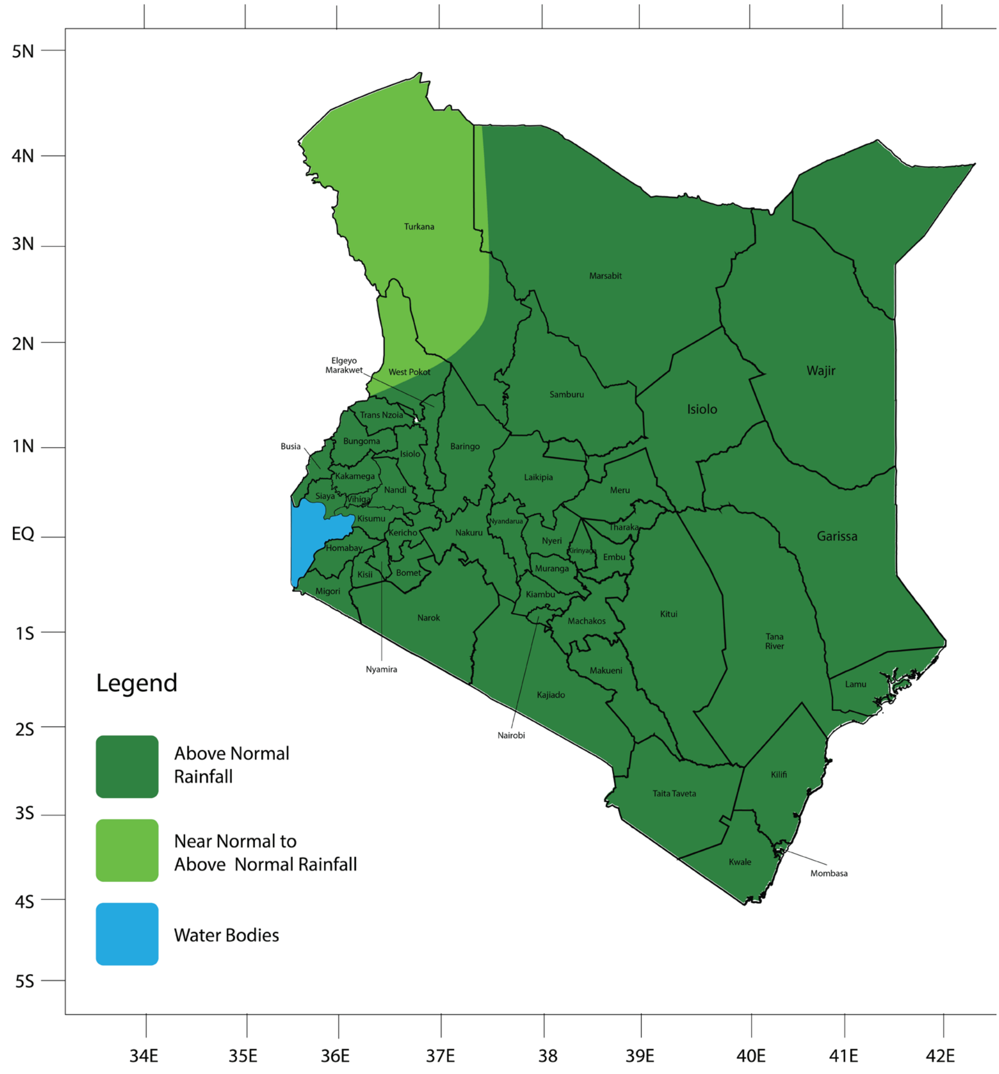
BARRIERS OF USING CLIMATE AND WEATHER FORECASTS IN DROUGHT PLANNING AND DECISION MAKING



Kenya
Red Cross

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LIST OF ABBREVIATIONS

ASAL	Arid and Semi-Arid Lands
DEWS	Drought Early Warning Systems
EDE	Ending Drought Emergencies
FAO	Food and Agricultural Organisation
FbA	Forecast-based Early Action
ForPAc	Towards Forecast Based Preparedness
KENGEN	Kenya Electricity Generating Company
KMD	Kenya Meteorological Department
KRCS	Kenya Red Cross Society
MAM	March April May
LRA	Long Rains Assessment
NDCF	National Drought Contigency Fund
NDMA	National Drought Management Authority
OND	October-November-December
SRA	Short Rains Assessment

1.0 INTRODUCTION

1.1 Background

Recurring droughts have significantly impacted livelihoods and economic development in Kenya. The frequency of these events is increasing; for example, from 1993 the Government of Kenya has declared drought as a national disaster 7 times . These declarations were during the droughts of 1992-93,1996-97, 1999-2000, 2005-06, 2008-09, 2010-2011 and 2016-2017. Not only has the frequency of the drought events increased to every 2-3 years, the severity has also increased in terms of the total population affected and the humanitarian aid needed for response (Table 1). According to the post-disaster needs assessment conducted by the Kenya Government , the 2008-2009 and the 2010-2011 drought events affected a total of 3.7 million people and caused $12.1 billion in damages and losses . The 2016/2017 drought event affected 23 of 47 counties, where 2.7 million people were declared to be food insecure and 357,285 children and pregnant and lactating mothers were acutely malnourished .

Following the 2010-2011 devastating drought, the Kenyan Government launched a Medium Term Plan for Drought Risk Management and Ending Drought Emergencies (EDE) for 2013-2017. The EDE commits to end drought as an emergency by the year 2022, by strengthening institutional and financial frameworks for drought risk management. To this end, the EDE established the National Drought Management Authority (NDMA) with a mandate to provide leadership and coordinate drought risk management plans, interventions, polices and stakeholders across national and county levels. To address the challenges of financing drought management, the EDE established the National Drought Contingency Fund (NDCF). The fund allows the pooling of resources from different actors.

Amongst NDMA's responsibilities is monitoring of drought conditions by establishing and operating a Drought Early Warning System (DEWS) in 23 Arid and Semi-Arid Counties. The DEWS aggregates data and information monthly from sentinel sites and key sectors like education, agriculture, health, livestock and health. Currently, the DEWS monitors biophysical, production, access and utilization indicators (Table 2). Biophysical indicators are used to monitor progression of the drought hazard while production, utility and access indicators monitor the impacts of the drought. For each indicator, thresholds are set to define three drought stages: alert, alarm and emergency.

The use of observed indicators to monitor and define drought stages and to trigger funding from the National Drought Contingency Fund (NDCF) means the drought management system is reactive and not anticipatory. The integration

Table 1: Historical Comparison of Drought Events in Kenya 2

MAJOR DROUGHT EVENTS	GOK[2] AND INTERNATIONAL HUMANITARIAN AID RECEIVED (US$)	NUMBER PEOPLE AFFECTED[3]	TOTAL POPULATION	% OF POPULATION AFFECTED
2011	427.4m	3.75m	41.4m	9.1%
2009	432.5m	3.79m	39.3m	9.6%
2006	197m	2.97m	36.3m	8.2%
2003/2004	219.1m	2.23m	34.4m	6.5%
1998-2001	287.5m	3.2m	31.9m	10.0%

[1]'DROUGHT IN KENYA.' <https://www.researchgate.net/publication/321461935_DROUGHT_IN_KENYA> [accessed 15 April 2019].
[2]The Post Disaster Needs Assessment- droughts in 2008-2011 was done with technical support from the European Union, United Nations, and World Bank. https://www.gfdrr.org/en/publication/kenya-post-disaster-needs-assessment-droughts-2008-2011 [accessed 28 June 2019]
[3]USAID, 'Economics of Resilience to Drought: Kenya Analysis', 43.
[4]'Kenya: Drought- 2014-2019', ReliefWeb <https://reliefweb.int/disaster/dr-2014-000131-ken> [accessed 18 June 2019].

Table 2: Indicators monitored by the NDMA drought EWS (Source: NDMA)

TYPE OF INDICATOR	SPECIFIC INDICATORS MONITORED
Biophysical	Rainfall estimates Vegetation Condition Index (VCI) State of natural vegetation and pasture conditions State of water sources
Production	Livestock production –Livestock body condition, livestock diseases and pests, milk production, livestock migration patterns, livestock mortality Crop production – Timeliness and status of crops, implication on food security
Access	Livestock Prices - Terms of trade, cattle/ goat prices Price of cereals and other food products Distance to water for households Distance to grazing areas
Utilisation	Health and Nutrition Status – Mid-Upper Arm Circumference (MUAC), human diseases and epidemics Coping strategy index Milk and food consumption

of weather and climate forecast in the system can shift the system to be anticipatory and hence better inform actions to reduce the impacts of droughts on the economy as well as on vulnerable communities before the droughts occur.

1.2 Anticipatory Approach in Disaster Management

Despite the availability of early warning systems and information, very often communities, governments, humanitarian organisations and international aid agencies tend to respond after, rather than in advance of a severe drought. And yet there exists a window of opportunity between the issuance of early warning information and the impacts of drought events being felt where early actions can be taken to mitigate impacts on society.

Recognising this window of opportunity, and taking advantage of advances in science, data and technology, the Red Cross Red Crescent Movement developed and has piloted an approach known as Forecast-based early Action (FbA), in partnership with meteorological and hydrological services and other humanitarian agencies. Coughlan de Perez et al. defined FbA as when a forecast states that an agreed-upon probability threshold will be exceeded for a hazard of a designated magnitude, then an action with an associated cost must be taken that has a desired effect and is carried out by a designated organisation .

FbA initiatives seek to jointly develop standard operating procedures with key stakeholders, where each stakeholder commits to undertake certain actions when a forecast for an extreme event is issued. For example, in 2017 when rains were set to fail in the Horn of Africa region, the Food Agricultural Organization (FAO) piloted an early warning early action system in Marsabit, Wajir, Kilifi and Kwale . The system initiated early actions such as, providing veterinary care for livestock and distributing animal feeds.

The FbA approach has the potential to transform the way governments, humanitarian actors and communities view and address crises caused by climatic hazards from reactive to proactive actions. Moreover, investment into early action can be a more effective way of delivering

[5]E. Coughlan de Perez and others, 'Forecast-Based Financing: An Approach for Catalyzing Humanitarian Action Based on Extreme Weather and Climate Forecasts', Natural Hazards and Earth System Sciences, 15.4 (2015), 895–904 <https://doi.org/10.5194/nhess-15-895-2015>.
[6]'CA0227EN.Pdf' <http://www.fao.org/3/ca0227en/CA0227EN.pdf> [accessed 18 June 2019].

humanitarian aid in the long term by acting before the worst effects of disasters are felt. According to the FAO, for every 1 USD they spent per household in early action in 2017, 3.5 USD was saved. However, had the FAO waited for the drought to hit before responding with assistance such as restocking, the response would have cost an additional 9 USD per household6.

2.0 CLIMATE AND WEATHER FORECASTS IN KENYA

The Kenya Meteorological Department (KMD) provides weather and climate forecasts at different timescales, ranging from 24 hours to three months ahead. Every day KMD produces a 24-hours ahead forecast and a forecast of average conditions for the next five days. At the start of every week (Monday), a seven days' average forecast is also produced.

At the end of every month, a forecast for the next month is produced showing the likelihood of total precipitation in that month being above normal, normal or below normal (Figure 1). A month or weeks to the main rainfall seasons, March-April-May (MAM) and October-November-December (OND), a seasonal forecast is produced showing the likelihood of the total seasonal rainfall being above normal, normal or below normal (Figure 2).

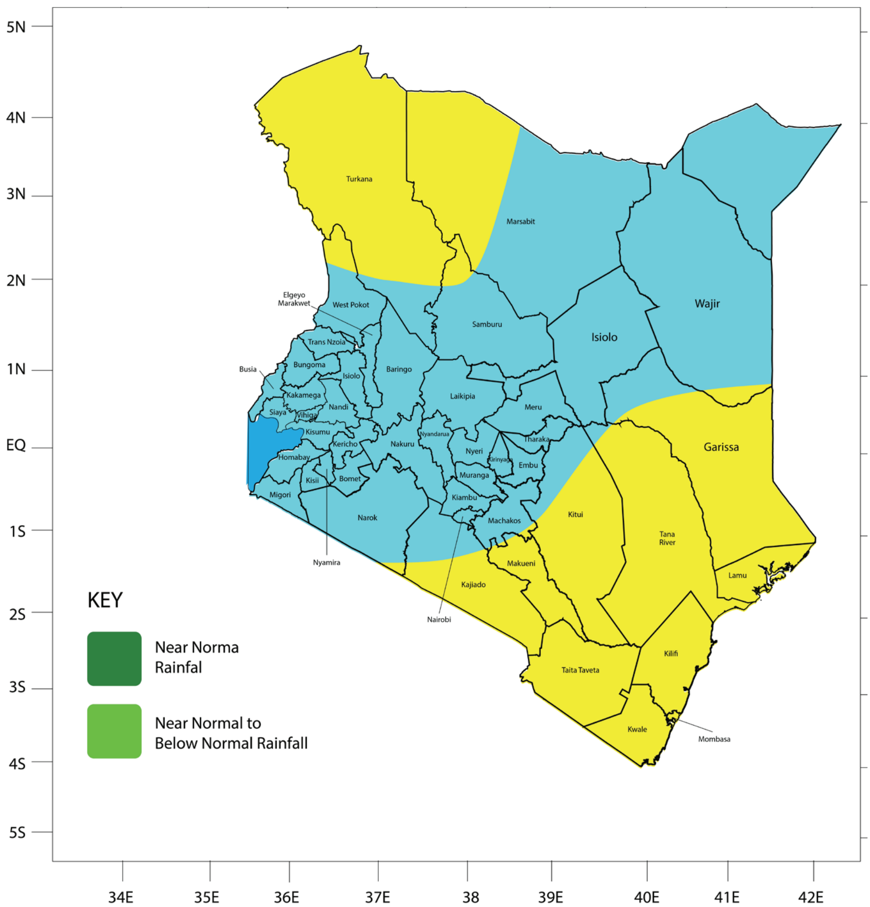

Figure 1: April 2019 monthly rainfall forecast. Source; Kenya Meteorological Department

7'329335905_Extreme_Rainfall_and_Flooding_over_Central_Kenya_Including_Nairobi_City_during_the_Long-Rains_Season_2018_Causes_Predictability_and_Potential_for_Early_Warning_and_Actions.Pdf'

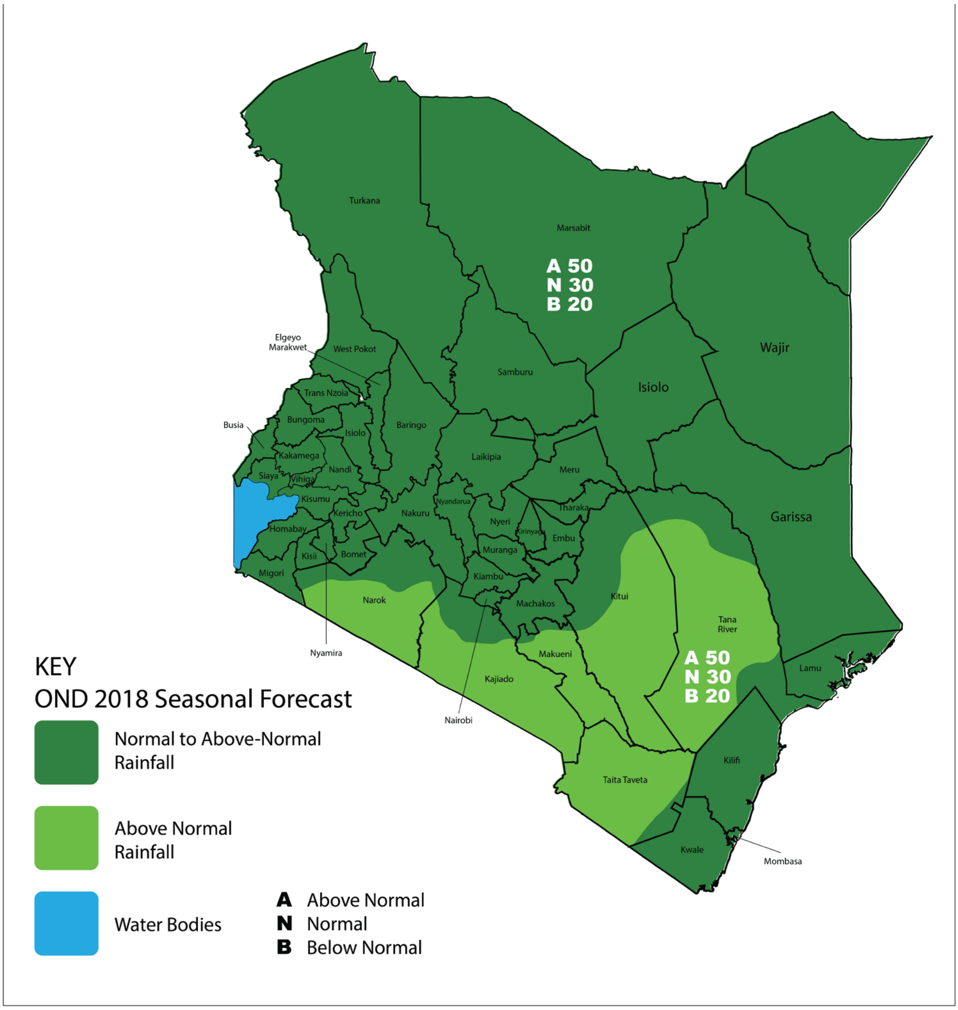

Figure 2: October-November-December 2018 seasonal rainfall forecast. Source; Kenya Meteorological Department

The seasonal, monthly, seven days' and five days' forecast bulletins indicate that these forecast should be used in conjunction with subsequent forecast updates issued by KMD. This means users need to continuously monitor the forecasts provided. This provides an opportunity for users track the progress of the level of certainty in an earlier forecast, and use the latest information to update their contingency plans.

However, a long-standing issue with the forecasts released by KMD is that they do not include the skill of the forecast. In the absence of this, users do not know how skillful the forecast is – for example, how many times the forecast is correct versus hence how many time they would be acting in vain if they took actions based on the forecast. To support FbA the forecast skill should go beyond the scientific one and introduce stakeholder early actions and associated avoidable losses and evaluate the forecasts in terms of their potential to reduce expected losses from extreme events.

2.1 Challenges in using climate and weather forecasts

2.1.1 Towards Forecast Based Preparedness (ForPAc) project

In an effort to understand why forecasts produced by KMD are not effectively informing the drought management process in Kenya, the Towards Forecast based Preparedness Action (ForPAc) project (Box 1) conducted a workshop in Kitui County, one of the Arid and Semi-Arid Lands (ASAL) counties in Kenya. The aims of the workshop were to map the current drought management process and to understand the constraints to forecasts from informing the process.

2.1.2 Challenges

Current forecast production is not in sync with drought planning and decision making processes

Every year, NDMA conducts two assessments namely, the Short Rains Assessment (SRA) and the Long Rains Assessment (LRA) which aim to analyze and determine the impact of the Long (March-May) and Short (October-December) rain seasons on food and nutrition security, as well as the food security prognosis for the next six months. Climate forecasts could inform the food prognosis however; the forecasts are not available at the time when assessments are conducted. The Meteorological Department issues the Long rains forecast towards Mid-February while the Short rains forecast is issued in September, which are times when the SRA and LRA have been concluded (Figure 3). Further, the seasonal forecasts are only for a three-month period while the food prognosis is for the next six months thus leaving a three months' gap in information.

Limited technical capacity to interpret and use probabilistic forecasts in decision making. Seasonal climate forecasts, which are crucial for planning and management of rain fed agriculture with implications on food security, are presented in form of probability, to cater for the inherently chaotic nature of the atmosphere.

The probabilities indicate the likelihood of the seasonal total rainfall being above normal, normal and below normal. The tendency is for stakeholders to consider the highest probability in decisions and actions, often disregarding other lower probabilities. Further, it is not always known what 'normal' rainfall means for specific areas and the implications of this amount of rainfall. This makes probabilistic forecast complex to use in decision making, hence technical guidance is required to interpret and incorporate the forecasts in decision making. Most decision makers have limited capacity to build scenarios that cater for the different probabilities.

For example, in OND and MAM 2018, the category that had been forecasted with a low probability of occurrence is the one that actually occurred while stakeholders had planned with the category with the highest

Box 1: The Towards Forecast Based Preparedness (ForPAc) Project

The Towards Forecast Based Preparedness (ForPAc) project is a research consortium made up of institutions in the United Kingdom, Kenya and the Greater Horn of Africa region, including universities, national meteorological agencies such as the UK Met Office and the Kenya Meteorological Department and humanitarian organization the Kenya Red Cross (for full project membership see www.forpac.org)

The project aims to address limitations to taking early action on climate information. Firstly, by improving the availability of decision-relevant climate information by piloting research forecasts for extreme flood and drought events. Secondly, the project is promoting the use of climate information by identifying and addressing barriers to preparedness action in existing early warning systems in Kenya.

The project's pilot work on drought is currently focused on Kitui county. This aims to promote systematic early action in the operational Drought Early Warning System (DEWS) managed by the National Drought Management Authority (NDMA). Flood focused case studies are also being undertaken in Nairobi County and the Nzoia River basin.

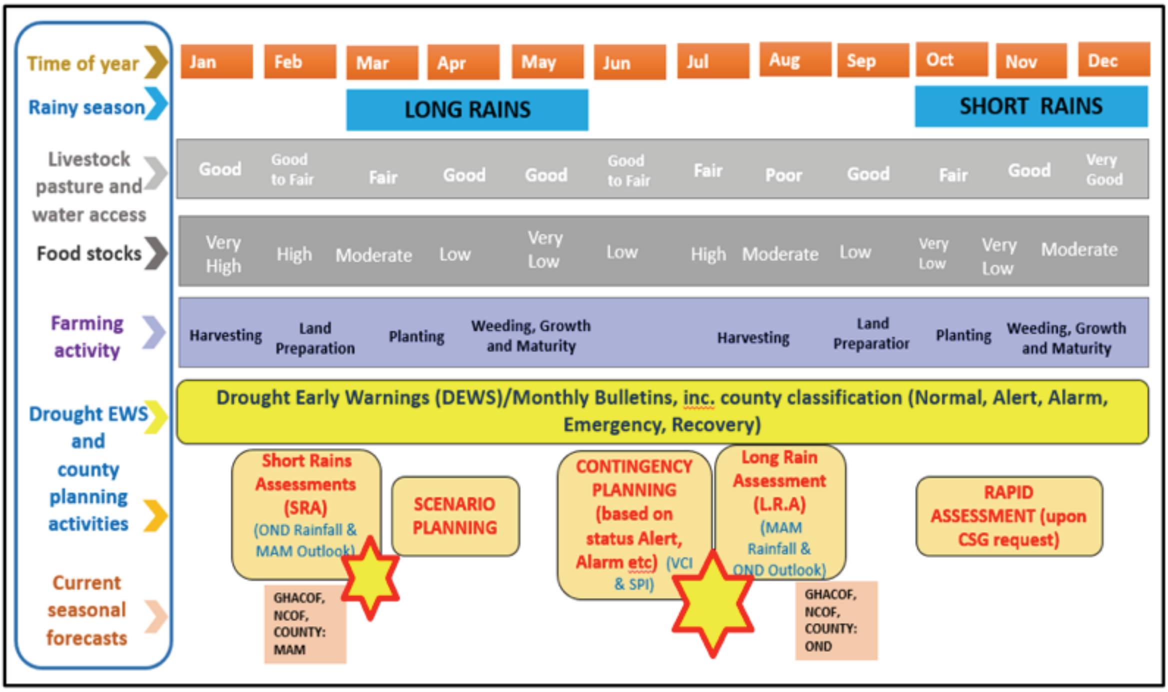

Figure 3: Schematic of annual climate, livelihoods, drought risk management and seasonal forecasts for Kitui county, developed with stakeholders

probability of occurrence. This experience has made decision makers perceive that the forecasts are inaccurate and cannot be trusted, in future, this can prevent stakeholders from acting on available weather and climate forecasts.

Inadequate synergies between providers and decision makers.

KMD provides rainfall forecasts while as decision makers are most interested in the potential impacts of the rainfall. The need for impact information is demonstrated by indices used in drought decision making, such as Vegetation Condition Index (VCI) and Standardized Precipitation Index (SPI). Both indices are used to define the drought phases, while VCI is a trigger for funding. VCI compares the current state of the vegetation to the state at same period over a five-year period while SPI is the deviation of current observed rainfall total from a 30-year average. Currently, KMD does not produce impact based forecasts required by stakeholders because of limited knowledge and data on drought vulnerability and exposure.

Forecast communication

In an effort to get closer to users of weather and climate forecasts, KMD decentralized their services to the Counties. However, the County officers are not autonomous and do not have the equipment to produce County specific forecast hence they have to wait for forecasts to be developed at the head quarter for them to tailor the forecasts to their respective counties.

This means that the forecast will take long to reach the decision makers at the County level which affects the timeliness of decision making. Further, forecasts mostly do not get to benefit the most stakeholders because there are often packaged and disseminated without critical consideration of who needs the information, how best they can access, understand and use it to take action. The format and language of the climate and weather forecasts is sometimes too difficult and technical for decision makers to understand. The channels used for communication sometimes are not favorable for decision makers, email is most commonly used channel, it doesn't provide a good environment for user feedback and consultation.

Lack of Standard Operating Procedures for integrating forecasts

The drought management process currently relies heavily on observed indictors and not climate and weather forecast hence there are no standard operating procedures that spell out how the forecast integration should be done, the specific information that can be used and who can be consulted in case the forecast is not clear. The lack of standard operating procedures for integrating forecast information in the process could be linked to the limited technical capacity to interpret and use climate and weather forecasts.

Forecast production is not in sync with budgeting process

The production and release of seasonal forecasts in February and September doesn't correspond with the annual budgeting process that starts in December and ends in June when the budget is presented. This means money for implementing actions is not set aside annually based on a forecast. The County Emergency Fund, established by the Public Finance Management Act of 2012, mandates 2% of total county government revenue for use to manage events that threaten damage to human life or welfare and environment. Currently, these funds are only released when any kind of disaster happens.

3.0 RECOMMENDATIONS, IMPLICATIONS AND CONCLUSION

3.1 Recommendations

Collaboration between users and producers.
The drought decision making process has opportunities for integrating weather and climate forecasts. For example, the month ahead forecast could be integrated in the monthly bulletin in order to inform the sectoral recommendations and food security outlook. Stakeholders in drought management should involve KMD in the process so that they better understand the process and are able to provide the forecasts need for the process.

Early release of a skillful October-November-December seasonal forecast.
Research that has been carried out by the ForPAc project, has shown that the October-November-December (OND) season has higher predictability as early as July (Kilavi et al., 2018) . In light of this, it will be useful for KMD to issue an OND forecast in July, so that it coincides with the Long Rains drought assessment and inform the six months' food security prognosis.

Co-develop forecast with users.
Producers of weather and climate forecast need to work closely and regularly with users and decision makers to understand their evolving needs and to align these needs with production of forecasts. Additionally, users and decision makers should be involved in the design of climate and weather forecasts packages and metrics of presentation. This will ensure the content, format and language of the forecast are easy to understand, and it will also contribute to better uptake and use of forecasts.

Build capacity for communication and interpretation.

Producers need to enhance their technical capacity to communicate weather and climate forecasts to decision makers in a manner that is easy to understand and interpret and does not sacrifice the integrity of the underlying science. This should go hand in hand with building capacity of decision makers and users for them to be able to understand, interpret and integrate forecasts in institutional short term and long term plans.
Additionally, KMD should continually analyse the skill of forecasts at all timescales and communicate the same to stakeholders. This will inform users how often the forecasts are correct and how often they would be acting in vain. This information has the potential to increase the uptake and use of weather and climate forecasts.

[8] 'Bridging Forecast Verification and Humanitarian Decisions: A Valuation Approach for Setting up Action-Oriented Early Warnings | Elsevier Enhanced Reader' <https://doi.org/10.1016/j.wace.2018.03.006>.

Strengthen the mandate of County Directors of Meteorological Services.
For forecasts to reach users, especially in Counties, in a timely manner, the County Directors Meteorological Services in all Counties need to be semi-autonomous. This will give them the mandate to provide County specific forecasts without having to wait for the forecasts produced at KMD headquarters. There is opportunity for this to be integrated in the draft Meteorological Bill.

3.2 Implications on FbA

For FbA implementation there are three components that are critical. Firstly, what early actions can be triggered by a forecast so as to mitigate the impact of extreme events. Secondly, what forecast information can be used to trigger the early action. Thirdly, deciding whether or not it is worthwhile to act based on the available forecast information . The three components are dependent on available climate and weather forecasts hence the need enhance the production, communication, interpretation and use of forecasts as in the recommendations amongst stakeholders in the drought management process.

3.3 Conclusion

More needs to be done to advance the understanding and use of climate and weather forecasts in decision making. This article has pointed to a number of key areas where specific changes and improvements can be made to facilitate the integration of this information into decision making processes. However, fostering meaningful and sustained links and collaboration between producers and users of forecasts is essential for promoting the uptake of climate and weather forecasts into decision making. Additionally, uptake of forecasts can only improve if producers understand the dynamics of the decision making and tailor make products for these purposes.

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