KENYA METEOROLOGICAL SOCIETY

Report of the 12th Kenya Meteorological Society International Conference on Meteorological Research, Applications and Services

Theme:

Weather, Climate and Environmental Research Innovation in Support of Sustainable Development

Kisumu, Kenya

11th – 13th November 2015

Conference Sponsors:

World Meteorological Organization

National Drought Management Authority NDMA Committed to ending drought emergencies

United Nations Educational, Scientific and Cultural Organization

Intergovernmental Oceanographic Commission

Intergovernmental Authority on Development IGAD

Kenya Meteorological Department

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Special appreciation is extended to the Government of the County of Kisumu and in particular His Excellency Governor Jack Ranguma for not only gracing the opening ceremony, but also his kind support for the Conference and, through him, his staff for facilitating this important KMS activity. The Kisumu County Commissioner, John Elungata and his staff deserve special mention for their encouragement, support and participation in the Conference. Last but not least, our acknowledgement goes to all the researchers who responded to the Conference's call for papers, as well as to all those who attended and/or participated actively in the Conference by sharing and disseminating their research results and experiences.

The following members of the Local Conference Organizing Committee prepared this report:

- Mr. Bethwel. K. Mutai: Member & KMS Secretary
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Cover Photo: *A group photo of the Conference participants at the opening of the Conference.*

Executive Summary

Weather and climate have direct influence and impact on human comfort, socio-economic activities and the natural environment. Over the years, humans have altered natural ecosystems through various activities leading to modified local and regional climates. Today, human influence on the physical environment at a global scale is depicted by rapid increase in population size, energy consumption, intensity of land use, international trade and travel, and other human activities. The resulting global change have heightened awareness that the long-term good health of populations depends on the continued stability and functioning of the biosphere's ecological, physical, and socio-economic systems.

There is no doubt that the vagaries of weather and climate play a critical role in shaping Africa's development agenda. This requires a collective approach, unity of purpose based upon the shared vision on climate proofing, genuine partnerships and commitment. National Meteorological and Hydrological Services (NMHSs) and Societies are critical actors in supporting sustainable development. Although there is today, increased awareness of the socio-economic benefits derived from weather and climate services, there is still a need to enhance the uptake of scientific knowledge within our society. Information exchange and public education are some of the interventions that can help attain this goal.

There is, therefore, need for various stakeholders to have a forum to share various findings and engage on the role of weather, climate and environmental research in achieving sustainable development. It is with this in mind that the Kenya Meteorological Society (KMS), with the support of National Drought Management Authority (NDMA), Intergovernmental Authority on Development (IGAD), World Meteorological Organization (WMO), Kenya Meteorological Department (KMD), United Nations Educational, Social and Cultural Organization/Intergovernmental Oceanographic Commission (UNESCO/IOC), organized the 12th KMS International Conference.

This 12th biennial KMS International Conference was a big success and achieved its objectives which included providing a forum through which scientists, researchers, academia, policy makers and other stakeholders from local and international institutions interacted and shared their research work and applications in various socio-economic sectors; networks were initiated and/or strengthened with the partnerships aimed at improving scientific research capacity and uptake; and recommendations were made that will assist in the formulation of appropriate policies on Weather, Climate and Environmental Research Innovation in support of Sustainable Development

This report is a summary of the proceedings of the Twelfth KMS Conference.

Stella Aura, MBS
Chair, KMS

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List of Acronyms

AOD	Aerosol Optical Depth
AR5	Fifth Assessment Report of IPCC
AWS	Automatic Weather Station
CC&AC	Climate Change Research & Advisory Centre
CDMHA	Center for Disaster Management and Humanitarian Assistance
CMIP	Coupled Model Intercomparison Project
CO2	Carbon Dioxide
CORDEX	COordinated Regional Downscaling Experiment
CPTEC	Center For Weather Forecasts and. Climate Studies
EAC	East African Community
ECMWF	European Centre for Medium-Range Weather Forecasts
ECMRF	European Centre for Medium Range Weather Forecasting
GCM	Global Climate Model
GDP	Gross Domestic Product
GHG	Green House Gases
ICPAC	IGAD Climate Prediction and Applications Centre
IDF	Intensity Duration-Frequency
IGAD	Intergovernmental Authority on Development
IGAD/HYCOS	IGAD Hydrological Cycle Observing System
IK	Indigenous Knowledge
IPCC	Intergovernmental Panel on Climate Change
KMD	Kenya Meteorological Department
KMS	Kenya Meteorological Society
MAM	March-April-May
MODIS	Moderate Resolution Imaging Spectroradiometer
NCEP	National Centers for Environmental Prediction
NDMA	National Drought Management Authority
NDVI	Normalised Difference Vegetation Index
NEMA	Ntional Environment Management Authirity
NMHS	National Meteorological and Hydrological Service
OND	October-November-December
RCM	Regional Climate Models
RMSE	Root Mean Square Error
SEKU	South Eastern Kenya University
TRMM	Tropical Rainfall Measuring Mission
UKMO	UK Met. Office
UNDP	United Nations Development Programme
UNESCO/IOC	United Nations Educational, Social and Cultural Organization/Intergovernmental Oceanographic Commission
UoN	University of Nairobi
WHO	World Health Organization
WMO	World Meteorological Organisation

WEDNESDAY 11TH NOVEMBER 2015

1.0 OPENING CEREMONY AND GENERAL SESSION

Chair: ***Nicholas Maingi*** Rapporteur: ***Ms. Pascaline Chemaiyo***

The Twelfth Kenya Meteorological Society International Conference was officially opened on 11th November 2015 by **H.E. Hon. Jack Ranguma**, Governor, County Government of Kisumu.

From Left: Roselyn Ojala, HSC [Deputy Director, KMD]; His Excellency, Hon. Jack Ranguma [Governor] and Stella Aura, MBS [KMS Chair]

In his speech, Hon Ranguma underscored the importance of the Conference and reiterated that it accorded eminent scientists and stakeholders an opportunity to share their research findings and provide possible solutions to the socio-economic challenges facing the society. He challenged scientific and research institutions to effectively and efficiently disseminate the necessary climate change information so as to inform policies that are beneficial not only to Kenyans but to all mankind. He noted that even though the Constitution of Kenya accords professional organizations a crucial role to play in the socio-economic well being of the country, their participation in the application of scientific knowledge is still very limited in spite of the available numerous research findings and recommendations. He lauded the

close cooperation among scientists in the field of weather and climate. He emphasized that the time to take action to mitigate against the effects of severe weather events and disasters associated with climate change is now.

Hon. Ranguma observed that early warnings of climate/weather events such as the ongoing rains associated with El-Niño assists policy makers in planning for the impacts as well as preparing the public to cope with the impacts. Hon. Ranguma commended the Kenya Meteorological Department (KMD) for the accurate and timely issuance of early warning of seasonal rainfall, which enabled the Government to put in place mechanisms to assist the public cope with the effects of excess rainfall. He concluded by thanking the sponsors for their support without which the Conference would not have taken place. He challenged the KMS to take up the responsibility of ensuring and demonstrating that the good gesture by the partners is put to good use. Details of Hon Ranguma's speech can be found in *Annex 2*.

Roselyn Ojala, representing the Director of KMD and Permanent Representative of Kenya with the World Meteorological Organization (WMO) who is also the Patron of KMS highlighted the role of KMD in the socio-economic development of Kenya emphasizing on the critical role of KMS in enhancing and making more visible the activities of the Department at County Level

Stella Aura, MBS, thanked H.E. Hon Ranguma for taking time to officiate at the opening of the Conference. She acknowledged the presence of the guests and participants and assured them that the Conference would be interactive and that the recommendations would be implemented. She reiterated the relevance of the Conference taking place in Kisumu in the middle of the short-rains season. Issues of climate change are pertinent and cut across all sectors with implications for socio-economic development of any County. She noted that the Conference had come at the right time when Counties were developing County specific weather and climate mitigation strategies which would be useful during this El Nino period and also in the future.

She encouraged participants to actively participate in the discussions to ensure the Conference objectives were met in an effort to improve the science of meteorology. Finally, she wished the participants fruitful deliberations.

1.1 Conference Participants

There were one hundred and eighteen conference participants drawn from various countries namely Djibouti, Ethiopia, Kenya, Tanzania, Uganda and United Kingdom. The institutional (sectoral) representation included the County Government of Kisumu, National Drought Management Authority (NDMA), Intergovernmental Authority on Development (IGAD), United Nations Educational, Social and Cultural Organization/Intergovernmental Oceanographic Commission (UNESCO/IOC), IGAD Climate Prediction and Application Centre (ICPAC), IGAD-HYCOS Project, World Meteorological Organization (WMO), Kenya Meteorological Department (KMD), United Nations Development Programme (UNDP), United Kingdom Meteorological Office, CARE International, Centre for Water and Environmental Education Network (CEWEEN), National Environmental Management Authority Environment (NEMA), Climate Change Research & Advisory Centre (CCR&AC), Kenya Wildlife Services (KWS), National Agricultural Research Laboratories (NARL), Ethiopian

Meteorological Society and Uganda National Meteorological Authority. The following universities were represented at the Conference: University of Nairobi (UON), Kenyatta University (KU), Moi University (MU), Masinde Muliro University of Science and Technology (MMUST), Catholic University of East Africa (CUEA), South Eastern Kenya University (SEKU) and University of Dodoma, Tanzania. Participants also came from Non-Governmental Organizations (NGOs), media industry and the general public. The list of participants is available in in *Annex 3*.

1.2 Conference Sponsorship

The 12th KMS International Conference would not have been a success without the support of various institutions in cash and in kind. The entire KMS fraternity is grateful to the County Government of Kisumu, Kisumu Hotel, World Meteorological Organization, UNESCO/IOC, NDMA, IGAD, ICPAC, IGAD-HYCOS project and KMD. Their continued support to the activities of the Society has been very beneficial to making the Conference a success.

1.3 Conference Perspectives

Stella Aura, MBS, the Chair of the Kenya Meteorological Society, highlighted the Conference perspectives, objectives and expectations. There were nine sessions covering a broad range of sectors, and each session had a lead paper presented by a lead expert in the thematic area. She observed that the papers to be presented were of high quality, and that the discussions at the end of each session would enhance interaction with the presenters. She told participants that the aims of the Conference were information exchange, awareness creation, sharing experiences on emerging issues, increased interaction among academia, operational scientists, industry and other stakeholders, and also a learning experience for young scientists. The expected outcomes were that participants develop networks (local/regional-based networks), strengthen research and innovation in weather and climate, sensitize and create awareness on emerging issues, including new opportunities for future research collaboration. The list of poster presentations is in *Annex 1.*

1.4 Conference Objectives

The objectives of the Conference were to:-

a) Provide a forum through which members of the Kenya Meteorological Society and other stakeholders can present the past and ongoing research activities and impacts to different sectors of the economy as well as societal response;

b) Create a forum for members of Kenya Meteorological Society to network and share experiences from other societies, institutions, professionals and stakeholders so as to improve scientific research capacity and uptake;

c) Provide a forum for researchers and other stakeholders from local and international institutions to discuss and share information on weather and climate research and innovation for sustainable development;

d) Provide an opportunity for interaction between scientists, policy makers and society; and make recommendations that will assist in the formulation of appropriate policy on climate change and sustainable development.

1.5 Thematic Areas covered during the Conference

The overall theme of the Conference was "**Weather, Climate and Environmental Research Innovation in Support of Sustainable Development"**. There were nine (9) sessions focusing on the key thematic areas such as green energy resources, health and environment, water resources, disaster risks, agriculture and food security, applied weather and climate prediction among others. There were a total of 37 papers presented during the conference.. Invited Papers were presented during the General Session, while the lead and the scientific papers set the tone for the various thematic sessions.

Under this main theme, the following specific thematic topics/areas were addressed:

2.0 GENERAL SESSION

2.1 Our Common Future over Greater Horn of Africa under a Changing Climate: Prof. L. A. Ogallo; ICPAC/UNDP

Prof. Ogallo in his introductory remark challenged participants by posing the following questions:

- Do we have the critical climate knowledge for building accurate climate scenarios for a sustainable future?
- What lessons have we learnt from the Past and present lessons?
- How can we look at the future differently?
- What are KMS roles at national, regional and global levels?

At the international level, he outlined some of the efforts, inspirations and critical players in Climate change information and knowledge base as composed of IPCC AR(5), ongoing UNFCCC/COP21, Global efforts under ICSU etc , pre-COP 21 international workshop June 2015 Paris, National Level UNFCCC reporting, Pope Francis climate change statement: "*We have slapped nature in the face, the Earth, our home, is beginning to look more and more like an immense pile of filth, We need an ethical and economic revolution to prevent catastrophic climate change and growing inequality in the world"*- Challenging COP21. KMS must therefore find its place in these efforts, he added.

The paper pointed out that human activities and land cover changes such as overstocking, use of wood fuel, charcoal burning, industries etc affect climate. Green house gases (GHGs) such as carbon dioxide, methane and nitrous oxide have been increasing with time and this impacts the energy balance and consequently leads to global warming. In 2013, the concentration of CO2 in the atmosphere was 142% of the pre-industrial era (1750), and 253% and 121% of methane and nitrous oxide, respectively. The result is direct impact on the global water cycle with incidences of floods and droughts being common. I addition, any changes in the future climate can lead to sea level rise, salt water intrusion, changes in water/air quality among other effects.. There is a lot of information from local communities which must not only be continuously documented but also integrated with modern science to address the challenges of climate change. KMS should, therefore, continue to provide a

platform for government and non-government organisations to come together and discuss practical solutions to the challenges brought about by climate change.

2.2 El Nino and La Nina Manifestations, Mitigations and Opportunities: Roselyn Ojala, HSC Deputy Director, Kenya Meteorological Department

The presenter gave basic definitions of El Nino and La Nina, general circulation and climate variability explaining that sea surface temperatures (SSTs) is one of the indicators used to predict seasonal rainfall. It was noted that El Nino peak normally occurs in December. She observed that there has to be a consistent rise in temperature by 0.5^0C for 3 months for the four Nino regions in order to declare an El Nino occurrence. During 1997 El Nino episode, temperatures rose by about 5^0C.

In her concluding remarks, she noted that natural events cannot be stopped therefore there is need for mitigation planning. She added that the phenomena provide an opportunity for KMD to create awareness up to the grassroots level through the RANET Project.

2.3 Climate Science to Action: Karen McCourt, UK Met Office

The presenter focused her talk on the need for partnerships between Meteorological offices and stakeholders to ensure that research results are translated into action and services. She outlined the functions of UK Met office such as providing climate information to various stakeholders such as the aviation industry, media, health sector, etc. Warnings should be issued when there is likelihood of an occurrence/hazard and its potential impacts communicated.

In her concluding remarks, she recommended that there is need for researchers and meteorological services to work in partnership since weather has no boundaries. Research findings also need to be communicated and translated into action..

3.0 SESSION 1: ADAPTATION TO CLIMATE CHANGE

Chair**:** ***Dr. D. K. Musembi*** Rapporteur**:** ***Ms. Mary Mwangi***

3.1 Introduction

This session addressed the changing climate conditions, exposure to climate hazards and threats to the environment and human wellbeing. Many communities are exposed to risks of climate and there are efforts to mitigate against the human causes of climate change. Effective adaptation requires understanding the vulnerabilities factors and adaptation options that can be time and region specific. The session had three papers, summarized as follows:

3.2 The Experiences of Application of Climate Change Sciences: Mr. Charles Ng'ang'a from Climate Change Research & Advisory Centre (CC&AC)

This presentation was based on daily rainfall and temperature data collected at the CC&AC in cooperation with the Kenya Meteorological Department (KMD). The main points in this presentation were as follows:

- Users of climate information do not understand easily the probabilistic forecasts issued by KMD and so the CC&AC has attempted to internalize these forecasts in terms of liters of water spread over a specific area of land.
- The Centre has discovered that this internalization of national rainfall projections has enhanced the understanding and uptake of climate forecasts.
- In addition to rainfall, they have also been recording temperature and soil data for the last 19 years which enhances the forecast internalization process.
- The Center also undertakes other activities such as monitoring river levels, research on bee keeping and chicken farming in relationship to existing climate variability and change.

Conclusion: National climate forecasts from KMD should be interpreted/ internalized in forms that make meaning to the farmers and this will go a long way to enhance adaptation to climate change at the local level.

3.3 Mainstreaming Indigenous Knowledge to Enhance Climate Change Adaptation among Local Communities in Western Kenya: Dr. Evans Wabwire, Catholic University of East Africa

This presentation pointed out the following:

- Climate change is real and we need to find adaptation solutions that can work for local communities.
- Over western Kenya, most climate forecasting models have indicated that climate is already changing and this will affect socio-economic activities.
- Indigenous knowledge (IK) has always been used by various communities to forecast weather. IK can be defined as "an organization of knowledge for a particular community that has survived for a long time and passed from one generation to another and which depends on the needs of the community."
- Key IK indicators majorly used in western Kenya include: migratory birds, strong winds, croaking frogs among others.
- IK validated against observed data sets indicated a deviation of ± 1 day of occurrence.
- Local people's perception of climate change is not consistent and IK experts demonstrate an inability to forecast extreme events such as El Nino.

Conclusion: There is need to blend IK and modern science methods so that the two can supplement each other. There is also an urgent need to document IK.

3.4 Use of Indigenous Knowledge as an Adaptation Strategy against the Impacts of Climate Change - A Case Study of the Sengwer people of Kapcherop: Prof.Ininda, University of Nairobi

The main points were as follows:

- Livelihoods of most rural communities depend on natural resources that are very sensitive to climate and this increases their vulnerability to climate change. This vulnerability is compounded by population pressure and changing environment.
- This study was conducted following a project funded by the World Bank to help vulnerable people adapt to climate change through improving their livelihoods.
- Through embracing IK, the value of honey as well as the amount of sales of honey increased among the community.
- Local communities embraced combined benefits of commercial bee keeping and forest conservation

Conclusion: If the local peoples' skills in the use of IK are enhanced the results can be beneficial to both the community and the environment at large.

4.0 SESSION 2: GREEN ENERGY RESOURCE AND CLIMATE

Chair: ***Dr. Gilbert Ouma*** Rapporteur: ***Kainga M.Mutembei***

4.1 Introduction

Greenhouse gas emissions are primarily due to combustion of fossil fuels in the use of energy. Energy use is largely driven by economic growth with short-term fluctuations in its growth rate created by weather patterns affecting heating and cooling needs, as well as changes in the fuel used in electricity generation. Energy-related carbon dioxide emissions, resulting from the combustion of petroleum, coal, and natural gas, constitute the highest percentage of greenhouse gas emissions. In order to lower the rate of emission of greenhouse gases into the atmosphere, there will be need to shift from fossil fuels to other forms of energy and in particular green/renewable energy. Below is a summary of the papers presented at this session.

4.2 Assessing the Potential of Solar Energy in Northern Kenya: Misiani Mwambi Zachary, Kenya Meteorological Department

The research paper outlined how to apply GIS skills and GIS software called ArcGIS, in carrying out spatial and temporal variation of solar radiation, sunshine and maximum temperature in the study area noting that Kenya receives relatively more solar insolation because it's near equator.

4.3 Assessing the Resource Potential of Solar Energy over the Coastal Areas of Kenya: Dr. Christopher Oludhe, University of Nairobi/Department of Meteorology

The study revealed that Tana River County has more solar energy potential than other areas in the Coastal region.

5.0 SESSION 3: HEALTH, CLIMATE AND ENVIRONMENT

Chair: ***Prof. J. M. Ininda*** Rapporteur: ***Pamela Kaithuru***

5.1 Introduction

Climate and weather have adverse impacts on human and animal health and well-being. Like other large natural systems, the global climate system is coming under pressure from human activities. This session had two presentations:

5.2 Drought Induced Elephant Mortality in Tropical Savanna: Yussuf A. Wato, Kenya Wildlife Service

In his introduction, Mr Yusuf argued that there has been a notable decline in the number of elephants from one million to 500,000 thousand in 3 decades. The climate data used was from the Tsavo National park rain gauges and satellite observations. The degradation of forest cover resulting in a negative impact of climate change has led to decline in forage for the elephants causing elephant mortality. The researcher used aerial and ground surveillance to track the elephants for a period of one year. The Maxent Model was used in the study.

Conclusion: Starvation was the most probable cause of the elephants' mortality since they were found to have died mostly near water sources.

5.3 An Assessment of Air Pollution Levels in Athi River Township and Olkaria Ecosystems: John Nguyo, Kenya Meteorological Department

This study uses an assessment of air pollution to identify environmental health risks on the populations in the area of study, and in particular the respiratory diseases that could be due to the pollution. The site, Athi River, was chosen due to its location downstream of factories and cognizant of the wind flow in the region (majorly easterlies). The results indicated evidence of pollution with high concentrations, with 2 peaks of high concentration of gases that pose a threat to health since they exceed the WHO threshold. The stable conditions of the atmosphere at night and early morning are responsible for low dispersal rates hence the high concentration of pollutants at those times.

Conclusion: There is need for an inventory of pollutants that can inform issuance of alerts for purpose of protecting life (for man, plants and animals).

THURSDAY, 12 NOVEMBER 2015

1.0 SESSION 4: DISASTER RISK REDUCTION AND SOCIO-ECONOMIC BENEFITS OF METEOROLOGICAL SERVICES

Chair: ***Evans Mukolwe*** Rapporteur: ***John Rotich***

1.1 Introduction

Disaster may be defined as a temporary event triggered by natural hazards that overwhelm local response capacity and seriously affects social and economic development of the region. Disasters can cause widespread human, material and environmental losses which exceed the capacity of the affected society to cope without external intervention. A summary of the four papers presented under this session is given hereunder:

1.2 The Disaster Management Cycle and its Implications for Capacity Building: Prof. Silvery B. Oteng'I, Masinde Muliro University of Science and Technology

Prof. Oteng'i presented the training program at the CDMHA; from Certificate to PhD level. He briefly discussed the Biblical Disaster Cycle and finally showed pictures of Recent Disaster Events including broken Dykes in Budalang'i.

Conclusion: The importance of disaster management (DM) and disaster risk reduction (DRR) in reducing disasters cannot be overemphasized..

1.3 Economic Opportunities in Combating Climate Change: Samuel Kahuha, Kenya Meteorological Department

The presentation covered challenges of Climate Change and Associated Economic Opportunities His paper discussed, causes of Climate Change, effects of Climate Change, international concerns; global efforts, Sustainable Development Goals, local efforts eg. Climate Change Bill, and economic Benefits where he listed 6 sectors that present opportunities as

- Awareness Creation and education,
- Afforestation and reforestation,
- Science and Technological Innovation,
- Regeneration of wastelands,
- Promotion of Green Energy Resources, and
- Enforcement of environmental conservation regulation

1.4 Evolution of the Kenyan AWS: Tom Ekajja, Broadcast Solutions International

Mr. Ekajja presented three successive AWS prototypes with improvements on communications, protocol, processing and memory/storage.

Conclusion: There is need to create partnerships with professional bodies and to obtain the relevant statutory approvals for the AWSs. Sustainability of this initiative is pertinent.

1.5 Differences between Satellite and Observed Climate Data as Predictors of Rift Valley Fever in Kenya: David Gikungu, Kenya Meteorological Department

An RVF prediction Model with rainfall, NDVI, RH and temperature as inputs was presented.

Conclusion: There was over estimation over arid and coastal areas and under estimation in mountainous areas. Some bias was displayed by remotely sensed data.

2.0 SESSION 5: CLIMATE, AGRICULTURE AND FOOD SECURITY

Chair*: **Ms. Mary Githinji*** Rapporteur*: **Ms. Emily Bosire***

2.1 Introduction

Agriculture and food security in the developing countries is mainly rain-fed and therefore highly vulnerable to climate variability/change. The main challenge confronting agriculture is how to respond, adapt and be more resilient. The six papers presented in this session are here below:

2.2 Sustainable Water Resources Management for Food Security in Kenya: Case of Bwathonaro Catchment: Prof. Chris A. Shisanya, Kenyatta University

The key problems associated with the pace of development of Bwathonaro water shed include conflicts over the use of water resources and food scarcity, increasing poverty and food insecurity and deteriorating environmental conditions and degradation of water resources. Prof. Shisanya mentioned that the goal of the Project was to enhance water resource availability & management as a food security strategy in Bwathonaro watershed, in Igembe.

Conclusion: In his presentation, he made the following conclusions:

- That through the integrated watershed management approach adopted by the present project, the local community members have been made aware of their potential in dealing with any emerging water related conflicts.
- Greater stakeholder participation in water resources management has the potential to improve access to water for irrigation and therefore food security.
- Adoption of drip irrigation by farmers for increased water use efficiency and crop production is important.
- Intercropping high value crops with khat trees is necessary

2.3 Increasing Food Production through Integrated Farming under Changing Climate in Taita Taveta County, Kenya: Victoria Gioto, National Drought Management Authority

The main objective of the study was to increase food production through integrated farming under a changing climate in Taita-taveta County.

Conclusion: The paper revealed that priorities should be set up based on what the local communities identify as important and the following were suggested:

- Scaling up of sustainable agricultural practices and intensifying production alternatives would increase community resilience in food production as well as the ability of the community to cushion the vulnerable groups.
- Use of early warning information through a trans-disciplinary approach, education, awareness of climate change and food security is important.
- Collaboration and participation of the local community in adaptation programmes coupled with Governance and enabling adaptation frameworks are pertinent.

2.4 Determinants of Agricultural Production in Kenya under Climate Change: Dr. Nwachukwu Ifeanyi Ndubuto, Kenyatta University

The presenter noted that agriculture is considered the most important sector in sub-Saharan Africa (SSA) and is set to be hit the hardest by climate change. Growing gaps between population growth and agricultural capacity in the face of declining food security, increasing vulnerability cum rural poverty amplify the impact of climate change. He pointed out that the motivation of doing the study was an attempt to realize goals two (end hunger, achieve food security) and thirteen (combat climate change & its impacts) of the Sustainable Development Goals.

Conclusion: The major conclusions from his study were that agricultural labour, livestock, land and precipitation posted positive coefficients; land has the most effect in determining production under climate change; and precipitation influences production positively in the short run but negatively in the long run.

2.5 A Critical Analysis of Planting Dates of Maize for Adaptation under Rainfall Variability for Enhanced Food Security at Oljoro Orok, Kenya: Joab Wamari, KALRO

Mr. Philip Sagero presented this paper on behalf of Joab Wamari of KARLO. The presenter pointed out that in order to optimize on yield under variable climatic conditions; planting at the appropriate time to fit with limited multiyear, multi-location replications, and crop maturity length and growing season is critical.

Conclusion: The effect of wet planting was negligible while dry planting increased grain yields compared to wet planting.

2.6 Effects of Surface Ozone on Some Crops in Nairobi County: William Apondo, Moi University

Mr. Apondo emphasized that elevated exposures beyond threshold ozone levels have been found to be responsible for an overall yield reduction of many crop species, such as wheat, rice, soybean and cotton. From his analysis he concluded that the potential yield reduction due to surface ozone showed 2 – 4 %, for maize 1- 2 % for beans and 1 % for wheat.

Conclusion: More studies need to be conducted on surface ozone exposure impacts on agriculture. There is need to and increase ozone observational points around Nairobi s well as in the agro-economic areas in Kenya.

2.7 Increasing Resilience of African Smallholder Agriculture to Climate Variability and Change Impacts through Value Added Climate Information Services: Cromwel Lukorito, University of Nairobi

The presenter chose agriculture because it is the driver of rural and national economic development, food security, employment, recreation, poverty eradication and livelihood sustainability. He stated that the sector continues to battle with the adverse effects of climate variability and change that present deleterious impacts on the efforts and investment made to deliver on these benefits.

The goal for the research was to develop web and mobile-phone based agro-weather tools that incorporate climate-information and best-bet agronomic management recommendations for the agricultural stakeholders (farmers). These tools will help farmers to plan and manage weather risks, maximize productivity, and minimize the environmental impacts of farming practices.

Conclusion: Mainstreaming weather and climate information into planning and decision-making is crucial in adapting agriculture in Africa to climate change. Increased investment in the generation of location-specific, value added, climate products and services would support smallholder farmers in building the resilience of their farming systems to the adverse impacts of climate variability and change.

3.0 SESSION 6: APPLIED WEATHER AND CLIMATE PREDICTION

Chair: **Dr. Alfred Opere** Rapporteur: **Dr. Richard Muita**

3.1 Anthropogenic Energy Trends in the Changing Climate of Nairobi: Dr. Franklin J. Opijah, University of Nairobi

This paper highlighted the use of ground station temperature observations and those from the MPI, MRI, HadGEM global models to simulate and project temperature for Dagoretti station in Kenya. The study highlighted that projected (model) maximum temperatures over Dagoretti occurred in April and October in contrast to that of the actual (observed) temperatures which occurred in February and October. Both MPI and MRI simulations appear to slightly underestimate the observed mean temperatures in the eastern and north-western parts of the Kenya based on the 1971-2001 period.

Temperature shifts of 20C – 30C are projected by the period 2071 – 2100. By 2040, anthropogenic heating flux has no effect in Africa apart from the South Africa region. Much of the global heat flux is in the northern hemisphere regions (Asia, Europe and North America). The annual energy consumption per capita in Kenya was found to be modest

whereas most of vehicular energy generation comes from cars and vans (91%). Population is increasing at a higher rate and energy needs are projected to increase from the current 61 Wm-2 to 393W-2 by 2029. The projected energy increase (393 Wm-2) could measurably alter the heat balance (UHI) of Nairobi.

Conclusion: In conclusion, the presenter recommended that future research can focus on diurnal, weekly and seasonal cycles of anthropogenic heating in relation to climate change and extend this to other cities in Kenya. It is concluded that energy consumed and converted to heat depends on energy needs and not the available energy resources.

3.2 Precipitation Enhancement through Cloud Seeding in Kenya: Chris Kiptum, Kenya Meteorological Department

Focus was on precipitation enhancement in more than 5 locations in Kenya using precipitation and temperature data from KMD as well as gridded Aerosol Optical Depth (AOD) and Cloud Top Temperature (CTT) data from MODIS. The analyses indicated that there is a general decline in precipitation in most of the study locations. The rainfall pentads (anomalies) are higher in highland locations (Dagoretti, Kisumu etc) compared to arid locations (Garissa, Lodwar etc) during both dry and wet years in the October – December (OND) season

Aerosol Optical Depth (AOD) of clouds was more evident in OND season and at 700mb level with south-easterly winds dominating the wet years and north-easterly winds during the dry years. In addition, particulates and aerosols tend to follow the wind direction in the study locations and higher aerosol loads are spatially indicated in areas with low and erratic rainfall such as Lodwar (4.2) and Makindu (6.6), most of the year.

Conclusion: Cloud seeding is more conducive in the inland locations. The correlation between aerosols and precipitation are mostly negative in the dry years (seasons) and positive in the wet years (seasons). The negative correlation between cloud temperatures and rainfall indicates the potential for cloud seeding in the study areas.

3.3 Climate Impact on Variability of Rainfall Intensity in Upper Blue Nile Basin: Lakemariam Yohannes Worku, Ethiopian Meteorological Society

The study examined the historical and future rainfall Intensity-Duration-Frequency (IDF) in 12 stations within the Abbay Basin (NW Ethiopia) and analyzed the impacts of climate change on IDF using GCMs (HaDCM3 & CGCM with A2 Emission Scenario). The analysis from the L-Moment ratio diagram indicated there were three different homogeneous regions within the basin although the 12 stations are not sufficient for regionalization. Further, the disaggregated (estimated) and the observed hourly rainfall values for these locations (basin) between 1970 and 1990 were approximately similar. The simulated maximum rainfall from the two GCMs underestimated the observed maximum rainfall for Bahir Dar, Debre Markos, Gondar, and Nekemte while they tended to overestimate the observed maximum rainfall for Assossa, Combolcha, Gore, and Hayk. Additionally, both GCMs provide an approximately equivalent estimation for the other locations (Dangila, Debre Birhan, Debre Tabore, and Fitche).

Conclusion: CGCM3 overestimates rainfall for some stations while the HadCM3 model gives a better estimation for most locations. In future and by 2020s the maximum rainfall is expected to decrease for some areas and increase for most parts of the basin while in the 2050s and 2080s maximum rainfall will increase basin wide.

3.4 Predictability of Precipitation on Medium Range Timescale over the Greater Horn of Africa Region Using the Super Ensemble Technique: Oliver Kipkogei, University of Nairobi

This presentation show cased the use of model outputs from NCEP, UKMO, CPTEC, ECMWF and Satellite estimates from TRMM to evaluate the predictability of medium range precipitation over the Greater Horn of Africa for the period 2008 to 2012. Findings from this work include: The spatial correlation for satellite estimates and forecasts of precipitation for the multi-model super-ensemble for the periods 20th - 29th Nov 2013 was higher compared with that of the other model outputs (CPTEC, ECMRF, NCEP and UKMO). This means that the RMSE was lowest for SE (e.g. RMSE=5.43 for forecast of 24th November 2013) than for the other ensembles (RMSE>5.43). Again, model evaluations indicated that SE had the best skill as shown by the low ETS (equitable threat score) and BIAS as the amount and intensity of rainfall increased compared relative to the other model outputs.

Conclusion: Satellite estimates are better in reducing biases arising from systematic errors in forecast models compared to other global model outputs.

3.5 Investigating the Homogeneity of Monthly Rainfall Records in Kenya: Hezron Awiti University of Nairobi

This study used the Standard Normal Homogeneity Test (SNHT) and Buishand Range Test (BRT) to examine the homogeneity of monthly rainfall records in Kenya for the period 1960 -2013. Results for the annual mean monthly rainfall series for a few locations indicate that there was a positive shift (maximum value) and break in the years 1989, 1998 and 2004 for Garissa (BR and SNHT test). For Kakamega the shifts were in 1989 and 2000 and for Moyale breaks occurred in 1997 and 1983 for both homogeneity tests. In conclusion, both BR and SNHT tests appear to give similar results which are better compared to the commonly used mass curves method.

Conclusion: Information of the station relocation, observing practices and instruments which were missing in this analysis could further enrich this work.

3.6 Seasonal Rainfall Extremes over Kenya as Projected by the CORDEX Models: Misiani Omondi, University of Nairobi

This study investigated the seasonal rainfall extremes using daily observed rainfall datasets for 12 station in Kenya over the 1960-2010 period and CORDEX scenario datasets. CORDEX scenario datasets provide projections for impact and adaptation studies from CMIP5 models of AR5 and beyond where, over Africa, 10 Regional Climate Models (RCMs) are used.

Conclusion: In general, the MAM season tended to experience a decrease (though insignificant) in the number of days with rainfall greater than the 99th percentile (R99P)

over the 1960-2010 whereas the OND season experienced an increase in the number of days with extreme rainfall except over a few areas. Future projections (2021-2050) of number of days with rainfall greater than the 99th percentile based on RCP4.5 and RCP8.5 scenarios indicate that both the MAM and OND seasons may experience an increased number of days with extreme rainfall over the eastern parts of Kenya. The future projections however were considered without bias correction of the CORDEX datasets

3.7 AWOs Technology and its Effect on Surface Weather Observation in Uganda: Kituusa Mohamed, Uganda National Meteorological Authority

This study showcased the status and impact of Automated Weather Observing Stations (AWOs) in Uganda. Uganda has over the years successfully equipped most of the surface data observatories (332 synoptic/agro-meteorological stations) with AWOS. Uganda still has a sparse Meteorology network which stands at about 35% of weather stations with only 49.5 % of these being operational.

Conclusion: The costs of the standard weather stations and the AWOs are high and require technical knowledge for installation, operation and maintenance. Security of AWS in remote areas is also a big challenge.

3.8 A New Gridded Climate Dataset for the East African Community Region: Dr. Gilbert Ouma, University of Nairobi

The purpose of this study was to close up the gaps in monthly observed rainfall data for the period 1981 – 2013 by developing a gridded climate dataset for the East African Community (EAC) region as well as building capacity to derive the gridded climate dataset within the National Meteorological Services (NMSs) of the EAC region. To achieve this, the Climate Hazards Group Infra-Red Precipitation datasets (CHIRPS) for 30+ years including functions of elevation, latitude and longitude were used spanning 50°S–50°N (and all longitudes) from 1981 to near-present. In general, the gridded data was able to provide monthly, seasonal and annual data sets at temporal and spatial scales across the EAC region. However, bias evaluations may be required to ascertain the extent to which these datasets compare with the available observed data.

Conclusion: Gridded climate datasets have the potential to improve the NMSs climate data bases through filling of gaps in their sparse data networks with fairly accurate data.

FRIDAY 13 NOVEMBER 2015

1.0 SESSION 7: CLIMATE, OCEANOGRAPHY AND WATER RESOURCES

Chair: ***Dr. Christopher Oludhe*** Rapporteur: ***Andrew Njogu***

1.1 Implications of Climate Change on Water Resources: Dr. Alfred Opere, University of Nairobi

This presentation highlighted climate as the major driver of water quality and quantity in all hydrological regimes. . Keys issues revolve around climate extremes such as floods and droughts, changes in precipitation and runoff regimes alongside pronounced impacts such as economic losses, food security and agricultural production, social impacts as well as health. Societal factors such as poor land use planning, deforestation and land degradation are catalysts for climate extremes such as droughts and floods which tend to put pressure on the hydro-systems with the attendant negative impacts such as pollution of wells and bore holes, river bank erosion, lateral shifting of river channels, silting of river beds due to poor cultivation methods, loss of top soil (soil erosion), poor land use practices and destruction of natural vegetation.

Climate change will alter the timing, distribution and quantity of water resources across the East African region. Climate models show a consistent response in both mean annual and seasonal temperature change in the region, projecting warmer conditions of +3.2°C for East Africa by the 2080s. There is consistency amongst models in projecting wetter conditions in East Africa, by +7%.

Conclusion: A number of countries in the region have carried out seen reforms of water resource policy, legislation and planning frameworks over the past ten years. If implemented, the policies seek to promote sustainable environmental management and development. on adaptation, policies that promote efficient use of land and water resources need to be adopted and implemented as well as develop alternative sources of energy such as investing in water harvesting technologies.

1.2 Evaluation of Potential Changes in Hydrologically Relevant Rainfall Statistics in Sondu River Basin in View of Climate Change: Dr. Rwigi S.Kibe, University of Nairobi

This paper focused on regional climate scenario modeling over the Sondu river basin. The PRECIS regional climate model was used to downscale global climate scenarios from the EHAM4 model for the baseline period (1961-1990), present and intermediate future (1991-2020) and the intermediate future (2021-2050). PRECIS model-simulated rainfall scenarios were validated using corresponding observed rainfall data grid values of model data extracted at three observation sites of KMD namely; Kericho, Keresoi and Sotik. The model performance was evaluated as the percentage difference between the observed and model-estimated rainfall. Rainfall statistics that were assessed in this study include: Mean

annual rainfall (MAR,) Coefficient of variation of annual rainfall (CV), Average number of rainfall days in a month (PCPD), Probability of a wet day following a dry day in a month (PR_W1), Probability of a wet day following a wet day in a month (PR_W2). Changes from the baseline values were used to determine rainfall trends.

Conclusion: Results show there is a general tendency towards increase in rainfall in the basin as we move towards 2030 and 2050. The combination of wetter antecedent conditions and more rainy days are likely to generate more runoff and thus cause increased flooding incidents in the lower parts of the basin.

1.3 How Does the Subsurface Sea Temperature Vary in Inter-Annual Timescale off East Africa?: Majuto Manyilizu, Tanzania Meteorological Agency

The paper showed that the tropical western Indian Ocean experiences strong inter-annual variations of the upper ocean temperatures associated with strong subsurface variations. The positive sea surface temperature (SST) anomalies retard the movement of the Inter Tropical Convergence Zone towards the Indian sub-continent thus delaying the rainfall onset. They also lead to devastating rainfall and cyclone activities over the South African region. ROMS model configuration with external forcing using data from NCEP was run for 10 years with a 2 year spin up time over the domain 37.5 - 60E; 50N-18S. Validation was done with ROMS model forced with COADS data in the same domain in addition to world Ocean Atlas 2009 data.

Conclusion: Weak inter-annual variations of the vertical temperature anomalies occur near the coast with weak inter-annual variations in the thermocline suggesting that local forcing are responsible for the variability. However, stronger inter-annual variability of the temperature occurs in the subsurface waters than in the SST in the offshore region. Strong inter-annual variability in the thermocline depth associated with the local surface forcing and the remote forcing from ENSO and the IOD is responsible for the strong inter-annual variability in the region.

1.4 Rainfall Intensity-Duration-Frequency Relationship for Nzoia River Basin in Western Kenya: Andrew Njogu, Kenya Meteorological Department

This paper outlined the importance of Intensity-Duration-Frequency (IDF) curves as a commonly used tool in water resources engineering for planning, design and operation of water resources projects. These relationships are useful in the design of urban drainage works, e.g. storm sewers, culverts and other hydraulic structures. Two commonly used frequency distributions are employed in developing the IDF relationship from rainfall data namely; the Gumbel (Extreme Value Type I) and Generalized Extreme Value (GEV). Methods of maximum likelihood and L-Moments are used in parameter estimation for the two distributions, respectively. The peak over threshold (POT) technique was used to pick storm series data from automatic hydromet stations recording rainfall at 10 minute intervals. Intensity–frequency–duration design rainfall curves range from 10 minutes to 24 hours in duration and average recurrence interval (ARI) of 2, 5, 10, 25, 50 and 100 years were used.

Rainfall intensity estimates for each station was derived using both parameter estimation methods. The quantile values obtained using maximum likelihood parameter estimation method was slightly higher than those obtained using L-Moments.

There is a marked spatial variability in the intensities across the basin with Lugari station having the highest 317 mm/hr and Nabkoi with the lowest 70 mm/hr for 10 minute duration and 100 year average recurrence interval, respectively. Rainfall estimates increase with increase in the return period and rainfall intensity decreases with rainfall duration in all return periods. Rainfall intensities rise in parallel with the rainfall return periods. IDF curves were formulated and constructed from automatic hydromet station data which is of high temporal and spatial resolution giving greater spatial detail of IDF rainfall maps in the Nzoia river basin.

Conclusion: Comparative study is recommended using data from autographic rainfall charts, if available, as well as the updating of IDF curves under a changing climate.

1.5 HYCOS Project Regional Activities: B. Kebede , IGAD-HYCOS/WMO

This paper discussed the **IGAD-HYCOS** project's regional activities with participating countries namely; Burundi, Djibouti, Eritrea, Ethiopia, Kenya, Rwanda, Somalia, South Sudan, Sudan and Uganda. The project is being executed in two phases; the preparatory phase (Phase I - one year) and the implementation phase (Phase II - 33 months). It aims at providing adequate infrastructure for hydrological observations and appropriate regional cooperation in information exchange among the participating countries. An amount of 6.6 million Euros has been secured for the implementation of the IGAD-HYCOS project under the European Union and is being implemented by the World Meteorological Organization. The project envisages the installation of 96 hydromet stations and each country will carry out 5 out of 7 training activities.

The project has so far carried out the following

- Regional Training of Trainers Workshops to enhance their work within the region:
- Regional Workshop on Hydrological Forecasting and Time Series Analysis
- Regional Workshop on Hydrological Modeling and GIS Application
- Regional Workshop on Integrated Flood Management
- Regional Workshop on Instrumentation and Hydrological Networking
- Integrated Water Resources Management (IWRM) Regional Training of Trainers
- Regional Workshop on Database Development and Web Portal

1.6 IGAD-HYCOS Project National Activities and Progress - Ethiopia Case: Surafel Mamo, IGAD-HYCOS/WMO

This paper gave the perspective of IGAD-HYCOS as a regional organization for development integration through improving the National Meteorological Services. Member states are: Burundi, Djibouti, Eritrea, Ethiopia, Kenya, Rwanda, Somalia, South Sudan, Sudan and Uganda. The activities of the project at Regional level are;

- Procurement of hydrological instrument (18 telemetry equipments – SEBA is the supplier), 7 pressure sensors, and 11 shaft encoder, Surfloat, Training of trainers (Integrated Flood Management, IFM), Instrumentation, Database Management.
  Completed activities at National level are;
- Training of trainers in Integrated Flood Management, instrumentation and configuration, and Database Management
- Training of: staff within the MoWIE (Directorates), Basin Authorities, regional water bureaus, DPs, and stakeholders
  Ongoing activities;
- Enhancing capacities: (human + logistics + technology), On job training and awareness for national and local experts, database management, database setup and configuration, linking and integration of services (data, skills, technology, models, etc) together for data exchange, monitoring and management systems, configuration, installation, and testing.
  Challenges and Gaps;
- Specification – the providers (through IGAD-HYCOS) supplied equipment without incorporating specifications proposed by the MoWIE/ HWQD, available communication access and technology GSM/GPRS, and power sources options i.e. solar, Missing accessories, cables and connectors, Coordination (weak linkage between the provider and implementer during configuration, trouble shooting and testing).

Conclusion: Advanced training is needed in configuration, implementation, operation, maintenance, and data exchange services and protocols within the region for better project implementation.

2.0 SESSION 8: CLIMATE INFORMATION AND PUBLIC AWARENESS

Chair: ***Rwigi S.Kibe*** Rapporteur**:** ***Bahati Musilu***

2.1 A Framework for Co-Producing Decision Relevant Climate Information Services at Country Levels: Mr. Ayub Shaka, Kenya Meteorological Department

Mr. Shaka introduced Climate Information Services program in Kenya defining the use of Participatory Scenario Planning to ensure scientific climate information reaches the grassroots level and is relevant to the target audience. He introduced the ADA Consortium and its specific role in Kenya through KMD, adding that the Consortium addresses the issues of a framework to ensure information services reached the county levels. He further gave a detailed explanation of the ADA consortium project, their activities, their reach and the critical role they play in ensuring that climate information is disseminated to the local communities to assist in planning their daily activities and the role of KMD in the project.

Conclusion: He concluded his presentation by reiterating that that partnerships are key in climate information service dissemination adding that the ADA project working with KMD

has enabled the Department to achieve a better understanding of climate and weather among its users especially in the South Eastern region of the Country.

2.2 Indigenous Knowledge in Forecasting Rainfall among the Kamba Community in Makindu, Makueni Counties: The case for validation: Dr. Musembi, South Eastern Kenya University

The presenter stated that the objective of the research was to validate indigenous knowledge with modern forecasting methods adding that there is a deliberate effort to mainstream it to forecasting. Research carried out in the Makindu and Makueni Counties on the use of indigenous knowledge among farmers in the area, sought to establish if the farmers were using the scientific forecasts that were given to them before the planting season. In his research, Dr. Musembi established that most farmers preferred the tried and tested indigenous knowledge to the scientific forecasts issued by KMD. The research also sought to integrate scientific and indigenous forecasting methods to come up with a forecast acceptable to all.

Conclusion: Dr. Musembi concluded his presentation by emphasizing the need to carry out further research to integrate the two methods of forecasting to achieve good understanding of climate change among the non-scientific community of rural Kenya.

3.0 SESSION 9: CLIMATE AND SUSTAINABLE DEVELOPMENT

Chair: ***Mr. Francis Inganga*** Rapporteur*:* ***O. Kipkogei***

3.1 Unlocking the Potential of Climate Information Services to Achieve Climate Change Resilient Agriculture and Sustainable Development: Pamela Kimkung, CARE International Kisumu

The presenter stressed that most of our communities are poor and therefore have low adaptive capacity. The presentation noted that adaptation action is needed for sustainable development. There is need to build capacity by making climate informed decisions. Particularly, she discussed the use of Community Based Adaptation (CBA). Finally, she concluded by emphasizing the need to strengthen linkages between the producers of climate products and the final consumer.

3.2 The Common and Diverse Attributes of Climate Extremes, Variability and Change Knowledge Products to Inform Policy Decisions for Sustainable Development over East Africa with Examples for Kenya: Dr. J N Mutemi, University of Nairobi

The presenter revisited the projection of the OND 2015 seasonal forecast and noted that the projection showed enhancement of the rains throughout the equatorial sector and depression in the northern parts of the GHA region. He further gave the status of the ENSO and Indian Ocean Dipole conditions and explained the delay in the onset of rains which sometimes impacts negatively on agriculture and other sectors.

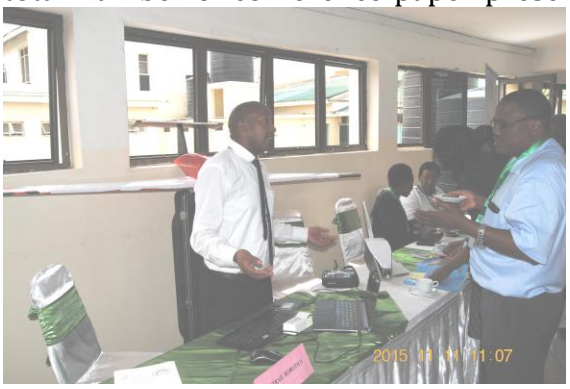
Finally, he reiterated the need to collaborate with other institutions in order to build their capacity.

3.3 Climate Variability and Change over the Arid and Semi-Arid lands of Kenya: Jully O. Ouma, University of Nairobi

The presentation looked into the extreme climate events that affect the arid and semi-arid areas of Kenya. The study noted the increase in temperature trends especially over Samburu area.

3.4 *Posters and Exhibition*

Additionally, there were six (7) poster presentations and four (4) exhibitions, bringing the total number of conference paper presentations to 44, with a 15% poster representation.



4.0 SESSION 10: Plenary session and Closing Ceremony

Chair: *Stella Aura, MBS* **Rapporteur:** *Bethwel Mutai*

RECOMMENDATIONS AND WAY FORWARD

The plenary session and closing ceremony were chaired by Stella Aura, MBS, and KMS Chair.

4.1 Plenary Session

During the plenary, the recommendations and way forward were summarized as follows:

- KMS should establish collaboration with other institutions like KMD, KFS, NEMA to facilitate accessibility of meteorological and climate data to enable researchers carry out effective scientific research.

- KMS members should take advantage of the availability,-on-request, of a robust dataset on land/soil pollution emissions estimates that is being compiled by institutions such as the Kenya Forest Service, NEMA.

- KMS should expand and strengthen its mentorship program by taking a deliberate step to include the youth in its activities as a critical component for continuance in scientific research progression; and by encouraging the young scientists in meteorology and climate areas by introducing an award scheme in future Conferences for the best paper presentations for students studying at the Universities.

- KMS to play an active role in public education by disseminating research information through various workshops and seminars.

- KMS should facilitate collaboration and networking of KMD with other institutions to ensure that the observation instruments are serviced and standardized and observations are conducted professionally for authentic data for research and other purposes. Networking, servicing of instruments, professionalism in data observations is pertinent.

- KMS should partner with CARE, Faith Based Organizations, Civil Based Organizations, Non-Governmental Organizations among others which can assist in communication of the weather and climate information at the grassroots level.

- KMS should facilitate preparation of a data set that indicates solar potential overlaying cloud cover, which will then make it easier to carry out research on solar energy as a renewable source of energy.

- KMS should spearhead the development of the national strategy for applied meteorology

- KMS should facilitate capture and documentation of Indigenous Knowledge (IK) and enhance the integration of IK in modern science.

4.2 CLOSING OF THE CONFERENCE

The Conference was officially closed on Friday 13th November 2015 at 3:00pm by the Deputy County Commissioner Madam **Susan Waweru**, representing the Kisumu County Commissioner. She was accompanied by the Chair of the Society. In her closing remarks, the Deputy Commissioner thanked the Society for choosing to host the 12th KMS International Conference in Kisumu. She added that the deliberations and recommendations from the Conference should be acted upon as swiftly as possible to enable the Kenyan society, especially those in Kisumu County, benefit from the Conference outcomes. She reiterated that the Kisumu County Commissioner's Office was ready to work with the Society and other stakeholders on issues of weather, climate and related impacts.

In her remarks, the Chair of the Society, thanked all who attended and participated in the Conference. She thanked the National and County governments for supporting the event and assured them of the Society's commitment in addressing the challenges of climate change in the County by acting on the Conference recommendations.

Annex 1: Papers for Poster Presentation

Presentation	Name Of Presenter	Institution	Theme
1. The Spatial-Temporal Characteristics Of Particulate Air Pollutants And Its Association With Rainfall And Wind Variation In A Tropical Urban Setting: A Case Study Of Nairobi City And The Upcoming Lamu City	Cohen Ang'u	University Of Nairobi	Applied Weather And Climate Prediction
2. Assessing Household Vulnerability and Adaptive Capacity to Impacts of Climate Change and Variability in Soroti District, Eastern Uganda	Edith Amondi	University of Nairobi	
3. Evaluate The Impact Of Indian Ocean Processes On Kenyan Coastal Rainfall.	Paul Ng'ala Oloo	Kenya Meteorological Department	Climate, Oceanography and Water Recourses
4. Potential Of Using Climate And Weather Information To Forecast Frost In Kenya	Richard .R. Muita	Kenya Meteorological Department	Applied Weather And Climate Prediction
5. Examining The Thunderstorm Trends In Regions Around The Western Rift Valley And Lake Victoria Region	Mary Chelangat Kurgat	Kenya Meteorological Department	Applied Weather And Climate Prediction
6. Determination Of Water Balance For The Management Of Flood Flows In Yala River Kenya	Wanyonyi E. Sabuni	Water Resource Management Authority	Applied Weather And Climate Prediction

Annex2: Speech by H.E. Hon Ranguma, Governor County Government of Kisumu at the opening of the 12TH KENYA METEOROLOGICAL SOCIETY INTERNATIONAL CONFERENCE;

11 SEPTEMBER 2015; KISUMU HOTEL

- **Mr. John Elungata**, County Commissioner, Kisumu County
- **Ms. Roselyn Ojala,** Representative of the Director, Kenya Meteorological Department and Permanent Representative of Kenya with WMO
- **Mr. James Oduor**, Chief Executive Officer, National Drought Management Authority
- **Representative of the Secretary General**, World Meteorological Organization
- **Representative of the Executive Secretary**, Intergovernmental Authority on Development
- **Representative of the Secretary General**, East African Community
- **Representative of UNESCO/IOC**
- **Stella Aura, MBS**, Chair, Kenya Meteorological Society
- Conference participants
- Distinguished guests
- Ladies and gentlemen

I feel greatly honored to be here with you today to mark this important occasion in the calendar of the Kenya Meteorological Society. The 12th KMS International Conference on Meteorological Research, Applications and Services signifies a continuation of the long tradition of the Kenya Meteorological Society of organizing biennial International Conferences during which eminent scientists and stakeholders are called in to share their research findings and provide possible solutions to the socio-economic challenges facing our people. These Conferences also offer our budding scientists an opportunity to develop their research skills.

Distinguished Guests Ladies and Gentlemen, allow me to take this early opportunity to express my gratitude to the organizers of the conference who identified Kisumu City to host

this forum. This not only offers us the opportunity to showcase our excellent conference facilities in Kisumu, but also gives us an opportunity to be first beneficiaries of the recommendations coming out of the conference as I expect them to be implemented as soon as is practically possible.

The contribution of science to the socio-economic development of any country the world over cannot be over emphasized. Our beloved country has embarked on a journey that will lead to Kenya becoming a *"newly industrialized, middle-income, country providing a high quality of life to all its citizens in a clean and secure environment"* by the year 2030. As we continue to lay the building blocks towards the attainment of Kenya Vision 2030, I will expect the Kenya Meteorological Society, as well as other research and application organizations in the field of weather and climate to join the Kenya Meteorological Department in ensuring that the right input is provided to not only the National Government, but to the County governments as well, to ensure that the necessary information, particularly concerning Climate and Climate change is passed on to Kenyans at the grassroots . I will count on the professional Organizations like yours as well as other Scientific and Research Institutions to join us to make sure that this initiative is taken to the next level where the policy is implemented and produces results that are beneficial to not only Kenyans but the rest of human kind.

Distinguished Guests, Ladies and Gentlemen, the Constitution of Kenya accords professional organizations a crucial role to play in the Socio-economic well being of the country. It is in recognition of this that the Government of Kenya has given them, under the general umbrella of the Association of Professional Societies in East Africa (APSEA), an opportunity to contribute to and to participate in, the implementation of the Constitution. I note, however, that the participation of professional bodies in the application of scientific knowledge in real life situations out there in the field is still very limited. This is in spite of the numerous research findings and recommendations lying on shelves in offices and libraries, without any initiative to put them to practical use.

Distinguished Guests, Ladies and Gentlemen, Science is universal. The science of weather and climate does not recognize political borders. It is for this reason that I wish to applaud the Kenya Meteorological Society for its efforts to organize an international conference like the one we are opening today. I note that we have presentations by scientists from Zimbabwe, Zambia, United Kingdom, Uganda, Tanzania, South Sudan Ethiopia and Kenya. This clearly attests to the close cooperation of scientists in the field of weather and climate.

We have been told by the Inter Governmental Panel on Climate Change (IPCC) that Climate change is here with us. The negative effects of climate change can be seen all around us in the form of global warming and the corresponding increase in frequency of adverse weather and extreme climate events that occasionally evolve into disasters. The time to take action to mitigate against the effects of severe weather events and disasters is now.

As we are meeting here **ladies and gentlemen**, our country is under the influence of El-Niño rains. Early warnings of such climate events help the policy makers in planning for them as well as preparing the public to cope with them. I note that the Meteorological Department had issued early warning of the rains, which enabled the National Government, as well as the County Governments, put in place mechanisms to help the public cope with the effects of excess rainfall. This is commendable and should continue.

Looking at the research papers lined up for presentation at this Workshop, I note that they address various Sectors ranging from Agriculture, Health, Marine and Water Resources, Disaster Management as well as Energy Resources. These topics cover challenges facing the Kenyan *mwananchi* in their daily activities. I have no doubt, **ladies and gentlemen** that the Research findings discussed here will be implemented not only by the policy makers but also relevant stakeholders. I will expect that the 12th KMS International Conference will have a session to discuss the decisions emanating from this forum.

Distinguished Guests, Ladies and Gentlemen, this Conference has been made possible through continuous efforts and support of a number of organizations who contributed

financially to ensure it succeeds. In this respect, I wish to thank the Kenya Meteorological Department (KMD), World Meteorological Organization (WMO), the Inter-Governmental Authority on Development (IGAD), the National Drought Management Authority (NDMA), and UNESCO-IOC through their representatives who are here with us for kindly providing the necessary financial support towards the Conference. I also wish to appreciate the in-kind support, provided by various institutions, including the UK Met. Office. It is now the responsibility of the Society to ensure, and demonstrate, that the good gesture by your partners is put to good use.

To conclude, I wish to urge all of us to visit our tourist sites in Kisumu before you leave for your homes. You will find the people of Kisumu County friendly and hospitable.

With those few remarks, **Ladies and Gentlemen**, I am pleased to declare the **12th Kenya Meteorological Society International Conference on Meteorological Research, Applications and Services** officially open.

Thank you.

Annex 3: List of participants

No.	Surname	Other Name(s)	Profession	Organization	Country	Contact Address	Email address
1.	Ranguma	Jack	H. E. Governor	County Government of Kisumu	Kenya	P. O. Box 2738, 40100 Kisumu	jranguma@gmail.com
2.	Elungata	John	County Commissioner	County Government of Kisumu	Kenya		
3	Aura	Stella, MBS	Meteorologist	KMD	Kenya	P. O. Box 30259, 00100 Nairobi	aura@meteo.go.ke
4	Opere	Alfred	Snr Lecturer	UoN	Kenya	P. O. Box 30197-00100 Nairobi	aopere@uonbi.ac.ke
5	Ojala	Roselyn, HSC	Meteorologist	KMD.	Kenya	P. O. Box 30259, 00100 Nairobi	ojala@meteo.go.ke
6	Inganga	Francis	Environment	NEMA	Kenya	P. O. Box 67839-00200 Nairobi	ifrancis@nema.go.ke
7	Mc'Court	Karen	UK Civil Service	UK Met Office	UK		karen.mmcourt@metoffice.gov.uk
8	Oludhe	Christopher	Snr Lecturer	UoN	Kenya	P. O. Box 30197-00100 Nairobi	coludhe@uonbi.ac.ke
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