FUTURE CLIMATE FOR AFRICA

Research Consortium Summary

June 2020

HyCRISTAL: Integrating Hydro-Climate Science into Policy Decisions for Climate-Resilient Infrastructure and Livelihoods in Africa

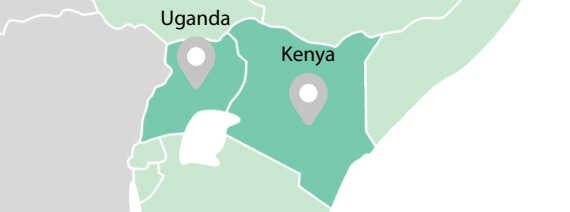
About FCFA

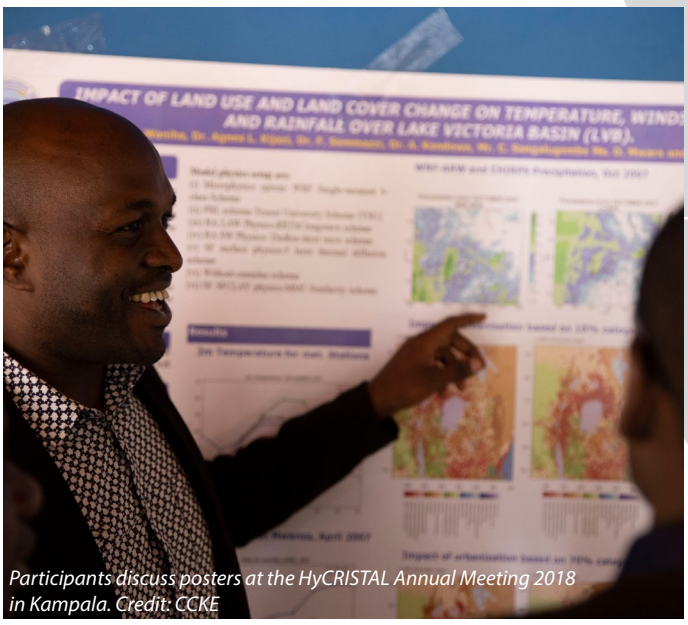
Future Climate for Africa (FCFA) is generating fundamentally new climate science focused on Africa, and ensuring that this science has an impact on human development across the continent.

FCFA consists of five research consortia who are undertaking research to significantly improve the understanding of climate variability and change across Africa and contributing to improved medium to long-term (5-40 year) decision-making, policies, planning and investment by African stakeholders and donors.

About HyCRISTAL

HyCRISTAL (Integrating Hydro-Climate Science into Policy Decisions for Climate-Resilient Infrastructure and Livelihoods in Africa) aimed to develop new understanding of East African climate change and variability and work with regional decision-makers to support effective long-term (5 to 40 year) decision-making in the face of a changing climate.





Participants discuss posters at the HyCRISTAL Annual Meeting 2018 in Kampala. Credit: CCKE

In collaboration with a range of stakeholders, and formally supported by the East African Community, HyCRISTAL is co-developing climate change adaptation options that meet the region's societal needs in both urban and rural areas. This is through a series of pilot projects covering: urban Water, Sanitation and Hygiene (WASH), rural livelihoods, water management and tea production. It is also contributing to the HyTPP project on transport and Lake Victoria water levels.

By developing climate science and helping users assess their vulnerabilities, HyCRISTAL aimed to increase the resilience of communities in East Africa. HyCRISTAL is working with policy makers to quantify risks and is providing new, accessible, and easy-to-use climate information tools that can be applied to the decision-making process.

Why it's important to understand climate change and variability over East Africa

East Africa's rapidly growing population faces large natural climate variability. The availability of water is fundamental for development in the region, but this vital resource is already under stress from the growing population through: increased extraction for water supply, land degradation, pollution, and overfishing.

Climate change adds to these problems, greatly increasing the vulnerability of the poorest people in the region. Climate change is expected to increase both temperatures and rainfall intensities, and change rainfall patterns. Recent devastating floods and droughts have demonstrated how East Africa is vulnerable to climate variability and extreme weather. Increasing resilience to weather extremes as the population grows is therefore vital for the future of millions of people in East Africa.

Kenyans wade through floodwaters from Lake Victoria. Credit: Mathew Okello, Practical Action

HyCRISTAL's approach to improving climate-resilient infrastructure and livelihoods in East Africa

HyCRISTAL's interdisciplinary approach brought together fundamental climate science with climate-impacts scientists, engineers, hydrologists, hydrogeologists and social scientists. The approach involved:

- Working with decision-makers to understand aspects of climate change and **identifying on-the-ground partners for project uptake** to ensure successful future impacts.
- Engaging with key stakeholders in linking weather and infrastructure/services to **identify critical 'hot spots'** where impacts of adverse weather events could be clearly demonstrated.

Testing observation equipment before installation on the Lake Victoria observation station. Credit: Prof. Kamazima Lwiza, Stony Brook University

- Using approaches that support **co-production of decision-relevant climate information** and enable channels for on-going dialogue between the providers and users of climate information across various sectors.
- **Improving understanding of** climate change over East Africa particularly focusing on furthering understanding of changes in rainfall (past and future), quantifying and narrowing uncertainty of projections, and incorporating processes not well represented in global climate models (e.g. moist convection, land-use change, aerosol changes).
- Taking a **risk-based approach**, with all climate model projections treated as plausible, unless proved otherwise.
- **Communicating possible future scenarios** for urban and rural areas through Climate Risk Narratives.
- Building and maintaining **hydroclimate monitoring infrastructure** that provides data to underpin long-term decision-making.

How HyCRISTAL went about improving climate-resilient infrastructure and livelihoodsin East Africa

Generating a step-change in the scientific understanding **of East African climate change** HyCRISTAL's unique methodology brought together information on possible change from global model ensembles, such as CMIP, with both bespoke modelling and observations to quantify climate change risks. This involved:

- **Quantifying** future user-relevant metrics**:** these were defined in a co-production approach from a wide range of global climate models.

- **Narrowing the range of possible future rainfall changes:** it is still unclear if total rainfall will increase or decrease, but the largest modelled increase in the East African long rains has been found to be implausible.
- **Demonstrating the role of non-greenhouse gas drivers of climate change:** future global patterns of aerosol emissions are expected to affect future East African climate, especially for the short rains, and the next-generation projections and analysis should account for this.
- **Understanding future increases in extremes:** using high-resolution "CP4A" climate simulations (from IMPALA) to show that extreme rainfall is expected to intensify more than is projected by global climate models, and that increases in extremes may be more widespread than in those models.

Participants discuss posters at the HyCRISTAL Annual Meeting 2018 in Kampala. Credit: CCKE.

- **Using global models and CP4A to show that significant changes in seasonality may occur:** many models show later and longer short rains and an earlier end to the long rains, with a larger rainfall increase in the short rains than the long rains (this is linked to deepening of the Saharan Heat Low). Although it must be noted that changes to both onset and cessation are still uncertain in both seasons.
- **Exploring the "East African climate change paradox":** showing that past rainfall trends resulted from shorter not drier long rains, linked to some regional drivers, and rainfall has increased again in recent years.
- **Understanding of rainfall variability:** including how remote tropical cyclones can increase or decrease East African rainfall depending on their location.

More details are provided in HyCRISTAL's climate change summary

Use of climate change information to support rural livelihoods in Homa Bay (Kenya) and Mukono (Uganda)

- **Developing new pathways for climate research** that supports resilience of rural communities vulnerable to climate change to help decision-makers with informed short-term and long-term decisions on rural adaptation.
- Building an **evidence-based pathway to rural adaptation** at the county and national levels, using the Household Economic Approach (HEA) and Individual Household Method (IHM).
- **Training local farmers in visual storytelling**, using filmmaking as a way to communicate directly with the Mukono district government.
- **Training of the Trainers approach employed for Household Economy Assessment** to build capacity in local HEIs to collect data going forward.
- **Providing users with access to an integrated resource** for climate, crop, fisheries, hydrology, and livelihoods information, by developing the Integrated Database for African Policymakers (IDAPS) platform.
- **Engaging with governments** on the National, sub-national and local level to influence policy, budget and implementation. Including; delivering a briefing paper on rural adaptation to the Ugandan Parliament, providing **input to the** Ugandan National Environmental Bill, engaging with Ministry of Agriculture to **support the implementation of the Koronovia Joint Work Programme on Agriculture** in Uganda, **enabling increased funding** for agriculture extension services in Mukono, providing **advice to the Ministry of Health** thereby influencing the Uganda Climate Change Act, and **providing information on the Kenyan livelihoods analysis and future climate scenarios** to the Lake Region Economic Bloc (LREB) to support adaptation and mitigation activities.


Fishermen working on their nets on the shores of Lake Victoria. Credit: Linda de Volde.

Use of climate change information in planning of urban Water, Sanitation and Hygiene (WASH) in Kisumu (Kenya) and Kampala (Uganda

- **Introducing local stakeholders to emerging climate research**, while supporting climate scientists to identify information that is locally relevant
- Created **simulations of surface water flooding** under various plausible climate scenarios.
- **Engaging with local community groups** about their lived experience of flooding to assess the local relevance of the flood model and producing an **informational** video to share these flood stories.

Drainage channel in informal settlements of Kamwookya, Kampala pose health hazards to residents particularly when flooding occurs.
Credit: Enno Schröder, SuSanA Secretariat / CC BY (https://creativecommons.org/licenses/by/2.0)

- **Making new observations** of urban hydrometeorology to characterise spatial variability, test flood models and inform decisions.
- Producing **enhanced spatial coverage of rainfall and flow measurements** in Kampala together with the Ugandan Ministry of Water and Environment (MWE) and Uganda National Meteorological Authority (UNMA) to inform hazard mapping.
- **Developing a geo-spatial health hazard model** to examine the health impacts of flooding.

Use of climate change information in water resource planning in Uganda

- **Improving use of climate information** in Integrated Water Resource Management (IWRM) in the Lake Victoria Basin (LVB) by partnering with the Ugandan Ministry of Water and Environment (MWE)
- Assessing future changes in river flow in the LVB by comparing data from the CP4-Africa climate model and global climate models. An automated system has been built to enable river models to be developed from historic river flow datasets and used with climate model outputs to assess future flows and their uncertainty. This system will be embedded in an existing water resource management information system in Uganda, operated by MWE.
- **Co-production and embedded learning from the impact modelling** in the LVB for both long-term strategic planning and for operational purposes. Uganda has in recent years adopted a decentralised Integrated Water Resource Management approach. The modelling tools developed within HyCRISTAL and the understanding gained from their application, will be used in decision-making undertaken within IWRM stakeholder fora.

Use of climate information in planning for Lake Victoria level changes (with HyTPP project)

- **Analysing possible future lake levels and outflow** under climate change with modelling showing that both increases and decreases are possible.
- **Enabling approaches that incorporate risks into decisions** based on plausible ranges in future lake levels by sharing results with the World Bank (Corridors for Growth Trust Fund administrators) and other stakeholders.

Use of climate change information in long-term decisions in tea production (CI4Tea) in Kenya (collaboration with UMFULA)

- **Developing a novel approach** to combine regional and global model uncertainty and observations and communicating locally relevant climate information for more resilient tea production.
- **Iteratively engaging tea sector stakeholders** to help tailor climate information to their needs and incorporate their feedback to develop usable climate information.
- **Producing a** video on the impacts of climate change on tea in Malawi and Kenya, which showcases the CI4Tea research.

Introducing climate change into the Greater Horn of Africa Climate Outlook Forum (GHACOF)

- Starting dialogues with climate information users on the timeline of actions needed in response to climate risks, with particular focus on the actions needed now, and providing tools to enable stakeholders to continue these dialogues to lead towards more effective decisions.
- **Using recent high-impact events**, such as the 2019 floods, locust outbreaks and 2020's record breaking Lake Victoria water levels, to engage decision-makers in planning for long-term change.
- **Sharing climate lessons from HyCRISTAL** to build on GHACOF's past experience of seasonal prediction (working with ICPAC, the UK Met Office and WISER).

Prof. Fred. Semazzi facilitating a group discussion during the Future Climate Current Policy (FCCP) Framework session at GHACOF 54. Credit: CCKE

Taking HyCRISTAL's Research Forward

HyCRISTAL is taking its science and pilot projects forward through 2020 and 2021;

- **Maximising uptake of urban WASH planning tools** by deepening the policy engagement in Kampala and Kisumu and widening the policy engagement both regionally and between the infrastructure and climate science communities.
- **Local capacity building for ongoing climate resilient livelihoods research.**
- **Extending the Integrated Database for African Policymakers (IDAPS)** platform through working with identified government partners to explore change scenarios that are relevant to their decision 'use cases' and developing a Training of Trainers (ToT) curriculum with local partners to support on-going quantitative climate-livelihoods impact monitoring.
- **Application of HyCRISTAL's climate change analysis and hydrological modelling** to water allocation planning in Uganda, building capacity and developing hydrological models used for operational decision-making in Uganda.
- Continued **two-way engagement with a wide range of users and user-sectors at GHACOF** by building on the successful HyCRISTAL/WISER collaboration to bring climate change into the forum, alongside its existing and primary focus on seasonal prediction.

Broader lessons from HyCRISTAL

- HyCRISTAL shows that research can deliver improved and usable predictions, and that the following are all valuable components of a useful and robust methodology:
  - relevant **evaluation of models**
  - understanding the processes that control **user-relevant weather** and **past climate change**
  - understanding **uncertainty in climate change** from ensembles of global models and narrowing this through **future-centric evaluation**
  - quantifying and understanding the roles of **processes or forcings not well-captured in CMIP** (e.g. aerosols or convection)
  - **quantitatively synthesising CMIP and non-CMIP uncertainties** with observations for co-production of projections for key metrics used for decisions.
- HyCRISTAL's climate science methodology could be replicated/built on for other regions. In East Africa much work remains to be done to both continue development of process understanding of recent and projected climate and weather, and to bring this through to improved predictive information. It is noted that:
  - future CP4A-like simulations would benefit from a

coupled lake model, and an ensemble approach that includes models with less wetting for East Africa,

- although **quantitative synthesis of CMIP & CP4A information for decisions has been achieved, this is still a new research area**, but could clearly be achieved 'at scale',
- **links between weather and climate physics** means that much science is applicable to predictions on all time-scales

- Many **users make decisions across a range of time-scales** and there is opportunity for scientists to engage across all of these too, with success on short time-scales in building trust to enable science to inform long-term planning.
- **Embedded researchers and/or trusted (and funded) on-the-ground partners** is often critical to the success of the project.
- **Projects acting as "an impartial 3rd party"** to facilitate multi-stakeholder workshops can be hugely beneficial. **Climate change is a great way to bring together individuals from diverse backgrounds and disciplines** and can be invaluable in complex multi-sectoral, multi-stakeholder decisions.
- **Recognising, leveraging and making agreements about the use of existing data or previous projects can help build relationships** and is essential for reducing duplication and to build on past work.
- HyCRISTAL's hydrogeology methodology could be built on and applied to understand longer term changes in groundwater resources in this region and elsewhere. **Understanding the resilience of this large, dispersed water resource to changes in climate is critical** to planning secure water futures in Africa.
- **Introducing climate science has provided context and added urgency to urban WASH decision making.** Incorporating climate change in planning of water and sanitation infrastructure reveals a lack of experience in incorporating even current weather related shocks. It has also provided the opportunity to highlight that sanitation is not a stand-alone 'problem'. Responding to climate impacts requires a **joint effort across a range of sectors**, which requires either decentralised planning and delivery or strong leadership in sector ministries.
- **Including experiences from households and practitioners** is important to understanding how climate changes are affecting peoples' lives and understanding the constraints and opportunities that practitioners have. This ensures outputs can be better tailored to stakeholder needs and thus have greater long-term impact.
- **Projects often uncover the 'real' problem through doing the research** – flexible project funding is invaluable for researchers being able to solve those problems within the project
- **The additional cost of building resilience into regular infrastructure delivery is often marginal when compared with the absolute investment costs required to make up existing shortfalls** in infrastructure and services provision.

Participants participate in group activities during the HyCRISTAL Annual Meeting 2019 in Kampala. Credit: CCKE

Partner Organisations:

Lead: University of Leeds (UK)

African Centre for Technology Studies (pan-Africa)

Africa Climate Exchange at the University of Reading (UK)

British Geological Survey (UK)

CEH: Centre for Ecology and Hydrology (UK)

Evidence for Development (UK)

IGAD Climate Predictions and Applications Centre (ICPAC), (Kenya)

Jomo Kenyatta University (Kenya)

Loughborough University (UK)

Makerere University (Uganda)

Maseno University (Kenya)

Met Office (UK)

National Centre for Atmospheric Science (UK)

North Carolina State University (USA)

Practical Action (UK)

Stony Brook University (USA)

Tanzanian Meteorological Agency (Tanzania)

Tea Research Institute (Kenya)

Ugandan National Meteorological Authority (Uganda)

Ugandan Ministry of Water and Environment (Uganda)

University of Connecticut (USA)

Victoria Institute for Research on Environment and Development (Kenya)

Walker Institute at the University of Reading (UK)

For more information visit https://futureclimateafrica.org/project/hycristal/ or contact hycristal@leeds.ac.uk or info@futureclimareafrica.org

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HyCRISTAL Team Photo at Annual General Meeting 2019 in Kampala. Credit CCKE

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Climate & Development Knowledge Network

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