Protecting groundwater for climate resilience and water security in Turkana

Story of change: Key findings & emerging impacts

Summary

- In Turkana County, groundwater research by the University of Nairobi is contributing to new policy and practice to protect the Lodwar Alluvial Aquifer System and enhance resilience to climate risks.
- Groundwater quality mapping indicates areas with poor groundwater quality to inform water infrastructure investments.
- The research is informing World Bank projects in the Horn of Africa to improve groundwater resilience for vulnerable lives and livelihoods.

Introduction

Lodwar Town, located within Turkana County, is a fast-growing town in sub-Saharan Africa. With a 42.5% population increase between 2009-2019, Lodwar has been experiencing a sharp increase in water demand from urban growth. In addition, industrial demand for water is on the rise due to oil production activities, mega-transport development and infrastructure projects such as the Lamu-South Sudan-Ethiopia (LAPSSET) corridor, and the expansion of commercial and industrial establishments.

Turkana County, Kenya

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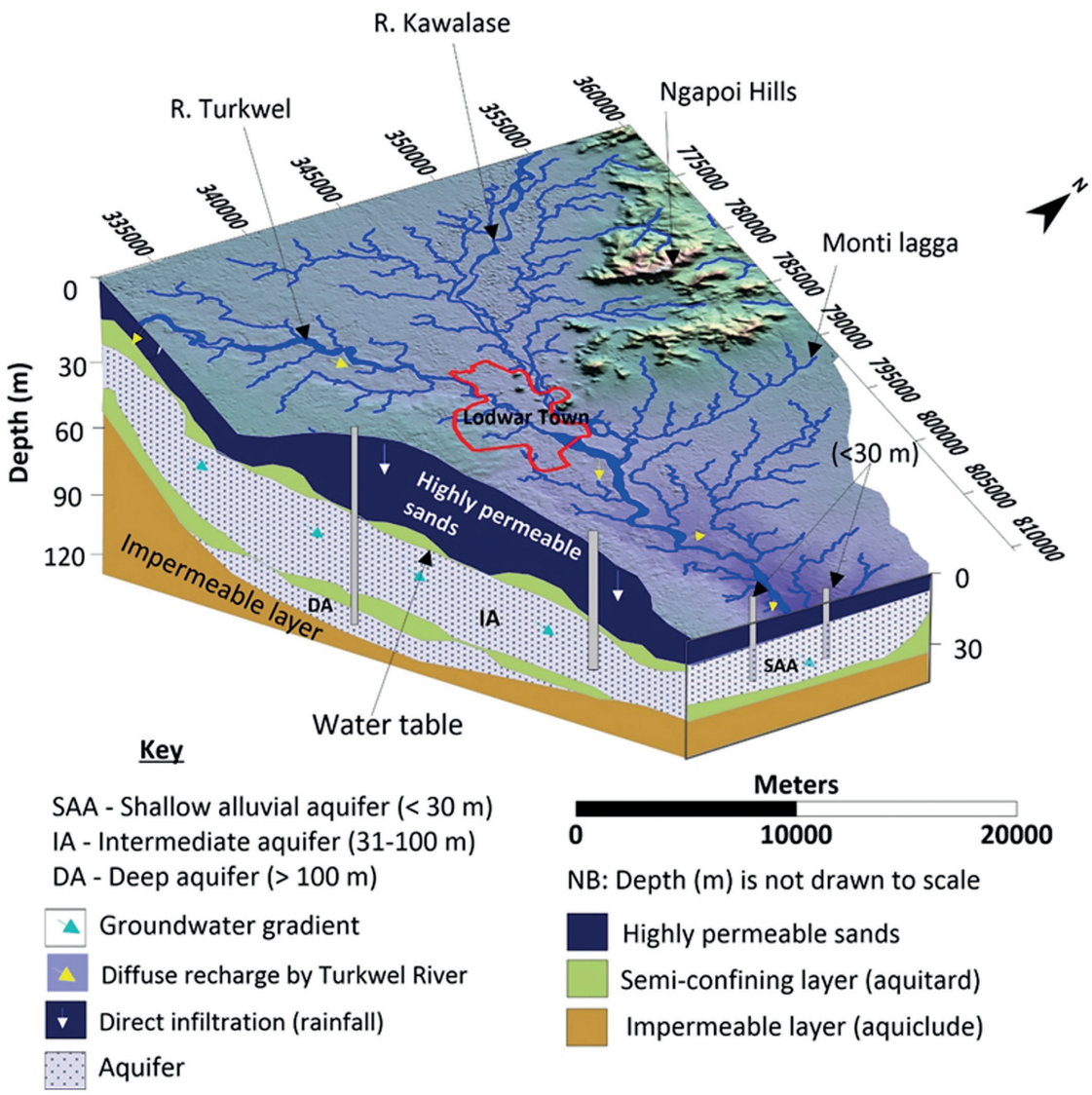
Figure 1: Hydrogeological aquifer conceptual model of the LAAS showing the three sub-systems of the LAAS (SAA, IA and DA) separated by a semi-confining layer allowing their interconnection



Reliable surface water supplies in the region are limited, due to low and erratic rainfall. Hence, groundwater remains the primary source of water for domestic, agricultural and industrial uses within Lodwar and its surroundings. The boreholes and handpumps are dug along the riparian zones of the Turkwel River, which is significantly influenced by climate variability. However, lack of research and data around Lodwar's underlying aquifers, the Lodwar Alluvial Aquifer System (LAAS), has been a critical limitation to the sustainable development and management of groundwater resources.

Key research findings

As part of REACH, the University of Nairobi has carried out comprehensive hydrogeological studies to characterise the aquifer and lay the basis for its sustainable management. Key findings include:

Aquifer delineation:

- Aquifer delineation has revealed that the LAAS comprises of three distinct sub-systems of shallow (<30 m), intermediate (31- 100 m) and deep aquifers (>100 m).
- The aquifer is estimated to hold 1.3 billion cubic metres of renewable and potable freshwater.

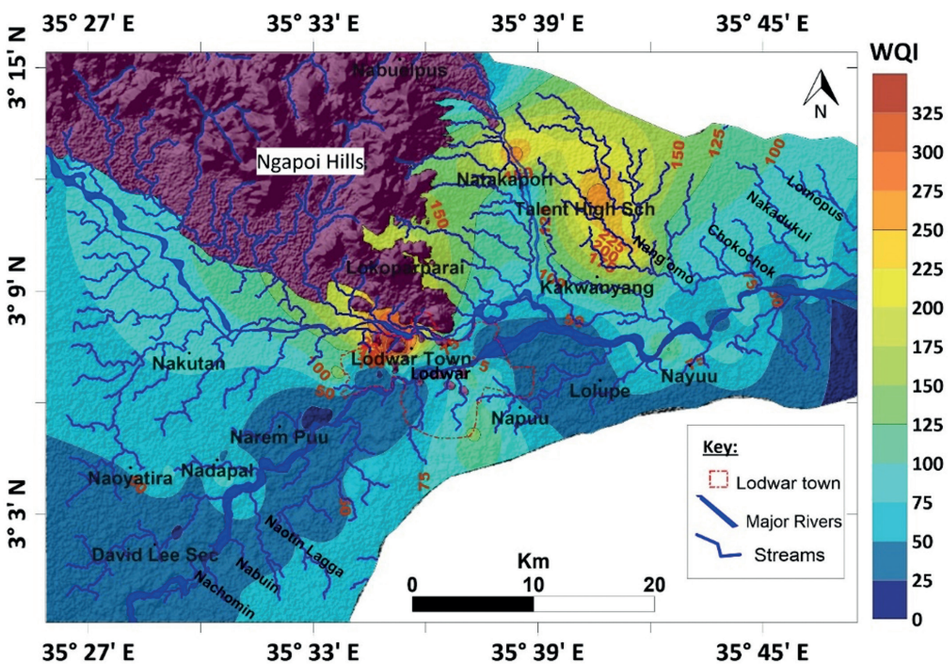
Surface water-groundwater linkages:

- Strong evidence was found to support previous hypotheses of possible aquifer recharge by the Turkwel River. In addition, pulsed hydrological recharge from the Turkwel River was found to play a key role in sustaining potable water supplies in the LAAS.
- Water quality and quantity are influenced by local events, as well events taking place in the extensive upstream catchment area of the Turkwel River (20,000 square kilometres). High climate variability, rising water demand, and land use conversion to irrigated crops in particular, were identified as key stressors.

Geological, climatic and human controls on water quality:

- Tritium is a naturally occurring radioactive isotope of hydrogen used to date modern groundwater. Groundwater with tritium is considered young groundwater, while groundwater lacking tritium is considered old. Young groundwater is linked to recharge by modern rainfall and is vulnerable to climate variability and human contamination.
- The tritium analyses indicate that potable groundwater is associated with modern rainfall (between 2002 and 2018), while saline groundwater is old (recharge before 1960) and has undetectable tritium levels.
- The aquifer is highly vulnerable to natural and anthropogenic pollution. For example, the quality of water from boreholes and handpumps in the Lodwar aquifers (Figure 2) was found to deteriorate during the wet season. This suggests a flushing of pollutants into the groundwater system by recharge water from the river and through piston recharge from the ground surface in the case of the shallow aquifer.

Figure 2: Water quality index map of Lodwar and its environs showing areas with index > 75 having poor groundwater quality. Piped water supplies should be considered for these areas.



Scientific impacts

REACH research, led by the University of Nairobi, in the LAAS has provided timely scientific data and information for a strategic urban aquifer that was previously under-researched. Findings point to the critical need for local to regional-scale environmental protection measures and for continuous monitoring of the surface and groundwater quality in order to secure groundwater resources over the long-term. The study also provides an opportunity for future comparative studies with other drylands in sub-Saharan Africa.

The research in Lodwar is also contributing to the design of aquifer monitoring and management in ongoing Horn of Africa groundwater and climate resilience programmes spearheaded by the World Bank: the North-Eastern Development Initiative (NEDI), and Horn of Africa Groundwater Resilience project (Djibouti, Ethiopia, Kenya, Somalia, South Sudan, Sudan and Uganda).

Policy and practice impact

REACH groundwater research has directly informed the County government's decision-making processes on aquifer protection, groundwater development, and management. This includes the Turkana County Integrated Development Plan (CIDP) 2018/2022, the Annual Development Plan (ADP) 2020/2021, and the Turkana County Climate Change Policy (CCCP) 2020.

In 2021, the Turkana County Government, through the Ministry of Water Services, Environment, and Mineral Resources, processed the gazettement of the areas delineated as the LAAS for protection, a fulfilment of the Vision 2030 environmental protection goals. Although the gazettement notice has not been released, this milestone followed the release of research evidence that the LAAS receives significant recharge from the Turkwel River. Earlier in 2019, the ministry established a County leadership team to guide and develop a work plan for the protection of its strategic groundwater resources.

Subsequently, the Turkana County Government Ministry of Lands stopped issuing allotment letters for parcels of land around the aquifer to reduce the development of residential houses. Where boreholes have already been drilled in sensitive zones of the aquifer system, these have been fenced off to control further development and contaminating activities.

Box 1: Policy statements in the Turkana County Climate Change Policy (CCCP) 2020

To harness and conserve water resources in the County, the Turkana County Government shall:

i. Enact rainwater harvesting regulation for mandatory water harvesting at household and institutional levels;

ii. Support research to map water resources in the County, including the aquifers;

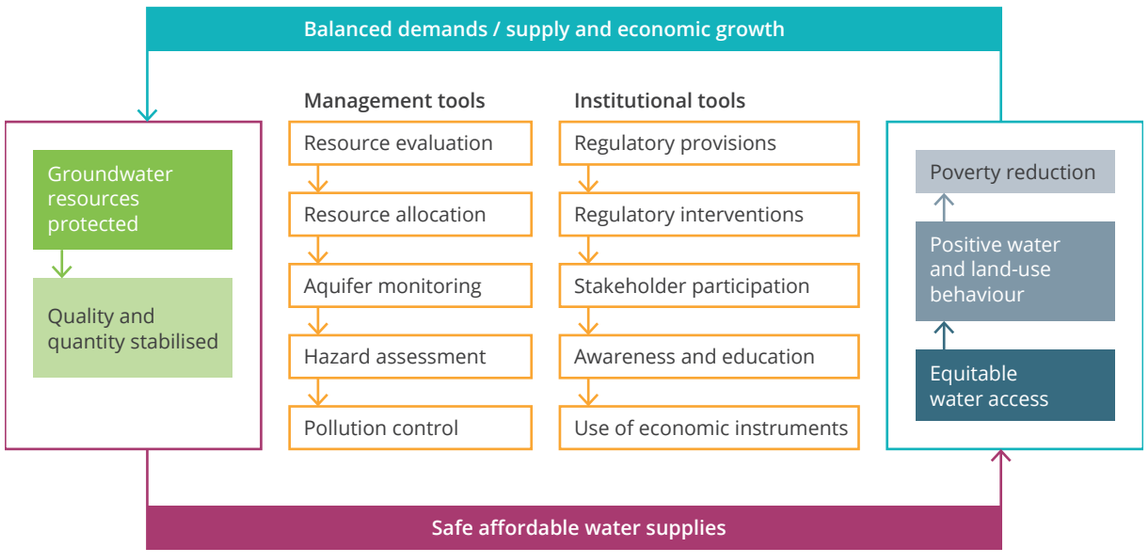
iii. Protect the LAAS from human-induced pollution. Protection measures could include, but are not limited to:

- Protect river buffer zones and well fields;
- Regulate upstream irrigation and conservation;
- Develop town land-use planning, so that town expansion, industries, high-density settlements and waste disposal zones are located away from the defined aquifer areas; and
- Carefully install a proper sewage network and re-evaluate the existing on-site sanitation in the aquifer zone; and

iv. Implement Turkana County Water, Sanitation Services Sector Strategic Plan 2017–2021.

The County Government has incorporated key policy statements emerging from this research into the recently launched Turkana County climate change policy.

Figure 3: Groundwater management tool "The REACH Model" for sustainable development of urban groundwater resources for equitable water access, positive land use, and poverty reduction.



Policy documents launched included; the Turkana County Climate Change Policy, Turkana Climate Change Act, Turkana County Climate Change Fund Regulation and training of 360 Turkana County and Ward climate change committee members from 30 wards in the county. These are policies that aim to positively impact the county's population of almost 1 million people.

The REACH Kenya Programme Director, Professor Daniel Olago, has shared these findings to with the African Ministerial Council on Water (AMCOW), through participation in AMCOW groundwater fora. Prof Olago was a Lead Author in charge of the water section in the Africa Chapter of the sixth IPCC Assessment Report, where these findings are considered in the wider context of sustainable management of groundwater resources under risks and uncertainties that are posed by climate change in dryland areas.

The REACH programme has also supported the development of an Environmental Monitoring and Management Plan (EMMP), a manual that will guide current and future activities within the aquifer for its sustainable use. The EMMP proposes a customised groundwater management tool, the "REACH Model", to ensure safe and affordable water supplies while balancing demand and supply, fuelling economic growth and subsequent poverty reduction. 30 water sectors professional and policymakers joined a capacity-building training workshop on the EMMP in October 2022.

REACH research from 2017 to 2022 provides baseline data for the EMMP, which outlines strategies for planning and implementing early mitigation measures of foreseen human and climate risks to groundwater resources.

The adoption and implementation of the EMMP by Turkana county and water sector professionals will contribute to progress by Kenya towards SDG 6: "Ensure availability and sustainable management of water and sanitation for all".

Poverty impact

Groundwater plays a critical role in enhancing livelihood and addressing poverty in Turkana, with 926,976 people depending on it for drinking, domestic uses, and livelihood support such as small-scale irrigation farming. Overall, it is estimated that 61% of rural households (565,455 people) in Turkana County use unimproved water sources, with the majority relying on unprotected wells and streams.

Poorer households are generally located farther away from the Turkwel River and fresh groundwater resources. These areas have highly mineralised groundwater with electrical conductivity levels reaching 8260 µS/cm, making the water unsuitable for human consumption and agriculture. Piped water supply interventions are required in such areas. REACH has communicated this evidence to the Turkana County Government, and sustainable interventions are being developed.

An example of such interventions is the UNICEF/ KOICA programme, which aims at strengthening community resilience to climate change through improved WASH services in Turkana County. The programme utilised the water quality index map (Figure 2) to identify sites for new community freshwater wells. This programme aims to improve the livelihood of the local communities by expanding water supplies.

Another intervention is the Lodwar Municipality's water trucking initiative to deliver water to communities living in peri-urban and far-flung areas with saline groundwater. Although water delivery is currently bi-weekly, recognising these vulnerable communities is an important milestone towards water security in the region. According to the municipality records, about 10,000 people since 2021 are benefiting from the water trucking programme.

Research outputs

Scientific publication

Tanui, F., Olago, D., Dulo, S., Ouma, G., & Kuria, Z. (2020). Hydrogeochemistry of a strategic alluvial aquifer system in a semi-arid setting and its implications for potable urban water supply: The Lodwar Alluvial Aquifer System (LAAS). *Groundwater for Sustainable Development*, **11**: 100451. doi: 10.1016/j.gsd.2020.100451

Tanui, F., Olago, D., Dulo, S., Ouma, G., & Kuria, Z. (2021). Petrography and geochemistry of the rocks in Lodwar, Kenya and their influences on groundwater chemistry. *Africa Journal of Physical Sciences*, 6: 15–44.

Other

COP 26: Research and knowledge to advance Glasgow commitments (November 2021 Report): Kenya Adaptation: Contributions by Florence Tanui, University of Nairobi.

IWRA Online Conference Report: June 2021. How can science better inform public policy, governance, and capacity building for water, food, and health – Comprehensive Groundwater Research: Evidence to Policy Perspectives in ASALs, Florence Tanui, University of Nairobi.

Ong'ech, D., Olago, D., Dulo, S., Opondo, M., Ouma, G., Albert, M., ... & Katrina, C. (2021). COVID-19 Impacts on water burden among households in Turkana County. *Kenya Policy Briefs*, **2**(1): 57–58. Office of DVC Research, Innovation and Enterprise, University of Nairobi.

Early Career Researcher Feature: Groundwater is a vital invisible resource – to use it, we need to better understand it and make it visible. Oxford: REACH Water.

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Story of change themes

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 Direct from the UK Government's Foreign, Commonwealth & Development Office, Project code 201880.