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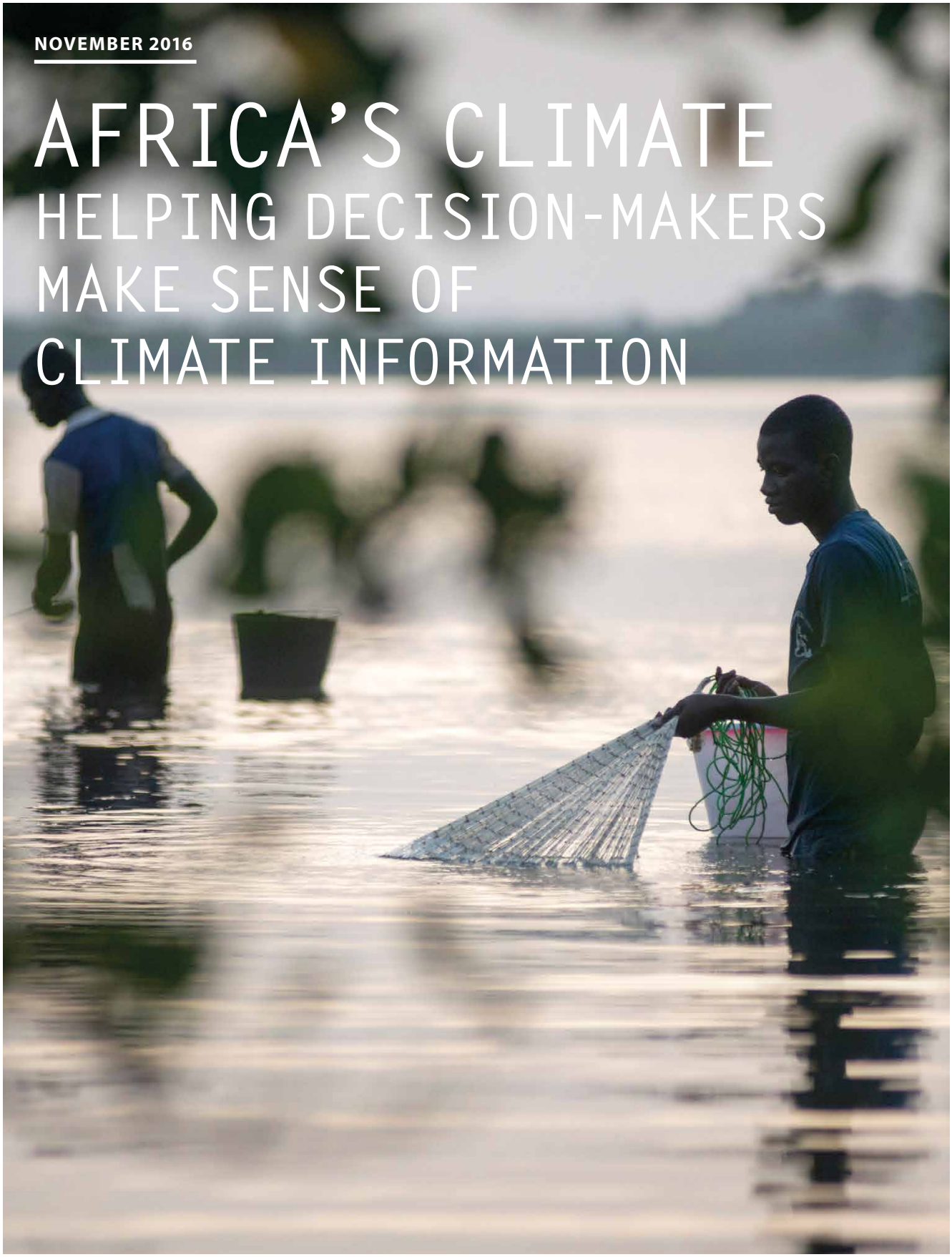
AFRICA'S CLIMATE
HELPING DECISION-MAKERS MAKE SENSE OF CLIMATE INFORMATION



FUTURE CLIMATE FOR AFRICA

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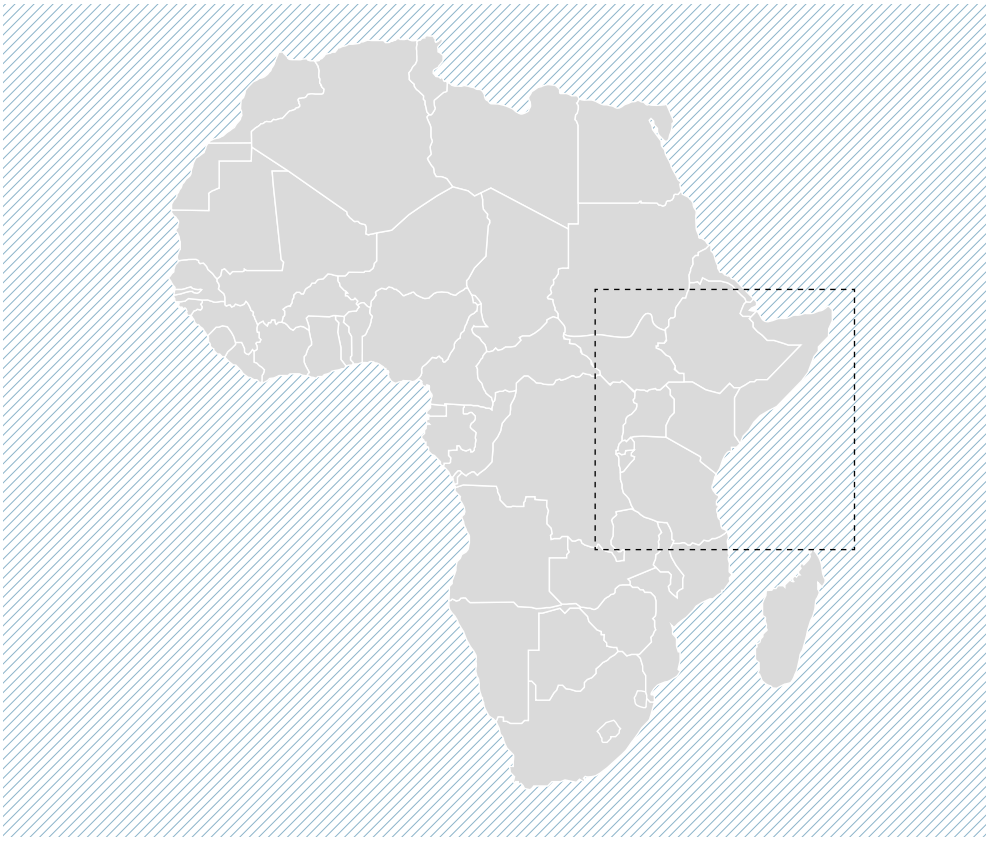
SCIENTISTS

EAST AFRICA
BURNING QUESTIONS

EAST AFRICAN CLIMATE VARIABILITY AND CHANGE

AUTHORS

Julio Araujo, John Marsham, Dave Rowell, Nkulumo Zinyengere, Andrew Ainslie, Andrew Clenaghan, Rosalind Cornforth, Giovanna De Giusti, Barbara Evans, Declan Finney, Dan Lapworth, David Macdonald, Celia Petty, John Seaman, Fredrick Semazzi, Celia Way



NEED TO KNOW

Scientists focusing on climate change in east Africa are interrogating climate models to provide more reliable information for decision-makers. Their burning questions include:

- How will aspects of climate that are relevant to decision-makers change? Will heavy rain and droughts increase? Will the region get wetter or drier in future?
- How will climate change impact on above- and below-ground water flow, the water levels of Lake Victoria, and underground water storage?
- What are the implications for rural livelihoods, including those dependent on rain-fed agriculture and fishing? And what are the policy and governance considerations within these sectors?
- How can cities design the most resilient water, sanitation and hygiene systems, in light of future climate change predictions?

INTRODUCTION

Climate change is expected to impact east Africa in the coming decades, with an overall warming trend, but much is still uncertain. Climate researchers working in this field aim to quantify, understand and reduce this uncertainty.

On a five to 40 year timescale, climate projections are uncertain because the models used to predict the expected response from greenhouse gas emissions cannot capture all the relevant processes sufficiently well. In addition, many of the standard climate models do not fully consider all regional factors causing local climate change. There are therefore several 'burning questions' that scientists hope to address.

WHAT DO DECISION-MAKERS NEED TO KNOW? HOW WILL EXTREME WEATHER CHANGE?

Climate research often considers factors such as average annual temperatures, or annual rainfall totals in its analysis. There are good scientific reasons for studying and understanding how and why these change. However, decision-makers often need more specific information, such as expected changes in sub-daily rainfall extremes, seasonal changes in night-time minimum temperatures, or changes in lengths of dry spells during the growing season. Although the overall change in rainfall is uncertain (see below) there is good evidence that both heavy rain and droughts will increase. Climate scientists aim to investigate such changes in the east African region and quantify decision-relevant metrics of climate change and their uncertainties from a range of climate models.

QUESTION 1: THE EAST AFRICAN 'CLIMATE PARADOX': WETTER OR DRIER?

While global warming is unequivocal, predicting changes in regional rainfall patterns over the coming decades is much more challenging. Over much of east Africa, the 'long rains' in March, April and May have been observed to be decreasing, whilst global climate models tend to predict a wetting.

Researchers will investigate the causes for the observed changes, as well as the modelled trends, to understand this so-called paradox. Currently, the different controls on the 'long rains' and 'short rains' are not well understood for an unperturbed climate. A better understanding of this will be a key step for climate scientists in their work to better understand climate change for east Africa throughout its seasonal cycle.

New understanding of how the east African climate responds to natural variations in Earth's climate in remote regions ('teleconnections', such as the El Niño Southern Oscillation and the Madden Julian Oscillation) will allow researchers to produce novel ways to test the reliability of different climate models.

As the Earth warms globally, rainfall increases, but some regions will get wetter and others drier

As the Earth warms globally, rainfall increases, but some regions will get wetter and others drier. Predicting changes in atmospheric circulation is critical to predicting changes in rainfall for any particular region. This requires sufficiently accurate modelling of both the drivers of change, and the atmospheric response.

Researchers will address drivers of change that are often not considered in standard climate models, such as:

- land use change
- changes in aerosol emissions in remote regions such as Asia, as a result of increased fossil fuel burning
- changes in lake temperatures; for example Lake Victoria is the largest tropical lake in the world, and its temperature affects circulations on scales of hundreds of kilometres
- how to represent small-scale storms in the models, which produce most rainfall in east Africa and are a key component of the atmospheric circulation.

Researchers will capitalise on unprecedented high-resolution modelling to understand how changes in moist convection may affect changes in rainfall and the regional circulation over east Africa. This work is expected to produce an expert judgement on the reliability of various aspects of climate projections for east Africa.

QUESTION 2: WATER FLOWS, LAKE LEVELS AND GROUND WATER RECHARGE

The impact of future climate change on surface and groundwater stores is highly uncertain. However, there are some emerging future climate narratives for east Africa around the duration of dry spells and rainfall intensity that help focus hydrology research questions. Current climate extremes cause significant impacts, including flooding and drought; these signals may be intensified under future climate scenarios.

While changes in climate are very important, it is worth noting that other impacts will also have larger implications for water resources across parts of east Africa on a five to 40 year time scale, namely population growth and land use change. The current uncertainty regarding the future climate, the complex interaction of climate and non-climate factors, as well as the limited data availability for long-term rainfall, river flow and groundwater levels in

this region, all combine to make the estimation of future changes in terrestrial water storage hugely challenging.

Future extremes and long-term water resources

Key questions include the extent to which surface water flow variability will change, whether there will be a significant difference in the amount of surface water flow, and what this means for lake levels. Behind these questions is the need to understand if future water flows and lake levels will be adequate to sustain environmental needs, water supply and energy requirements, and how these will impact on the future frequency and scale of flooding.

The lack of rainfall and river flow observations at a high temporal and spatial resolution currently limits flood impact modelling. Climate scientists are starting to address this deficit.

Another important research question is how changes in climate will alter the relative importance of recharge processes and groundwater storage in the long term. This will be particularly critical in more arid regions that are underlain by hard-rock aquifers with lower storage capacity, so are therefore more susceptible to over-exploitation.

Future water resources and meeting the demand

Irrigation is likely to be an important sector for investment and development, if food production is to increase to meet future demand, and if rainfall becomes more variable, or reduces. The region will need to seek alternatives to rain-fed agricultural practices, alongside exploring new climate-tolerant crops.

In addition, while there may be adequate water resources, how will socio-economic constraints limit future exploitation? Hotspots of higher water demand, such as urban centres and irrigation schemes, will grow. This is particularly true around the shores of Lake Victoria.

There may well be a future spatial mismatch between local water demand on the one hand, and the availability of water resources on the other. This needs to be assessed and quantified. Groundwater can help meet some of this demand, even in low storage hard-rock aquifer settings, provided there is effective water resource management. The increased use of water resources for irrigation will require agricultural extension, as well as more readily available financing, particularly for small-scale farming.

If groundwater becomes a more important source of water supply, which is highly likely, natural water quality considerations and constraints, such as fluoride, arsenic and iron may become more important. Overall, as is now the case in parts of Asia, water quality constraints may emerge as a bigger issue in the region than water resource availability, given population growth and urbanisation, as well as salinisation associated with agricultural intensification.

Environmental water flows

Environmental flows and water quality may emerge as a crucial issue around Lake Victoria, given the future impact from urbanisation in this region

Groundwater sustains baseflow in rivers during low rainfall periods, and shallow groundwater levels maintain groundwater-dependent wetlands. Baseflow typically provides an underlying good quality source of water that is key for maintaining the natural ecology in these habitats. These wetlands have local and international significance, as well as being important for tourism.

The necessity of this baseflow contribution may grow under future climate change if dry spells are longer on average, particularly in already marginal areas. Observations are required to underpin the assessment of habitat impact and modelling to predict future status. Environmental flows and water quality may emerge as a crucial issue around Lake Victoria, given the future impact from urbanisation in this region. Locally, the priority to maintain environmental flows may be considered low, with competing demands that override environmental considerations. Therefore, it is necessary to make impartial predictions

about the consequences of decisions. This is likely to be a growing issue across the whole of east Africa in the next 40 years, particularly in regions experiencing large increases in population growth.

QUESTION 3: RURAL LIVELIHOODS

- People (farmers, fishers, micro-entrepreneurs etc), households and businesses in the Lake Victoria Basin (LVB) are making daily decisions to adjust and hopefully enhance their diverse suite of short-term and longer-term livelihood strategies to household-level and wider changes. What are the key signals that currently drive decision-making across these domains?
- If the wider region takes successive hits from changes in rainfall and temperature and from increasingly unpredictable weather events, then what additional population movements could this give rise to, and how would that affect governance in the LVB, particularly regarding access to land, labour, livelihoods and crucially, the rule of law?
- In a scenario where fish stocks have contracted permanently over time, and the livelihoods and incomes for all those active in the fishing value chain are adversely affected, what other livelihood options do the affected people in the LVB realistically have to make a viable living?
- How effectively are the current actors and structures of governance serving local communities and administrations in the delivery of climate services and information?
- What kinds of bottlenecks (e.g. coordination, accessibility of data, financial, technological, human resources, and regulatory constraints) are present within and across these governance structures, and what is currently being done to overcome them?
- Given the specificities of the LVB context, which strategies that are effective in other regional contexts can be adapted for the generation and sharing of critical, scaled information about climate risk and livelihood adaptation with and for institutions and households?
- To what extent are climate change impacts currently integrated into decisions related to development projects, programmes and policies related to infrastructure, agriculture, fisheries, and resource management?
- Given the probabilistic nature of climatic events, the complex evaluation of costs and benefits, and the contextual bias towards the present, what innovations, including insurance schemes of various types, can be developed and/or repurposed to increase system resilience?

Decisions need to be made about investment in water, sanitation and hygiene systems, in the context of a range of possible future climate scenarios

QUESTION 4: WATER, SANITATION, AND HEALTH IN TOMORROW'S CITIES

Which types of infrastructure and services should cities prioritise to ensure that the benefits of water supply and sanitation are sustained under a range of probable climate futures?

Decisions need to be made about investment in water, sanitation and hygiene systems, in the context of a range of possible future climate scenarios. To ensure that cities can plan for and design resilient systems, climate scientists will seek to identify solutions that perform well under as many of these different scenarios as possible.

For example, changes in rainfall intensity under climate change are likely to affect requirements for drainage systems. Existing and best-available alternatives will be modelled in selected areas of the study cities, to explore how relative costs and benefits are likely to change in light of future climate trends. This will help develop a better understanding of long-term economically viable and sustainable approaches to water, sanitation and hygiene issues in east Africa.

FCFA'S HyCRISTAL PROJECT

Project objectives

Availability of water is fundamental for development in east Africa. However, this vital resource is already under stress from land degradation, pollution and overfishing. Climate change adds to these problems, greatly increasing the vulnerability of the poorest people in the region.

Climate projections show a warming trend in east Africa in the decades ahead, but changes in rainfall and weather extremes are currently uncertain. HyCRISTAL will tackle current uncertainties which exist around climate change projections for the region, concentrating in particular on what they mean for the availability and management of water.

HyCRISTAL will develop new understanding of climate change and its impacts in east Africa, working with the region's decision-makers to manage water for a more climate-resilient future. See www.futureclimateafrica.org/project/hycristal/

The institutions involved in HyCRISTAL are:

- University of Leeds
- African Centre for Technology Studies
- British Geological Survey
- Centre for Ecology and Hydrology (UK)
- Evidence for Development
- Jomo Kenyatta University
- Loughborough University
- Met Office (UK)
- National Centre for Atmospheric Science (UK)
- National Fisheries Resources Research Institute (Uganda)
- North Carolina State University
- Practical Action
- Stony Brook University
- Tanzanian Meteorological Agency
- Ugandan National Meteorological Authority
- Ugandan Ministry of Water Resources
- University of Connecticut
- Makerere University
- Maseno University
- Walker Institute
- University of Reading (Africa Climate Exchange)

CONTACT US

Future Climate for Africa
Jean-Pierre Roux, Manager
CDKN Africa / SouthSouthNorth
55 Salt River Road
Salt River
Cape Town 7925
South Africa
+27 21 447 0211
Email: info@futureclimateafrica.org

@future_climate
www.futureclimateafrica.org

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