Building drought resilience in Ethiopian river basins

Story of change: Key findings & emerging impacts

Summary

- REACH Ethiopia partner WLRC are implementing, with the Ministry of Water and Energy (MoWE), Ethiopia, a €45 million programme, BRIGHT, to improve resilience and reduce vulnerability to drought and climate change in Ethiopia, working in five river basins.
- BRIGHT will build upon and scale up WLRC research on water resources management, climate science, water quality and inequalities to benefit an estimated 2.5 millions people directly, and over 50 million people indirectly
- REACH has supported WLRC to build their capacity and leadership in water security in Ethiopia, with a rich track record in publishing and a strong team on climate resilience, groundwater, water quality and inequalities in the Awash basin.
- Structured engagement with MoWE and officers working in the Awash Basin through demand-led science and capacity building has created strong partnerships between WLRC and the government.

Photo by AlbertoLoyo from iStock

BRIGHT

ውሃና ኢነርጂ ሚኒስቴር
MINISTRY OF WATER AND ENERGY
የኢትዮጵያ ፌዴራላዊ ዲሞክራሲያዊ ሪፐብሊክ | Federal Democratic Republic of Ethiopia

WATER SECURITY & SUSTAINABLE DEVELOPMENT HUB

WATER & LAND RESOURCE CENTRE

Government of the Netherlands

UNIVERSITY OF OXFORD

REACH
Improving water security for the poor

UK International Development
Partnership | Progress | Prosperity

Introduction

The link between climate variability and water insecurity was well established in Ethiopia prior to the REACH programme, and a key reason for developing the programme there. Since 2015, the international disaster database (EM-DAT) estimates that over 41 million people in Ethiopia have been affected by droughts in 2015, 2021 and 2022; 2 million people have been affected by floods. This situation continues to be more challenging as the climate changes, and as patterns of development increase the population at risk.

In December 2023, the Federal Democratic Republic of Ethiopia and the Kingdom of the Netherlands signed a grant agreement to support Basin Management Support for Resilient Inclusive Growth and Harmonized Transformation for the national Integrated Water Resource Management Program (BRIGHT). The grant will provide €45 million of funding to improve resilience and reduce vulnerability to drought and climate change in Ethiopia, working in five river basins. REACH partner WLRC will be lead implementers of the programme, allowing them to build on the science and capacity developed across the REACH programme to extend benefits to over 50 million people living in the Abbay, Awash, Rift Valley, Omo-Gibe and Tekezie river basins.

Figure 1: Floods in Addis Ababa in 2016. Credit: Afhunta (istockphoto)

This project represents a significant investment towards sustaining and scaling-up the REACH programme's work in Ethiopia, in line with the Exit Strategy.

In this Story of Change, we will reflect on the partnerships and processes that have facilitated this success for WLRC and for Ethiopia, and in particular on three areas: building their leadership in water security science; building trusted relationships with practitioner partners; and training the next generation of water security leaders.

Leadership on water security science

WLRC were already internationally recognised for their work on sustainable land management before REACH, and have continued that work with REACH in the Abbay basin in our Observatory on Water Security in Fragile Environments. Since 2015, WLRC have developed their leadership and capacity on water security in Ethiopia further in the Awash basin, expanding to encompass expertise on water quality, and gender and inequalities.

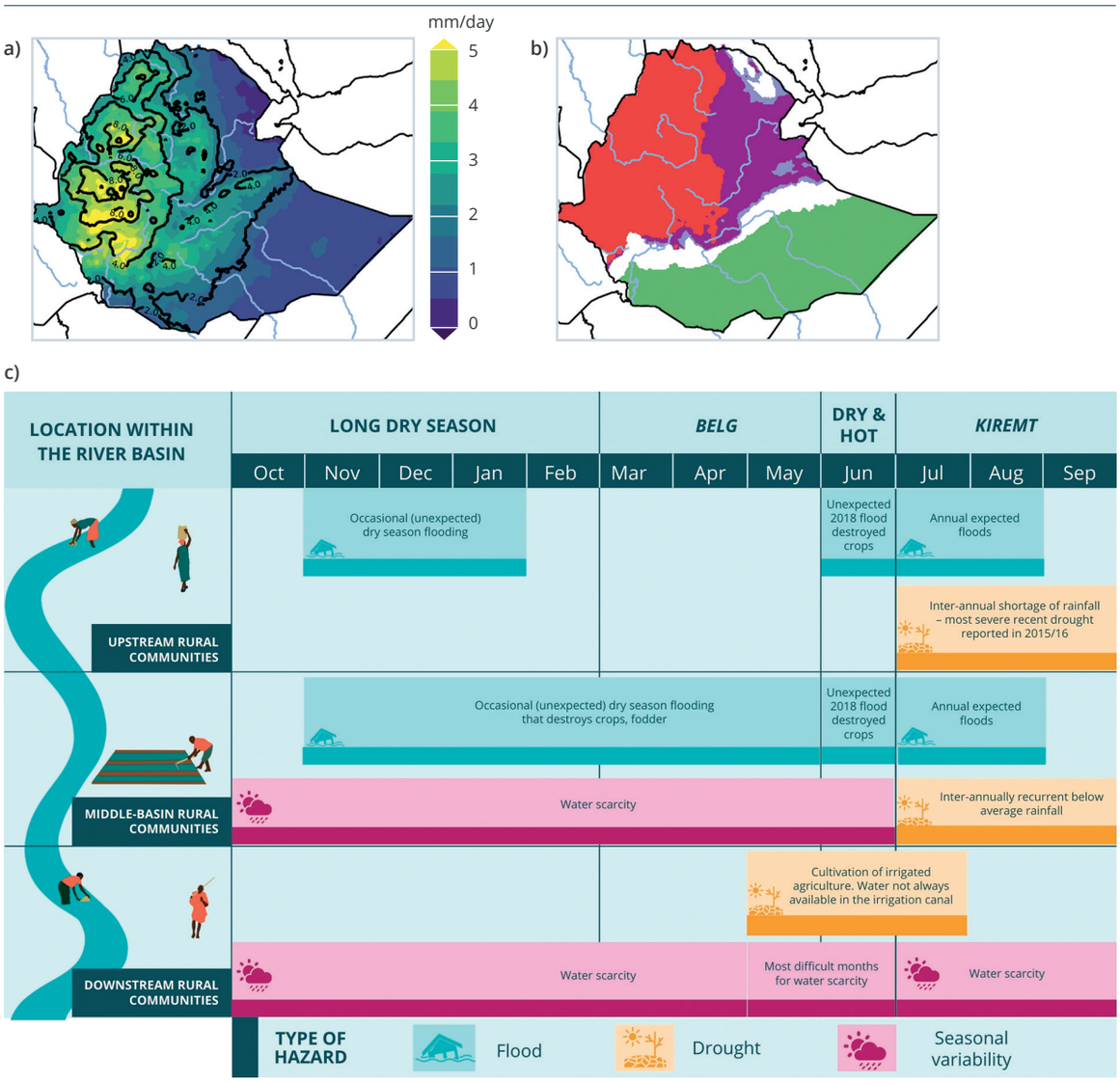
The Awash is a large and complex river basin, home to more than 18 million people, and many different types of water users. It is an important region for Ethiopia's economy, with its water resources supporting urban areas (including the capital, Addis Ababa), manufacturing, rural households, wetlands, agriculture and pastoralist livelihoods. In 2015, when the research started, water use in the basin was already high, with irrigation schemes expanding. Manufacturing and agriculture were linked to pollution and water shortages for the downstream populations, including the agro-pastoralists and pastoralists.

From the outset of REACH, in our aim to achieve improvements in water security at scale, it was recognised that a key outcome in our Theory of Change needed to be that research institutions established a global reputation based on excellence in water security research. In the past decade, the research led by WLRC has helped to capture and communicate water-related hazards, and advance solutions to manage trade-offs and improve water security. Key areas of scientific impact have included:

- The climatology of the Awash basin is poorly captured in global climate models as it sits at the juncture of the East African and Sahelian climate zones, in an area of complex topology. Models struggle to capture the start and end of the rainy seasons, hampering adaptation decision-making during key crop producing months (Dyer et al., 2020, Figure 2).

These variable climatic conditions mean that water insecurity is experienced differently in the upper, middle and lower parts of the basin (Dyer et al., 2022, Taye et al., 2018).

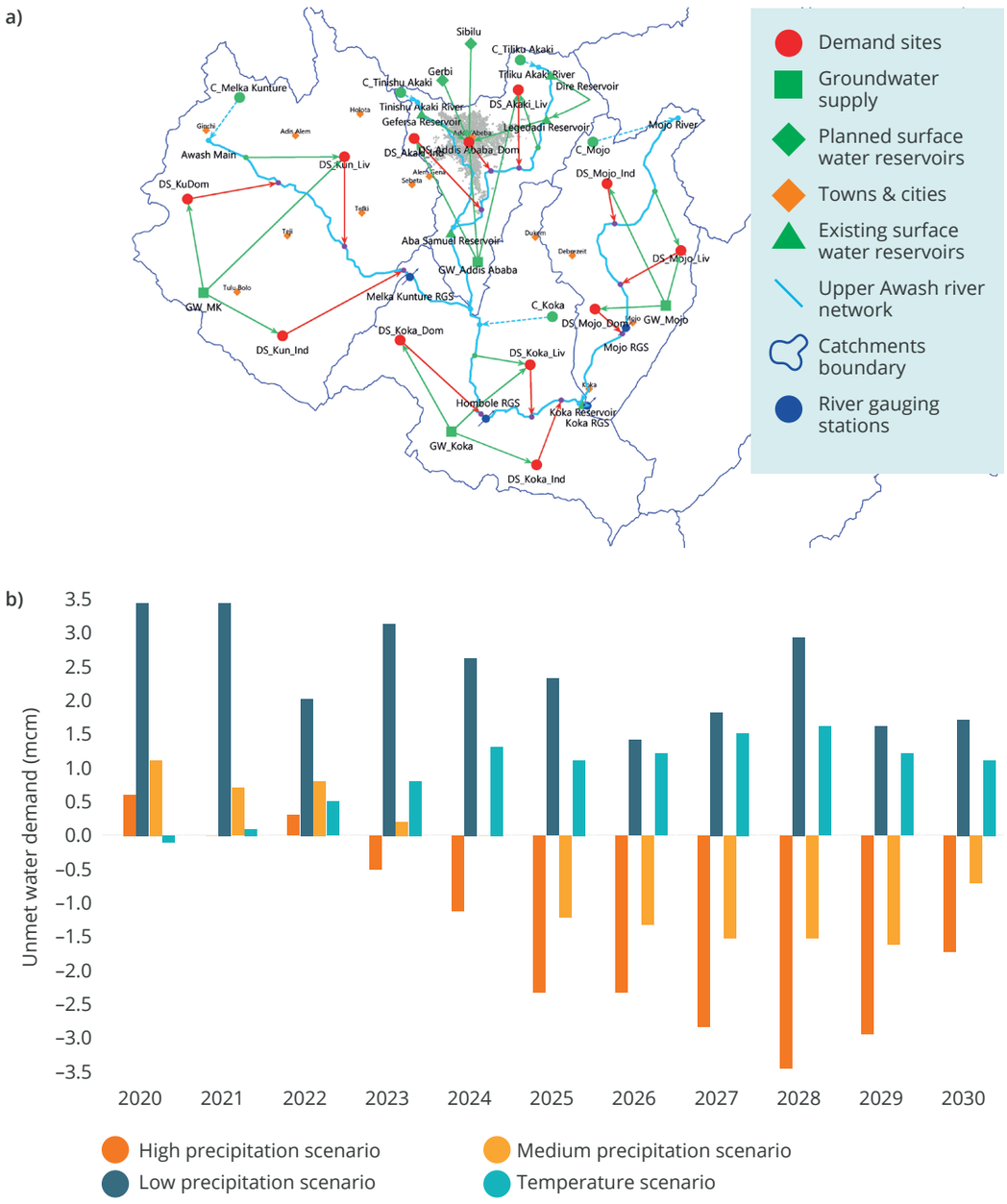
Figure 2: Rainfall in Ethiopia. a) Annual average rainfall in mm/day with the interquartile range (25th-75th) of monthly rainfall (mm/day) marked as black contours. (b) Rainfall zones in Ethiopia. The red and purple zones have a Kiremt season (JJAS>MAM rainfall); the green zone has a significant short rains season like the bimodal East African climate; the blue and purple region has a distinct Belg and Kiremt season with J<MAM and MAM<JAS rainfall. c) Temporal changes in recent extreme and recurrent water and climate-related hazards reported by communities living along the Awash basin. Source: Murgatroyd et al. (2021).



- Simulations using the dynamically linked WEAP-MODFLOW model and climate change projections indicate that increased groundwater abstraction could help to alleviate future water stress, but only if it is supported by careful management of surface water schemes (Birhanu et al. 2021, Figure 3).

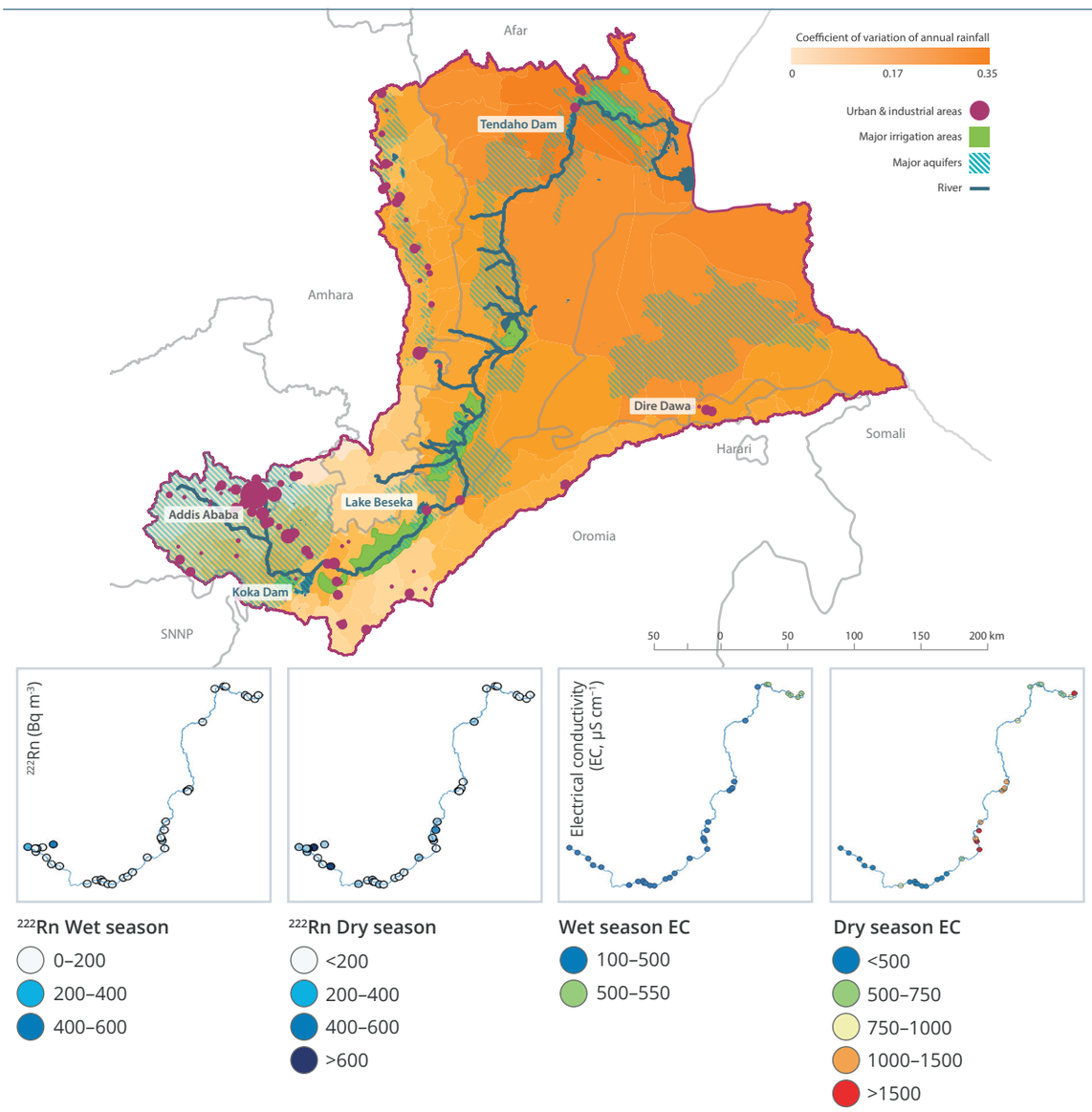
In other parts of the Awash basin, Taye et al. (2018) show similar increases in water deficiency due to projected increases in temperature and decreases in precipitation. The findings indicate that without adaptation, the basin will become seriously water stressed by the mid-21st Century.

Figure 3: a) WEAP-MODFLOW model schematic for the upper Awash basin. b) Unmet water demand variation under different climate change scenarios. Source: Birhanu et al. (2021) in Murgatroyd et al. (2021).



- Basin-wide Gross Domestic Product (GDP) could drop by 5% under a rainfall decrease scenario compared to the current GDP, whilst increases in rainfall could lead to GDP increases in the range of 5 to 10 % (Borgomeo et al., 2018). Sector-by-sector analysis reveals that rainfall decreases could lead to losses of up to 10% in the agricultural sector, and decreases of around 3% in the service and industrial sectors.
- Water quality threats further increase fresh-water scarcity in the basin. Unregulated discharge of saline water from the expanding Lake Beseka into the Awash river has large negative impact on water quality, especially in the dry season (Yimer and Jin, 2020, Kebede et al, 2021; Figure 4), including addition of geogenic heavy metals (Abebe et al, 2023). Untreated industrial, agricultural, and domestic discharges increase concentrations of heavy metals, such as chromium and manganese, in the upper catchment.

Figure 4: ^{222}Rn and electrical conductivity have been used to identify seasonal changes to groundwater influence and water quality in the Awash basin. Increasing salinity of surface water has led some towns in the middle and lower basin to change their water sources from the Awash river to groundwater during the dry season. Source: Kebede in Murgatroyd et al. (2021).



- Urbanisation and industrial zones are affecting local groundwater recharge zones, posing risks to recharge reduction and pollution (Hailu et al., 2023).

WLRC & REACH research forms and informs a significant part of the published academic literature available on the Awash basin.

Building trusted relationships with government partners

REACH's impact has been developed through science-practitioner partnerships (Hope et al., 2024) based on equitable partnerships (Charles et al., 2024). In Ethiopia, WLRC have led these partnerships, developing a strong relationship that has led to them collaboratively implementing BRIGHT with the MoWE.

The selection of the Awash River Basin was demand-led, through consultation with the government. In 2015, REACH set up a National Steering Committee in Ethiopia, chaired by the State Minister for Water Resources Management, and led a series of consultations with MoWE, Awash Basin officers, and UNICEF. The Awash River Basin was identified as a priority for a Water Security Observatory, to focus on Sustaining Growth through Water Security, specifically exploring drought risks on economic growth and multidimensional poverty. The National Steering Committee has remained active in guiding the research throughout the programme.

Figure 5: Dr Tena Alamirew at REACH Ethiopia meeting in 2019. Credit: REACH

Associated with this partnership, WLRC leadership have further developed their relationship with the Ministry supporting water resources decision making. Dr Gete Zeleke and Dr Tena Alamirew have been members of MOWE's national advisory committee on issues of land management and integrated watershed management. Dr Tena has led work on IWRM as part of a task force on national water resource management policy. This included the development of the first National IWRM Program in 2018.

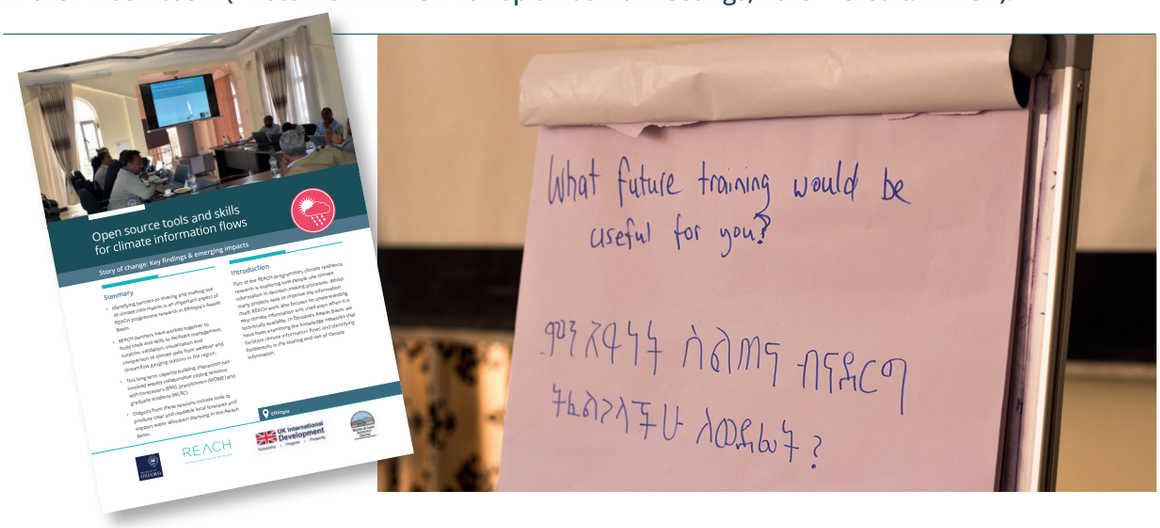
These partnerships have been further developed through regular, structure capacity building of government staff in the Ministry and basin offices, on water allocation modelling, climate information, and water quality modelling and monitoring. This has been further enhanced through development of targeted tools for practitioner, including WLRC's AwashWare platform for consolidated data sharing on Awash basin research and data.

Figure 6: Zizile Jele demonstrates macroinvertebrate sampling and identification for water quality assessment at WLRC's MiniSASS Bio Monitoring Tool Awareness Creation Workshop

Training the next generation of water security leaders

As part of the REACH programme, WLRC have provided 17 years of training to early career researchers. With the BRIGHT project, a number of those researchers with expertise in water resources management, water quality and inequalities will have a chance to further develop their careers in water security.

Figure 7: The REACH Story of Change on Open source tools and skills for climate information flows describes how REACH partners have been working together to meet training interests in the Ethiopian team and facilitate the use of climate data from weather and streamflow gauging stations in the Awash basin (Photo from REACH Ethiopia Adama meetings, 2019 – Credit: REACH).



Policy and practice impact

- Through the three pathways identified – building leadership in water security science; building trusted relationships with practitioner partners; and training the next generation of water security leaders – REACH partners have worked to ensure the future for Ethiopia's water security research and practice.
- In recognition of their leadership, WLRC is attracting grants and is implementing, with the Ministry of Water and Energy (MoWE), Ethiopia, a €45 million programme, BRIGHT, to improve resilience and reduce vulnerability to drought and climate change in Ethiopia, working in five river basins.
- BRIGHT is expected to directly benefit around 2.5 million people at the community level, and indirectly benefit more than 50 million people residing in the five basins.

Outputs

Over 21 resources have been published by REACH on the Awash basin, available via REACH website resource listings and collated on the Awash observatory page.

Blogs

WLRC and MoWE organise a national workshop on aligning IWRM-related projects and activities. April 2024.

Ethiopia's future is tied to water – a vital yet threatened resource in a changing climate by Dr Meron Teferi Taye and Dr Ellen Dyer. 28 August 2019.

Selected articles

Abebe, Y., Whitehead, P., Alamirew, T., Jin, L. and Alemayehu, E. (2022). Evaluating the effects of geochemical and anthropogenic factors on the concentration and treatability of heavy metals in Awash River and Lake Beseka, Ethiopia: arsenic and molybdenum issues. *Environmental Monitoring and Assessment*, 195: 1188. doi: 10.1007/s10661-023-11674-z

Birhanu, B., Kebede, S., Charles, K., Taye, M., Atlaw, A., Birhane, M. (2021). Impact of natural and anthropogenic stresses on surface and groundwater supply sources of the upper Awash Sub-Basin, Central Ethiopia. *Frontiers in Earth Sciences*, 9: 656726. doi: 10.3389/feart.2021.656726

Borgomeo, E., Vadheim, B., Woldeyes, F.B., Alamirew, T., Tamru, S., Charles, K.J., Kebede, S., Walker, O. (2018). The distributional and multi-sectoral impacts of rainfall shocks: Evidence from computable general equilibrium modelling for the Awash Basin, Ethiopia. *Ecological Economics*, 146: 621-632. doi: 10.1016/j.ecolecon.2017.11.038

Dyer, E., Hirons, L., and Taye, M.T. (2022). July–September rainfall in the Greater Horn of Africa: the combined influence of the Mascarene and South Atlantic highs. *Climate Dynamics*, 59: 3621-3641. doi: 10.1007/s00382-022-06287-0

Hailu, K., Birhanu, B., Azagegn, T., and Kebede, S. (2023) Regional groundwater flow system characterization of volcanic aquifers in upper Awash using multiple approaches, central Ethiopia. *Isotopes in Environmental and Health Studies*. doi: 10.1080/10256016.2023.2222221

Kebede, S., Charles ,K., Godfrey, S., MacDonald, A., and Taylor, R.G. (2021). Regional-scale interactions between groundwater and surface water under changing aridity: evidence from the River Awash Basin, Ethiopia. *Hydrological Sciences Journal*. doi: 10.1080/02626667.2021.1874613

Taye, M.T., Dyer, E., Hirpa, F.A., and Charles, K. (2018). Climate change impact on water resources in the Awash Basin, Ethiopia. *Water*, 10: 1560. doi: 10.3390/w10111560

Yimer, Y.A. and Jin, L. (2020). Impact of Lake Beseka on the Water Quality of Awash River, Ethiopia. American *Journal of Water Resources*, 8(1): 21-30. doi: 10.12691/ajwr-8-1-3

Reports / working papers

Murgatroyd, A., Charles, K.J., Chautard, A., Dyer, E., Grasham, C., Hope, R., Hoque, S.F., Korzenevica, M., Munday, C., Alvarez-Sala, J., Dadson, S., Hall, J.W., Kebede, S., Nileshwar, A., Olago, D., Salehin, M., Ward, F., Washington, R., Yeo, D. and Zeleke, G. (2021). Water security for climate resilience report: A synthesis of research from the Oxford University REACH programme. University of Oxford, UK: REACH.

Key contacts

Dr Gete Zeleke
Director, Water and Land Resources Centre, Addis Ababa, Ethiopia

gete.z@wlrc-eth.org

Dr Tena Alamirew Agumassie
Deputy Director, Water and Land Resources Centre, Addis Ababa, Ethiopia

tena.a@wlrc-eth.org

Prof Katrina Charles
School of Geography and the Environment

University of Oxford, UK

katrina.charles@ouce.ox.ac.uk

REACH is a global research programme to improve water security for the poor by delivering world-class science that transforms policy and practice. The REACH programme runs from 2015–2024 and is led by Oxford University with international consortium of partners and funded with UK Aid from the UK Government's Foreign, Commonwealth & Development Office. Project code 201880.