GCRF AFRICAN SWIFT
SCIENCE FOR WEATHER INFORMATION AND FORECASTING TECHNIQUES

# Exploiting Sub-seasonal Forecast Predictability in Africa: a key to sustainable development

New real-time sub-seasonal forecast information is aiding preparedness and disaster risk reduction decisions in key flood- and drought-vulnerable sectors across Africa and enabling significant progress in sub-Saharan Africa towards the UN Sustainable Development Goals. These services are demonstrating the potential for wider development of sub-seasonal user-focussed services at scale across Africa. We make key recommendations to achieve this vision.

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## Background

Sub-Saharan Africa is particularly vulnerable to weather-related extremes: African floods, heat waves, droughts and storms affect hundreds of millions of people every year, leading to economic impacts amounting to billions of dollars. The populations of sub-Saharan Africa have a great need for skilful and actionable sub-seasonal (one to four week) forecast information to support early warning systems, as lives, livelihoods and national economies are heavily dependent on weather-sensitive environments and sectors. The availability and uptake of sub-seasonal information and services is still low in Africa, the use of which would allow action-based sub-seasonal forecasting to build socio-economic resilience across the continent.

Recent advances in sub-seasonal prediction have the potential to support preparedness action leading to societal and economic benefits across sub-Saharan Africa. However, there are significant barriers to realising this potential. Improved understanding and forecasting of the sources of sub-seasonal predictability and their impacts on local African weather, is necessary, but not sufficient to produce useful and actionable sub-seasonal information for users. There remains a further important gap in knowledge: how to improve the appropriate use of operational sub-seasonal forecasting products for actionable decision-making.

Realising this potential requires the co-production of new forecast products and tools through an iterative collaboration across a range of stakeholders and disciplines. By including the knowledge from the decision-making context of forecast users, such an approach shifts the forecast development process away from being supply-driven to demand-led. Forecast users are also integral to the evaluation process: assessing the skill of a sub-seasonal forecast should combine a comprehensive evaluation of meteorological skill with an evaluation of how forecasts can best support weather-sensitive decisions. It is important to recognise that effective co-production of bespoke forecast products is resource-intensive and requires capacity-building and training for all groups involved, who can then deliver solutions at scale, whilst tailoring to individual needs.

Another significant challenge is data availability. Having direct access to real-time forecast model data has enabled user-directed iterations, both in terms of data manipulation and visualisation, to make new forecast products more actionable. Making project-initiated services sustainable (i.e. integrated into meteorological services' Standard Operating Procedures) is a challenge and longer-term aim of the GCRF African SWIFT sub-seasonal testbed, which hinges on the continued access to real-time sub-seasonal forecast data.

## GCRF African SWIFT Sub-seasonal Forecasting Testbed

Through a Real-Time Pilot Initiative of the World Meteorological Organisation (WMO) Sub-seasonal to Seasonal Prediction Project, the GCRF African SWIFT sub-seasonal forecasting testbed has brought together forecast producers, researchers and forecast users in tropical Africa, to develop sub-seasonal forecasts through a forum approach. Prototype forecast products are co-produced and operationally trialled in real-time using forecast data from the European Centre for Medium-Range Weather Forecasts (ECMWF), for the first time. Launched in November 2019 in Ngong, Kenya, the testbed provides an opportunity for close collaboration between participants to support the co-production of useful (actionable and skilful), tailored sub-seasonal forecasts.

*GCRF African SWIFT Sub-seasonal Testbed participants at the kick-off event, Ngong, Kenya, November 2019*

Throughout the testbed process, National Meteorological Services and Regional Climate Centres act as a broker of sub-seasonal forecast information to provide invaluable expertise in using these data to co-develop useable forecast products. Socio-economic sectors, such as agriculture, health, disaster risk reduction and energy, have been able to use sub-seasonal forecasts to inform effective preparedness for events such as droughts and extreme rainfall, as well as supporting planning decisions to enable the best use of the prevailing weather. The co-production approach applied in this forecasting testbed supports co-ownership of the process and comprehensive documentation of the products, both of which supports the possibility for legacy by scaling outcomes to other locations, users and sectors.

Crucially, co-production within a forecasting testbed shortens the timescale between the development of meteorological research and the application of forecasting knowledge into decision-making. This has the potential to strengthen important relationships between forecast providers and users, and minimise the delay in getting useful, actionable information to those most vulnerable to weather-related risks. However, there is a fine balance to strike between providing new information quickly, and fully verifying the reliability of forecast products through thorough evaluation.

## The Impact and Value of Sub-seasonal Forecasts in Africa

The skill of sub-seasonal forecasts is regime-dependent, that is, as well as particular regions and seasons having higher (or lower) skill, there is a dependence on the strength of important large-scale drivers such as El Niño and the Madden-Julian Oscillation. Understanding the regime-dependence in different regions and in different seasons is particularly important as it allows a better understanding of the skill we expect forecast models to demonstrate under particular large-scale conditions. Therefore, the decisions and sectors informed by sub-seasonal forecasts depend, partially, on the large-scale drivers (and the local weather conditions they influence) within the region and the desired timing for both operational and strategic decision-making. For example, precipitation from the West African monsoon is important due to the large number of socio-economic activities dependent on the onset of the monsoon, including agriculture, water resource management, transportation, and health. Similarly, in some regions of East Africa most rainfall occurs during the 'long rains' season (March to May), where a significant proportion of the region's population depends on rain-fed agriculture. Long rains failures in the 2010/2011 and 2016/2017 seasons led to climate-related crises that resulted in 12 million and 26 million people, respectively, in need of humanitarian assistance. Although weather forecasting in the tropics is not currently fully understood in economic terms across the continent and sectors, it is clear that producing reliable and actionable forecasts on sub-seasonal timescales has enormous potential to benefit the lives, livelihoods and national economies of African countries.

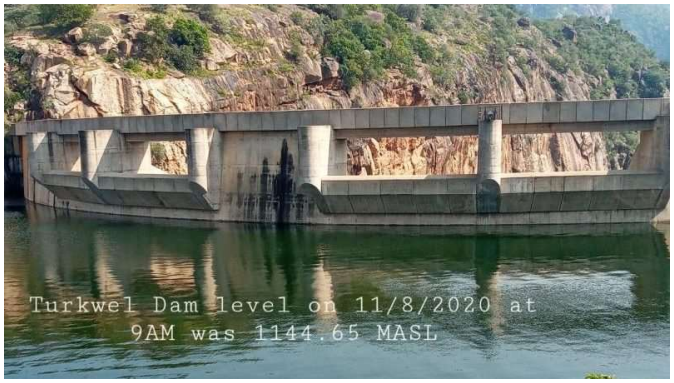
### *Case Study: Sub-seasonal forecasts progress Nigeria towards greater food security*

*A farmer from Yobe state reports benefits of the sub-seasonal rainfall prediction. Photo supplied by CASP.*

Tailored, co-produced forecast information provided by the Nigerian Meteorological Agency (NiMet) to farmers has improved decision-making, supporting national ambitions to achieve food security for Nigeria's growing population. Prior to the testbed, farmers in Nigeria made their decisions without the support of local weather information. The Climate Change Adaptation and Agribusiness Support Programme (CASP) has worked with NiMet to provide forecasts to 663 village areas and approximately 104 local communities across seven states, supporting more than 10,500 farmers in 2020.

For the first time, through the testbed, every village got access to sub-seasonal forecast information, such as predicted onset date, dry spell periods, length of the growing season, volume of rain expected, and cessation date. Farmers were able to make informed decisions about what and when to plant, as well as what actions to take to ensure their crops did not fail. CASP has started seeing benefits of the testbed already in terms of increasing food security (contributing to UN SDG 2) through an improved prediction of the monsoon onset date and better irrigation management. In just the first year of working with NiMet, Nigerian farmers are now relying on the sub-seasonal forecast information and are planning for the season ahead.

***Case Study: Electricity blackouts in Kenya prevented by sub-seasonal forecasting***




*Kenya's Turkwel dam at historical highest level of 1144.65 meters above sea level, August 2020.*

In Kenya, sub-seasonal forecasts co-produced by the Kenya Meteorological Department (KMD) and KenGen, Kenya's leading power generator, have resulted in improved planning decisions for increasing hydropower generation in the national power supply and for the provision of dam management. Hydropower is KenGen's most important form of energy, accounting for 45% of their total supply. Before the onset of the rainfall season, KenGen lowers the water levels in their dams to create space for the expected rainwater in order to collect as much water as possible for power generation without overflowing and causing flooding downstream. KenGen prepares power generation schedules based on sub-seasonal forecast products from KMD, making them critical to avoiding blackouts, even during droughts. This forecast-based decision-making is both improving power generation in terms of supply and predictability, and contributing to the UN Sustainable Development Goals, through provision of affordable and clean energy from greater renewable energy generation (SDG 7) and contributing to climate action by phasing-out diesel power generation (SDG 13). Forecast products are also proving key to building sustainable cities and communities (SDG 11) through better disaster management in Kenya. Forecasts provided by KMD help KenGen determine when dams will overflow and by how much, enabling them to alert communities who live downstream to take precautions or evacuate, while also supporting organisations such as the Kenya Red Cross who respond to flood disasters.

***Case Study: Sub-seasonal forecasts predict the location and scale of meningitis outbreaks in sub-Saharan Africa***

The African Centre of Meteorological Applications for Development (ACMAD), is using sub-seasonal weather data to give up to two weeks' advanced warning of conditions 'likely' or 'highly likely' to trigger a meningitis outbreak. There are around 30,000 cases of meningitis in Africa each year: one in ten infected people die and others suffer with brain damage, epilepsy and deafness. During the dry season from November to June, there is an elevated risk of meningitis outbreaks due to the hot, dry conditions and the prevalence of dust particles, which irritate people's airways and allow airborne microorganisms to get into the body and cause a meningitis infection. Previous health alerts, which had been based on the analysis of weather observations from the previous week, informed health agencies to identify areas where meningitis-risk conditions were developing – but not what was likely to happen over the next one to two weeks. As such, it gave little or no advance warning. Now, by analysing contributing factors such as humidity, air quality, temperature and wind speed, meningitis vigilance maps can provide an early warning (two weeks in advance) to those areas where conditions are predicted to be favourable for an outbreak to occur. Getting such information out to governments and health workers in advance allows for more effective preparedness action to prevent or control disease outbreak, essentially contributing to UN SDG 3: Good health and well-being through the reduction in impact of communicable diseases.

## Summary and recommendations

Sub-seasonal ensemble forecast products are now being co-produced and applied across Africa due to the GCRF African SWIFT real-time pilot testbed. Whilst forecast skill varies spatially and temporally, the case studies provided in this policy brief, shows their potential for significant progress

made towards preparedness action in addition to supporting the wider UN SDGs, including: Zero Hunger; Good Health and Well-Being; Affordable and Clean Energy; and Climate Action.

As an international community of forecasters, researchers and scientists, there is now a pressing need to better evaluate these systems and co-produce new forecast products that are tailored to support the decision-making processes most impacted by weather and climate-related risks across these timescales.

- It should be recognised that the success of the GCRF African SWIFT sub-seasonal forecasting testbed and its impact has only been possible due to the availability of real-time sub-seasonal weather forecasting data produced by the European Centre for Medium-Range Weather Forecasts (ECMWF), made available to African-SWIFT through the World Meteorological Organization's Sub-seasonal to Seasonal Prediction Real Time Pilot Initiative.
  ***Recommendation: Continued access to real-time high quality sub-seasonal weather forecast data for African National Meteorological Services to determine the full value of forecasts for preparedness action and progress towards the UN SDGs.***
- In order for services to be delivered at scale across Africa, the African forecasting agencies in every region need sufficient technical scientific skills and infrastructure to process the data and produce bespoke products for their clients without continued reliance on partners from outside Africa.
  ***Recommendation: Prioritise the sustained training of African meteorological professionals in the handling, processing and visualisation of data for forecast service co-production.***
- Understanding what drives sub-seasonal predictability and being able to accurately model the impact on local weather over Africa is necessary, but not sufficient to produce useful and actionable forecast products. There remains a need to improve the appropriate use of operational sub-seasonal forecasting products for actionable decision-making by including forecast users in the knowledge generation and evaluation process through co-production.
  ***Recommendation: Further funding is needed to determine predictability on sub-seasonal timescales, and to test and apply the appropriate use of these forecasts. UK funders (FCDO, UKRI), the European Innovation Union (H2020), and global philanthropic funders should be aware of the potential for investment in research and innovation supporting sub-seasonal forecasting. Through investment, we can move towards full operationalisation of forecasts using sub-seasonal forecast data across sectors and nations in sub-Saharan Africa.***
- It is becoming increasingly clear that the evaluation of sub-seasonal forecast skill is not only a question of meteorological verification, but also a comprehensive process that should combine meteorological skill with evaluation from users and decision-makers.
  ***Recommendation: Ongoing research and development must continue to assess impact-based evaluation. Directed efforts into evaluating and assessing the benefits of sub-seasonal forecasts will provide evidence to support investments from both private and public funders to National Meteorological Services.***
- Knowledge generated through effective co-production of weather and climate services needs to be institutionalised to enable the African SWIFT sub-seasonal testbed framework to be implemented at scale. Co-production approaches have been predominantly employed in project-initiated services, which have devoted significant resource to the development and ongoing evaluation of forecast products. Increasing the range of users and decisions being supported by sub-seasonal forecasts will require increased institutional capacity in the African agencies in terms of scientifically skilled staff with training and experience in co-production of services.
  ***Recommendation: Project-led initiatives need a legacy plan to ensure greater ownership and implementation of forecasting solutions by National Meteorological Services.***
- There is a skills gap in co-production experience and expertise for many forecasters working in National Meteorological Services and Regional Climate Centres.
  ***Recommendation: WMO should integrate a transferable methodology into National Frameworks for Climate Services in Africa to share learning to support the development of cost-effective co-production, together with capability building through directed training.***

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