

Africa as a whole faces significant water management challenges driven by climate variability, rapid population growth, and competing demands from agriculture, industry, and urbanization. In Nigeria, water stress is particularly evident in the northern regions, where frequent droughts, rapid population growth, and industrial contamination, including oil spills, exacerbate water scarcity (Chepyegon and Kamiya, 2018). Similarly, in South Africa's Western Cape, including Cape Town, the "Day Zero" crisis highlighted the severity of water shortages, which were worsened by drought and poor water management practices (Chepyegon and Kamiya, 2018).

East African nations, such as Uganda, Tanzania, Rwanda, and Burundi, face similar water allocation and management issues, each with unique challenges. In Uganda, despite vast water resources, equitable distribution is a challenge, particularly in the northern and eastern parts of the country, where infrastructure is lacking (Galema et al., 2024). The rapid population growth in urban areas like Kampala adds pressure to already limited water resources (Husain and Rhyme, 2020). Rwanda, with its abundant rainfall and numerous lakes, faces challenges related to urbanization and balancing agricultural water use with environmental sustainability. In cities like Kigali, increasing water demand has led to significant investments in water infrastructure, but the country must also address water quality and pollution issues (Chopra and Ramachandran, 2021).

Kenya is grappling with a complex set of challenges related to water supply and demand, influenced by its variable climate, rapid population growth, and the pressures of economic development. Water availability is unevenly distributed across the country, with arid and semi-arid regions facing significant water scarcity (Mulwa et al., 2021). This disparity is exacerbated by the country's dependence on erratic rainfall patterns, which often lead to water shortages, particularly in areas with low annual precipitation (Chepyegon and Kamiya, 2018). As the population grows and urbanizes, the demand for water continues to rise, placing additional strain on the already limited resources and infrastructure (Kou et al., 2025).

Kenya's Lake Victoria Basin serves as an essential water source, but rising populations around the lake, compounded by climate change, threaten the sustainability of water resources in the region. Efforts to regulate water use and prevent pollution face challenges, especially in managing cross-border water resources with neighboring Uganda and Tanzania (Robledo et al., 2024).

The current challenges are further exacerbated by a lack of robust scientific information on the hydrological dynamics of the catchment, including seasonal variability and long-term trends in water availability. Without detailed, accurate data and integrated planning mechanisms, it is difficult to predict the future impact of various water demands and allocations on the catchment's water resources. As a result, water management decisions are often based on unverified assumptions, which may lead to inefficient water use and increased competition for water resources, threatening both environmental sustainability and the livelihoods of local communities.

The study aimed at addressing key water management challenges in the Middle Nzoia Catchment, with a focus on Middle Nzoia. By evaluating current water availability and demand, simulating various scenarios using the WEAP model, and determining optimal water allocation strategies, the study provides a comprehensive understanding of the region's water dynamics (Agarwal et al., 2019). The ultimate goal of the study was to recommend actionable strategies for sustainable water resource management and policy-making. These recommendations, grounded in detailed assessments and scenario simulations, are intended to guide effective water management practices, ensuring that resources are utilized efficiently and sustainably, thereby addressing both current and future water challenges in the Middle Nzoia Catchment.

Parts of Kakamega, Bungoma and Siaya Counties where the Middle Nzoia River Catchment traverses each, have independent development plans, many of which fail to consider the cumulative water supply and demand needs of the entire region. This fragmented approach to water management exacerbates inequities in water allocation and increases the risk of unsustainable water use. The absence of a coordinated, scientific framework for water resource management further limits the region's ability to manage its water resources effectively (Groves et al., 2015). The current challenges are further exacerbated by a lack of robust scientific information on the