The effectiveness of agrometeorological information in the realization of Kenya's Vision 2030; lessons learnt from China

Victor Ongoma[1,2], Zablon W. Shilenje[3]*

Abstract: *Agriculture is the backbone of Kenya's economy. The agricultural practices in Kenya are mainly rain fed making them vulnerable to effects of climate variability and climate change. Weather forecast helps farming to maximize farm produce under prevailing meteorological conditions. Kenya's Vision 2030 economic pillar is anchored on agriculture among other sectors. This calls for best farming practices and accurate, timely and reliable weather forecast. The Kenya Meteorological Department (KMD) as well as China Meteorological Administration (CMA) issue closely similar agrometeorological forecast among other products. The main difference is the dissemination and uptake of the information, with CMA embracing dedicated daily television channel and daily newspaper to agrometeorological forecast unlike KMD that only uses media briefing and newspaper print on the day of seasonal weather release. The utilization of weather forecast has greatly helped China to grow its agricultural sector. The study recommends for KMD to adopt the approach of the media avenues adopted by CMA for effectiveness of weather forecast.*
Keywords: *weather forecast, agriculture, Vision 2030, climate change.*

Riassunto: *L'agricoltura è la spina dorsale dell'economia del Kenya. In Kenya l'agricoltura è principalmente di tipo pluviale ed è quindi vulnerabile agli effetti della variabilità del clima e dei cambiamenti climatici. Le previsioni meteorologiche aiutano l'agricoltura a massimizzare le produzioni. Il pilastro economico della "Vision 2030" del Kenya è incentrato sull'agricoltura e richiede pratiche agricole migliori e previsioni meteo accurate, tempestive e affidabili. Il Dipartimento Meteorologico del Kenya (KMD), così come l'Amministrazione Meteorologica della Cina (CMA) pubblica previsioni agrometeorologiche. Le differenze principali sono l'acquisizione e la divulgazione delle informazioni, CMA diffonde le previsioni agrometeorologiche giornalmente tramite canali televisivi dedicati e quotidiani a differenza di KMD che diffonde le informazioni meteorologiche stagionali tramite conferenze stampa e carta stampata. L'utilizzo di previsioni meteorologiche ha notevolmente aiutato la Cina a sviluppare il settore agricolo. Lo studio raccomanda al KMD di adottare l'approccio ai mezzi mediatici adottati dalla CMA per l'efficacia delle previsioni meteorologiche.*
Parole chiave: *previsioni del tempo, agricoltura, Vision 2030, cambiamenti climatici.*

1. INTRODUCTION

Weather and climate affects almost all socio-economic activities. Kenya's economy heavily relies on agriculture. The sector currently contributes to approximately 24 percent of the country's Gross Domestic Product (GDP), as well as creating the largest share of the job opportunities. Agriculture practiced in Kenya is mainly rain fed, qualifying rainfall to be the most important weather element in the country and region at large (Muthama *et al*., 2012). This calls for continuous monitoring of rainfall and general weather for provision of accurate and timely weather forecast to improve and sustain agricultural productivity. The economy of Kenya and many other developing nations especially in Africa that are dependent on rain fed agriculture are highly vulnerable to the effects of climate variability and climate change (IPCC, 2007).

Kenya and other neighboring east Africa nations (Fig. 1), being in the tropics, mainly experience bimodal rainfall; 'long rains' occurring in March-May (MAM) and the 'short rains' in October-December (OND) (Yang *et al*., 2015; Lyon 2014). However, the rainfall is highly variable both in space-time and magnitude (Oettli and Camberlin, 2005; Indeje *et al*., 2000; Nyakwada, 2009). Some regions, especially the Lake Victoria region receive trimodal rainfall, the third season occuring during the months of June-August (JJA). The space-time variability of rainfall is attributed to complex topographical features and existence of water bodies e.g. Lake Victoria to the west and the Indian Ocean on the south-east border. The rainfall over the country is also highly influenced by global teleconnections e.g. El-Nino Southern Oscillation

* Corresponding Author e-mail: victor.ongoma@gmail.com
[1] Nanjing University of Information, Science and Technology, Nanjing 210044, China.
[2] South Eastern Kenya University, Kitui, Kenya.
[3] Kenya Meteorological Department, Nairobi, Kenya.

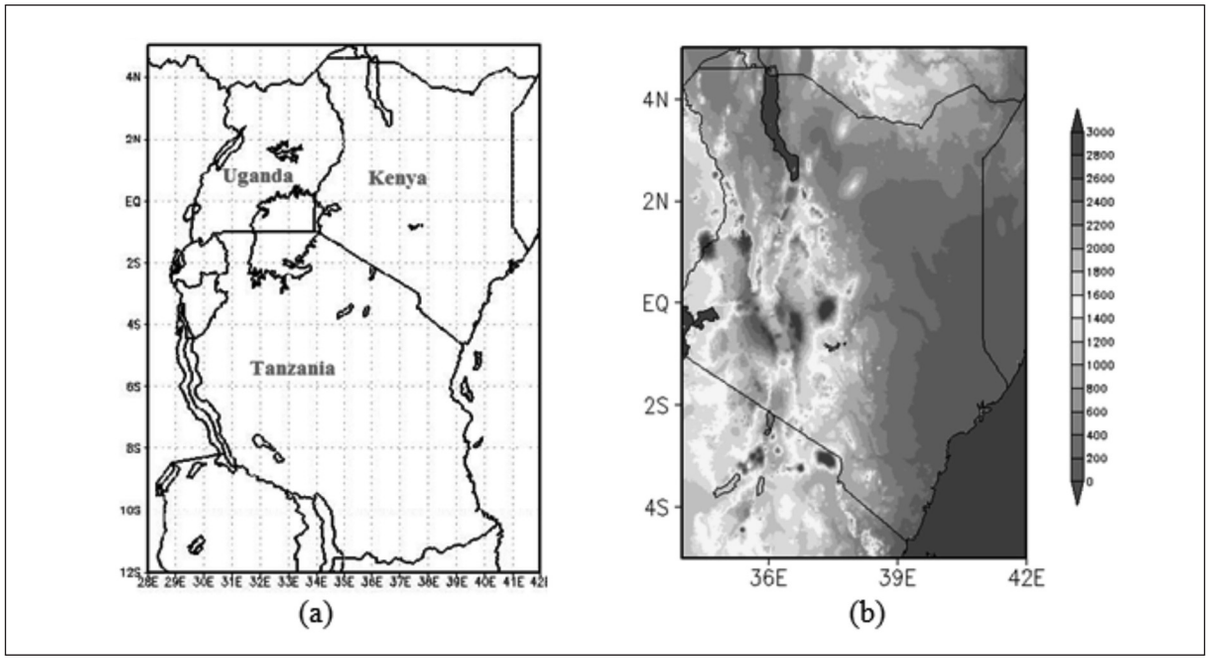

Fig. 1 - Area of study, (a) east Africa (left), (b) Map of Kenya, showing the topography of the area of study and the elevation in meters (The areas shaded blue are water bodies).
Fig. 1 - Area di studio, (a) Est Africa (sinistra), (b) mappa del Kenya che mostra la topografia dell'area di studio e l'elevazione in metri (le aree blu sfumate sono corpi d'acqua).

(Schreck and Semazzi, 2004; Indeje *et al*., 2000) and Indian Ocean Dipole (Black *et al*., 2003; Owiti *et al*., 2008). El-Nino is associated with above normal rainfall over the larger east Africa, while La-Nina is associated to below normal rainfall (Ogallo, 1988).
The ongoing climate change threatens food security especially in developing nations. Although it is a global phenomenon, its effects and manifestation varies from one region to another owing to several factors. In east Africa, change in climate is characterized by increase in intensity and frequency of extreme weather events that will significantly increase the risk of floods and drought (ICPAC, 2007; IPCC, 2007; Ogallo and Oludhe, 2009). The common extreme weather events in Kenya are drought and floods (Hastenrath *et al*., 2007; Lyon and Dewitt, 2012). These extreme weather events are associated with loss of lives and huge destruction of property. Although high levels of uncertainty still exist on the temporal and spatial variability of rainfall events over east Africa, most studies (e.g. Yang *et al*., 2014; Funk *et al*., 2008; Tierney *et al*., 2015; Williams and Funk, 2011) have reported a general reduction in rainfall over the region, but projected an increase in future (Shongwe *et al*., 2011; Giannini *et al*., 2008; Niang *et al*., 2014).

Generally, the impact of climate change on agriculture is negative. The negative impact manifests through shortening the length of the growing season, increasing water stress and increase in outbreak and spread of pests, diseases and weeds (Niang *et al*., 2014). Over eastern Africa, Adhikari *et al*., (2015) identified wheat, maize, rice and soybean to be among the most venerable crops to the effects of climate change. The study noted that although construction of small-scale irrigation systems and water harvesting structures are helpful in adapting to climate change impacts, the approach is generally expensive and thus hindering its uptake. This is a proof that accurate and timely weather forecast is the most effective and economic approach in minimizing losses associated with climate effects. Climate projections can help in planning purposes to minimize the anticipated effects, as well as devising mitigation measures to mitigate against the effects of climate change.
Agricultural sector requires tailored weather forecast with special focus on crops, animals and farm operations at large. Almost all farm activities and planning requires agrometeorological forecast (Motha *et al*., 2006; Stefanski, 2007). The types of forecasts

issued to farmers include the seasonal rainfall onset and cessation, the rainfall amounts, and anticipated extreme weather events such as wind gusts, hail, among others. However, despite the availability of these services, the uptake and practical applications of these forecasts for decision-making in various areas of agriculture by farmers has remained limited (Amissah-Arthur, 2003). Different avenues are utilized in dissemination of the information depending on the target group, resources among others. In Kenya, television and radio play a very important role in disseminating daily weather forecasts (Muthama *et al*., 2012; Zendera *et al*., 2011). According to Zendera *et al*., (2011), 98 percent of the farmers have at least access to radio; up to 90.4% of these farmers are able to listen to the radio daily. The study notes that the type of weather reports aired through these disseminated avenues are very brief and technical, this forms a basis of this study.

2. METHODOLOGY

The study employed desktop review and experience of the Chinese meteorological and agricultural systems. The research outlines the successes and experiences of the China Meteorological Administration with focus on agricultural forecast dissemination.

3. FINDINGS AND DISCUSSION

The general and special weather forecast for the agrometeorological sector in Kenya is provided by the KMD. The general forecast issues include 1, 4 and 7 day forecasts. In the marine sector, the products issued by KMD include general state of the ocean such as wave heights, wind direction and speeds, and ocean currents. For the agricultural sector, the institution carries out observations of air maximum and minimum, wet bulb, dry bulb, dew point and soil temperature, sunshine duration, radiation, wind speed and direction, humidity at 0900 and 1500 hours, pan evaporation in mm per day, calculated potential evapotranspiration in mm per dekad (10 - day period) and rainfall in mm per day.

Other important products issued to the farmers include the onset and cessation, and the expected seasonal rainfall amounts (Fig. 2). The former is very important in timing crop of planting.

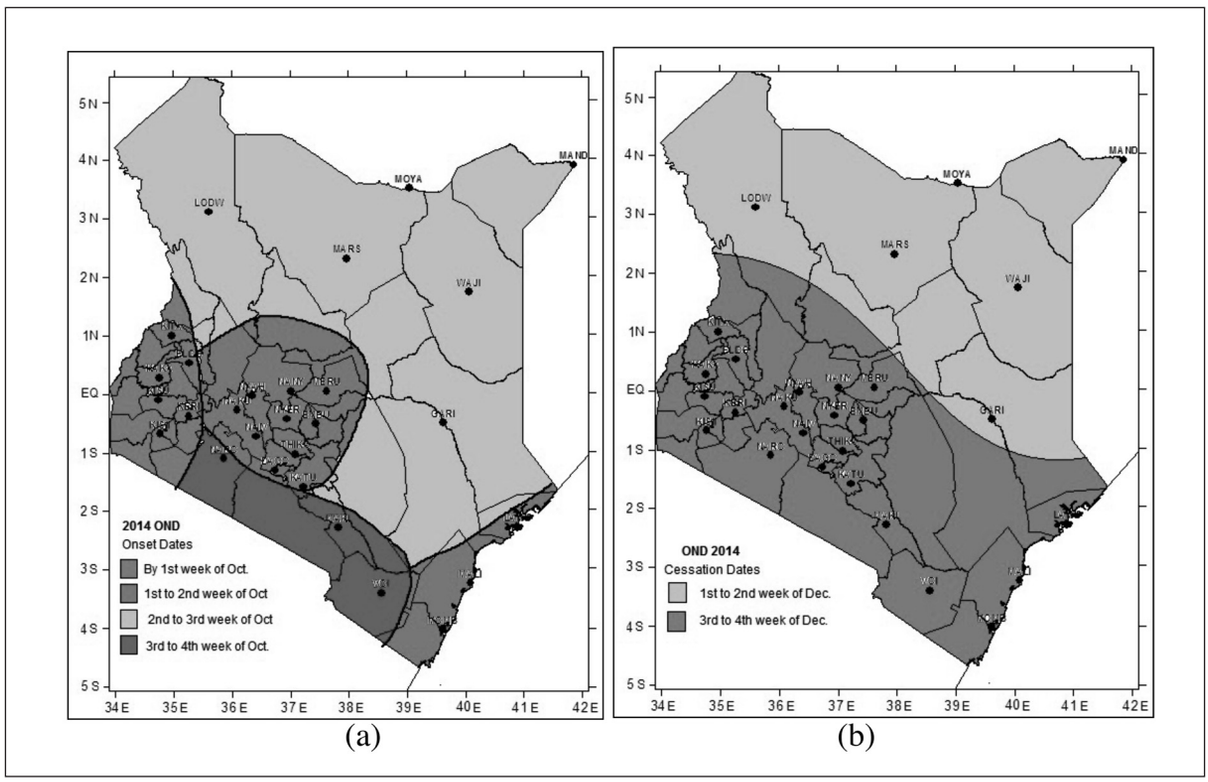

Fig. 2 - OND 2014 Seasonal Rainfall Forecast (a) Onset and (b) Cessation. (Source: KMD, 2014)
Fig. 2 - OND 2014 Previsione delle precipitazioni stagionali (a) Inizio e (b) Fine. (Fonte: KMD, 2014)

The KMD through its agrometeorological section prepares the 10 day (dekadal) agrometeorological bulletin, which is available freely on its website for public utilization. The bulletin normally has updates on weather evolution and crop development. In addition, the bulletin mainly contains: forecast on crop performance, advisory services on adverse effects of weather on crops, advisory services on harvest and post harvest operations.

The CMA equally offers similar products, in addition to what is offered by KMD to farmers, CMA offers products and service that can are equally useful in Kenya include: ecological meteorological monitoring and assessment, specialized agricultural yield and quality forecasts, agrometeorological disaster monitoring, assessment and warning.

The provision of meteorological products is not however a guarantee of uptake by the targeted users. The effectiveness of the products is realized when they are relayed timely to the end users and in unpackaged such that that can easily be understood by users. Previous studies in Kenya show that radio and television (TV) are the main sources of general information (e.g. Muthama *et al.*, 2012; Zendera *et al.*, 2011). Unlike in Kenya where the products are mainly passed to farmers through television and radio at news time, and briefing to the media and newspaper during seasonal weather forecast release, the China has exclusive TV channels such as China Weather TV (http://www.topv.com.cn/channelpay/2010/1216/281.html) for dissemination of meteorological information as news. The TV channel runs for 24 hours since its launch in 2006, airing among others: live weather forecast, life meteorological index, all kinds of early warnings and weather science knowledge. Among other dissemination avenues employed by the TVs include airing expert interviews and popular science films. In addition, the country has a film and television centre dedicated to agriculture, 'China Agriculture Film and Television Centre' (http://english.agri.gov.cn/aboutmoa/ium/201301/t20130115_9531.htm). The institution produces agriculture-related films and television programmes that are aired on CCTV 7, being on air for 8 hours daily.

Although KMD now runs Radio Internet Communication System (RANET), the project is part of the global RANET; a collaboration of various national, regional and international partners in meteorology and similar services operating in rural and remote areas to improve accessibility to weather, climate, and related information. The project, currently operational in Kenya, runs 5 FM radio stations: Budalang'i in Busia County (http://www.meteo.go.ke/rnet/; http://www. environment.go.ke/?p=918) there is still need to expand this to national scale. The four areas/stations targeted so far are vulnerable to weather and climate extreme events. The program takes advantage of the improving quality of Severe Weather Forecasting Demonstation Project (SWFDP) in east Africa, to pass the information to the target users. In these areas, it is now possible to receive, information in web format without the necessity of internet connections. The pilot project in Kenya is indeed a success story; however, the coverage of the RANET stations is limited in terms of audience since its news is relayed in vernacular language, targeting its local people. The country has approximately 40 tribes, each speaking its own vernacular.

China equally has a newspaper; 'Farmers Daily' (http://www.chinaculture.org/gb/en_aboutchina/2003-09/24/content_23439.htm), specifically dedicated to communicating technical advances in agriculture as well as weather and climate, especially agrometeorological forecasts to the farmers. The same information is equally broadcasted to the public on trains, public buses, subways and outdoor electronic display.

These information dissemination options employed by CMA and the Chinese government at large definitely gives them an egde in the effectiveness of the services offered to farmers by CMA as compared to KMD's.

Unfortunately, the cost of input in the meteorology sector is very high. A study by Shilenje and Ogwang (2015), looking at role of KMD in weather early warning in Kenya, called for strengthening the existing metereological structures in Kenya so as to enhance the effectiveness of its services. The improvement of meteorological services in most developing countries is pegged on funding. Despite the recurrent drought and floods in Kenya, the meteorological sector is still underfunded to achieve its objectives of saving property and live, as observed by Aura *et al.*, (2015). In the counterpart nation China, weather issues are given high priority especially in funding both in operations and research. Although it may be argued that this is informed by its proneness to extreme events such as winter, summer, and landslides, other sectors such as agriculture are equally big beneficiaries of the developed meteorological service. The benefit consequently flows to other key sectors such as economy, health, tourism and environment which are key for any nation's development.

CONCLUSION AND RECOMMENDATIONS

Weather forecast is key for agricultural development. Although establishment of a TV station exclusively dedicated to weather and climate is expensive, this is an option to be considered by the KMD, the Ministry of Agriculture and other directly affected sectors at large to increase the uptake of the information by the locals in Kenya especially farmers. The study however proposes the consideration of establishing a radio station to serve the same purpose in place of the newspaper following the preferences and accessibility to it in remote areas over newspapers. These are long term venture that seek to increase uptake and utilization of weather and climate information in Kenya.

Although huge resources are involved in the weather related projects, they should not be forgone for something else since the opportunity cost of doing so is high. Just like in China where similar initiatives are taken by provincial governments in collaboration with the national government, the counties in Kenya, especially those in food basket zones should take this as a growth opportunity and work together with the national government for public good.

REFERENCES

Adhikari U., Nejadhashemi A.P., Woznicki S.A., 2015. Climate change and eastern Africa: a review of impact on major crops. Food and Energy Security, 4: 110-132.

Amissah-Arthur A., 2003. Targeting climate forecasts for agricultural applications in sub-Saharan Africa: Situating farmers in user space. Climatic Change, 58: 73-92.

Aura S., Muthama N.J., Karanja F.K., Kahuha S., Chanzu B., King'uyu S., 2015. Making Meteorological Services More Beneficial to Farmers. WMO Bulletin, 64 http://www.wmo.int/bulletin/en/content/making-meteorological-services-more-beneficial-farmers (Accessed on 30/05/2015).

Funk C., Dettinger M.D., Michaelsen J.C., Verdin J.P., Brown M.E., Barlow M., Hoell A., 2008. Warming of the Indian Ocean threatens eastern and southern African food security but could be mitigated by agricultural development. Proceedings of the National Academy of Sciences, USA, 105: 11081-11086.

Giannini A., Biasutti M., Held I.M., Sobel A.H., 2008. A global perspective of African Climate. Climatic Change, 90:359-383.

GoK, 2007. Kenya Vision 2030. A Globally Competitive and Prosperous Kenya. Ministry of Planning and National Development, Go-vernment Printing Press, Nairobi-Kenya. http://www.vision2030.go.ke/wp-content/uploads/ 2015/06/Vision2030_Popular_version_final2.pdf (Accessed on 21/09/2014).

Hastenrath S., 2007. Circulation mechanisms of climate anomalies in East Africa and the equatorial Indian Ocean. Dynamics of Atmospheric Oceans, 43: 25-35.

ICPAC, 2007. Climate Change and Human Development in Africa: Assessing the Risks and Vulnerability of Climate Change in Kenya, Malawi and Ethiopia. http://hdr.undp.org/sites/default/files/igad.pdf (Accessed on 21/09/2014).

Indeje M., Semazzi F.H.M., Ogallo L.J., 2000. ENSO signals in East African rainfall seasons. International Journal of Climatology, 20: 19-46.

IPCC, 2007. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry *et al.*, (Eds), Cambridge University Press, Cambridge, UK, 976 pp.

KMD, 2014. OND 2014 Seasonal Weather Forecast. http://www.meteo.go.ke/ranet/Wx/seasonal.pdf (Accessed on 30/09/2014).

Lyon B., Dewitt D.G., 2012. A recent and abrupt decline in the East African long rains. Geophysical Research Letters, 39: 1-5.

Lyon B., 2014. Seasonal drought in the Greater Horn of Africa and its recent increase during the March-May long rains. J Climate, 27: 7953-7975.

Motha R., Sivakumar M.V.K., Bernardi M., (eds), 2006. Strengthening Operational Agrometeorological Services at the National Level: Proceedings of the Inter-Regional Workshop, Manila, Philippines, 22-26 March 2004.

Muthama N.J, Masieyi W.B., Okoola R.E., Opere A.O., Mukabana J.R., Nyakwada W., Aura S., Chanzu B.A., Manene M.M., 2012. Survey on the Utilization of Weather Information and Products for Selected Districts in Kenya. Journal of Meteorology and Related Sciences, 6: 51-58

Niang I., Ruppel O.C., Abdrabo M. A., Essel A., Lennard C., Padgham J., *et al.*, 2014. Africa. Pp. 1199-1265. In Climate change 2014: impacts, adaptation, and vulnerability. Part B: regional Aspects. Contribution of Working Group II to the Fifth Assessment Report ofthe Intergovernmental Panel on Climate Change [Barros V.R., Field C.B., Dokken D.J., Mastrandrea M.D., Mach K.J., Bilir T.E., Chatterjee M., Ebi K.L., Estrada Y.O., Genova R.C., Girma B., Kissel E.S., Levy A.N.,

MacCracken S., Mastrandrea P.R., White L.L., (eds)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY.

Nyakwada W., 2009. Predictability of East African seasonal rainfall with sea surface temperature gradient modes. PhD Thesis, Department of Meteorology, University of Nairobi, Kenya.

Oettli P., Camberlin P., 2005. Influence of topography on monthly rainfall distribution over East Africa. Climate Research, 28: 199-212.

Ogallo L., Oludhe C., 2009. Climate information in decision making in the greater horn of Africa: lessons and experiences. WMO Bulletin, 58: 184-187.

Ogallo L., 1988. Relationships between seasonal rainfall in East Africa and the Southern Oscillation. Journal of Climatology, 8: 31-43.

Owiti Z., Ogallo L.A., Mutemi J., 2009. Linkages between the Indian Ocean Dipole and East African Seasonal Rainfall Anomalies. Journal of Kenya Meteorological Society, 2:3-17.

Shilenje Z.W., Ogwang B.A., 2015. The Role of Kenya Meteorological Service in Weather Early Warning in Kenya. International Journal of Atmospheric Sciences, 2015: ID 302076. http://dx.doi.org/10.1155/2015/302076

Schreck C.J., Semazzi F.H.M., 2004. Variability of the Recent Climate of Eastern Africa. International Journal of Climatology, 24: 681-701.

Shongwe M.E., van Oldenborgh G.J., van den Hurk B., van Aalst M., 2011. Projected Changes in Mean and Extreme Precipitation in Africa under Global Warming. Part II: East Africa. Journal of Climate, 24:3718-3733.

Stefanski R., 2007. Applications of Meteorology to Agriculture. In: Stigter, K. (eds.). Guide to Agrometeorological Practices. 3rd Edition (WMO No. 134) World Meteorological Organization, Geneva, Switzerland.

Tierney J.E., Ummenhofer C.C., deMenocal P.B., 2015. Past and future rainfall in the Horn of Africa. Science Advances, 1:e1500682. DOI: 10.1126/sciadv.1500682.

Williams A.P., Funk C., 2011. A westward extension of the warm pool leads to a westward extension of the Walker circulation, drying eastern Africa. Climate Dynamics, 37: 2417-2435.

Yang W., Seager R., Cane M.A., Lyon B., 2014. The East African Long Rains in Observations and Models. Journal of Climate, 27: 7185-7202.

Yang W., Seager R., Cane M.A., Lyon B., 2015. The Annual Cycle of the East African Precipitation. Journal of Climate, 28: 2385-2404.

Zendera W., Obwoyere G.O., Maranga E.K., 2011. Access and utilization of agro meteorological information by smallholder irrigation farmers in Kenya. African Crop Science Conference Proceedings, 10: 643-646.