellite had been reserved for data transmission from the AWSs. The data flow was only in one direction, AWS to Satellite, and this meant that the systems could not be remotely controlled, even for the most basic maintenance. This required a technician to be dispatched to the station even for the most minor fault. This type of AWS proved to be quite expensive to own and operate and quite complex to maintain. None of these AWSs is operational today although most of them are still intact.

Although the AWSs were quite robust, its internal clock kept drifting and required regular resetting. This required some special tools that unfortunately were retained by the contractor. This meant the contractor had to be hired for each reset. This proved unsustainable due to the high cost of just maintaining the internal clock. Another challenge was that only one technician was conversant with the system. When he retired, there was nobody else who had the know-how.

Due to these challenges, the data from these AWSs was never fully integrated into KMD operations such as forecasting and the climate database.

Lessons learnt

For sustainability, the AWSs should be of such a type that can be maintained with locally available tools and they must be supplied with all required special tools not locally available.

An adequate number of well trained local personnel, on any one type of AWSs, need to be maintained at KMD, at all times.

Local staff and observers, residing near the AWSs, need to be trained on operation and basic maintenance such as cleaning of the sensors, and encouraged to make use of the data.

There is need to utilise locally available telecommunication systems, for data transmission and remote control. This would lead to sustainable operation costs and reduced trips to the field by AWS technicians.

3. The Current AWS Network

Currently, KMD operates more than 100 AWSs, which range from aviation, synoptic, agromet, hydromet, marine to purely rainfall AWSs.

Aviation AWOS

These are installed at the 4 major airports, Jomo Kenyatta, Moi , Eldoret and Kisumu airports. They measure precipitation at 0.2mm resolution at the height of 1m from the ground. Temperature and relative humidity sensors are installed at a height of 2m, pressure at 1.2m and wind speed and direction at 10 metres, global radiation at 2 metres. Visibility and present weather sensors are installed at the beginning, middle and end of the landing and takeoff runways. They are powered by mains electricity with a battery backup. They were procured from Vaisalla.

Synoptic AWSs

These stations are installed in 39 sites around the country. They measure precipitation at 0.2mm resolution at the height of 1m from the ground. Temperature and relative humidity sensors are installed at a height of 2m, pressure at 1.2m and wind speed and direction at 10 metres, global radiation at 2 metres. They are powered by solar panel and 100AH lead acid battery. They have two communication channels, GSM modem transmits data to the base station at KMD headquarters and a local radio transmits the data locally to the display computer, in the observatory. These are manufactured by Sutron.

Figure 2 KMD AWSs

MicroStep Synoptic AWSs are installed at 36 sites around the country. They have similar setup to the Sutron AWSs.

Adcon Telemetry Synoptic Stations are installed at four sites, Miyare in Migori, Katuke in Transnzoia, Enkorionito in Narok and Karaba in Embu.

Data from these AWSs is used mainly in weather forecasting.

Agromet

28 AWSs suitable for agrometeorology applications have been installed in various parts of the country. They measure wind speed and direction at 2 metres, soil temperature profile (5, 10, 20, 30, 50 and 100cm) and soil moisture profile (10, 20, 30, 40, 50 60, 70, 80, 90cm) in addition to the common weather sensors. These AWSs are manufactured by Adcon Telemetry. The data is mainly used for crop insurance, to generate indexes used in WII and AYII.

Hydromet AWSs

There are 17 hydromet AWSs installed in various river basins in the country. In addition to the common meteorological instruments, these AWSs have river level sensors. They are powered by solar panels and the data is used in hydrological applications such as flood forecasting early warning System

Marine

There are 4 marine AWSs installed along the coast. The marine AWSs have tidal, salinity and conductivity sensors, in addition to the common weather sensors.

Automatic Raingauges

These AWSs only measure precipitation only. They are powered by batteries and data is collected by visiting the sites and downloading onto a notebook computer. Most of them are from Onset.

4. Challenges

The rolling out of AWSs network has been greatly a success but it has also met some challenges. These challenges range from lack of confidence in the data, resistance to change, to concerns about fear redundancy in observers and fear of the unknown.

Slow Adoption of New Technology

Although the first AWSs were installed in the 90s, it wasn't until recently, when some of the data was fully integrated into day to day operations in the various functions of KMD. This arose mainly due to lack of confidence in the AWSs data, preferring to use manually observed data. Lack of continuity and reliability of this data stream meant that those who wanted to use this data were forced to go back to the data from manual instrument, when these AWSs malfunctioned. Few of the local observers knew how to access the data, leading to a complete hands-off attitude towards the installations.

Maintenance and Repair

A major challenge has been the maintenance and repair. The failure of the AWSs has been found to be rather high. Some of the causes have been found to have been due to simple reason of dirty sensors, solar panels. In some cases, it was discovered that some of the AWSs needed to be reset by switching them off and then on again. As the local observers had not been trained on the basics, they could not perform even the simplest tasks such as unblocking a rain gauge, ensuring that insects did not nest on the sensors, or that cables were not severed by support staff when cutting the grass, near the sensors. Technician had to be dispatched from the headquarters to correct some of this rather minor but crucial maintenance, meaning that the faults would remain for a long time. Since the spare parts are usually not locally available, it became very difficult to keep the systems running for any length of time. There is a high rate of failure of the associated display computing equipment, installed at the observatories offices.

Figure 3 Maintenance Challenges

Vandalism

Vandalism has been reported from quite a number of the sites, especially the theft of solar

panels. Boys some times are tempted to do target practise, using stones, on the wind sensors, if installed too close to the roads and paths.

Resistance to Change

When AWSs were first introduced at KMD, there was suspicion by most observers that the management was introducing the AWSs as a way of declaring them redundant. This meant that most outstation staff regarded the installations as competitors instead of tools to make their work easier. Most of them exhibited lack of interest and they sometimes did not report on simple malfunctions as they normally would do on the manual instruments, leading to the high rate of failure of AWSs.

Mixed Standards

For the technicians, who had been used to installing and maintaining manual instruments, they were not always competent in installing the new setups of the AWSs, which did not always conform to the previous standards. For example, most of the AWSs have 1m high rain gauges while the standard manual rain gauges are 30cm high. This means the AWSs were not customised to meet local standards or they are not easily customisable.

5. New Strategies

To try to overcome some of the emerging challenges, KMD has been putting in place various measures. It is hoped that this strategies will greatly aid in the AWSs operation and maintenance in a sustainable manner.

Training Observers on AWS Operation and Basic Maintenance

KMD has started training CDMSs and observers, on AWSs operations and basic maintenance. It is hoped that through this strategy, failure of AWSs due to blocked rain gauges, nesting of insects and birds, discolouring of temperature screens by growth of algae and dust accumulation on radiation and solar panel, will be a thing of the past. Many costly trips by technicians to the stations will be reduced to manageable levels, thereby boosting the sustainability of the AWSs.

Through this training, the observers are also equipped with knowledge on how they can use the data from the AWSs to generate simple products, which they and their neighbouring communities might find beneficial. This will encourage them to become consumers of the data and hence become active stakeholders in the operations and maintenance of AWSs in their stations. It is hoped that this will be an added incentive to ensuring the AWSs are operational at all times.

A curriculum for a 5 day course on AWS Operations and Basic Maintenance has been developed at IMTR and the first training has been carried out. 9 CDMSs and 20 AWSs OiCs, were trained.

Figure 4 Basic Maintenance Training

Deploying Technicians to the regions

Previously, technicians to maintain and repair equipment in the counties had to travel from the headquarters, in Nairobi, to the stations. Due to the long distances, these missions were expensive and usually resulted in long outages, as the funding logistics were being worked out.

KMD has deployed technicians to various regions, with the responsibility of maintaining and repairing equipment deployed in a particular region. This is expected to reduce the overall cost of maintenance and also reduce response time.

Collaborating with other Stakeholders in Weather and Climate Observations

There are many public and private organisations that operate weather observation networks in Kenya. KMD is reaching out to these organisations with the aim of collaborating with them in the areas of metadata and data sharing, standardisation of equipment installation, methods of observation and data transmission. This is under the initiatives of WIGOS

6. Conclusion

KMD intends to continue expanding its AWSs Network to the recommended stations density, by exploiting the potential in these new strategies. As the staff strengths dwindle, due to a staff employment embargo by the Kenya government, AWSs will become more and more crucial in filling the gap created by observers exiting the service.