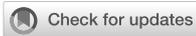


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Editorial: Climate, water and land in Africa: research trends and challenges

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Editorial on the Research Topic

[Climate, water and land in Africa: research trends and challenges](#)

1 Introduction

Water availability is essential to Africa's socio-economic prosperity in particular for both rain-fed and irrigated agriculture, municipal water supply, energy production and industry. Sustainable management of water resources is key for sustaining ecosystem health, natural resources and wellbeing for the local population. Yet, the African continent's water resources are currently facing severe pressures from (over) exploitation of water storages, severe pollution, and infrastructural challenges. In addition to pressure on water resources, it faces increased risks of hydro extremes like large river floods, flash floods after local high-intense rainstorms, and droughts.

As a continent Africa currently has over 1.4 billion people and is expecting >3 billion people till end of the century. It has a distinctly diverse climate and environment and, as elsewhere, faces problems related to insufficient interaction between hydrology and society. Despite financial constraints, institutional challenges and logistical difficulties in accessing remote or unstable regions which may hinder scientific research, Africa has considerable capacity in hydrological research. This Research Topic about "Climate, Water and Land in Africa: Research Trends and Challenge" presents 11 original research articles on issues of regional environmental and climate changes, impacts on land resources, agriculture, surface and sub-surface water resources and wetlands. It also discusses causes and effects of changing hydro-system conditions in Africa.

2 Overview of the Research Topic

Tanner et al. report on climate change impacts on eco-systems. They investigate how the particular climate change conditions in South Africa impact on minimum environmental flow (termed here “ecological reserve targets”) for a seasonal river in an agricultural catchment in the Western Cape region. Their study addresses issues as hydrological extremes, such as flood flashiness or drought duration, increasing erosion and geomorphological degradation, and endangered freshwater or estuarine ecosystems in the downstream part of the catchment.

Tessema et al. contribute to the relevant and urgent topic of soil-surface erosion, sediment transport and reservoir siltation. This topic is of particular relevance for both sustainable use of arable land and conservation of natural soils and for the usability and lifetime of artificial reservoirs. Their study was conducted on the Angereb reservoir in the sub-humid region of Ethiopia, in the Upper Blue Nile Basin. They found that sediment deposited on the reservoir bed from 2007 to 2022 reduced its storage capacity by 62%, which is a rather alarming rate of reservoir volume loss.

A modeling study of regional climate response to land cover change in tropical West Africa, comprising numerical sensitivity experiment and water resources modeling is presented by Mortey et al.. Their work investigates the regional climate response through introducing European Space Agency land cover data into the WRF-Hydro model. This study also models the potential impacts of afforestation and deforestation on regional water and energy fluxes. The results suggest that afforestation (deforestation) could increase the flood (drought) risk.

Potential effects of land cover change on flood events, using the Senegal River basin as a case study, is presented by Ndaye et al.. They report that the increase in flood events observed in West African countries, and often in specific river basins, can be influenced by several factors, including anthropogenic land use and land-cover changes. However, the potential contribution of land cover changes to flood events still needs to be explored more in depth, especially in West Africa. Here, the fully coupled atmosphere-hydrology WRF-Hydro system, which comprises an atmospheric model and additionally incorporates surface, subsurface, overland flow, and channel routing, is used to investigate the potential impacts of a land cover change on flooding in the Senegal River basin.

Sustainable land management practices in Africa to strengthen food security and the resilience against climate change and extremes requires a good understanding of land-atmosphere exchange processes, which is addressed by Nadolski et al.. They explore the energy balance closure of three eddy covariance (EC) sites implemented along a land use gradient (pristine savanna forest, cropland, and degraded grassland) in the Sudanian savanna of West Africa. They find that landscape heterogeneity seems to play an important role in the quality of the EC measurements. Moreover, they developed a novel post-closure adjustment based on a quantile-mapping technique conditioned on monsoonal circulation patterns specifically determined for the West African Monsoon.

The predictability of extreme rainfall over the city of Dakar, Senegal is approached using satellite data products by Diedhiou

et al.. They investigate the physical mechanisms associated with such events using multiple data sources, including satellite rainfall estimate products (GPM-IMERG, CHIRPS) and reanalysis data (ERA-5). By analyzing wind fields and mid-tropospheric moisture content, they examine the synoptic-dynamic evolution of the atmosphere and the moisture transport to the region, resulting in substantial rainfall events exceeding 100 mm. Additionally, they present a comparative analysis of satellite rainfall estimates, assessing their accuracy and reliability in capturing extreme rainfall events both spatially and at specific rainfall gauges situated in Dakar.

Seasonal prediction of rainfall variability for the West African Sudan-Sahel has been explored by Rauch et al.. They provide an assessment of seasonal rainfall prediction models in the region, between 1980s and 2023, focusing on the West African Regional Climate Outlook Forum (WARCOF), the latest generation of the seasonal forecasting system from the European Center for Medium-Range Weather Forecasts (ECMWF SEAS5), and a novel atmospheric circulation-pattern-based logistic regression model. By introducing this method and evaluating traditional forecasting techniques, this lays the groundwork for more accurate and reliable seasonal rainfall predictions.

The relevance of precipitation data and subsequent hydrological response for the tropical Upper Blue Nile Basin (UBNB) in Ethiopia is investigated by Zargar et al.. They evaluate the performance of different rainfall datasets, namely-CHIRPS, IMERG, ERA5, and ERA5-Land compared against ground-based rainfall data from 75 stations across the UBNB. Using the process-based and multi-scale hydrological model WASA-SED, they study the potentials of rainfall products for hydrological and water resources analysis in a complex, data-scarce tropical region like the UBNB. The potentials and constraints of adjusted satellite-derived rainfall data for hydrological prediction are shown.

Innovations and tools in decision-making are part of the work by Sliniski et al.. New methods using satellite data are tested to classify surface water that provide an opportunity to assess the performance of these tools. They compare water availability estimates derived from Landsat and Sentinel 1 satellite imagery to *in situ* observations and model simulations of water availability in 22 ephemeral ponds located in the Ferlo region of Senegal.

The article by Meier et al. presents an innovative approach using Earth Observation products taking rice agricultural regional mapping and classification of temporal-spectral metrics in Burkina Faso as an example. This includes vegetation indices such as NDVI and backscatter statistics, and validation against reference samples to assess accuracy. The integration of climatic suitability and landform-based potentials highlights considerable opportunities for expanding rice cultivation in Burkina Faso.

The study in Malawi in Southern Africa by Jushua et al. assesses the link between climate change and the occurrence, frequency, and magnitude of tropical cyclones in Southern Malawi. The research adopts a mixed-methods approach, combining spatial mapping, literature synthesis, and trend analysis of cyclone data from the past three decades, analyzing rainfall data from nine meteorological stations using the Standardized Precipitation Index (SPI), and substantiated with stakeholder benchmarking and interviews.

This Research Topic presents frontiers and insights of water research in Africa and provides scientific system knowledge to derive solutions for improved water management. The 11 studies have contributed to a further improved understanding of hydrology on the African continent and are scientific prerequisites for sustainable practices of innovative land and water management. Still, scientific innovation like the presented one needs to be combined with stakeholder participation and improved capacity of institutional innovation and governance structures.

Author contributions

BA: Writing – original draft, Conceptualization, Writing – review & editing. AB: Writing – review & editing, Conceptualization, Writing – original draft. MI: Writing – review & editing. HK: Writing – review & editing, Writing – original draft, Conceptualization. CL: Writing – review & editing.

Conflict of interest

The author(s) declared that this work was conducted in the absence of any commercial or financial relationships

that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declared that generative AI was not used in the creation of this manuscript.

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