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# Lessons from The Modernization of National Meteorological and Hydrological Services (NMHS) – A Case Study of The Zambia Meteorological Department.

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***ABSTRACT***

*According to the 7th Edition of the Advanced Learners' Dictionary, 'to modernize is to make a system or methods more suitable for use at the present.' Due to disaster risk reduction and climate change and variability issues as well as the need to mitigate the financial, human and operational constraints, most countries from the developing world have been undergoing National Meteorological and Hydrological Services (NMHSs) for the 21st Century World Bank modernization projects with the main objective of minimizing risks, ensuring safety and protecting life, goods and property. In case of Zambia, the key package of the modernization project was the installation of 68 Automatic Weather Observations Stations (AWOS) against a backdrop of 38 traditional old manual observation stations (MOS). The strategy of strengthening meteorological services is part of the country's modernization endeavor, which encompasses expanding and upgrading observation systems, improving connectivity with real time data acquisition, acquisition of High Performance Computers(HPC) for weather and climate modelling, establishment of numerical weather models and data assimilation from satellites as well as creating a modern information, communication technology(ICT) environment for overlaying numerical model outputs with synoptic outlook, and to ultimately develop ability to forecast at district and village/community level. The main goals of the Zambian modernization project are to:*

- *Increase the geographical coverage of the meteorological observation network and activating communication channels for disseminating severe weather warnings in the country.*
- *Enable the provision of high quality, timely and accurate location and sector tailored meteorological services that support sustainable development.*
- *Enhance adaptation to climate change and variability by the utilization of meteorological services for economic gains across all sectors.*

*According to the co-operation framework of World Bank-Global Facility for Disaster Reduction and Recovery (GFDRR)-InterMET Asia 2018 conference "since 2010 there has been significant growth in the flow of funds to the developing world but results are often unsatisfactory with 'sustainability' being the major challenge". The specific objective of the study was to share and exchange ideas on Zambia's experiences in the sustenance, maintenance and repair of the installed Automatic Weather Observation Stations (AWOS) under the modernization project. It is envisaged that the study will also foster and encourage communication and exchange of knowledge on best practices among NMHSs especially with the advent of the Weather Enterprise (GWE) concept.*

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## 1.0 INTRODUCTION

Since 1967 when the Zambian Meteorological Department (ZMD) was established, most of the weather observations was done using the traditional manual weather measuring instruments. However, from 2013 to date, ZMD started the modernization program that involved the installation of Automated Weather Observation Stations (AWOS) from one in 2013 to 68 operational AWOS to date. A further 30 AWOS are expected to be installed before the end of the 2018. Depending on the required parameters (Sutron 2013), these Automated Weather Observation Stations (AWOS) can have sensors for weather parameters such as rainfall, temperature, wind direction and speed, evaporation, sunshine duration, cloud height, visibility, air pressure, present weather and visibility.

### 1.1 Background

Due to the geographical location and climatological features, the natural hazards in Zambia comprise weather and climate-related hazards (Quayle, 2014) such as storms, heavy rains, floods and occasionally extreme temperatures and frost. Over the years, the Zambia National Meteorological Department (ZMD) and its collaborating authorities and partners have worked extensively to improve early warning and disaster management and mitigation systems by assisting ZMD undergo the 21st Century World Bank modernization project. The project which has been running since 2014 is aimed at disaster risk reduction of climate change and variability issues as well as the need to mitigate the financial, human and operational constraints.

#### 1.1.1 Statement of the problem

According to the co-operation framework of World Bank-Global Facility for Disaster Reduction and Recovery (GFDRR)-InterMET Asia 2018 conference "since 2010 there has been significant growth in the flow of funds towards modernization programs to the developing world, Zambia inclusive, but results are often unsatisfactory with **'sustainability'** being the major challenge (Shukla, 2017).

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1.1.2 Significance of the study

- The study was important because it helped to unravel causes of the sustainability challenges in the modernization programmes being undertaken by Zambia National Meteorological Department (ZMD). It is envisaged that lessons learnt from the Zambian case study will help other developing countries enhance the sustainability of their modernization programmes.
- This study will be of great benefit to entrepreneurs to understand the business environment and business opportunities (Mbetwa, 2015) in the value chain of the ZMD products and services.
- 'Sustainability' results in sustainable development. The study will also foster and encourage communication and exchange of knowledge on best practices among NMHSs especially with the advent of the Weather Enterprise (GWE) concept

## 2.0 OBJECTIVES

The main objective of the study was to establish some of the challenges associated with sustaining the operations of Automatic Weather Observation Stations (AWOS).

### 2.2 Specific Objectives

- To unravel some of the programmes and activities that are supposed to be put in place before, during and after in order to sustain the operations of AWOS.
- To share with other stakeholders some of the lessons learnt from the modernization case study of the Zambia Meteorological Department.
- To find economic and sustainable ways and methods of doing routine inspection and maintenance of AWOS.

### 2.3 Literature review

2.3.1 International

Japan, 2014: Review of Meteorological Services in Japan, Japan Meteorological Agency (JMA), Japan Meteorological Business Support Centre (JMBSC), Tokyo.

2.3.2 Local

Nkonde, 2017: Concept Note on the Modernization and strengthening of Observation and Forecasting systems and Service delivery in Zambia, Zambia Meteorological Department (ZMD), Lusaka.

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## 3.0 METHODOLOGY

The research study used a descriptive case study design (Mpolomoko, 2014) in which object observation and monitoring was the main method of data collection and analysis from 60 selected stations (Fig.2) with the 2020 projections (Fig.3). The following were the specific and comprehensive methodologies used in the research study:

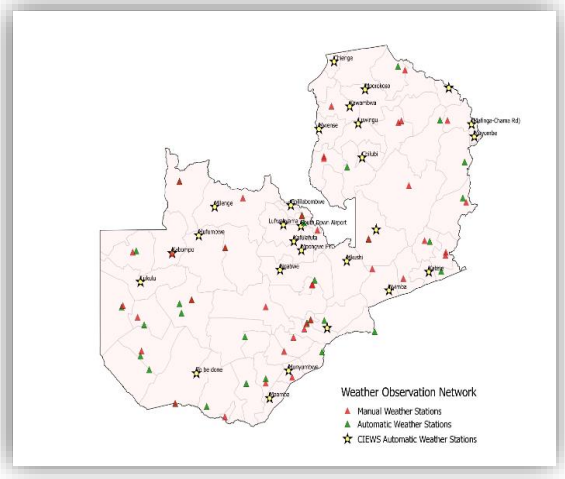


**Figure 2: Current Weather Observation Network**

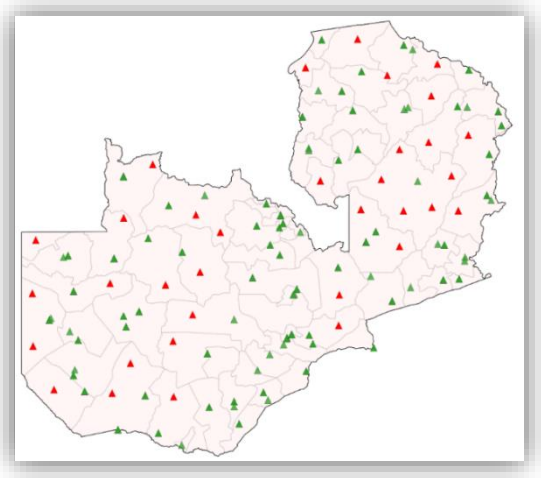

**Figure 3: Proposed Observation Network**

- On-the-spot routine inspection and maintenance of the selected 60 AWOS (Fig.2) every after 6 months from January 2015 to December 2017. The 6-months routine inspection and maintenance is the mandatory statutory requirement by the suppliers (Sutron, 2013) for the sustainable operations of the Automatic Weather Observation Stations (AWOS). It involved inspecting each station against vandalism, performance and functionality.
- To have a better understanding of the phenomena under study, the 60 AWOS were monitored for signal strength, abnormal and subnormal weather parameter readings using the main server at ZMD headquarters every day from January 2015 to December 2017.

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## 4.0 RESEARCH FINDINGS

### 4.1.1 Modernization stages in the evolution of ZMD Services over 50 years

All meteorological products and services in the Zambia Meteorological Department (ZMD) have been undergoing continuous improvement in accuracy and details. The modernization of meteorological services in the country has been driven mainly by growing user requirements and technical supports (Japan, 2014) offered by advances in Information Communication Technologies (ICT). The processes of modernization in Zambia can roughly be divided into four stages:

- **1stStage (~1967-1977):** Initial/primitive stage of modernization.
- **2nd Stage (1977-2013):** Networking development and limited automation stage.
- **3rdStage (2013-2017):** Nationwide automation, digitization, computerization and networking stage.
- **4th Stage (2017-present):** Advanced networking stage with modern ICT to meet further challenges in the coming years.

### 4.2.2 Key Drivers for Modernization

Zambia's modernization Programme has been done with 'sustainability' in mind. The key drivers for the modernization Programme are:

- Long-term, sustainable human resources development to foster highly educated experts capable of handling cutting-edge science and technology
- Long-term and step-by-step developments and investments based on advancing science and technology with verifications and improvements.

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## 5.0 BUSINESS MODEL OF THE NATIONAL METEOROLOGICAL SERVICE IN ZAMBIA

General, user and sector specific weather services including early warnings are delivered to users through various collaborating stakeholders in the mass media (Fig.4), the private sector, and mobile phone operators, central and local governments.

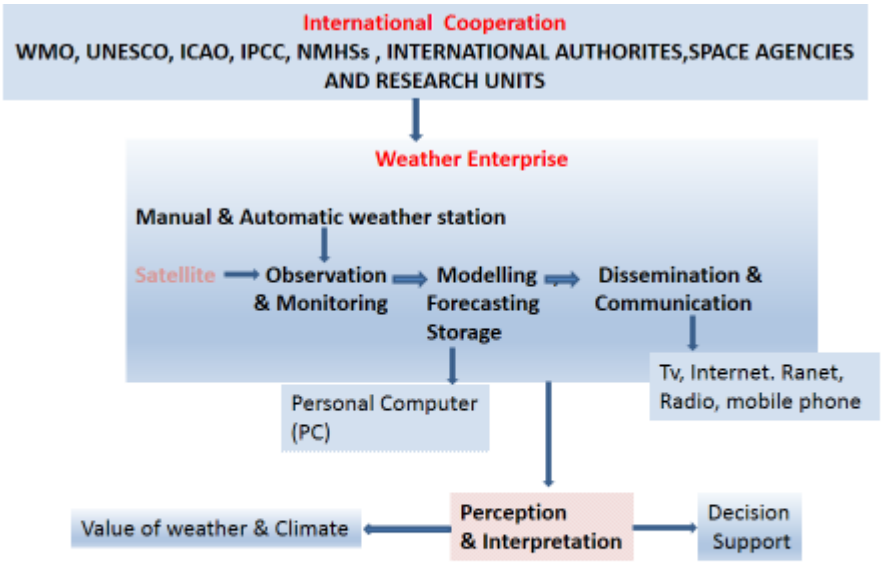


**Figure 4: ZMD Services' value Chain**

## 6.0 LESSONS LEARNT FROM MODERNIZATION OF NATIONAL METEOROLOGICAL AND HYDROLOGICAL SERVICES (NMHSS)

### 6.1 Need for strategic investments in human resource development

The modernization of ZMD operational observation and telecommunication systems in Zambia has been achieved through strategic investments to improve service delivery by effective human resource specialized in-house trainings to address growing societal needs, particularly for Disaster Risk Reduction (DRR) and through systematic improvements over a period of time. Societal needs for precise and accurate meteorological products and services in the face of persistent intra-seasonal dry spells and floods has been a good learning point for the Zambia Meteorological Department (ZMD).

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User requirements for timely and effective early warning services continue to increase on account of recent unprecedented prolonged intra-seasonal dry spells and floods. Generally, in trying to understand these prolonged intra dry spells and floods has led to modernization of systems resulting in more accurate analysis and forecasts with higher spatial and time resolutions.

### 6.2 Need for collaboration in scientific and technical research with learning institutions of higher learning.

Long term sustainable efforts in scientific and technical research and development in collaboration with higher learning institutions should be an on-going process. In case of ZMD (Nkonde 2017), the institution has been able to collaborate with University of Zambia (UNZA)-TDAU, Copperbelt University (CBU) and Zambia Institute of Communication Technology (ZICT) College to develop weather observation platform accessories that are being used in the observation network across the country. That has served the country and the Department in particular a lot of money used in importing and installing these systems. In addition, it has created employment for the Engineers and Technicians that develop and manufacture these value-added pieces of equipment and therefore enhancing the sustainability of the country's meteorological observation network.

### 6.3 Strategic linkages with statutory international bodies and agencies

In conjunction with the World Meteorological Organization (WMO), the ZMD institution has established a comprehensive strategic Programme that is based on both the many local Meteorological reports on the basic strategies and on WMO 2016-2019 strategic priorities. The main goal of the strategic Programme is to define the medium- and long-term strategies for observation, monitoring, telecommunication, data processing and forecasting systems such that the finer spatial and temporal resolutions of product and the more accurate and timely provision of early warning services are realized successfully (Nkonde 2017).

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### 6.4 Strategic linkages with Central and local government institutions

Enhanced collaboration and linkages with Central and local government authorities, Disaster Management and Mitigation Unit(DMMU), the media, the private sector, non-governmental organizations(NGOs), Community based organization(CBO) and related technical working groups with experts and stakeholders (Nkonde, 2017) has resulted in a robust Crisis Management system Development(CMSD) such as sound operational Meteorological systems and services to provide early warning services to the different sectors such as agriculture, Water, Energy, Health, Aviation, construction, tourism and Disaster Risk Reduction.

### 6.5 Need for value addition

National Meteorological and Hydrological Services (NMHSs) need to add value to most of their products and services so that the private sector can be attracted to buy-in the value chain. In case of ZMD, there has been overwhelming response from the private and cooperate world willing to sponsor our public weather forecast both on Television Zambia (ZNBC-TV) and the private Media houses. In addition, all Airline operators by law are required to pay for Air Navigation Services. It is expected that as soon as ZMD legal frame work is finalized towards the end of the year-2018, some of the revenue generated from the value chain of its products and services will go towards the sustainability of the station network.

## 7.0 CONCLUSION

It should be stressed that the improvement of service delivery in terms of quality (accuracy and timeliness) of forecasts and warnings has not been achieved by introducing specific state-of-the-art systems, but through long-term efforts to totally integrate systems of information, observations, analysis and monitoring. The modernization of ZMD operational services has been realized through strategic and challenging investments, and through step- by- step improvements designed to enhance service delivery to end users and mobilize human resources to meet growing societal needs. The total planning and management mechanisms have been established in cooperation with experts and stake holders such as central and local governments, the media and the private sector. In addition, other guidance mechanisms for the improvement of ZMD services were assessments, experiences

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and lessons learned from devastating disasters, which offered suitable opportunities to better collaborate with authorities and the public. The outcomes of modernization have not been limited to the efficient and effective operation of observation and information systems but to the total improvement of service delivery of real-time products to end users, in addition to the best utilization of human resources to meet emerging societal needs.

## Acknowledgements

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[5] Quayle, 2014: ICLEI African regional climate systems analysis concept paper.

[6] Sutron, 2013: Operational Manual for Automatic Weather Observation Stations (AWOS)