Droughts over Sub-Saharan Africa

A Joint UK-Ghana Contribution to the UNESCO Intergovernmental Hydrological Programme (IHP)

Organised by UK Centre for Ecology & Hydrology, Ghana Meteorological Agency, Ghana Hydrological Authority and Water Resources Commission of Ghana under the NC for Global Challenges Programme

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UK Centre for Ecology & Hydrology

NATIONAL CAPABILITY FOR GLOBAL CHALLENGES

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Highlights

The Droughts over Sub-Saharan Africa Workshop brought together key stakeholders, researchers, and policymakers to address key challenges in drought monitoring, prediction, and impact assessment in Ghana and the wider region. Participants' time and contributions were sincerely appreciated, as their insights and expertise enriched the discussions. The workshop covered three major research themes: seasonal drought forecasting, drought indicators and their impacts, and flash droughts, with a focus on integrating research insights into operational forecasting and decision-making. The agenda featured presentations from UK and Ghana participants, followed by breakout discussions. Special thanks to all the co-organizers and host institutions for their support in making this workshop a success.

Following the workshop, UK scientist engaged with key Ghana organizations focused on water research, to explore collaboration opportunities on common research topics of drought predictions. The visit aimed to build bridges between UK and Ghanaian organizations working on drought mitigation and resilience, fostering long-term collaborations to enhance hydrological forecasting and climate adaptation.

A recurring theme during this visit was the limited availability of data and knowledge exchange, which affects drought monitoring and forecasting. The event highlighted the need to bridge the gap between theoretical drought indices and real-world applications by incorporating unconventional data sources. Discussions centred on data sharing, co-developed forecasting tools, and capacity building through training initiatives, for example research exchanges. It proposed establishing the UKCEH West Africa Office as a regional collaboration hub to strengthen long-term sustained partnerships. Moving forward, these partnerships will ensure that scientific advancements translate into actionable solutions, supporting climate resilience, water resource management, and disaster preparedness across Ghana and the wider Sub-Saharan region.

1. Background

UKCEH's National Capability for Global Challenges program's mission is to drive global progress towards Net Zero Plus while fostering resilience to climate change impacts. One of its projects, the Adaptation and Mitigation: African Hydro-Meteorological Hazards project, endeavours to collaborate closely with global and sub-Saharan Africa partners to understand the hydro-meteorological hazards over Sub-Saharan Africa and build adaptation and resilience against climate change. Central to our efforts is the meticulous consideration of potential cascading effects and trade-offs.

Droughts represent a significant and escalating threat across much of Africa, exacerbating vulnerabilities and challenging traditional forecasting methodologies. The limited understanding of drought dynamics in the region, amplifies these complexities. Within the framework of this project, one of the main objectives is to advance understanding of droughts to equip stakeholders with timely and actionable insights. Key areas of drought research are:

i. Seasonal hydrological forecasting

Our previous research, conducted on a global scale, showcases the potential benefits of leveraging multi-model global hydrological forecasts to derive locally actionable predictions. Within the framework of this project, we want to understand the efficacy of blending and bias-correction techniques on global hydrological forecasting in improving the accuracy of local hydrological predictions, with a specific emphasis on mitigating the impacts of hydrological droughts in Africa. By bridging the gap between global-scale modelling insights and local-scale impacts, we aspire to enhance resilience against hydrological droughts in Africa, by providing evidence-based strategies for water security the face of evolving climatic challenges.

ii. Drought impact predictions

Due to large uncertainties, to enhance the accuracy of drought impact estimation, particularly focusing on agriculture, multi-faceted approaches are required. Leveraging a comprehensive review of existing vegetation indicators sourced from remote sensing data and local observations, we aim to refine our understanding of drought impact dynamics. By integrating climate data, high-resolution remote sensing data, and observed crop yield records, we seek to predict the impacts of drought on agricultural systems. Feasibility analyses on different crop types will help us develop proactive adaptation strategies to mitigate the adverse effects of drought on agricultural productivity and develop agricultural resilience.

iii. Flash drought forecasting

Flash droughts are rapid-onset drought events that pose significant challenges due to their sudden intensification and rapid onset, leaving decision-makers with limited time for effective response, especially with agricultural impacts often manifesting within weeks. Despite the high vulnerability to drought and the projected increase in drought risk under climate change, these events in Sub-Saharan Africa have received limited attention in research and monitoring efforts. Furthermore, the lack of comprehensive datasets spanning local to global scales presents a significant challenge in accurately assessing and monitoring them. Our key objective is to bridge these knowledge gaps by compiling and evaluating diverse datasets, exploring various metrics and approaches for their assessment, and monitoring tailored to the unique hydro-climatic conditions of Sub-Saharan Africa. We aim to work with national and regional stakeholders to co-develop tools and research necessary to enhance resilience against the growing threat of flash droughts in the region.

2. Agenda for the visit

i. Day 1 (22 October 2024): Workshop Event – Presentations & Discussions

Stakeholder workshop on "Droughts over Sub-Saharan Africa" at WASCAL Headquarters, Accra, Ghana attended by participants from various organisations across Ghana (Appendix A). The workshop was a Joint UK-Ghana Contribution to the UNESCO Intergovernmental Hydrological Programme (IHP) co-organised with Ghana Meteorological Agency (GMet), Ghana Hydrological Authority (HYDRO), and Water Resources Commission of Ghana (WRC) funded under the NC for Global Challenges Programme.

ii. Day 2-3 (23-24 October 2024): Deep Dive – Meetings & Visits

Researchers from UKCEH visited institutions in Accra renowned for their expertise in droughts. This visit aimed to foster collaborative research on droughts, leveraging advanced methodologies and data from diverse groups of stakeholders. The itinerary included field visits and engagements with different interested institutions, where the team shared insights, conducted in depth one-to-one meetings, and explored possible avenues of future collaborations. This initiative underscored the commitment to strengthening international partnerships and advancing scientific knowledge to address the pressing issue of droughts in Sub-Saharan Africa.

3. Day 1: Stakeholder Workshop

The stakeholder workshop on Day 1, held on October 22, 2024, at WASCAL Headquarters in Accra, Ghana, began with an opening session followed by three technical sessions focusing on key areas of drought research. Each technical session featured two presentations—one by UKCEH scientists and another by representatives from Ghanaian partner institutions— offering diverse perspectives and insights. Following the presentations, participants engaged in breakout discussions within three sub-groups, addressing key questions related to each session's theme. These discussions culminated in group summaries being presented, helping to identify critical conclusions, actionable recommendations, and priorities for future collaborative efforts.

The opening session commenced with a welcome address by Adelaide Asante (UKCEH), who expressed gratitude to participants and facilitated a round of introductions. Representatives from the co-organizing institutions—Dr. Eric Asumna (GMet), Dr. John Kissi (HYDRO), and Mr. Mawuli Lumor (WRC)—introduced their respective organizations, providing background on their mandates and highlighting their ongoing innovative work. Harry Dixon (UKCEH) provided an overview of UKCEH, its mission, and its involvement in various international initiatives, including the introduction of the UKCEH West Africa office. Jamie Hannaford (UKCEH) highlighted UKCEH's engagement in drought-focused programs, such as the ROBIN network and UNCCD initiatives, and shared examples of other previous workshops conducted in South-East Asia to illustrate potential approaches for future collaborative efforts in Ghana too.

3.1 Seasonal Hydrological Forecasting Session

3.1.1 Presentations

Sylvester Darko (HYDRO) presented the role of seasonal hydrological forecasts and flood early warning systems (FEWS) in mitigating risks and impacts associated with hydrological hazards. He introduced the HYDRO, highlighting its primary objectives, including operational and applied hydrology, coastal protection, drainage and sewage engineering, and land and hydrographic surveying. His presentation described the flood early warning system developed for Ghana and West Africa, which utilizes statistical models derived from observational data, sea surface temperature changes, forecasts from major global climate centres, and expert insights. He concluded by discussing the challenges faced in forecasting across Ghana and Sub-Saharan Africa, focusing on the limitations in the observational network while highlighting its critical role in national data collection.

Jamie Hannaford (UKCEH) introduced WMO HydroSOS initiative, which aims to integrate global and local data to improve hydrological forecasting. The work aims

to use ensemble forecasting with bias correction and blending to improve multi-model streamflow predictions, providing valuable tools for users to strengthen drought forecasting capabilities. He emphasized the importance of incorporating local forecasts and observations to ensure accurate, relevant predictions for effective water management in Ghana.

3.1.2 Breakout Discussions

Given the increasing vulnerability to hydrological hazards and water scarcity in the face of climate change, there is a critical need to develop accurate and dependable hydrological forecasts worldwide. The WMO HydroSOS initiative is currently spearheading an effort to build capacity for hydrological status and outlooks systems on a global scale. Previous research showcases the potential benefits of leveraging using multi-model global hydrological forecasts to provide accurate local predictions. Unfortunately, at present, operational forecasts specific to local regions are not widely available, and global hydrological models are not calibrated for local conditions, leading to difficulties in representing local-scale complexities. To address this gap, it is essential to integrate existing hydrological forecasting systems across global, regional, and local scales, aiming for skilful and consistent predictions, and rigorously validate and test these methods. By bridging the gap between global-scale modelling insights and local-scale impacts, we aspire to enhance resilience against hydrological droughts in Africa, by providing evidence-based strategies for water security the face of evolving climatic challenges.

In this session, our primary objective was to comprehensively understand the current status of operational hydrological forecasts in the region and identify sector specific user requirements. We aimed to engage with diverse stakeholders to identify impactful hydrological variables, identify reliable sources of observed data, determine useful spatio-temporal scales for forecasting, and recognize broader constraints associated with hydrological forecasting in the region.

i. Topics of discussion:

a) *Review of current hydrological forecasting systems*
Gaining insights into the existing hydrological forecasting systems in the country, whether academic or operational, with a specific emphasis on scale, data availability, and skill.

b) *Stakeholder requirements for hydrological forecasts*
Understanding sector-specific needs for hydrological forecasts in the country, with a particular emphasis on critical locations, meaningful hydrological variables, and considerations for forecasting frequency, as well as temporal and spatial resolution. Further, getting feedback from stakeholders on different methods to improve global hydrological forecasts.

c) *Future of hydrological forecasting*
Envisioning the “perfect” hydrological forecasting system for the region based on discussion with all stakeholders.

ii. Questions for discussion:

a) What is the status of current hydrological forecasting and monitoring systems in the region and how can the forecasting be improved?

b) How can global hydrological forecasting products be adapted to provide accurate regional forecasts and what are the potential challenges in doing so?

c) How can collaborative data sharing initiatives be optimized to ensure access to relevant observational data for hydrological forecasting?

d) What would be the ideal characteristics of a hydrological forecasting system tailored to our region's needs and challenges?

iii. Outcomes:

The breakout session highlighted several challenges and opportunities for improving hydrological resilience in the region. Participants identified limitations in the observational network, including the maintenance of stations and the lack of new station installations due to insufficient funding. Data sharing emerged as a significant issue due to licensing hurdles, further amplified by fragmented data storage across various platforms. Stakeholders emphasized the need for a centralized platform to facilitate data sharing in standardized formats, enabling better integration and use of observational data. These discussions unveiled the importance of strengthening the observational network, improving funding mechanisms, and fostering collaborative data-sharing initiatives to enhance the accuracy and reliability of hydrological forecasts tailored to regional needs.

3.2 Drought Indicators to Impacts Session

3.2.1 Presentations

Joachim Abungba (WRC) presented an in-depth analysis of hydro-climatic trends and drought risk reduction in the Volta Basin. He began by providing an overview of the basin's geography, the characteristics of the Volta River, its significance on livelihoods, and the context of shared governance of the basin. He further detailed the climate and hydrological patterns of the basin, analysing 60 years of climatic data across three distinct periods (1960–1980, 1981–2001, and 2002–present) and detailing the significant drought periods in Ghana. The presentation highlighted the economic consequences of drought impacts in the Volta Basin, emphasizing the need for effective cross-country drought adaptation programs and risk reduction strategies among the nations sharing the basin.

Burak Bulut (UKCEH) presented on the operational implementation of drought impact-based prediction for forecasting the impacts of future drought events. He provided a review of drought indicators used in machine-learning models and showcased a case study from the UK, demonstrating the application of such model in identifying drought impact occurrences and severity. The presentation underscored the importance of collaborative efforts in sharing impact data to develop and validate machine-learning models, highlighting the importance of

validation of current monitoring systems to enhance model accuracy. Burak concluded with the potential of this approach to be used to build an operational tool over Sub-Saharan Africa, with ready-to-use indicators demonstrated for Ghana.

3.2.2 Breakout Discussions

Drought events cause substantial challenges to communities and ecosystems worldwide, highlighting the need for effective predictive methodologies to mitigate their impacts. A significant gap exists between theoretical drought indices and practical drought impacts. Linking drought indicators with impacts involves correlating quantitative measurements of drought conditions (such as precipitation deficits, soil moisture levels, and streamflow reductions) with the actual consequences these conditions have on the environment, economy, and society. It allows policymakers and resource managers to allocate resources wisely and plan targeted responses, reducing the adverse effects on agriculture, water supply, and the economy. Additionally, it promotes efficient resource management and ongoing research, enhancing the ability to predict and manage drought conditions.

In this session, our primary objective was to explore drought indices, dataset requirements, and their practical applications. We aimed to review various drought indices and remotely sensed datasets, examine methods for linking drought indicators to impacts, and understand stakeholder requirements. Additionally, we discussed the importance of impact datasets in improving drought prediction and management strategies.

i. Topics of discussion:

a) *Review of drought indices and remotely sensed dataset*
This topic examines the various drought indices available, their datasets requirements and remotely sensed data sources and their effectiveness in monitoring and assessing drought conditions.

b) *Methods for linking drought indicators to impacts*
This topic explores the methodologies used to correlate quantitative drought indicators with their actual impacts on the environment, economy, and society.

c) *Stakeholder requirements for drought impacts*
This discussion addresses the needs and expectations of stakeholders, including policymakers and resource managers, in understanding and responding to drought impacts.

ii. Questions for discussion:

a) What hydrological and meteorological observations are available for defining drought indicators?

b) What is the status of current drought management in the region and how can it be improved?

c) What observation datasets can be provided to be used as impact datasets for different sectors (e.g., agriculture, water resources)?

d) Are there any region- or sector-specific considerations that need to be addressed regarding drought impacts?

iii. Outcomes:

The breakout session highlighted the importance of identifying diverse variables to validate machine learning models for drought prediction and management. Key drought indicators discussed included precipitation, potential evapotranspiration (PET), and other widely used indices. Impact datasets were recognized as essential for correlating drought conditions with real-world consequences, and thus validating the machine-learning models developed. Discussion included some commonly cited impact variables such as crop yields, alongside less conventional data like malaria cases and livestock mortality from different regions. These discussions underscored the need for comprehensive and interdisciplinary datasets to improve drought impact assessments and develop more effective management strategies tailored to regional and sector-specific needs.

3.3 Flash Droughts Session

3.3.1 Presentations

Maureen Ahiataku (GMet) began by providing an overview of GMet and its key products, which include impact-based forecasts, crop yield predictions, aeronautic services, weather forecasting, and climate change projections. She also showcased GMet's extensive equipment and website. The presentation highlighted GMet's seasonal forecasts for dry spells and GMet's collaboration with UKCEH in developing HydroSOS hydrological forecasting products for Ghana. Her talk addressed the agency's main challenges, delays in real-time data, a limited observational network, and concerns related to installations, maintenance and quality control of meteorological and hydrological stations. She emphasised the need for historical data rescue, and improvements in dissemination and communication channels.

Iván Noguera Corral (UKCEH) presented on flash droughts, focusing on their drivers, impacts, and the challenges associated with forecasting them in Sub-Saharan Africa. He presented a review of the state-of-the-art methods for flash drought assessment and highlighted disparities between different global-scale studies with various examples. The presentation discussed the challenges in identifying and forecasting flash droughts and uncertainties associated with their projected increase in frequency and severity under global warming. The presentation showcased new dataset that can identify global flash droughts and has potential to be implemented over Sub-Saharan region. Future steps suggested working with local experts for developing drought forecasting tool, while addressing the broader forecasting limitations tied to observation network constraints in the region.

3.3.2 Breakout Discussions

Flash droughts are rapidly developing drought events that intensify within days to weeks, often leaving little time for the decision makers for an effective response, particularly in the agricultural sector, where impacts can emerge quickly. Although Sub-Saharan Africa is highly vulnerable to drought and is expected to face increasing risks under climate change, flash droughts in the region receive limited attention. One major barrier is the lack of comprehensive datasets that span local to global scales, making accurate detection and assessment difficult. This project seeks to address these critical knowledge gaps by assembling and evaluating a wide range of datasets, testing different metrics and methodologies tailored to the region's distinct hydroclimatic conditions. There is a need for collaborative efforts across national and regional stakeholders to co-develop tools and research that support improved monitoring, preparedness, and resilience to flash droughts across Sub-Saharan Africa.

In this session, our main goal was to explain what flash droughts are and why it is crucial to assess and monitor this kind of events in Sub-Saharan Africa, especially under the current context of global warming. We sought engagement and collaboration with different stakeholders to establish the main lines of research and collaboration in the study of flash droughts in the region.

i. Topics of discussion:

a) *Relevance of flash drought in Sub-Saharan Africa*
Understanding the occurrence and prevalence of rapid-onset drought events over the region and identifying their impact on agriculture, local ecology and water demand.

b) *Methods and metrics for flash drought assessment*
In-depth review of the main approaches adopted for the identification and assessment of flash drought by regional operational departments, as well the most widely used metrics (i.e. drought indices).

c) *Monitoring flash droughts over Sub-Saharan Africa*
Understanding the needs for flash drought monitoring in the country, with a particular emphasis on critical locations, specific sectors, meaningful metrics, and considerations for monitoring frequency, as well as temporal and spatial resolution.

ii. Questions for discussion:

a) What is the current status of flash drought research in Sub-Saharan Africa?

b) How can we analyse such events in the region (methods, metrics, global and local datasets) and what are the main limitations?

c) How can collaboration of different stakeholders and data sharing initiatives improve the assessment of flash drought in the region?

d) What are the most relevant aspects that should be addressed for flash drought monitoring in the region?

iii. Outcomes:

The breakout session provided valuable insights into the context and understanding of these events in Ghana and Sub-Saharan Africa. Participants discussed the scientific and practical distinction between flash droughts and dry spells, concluding that while dry spells are necessary precursors, flash droughts are further characterized by rapid intensification driven by increasing temperatures and heightened evaporative demand. This discussion emphasized the need to consider both meteorological and hydrological factors in assessing flash droughts. The session also linked these events to their broader impacts, reinforcing the importance of monitoring efforts and collaborative research to address the region's vulnerability to these rapidly intensifying droughts under climate change.

4. Day 2: Deep Dives

4.1 West African Centre for Water, Irrigation and Sustainable Agriculture (WACWISA)

The team from UKCEH held an online meeting with representatives from WACWISA, University of Development Studies (UDS). The meeting primarily focused on introducing the organizations on both sides and exploring potential future collaborations. The discussion highlighted the three research themes for droughts over Sub-Saharan Africa discussed in the workshop to identify shared research interests. The meeting concluded with the UKCEH West Africa office proposed as the nexus for future collaborative efforts between the two agencies.

4.2 Volta River Authority (VRA)

The UKCEH team visited Akuse, to meet with the Water Resources and Renewable Energy team at the VRA. UKCEH team outlined its mission and motivations, and Philip Tetteh Padi (VRA) provided an overview of the Volta Dam's operational framework, and the methods used for streamflow forecasting. A shared research focus was identified, aligning the Volta River's forecasting needs with UKCEH's seasonal forecasting research conducted under the NC for Global Challenges program and the HydroSOS project. The discussion highlighted forecasting timescales of interest, spanning from short-range to long-range forecasts to climate change projections of streamflow. This led to identifying potential future collaborations, particularly the co-development of improved seasonal hydrological forecasting system for the Volta River Basin. These systems can integrate global modelled forecasts with VRA's streamflow forecasts, contributing to improved operational capabilities. The meeting emphasized the importance of data and knowledge sharing and concluded with a commitment to continue discussions in the future.

5. Day 3: Deep Dives

5.1 Ghana Hydrological Authority (HYDRO)

Kwaku Asante (HYDRO) guided the UKCEH team on a field visit to two hydrological gauging stations in Accra. He demonstrated the operation and maintenance of these stations, which use sensors to measure water surface height for determining river flow for data collection. Discussions during the visit focused on the frequent flooding in Accra, which occurs almost annually, and the issue of water pollution in Ghanaian rivers. Following the field visit, the team proceeded to the HYDRO office, where Sylvester Darko (HYDRO) demonstrated their flood early warning system, based on Deltares-FEWS HBV hydrological model, operational for the whole country.

5.2 Council for Scientific & Industrial Research - Water Research Institute (CSIR-WRI)

The UKCEH team visited CSIR-WRI, where the meeting was led by Emmanuel Oboubie (WRI). The UKCEH team presented their three key research themes in Sub-Saharan Africa: hydrological forecasting, drought impact prediction, and flash droughts. They highlighted the main challenges in these areas, particularly the limited availability of field data for training drought impact prediction models and validating flash drought indicators. The discussion focused on potential areas of collaboration between the two institutions, emphasizing the datasets available at CSIR-WRI. These datasets could serve as proxies for drought impacts, offering opportunities to enhance the development of datasets and models for improved drought analysis and forecasting.

5.3 British High Commission

The Foreign, Commonwealth and Development Office (FCDO) organised a brainstorming session with the UKCEH team. The session provided an opportunity to exchange insights on ongoing initiatives, with the UKCEH team showcasing their expertise in drought indicator-to-impact studies. The FCDO team, led by Magdalena Leisten Johansson, highlighted their primary focus on flood-related challenges, particularly efforts to protect flood-prone agricultural fields in northern Ghana. The session highlighted potential synergies with UKCEH's science and laid the groundwork for strengthening future partnerships in climate resilience and agricultural sustainability.

The British High Commissioner, Accra hosted a networking reception in honour of David Burton, Africa Director for Agriculture, Food & Drink and Blue Economy at the UK Department for Business & Trade. The event provided a valuable platform for introduction to the UK's Science and Innovation Network (SIN) for fostering connections with local leaders. Discussions focused on bridging the gap between

scientific innovation and real-world implementation of early warning systems for hazards and improving science communication to enhance confidence in these systems. The reception facilitated meaningful exchanges, helping both countries better understand each other's approaches and laying the foundation for long-term partnerships.

6. Priorities for Progress

6.1 Immediate Actions

A recurring theme throughout the visit was the limitations in observational and forecasting datasets available for Ghana, which poses significant challenges for effective hydrological and drought management. UKCEH's work on the HYDROSOS project, which aims to develop global hydrological forecasts, can address this need by providing tools to overcome data paucity. A priority action would be to identify high-impact hydrological stations, such as those in the Volta River Basin, to integrate their data into a multi-model blending framework. This approach would facilitate the co-creation of an improved prediction system that builds upon existing resources from global modelling centres and the local forecasting systems and generates outputs as per regional requirements.

Understanding the impacts of droughts emerged as a critical area for future collaboration. Ghana's history of long-term drought periods highlights the importance of exploring region-specific drought impact datasets. These could include common indicators, such as crop yields, and unconventional data sources, such as malaria cases and livestock mortality. Identifying institutions that hold such datasets is a key step toward building comprehensive prediction models. Planned collaboration with the WRI on datasets as proxies for drought indicators, enabling their integration into machine-learning models for impact-based drought forecasting. Immediate next steps include engaging visiting scientists from Ghana to co-develop these models with UKCEH experts.

Training emerged as another important area for future engagement. Building on past initiatives, such as the GMet-HYDRO visit to UKCEH in 2023, UKCEH could provide hands-on training in hydrological modelling and forecasting to interested institutions. A follow-up visit will focus on delivering workshops to build capacity in these areas, ensuring that local researchers and stakeholders are equipped with the tools and knowledge needed to enhance hydrological resilience in Ghana. This approach would enhance UKCEH's understanding of regional drought-related needs while empowering local institutions to implement, manage, and sustain more effective hydrological systems.

6.2 Future Directions

Beyond the workshop's primary focus on droughts, HYDRO's operational flood early warning system, based on the Deltares-FEWS HBV hydrological model, presents an opportunity for collaborative improvement. UKCEH could demonstrate its hydrological models—such as GR6J, PDM, and G2G—for comparison with the HBV model to identify areas for refinement. Additionally, insights from the UK Hydrological Outlooks could be compared against Ghana's existing modelling system, providing a basis for co-developing enhanced flood forecasting tools that are effective for both short- and long-term applications.

The visit highlighted significant opportunities for building sustained collaborations between UKCEH and Ghanaian institutions to address drought-related challenges. A key long-term goal is to establish UKCEH West Africa Office as a focal point of contact for all future collaborative efforts between various institutes. One of the aims of these efforts is to build strong collaborative networks to jointly develop drought monitoring and prediction tools. This effort will prioritize capacity building through training programs, visiting scientist exchanges, and collaborative research initiatives. Another objective is to enhance the hydrological observational and forecasting networks by improving data sharing, standardization, and integration across institutions. By addressing these gaps, the collaboration aims to strengthen resilience to hydrological extremes and climate change impacts in Ghana and Sub-Saharan Africa more broadly. Ultimately, these partnerships will aim to ensure that cutting-edge science and technology translate into actionable solutions, supporting sustainable water management and climate adaptation for the region.

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Natural Environment Research Council

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Appendix A: Participating Organisations

Bui Power Authority
Centre for Remote Sensing and Geographic Information Services
Coalition of NGOs in Water and Sanitation (CONIWAS)
Country Water Partnership of Global Water Partnership
Council for Scientific and Industrial Research (CSIR) - Institute of Industrial Research
Council for Scientific and Industrial Research (CSIR) - Water Research Institute
Department of Water Resources and Aquaculture management UESD
Department of Physics, University of Ghana - Legon
Directorate of Agricultural Extension Services, Ministry of Food and Agriculture
Environmental Protection Agency
Ghana Commission for UNESCO
Ghana Hydrological Authority (HYDRO)
Ghana Irrigation Development Authority
Ghana Meteorological Agency (GMet)
Ghana Space Science and Technology Institute
Global Water Partnership West Africa
Green Cities and Infrastructure Programme of FCDO
Kazuhiko Takeuchi Centre for Sustainability and Resilience/ University for Development Studies
Land Use and Spatial Planning Authority
Ministry for Sanitation and Water Resources
National Disaster Management Organization
UK Centre for Ecology & Hydrology (UKCEH)
University of Cape Coast
University for Environment and Sustainable Development
Volta River Authority/Water Resources & Renewable Energy Department
West African Science Service Centre on Climate Change and Adapted Land Use (WASCAL)
Water and Sanitation for the Urban Poor (WSUP)
Water Resources Commission (WRC)