

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 main objective of the study was to evaluate water demand over the period 2022 - 2052, in the Middle Nzoia River Catchment. The study aimed to address the gaps using Water Evaluation and Planning (WEAP) model by simulating various future scenarios using the WEAP model, and determining optimal water allocation strategies within the Middle Nzoia River Catchment, 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 the future water challenges in the Middle Nzoia Catchment.

This study aims to understand the implications of both current and future water abstraction on water availability in the catchment. By evaluating various scenarios, the study will provide a scientific basis for predicting future water shortages and help address the challenges of rising water demand. The study will generate essential knowledge on water distribution and demand across sectors, guiding effective water allocation strategies by the Water Resource Authority (WRA) and informing key government policies. Simulation models will help forecast future water needs and evaluate the potential impact of different allocation strategies, fostering discussions on equitable water distribution. Additionally, the study will enhance understanding of the relationship between water flow, ecological conditions, and water use in the catchment. The outcomes will provide critical insights for balancing water availability with demand, ensuring sustainable management of water resources in the Middle Nzoia River Catchment.

2 Materials and Methods

2.1 Description of the study area

This study was conducted in the Middle Nzoia River Catchment that traverses across Bungoma County, Kakamega County, and Siaya County. This study's boundaries was from upstream of the Bunyole water falls at the railway crossing bridge (UTM 67973.00 m N, 702154.00 m E) with an elevation of 1,516 m above sea level, and downstream at (UTM 27589.00 m N, 649276.00 m E) in Sigomere- masiro bridge in Siaya county, including all the major tributaries within that section, which are Lukusi, Surongai, Luandeti, Chebaiywa, Nambirima, Kuywa, Chwele, Maira, Mangango, Luji, Khalaba, and Lusumu (Figure 1).

The Nzoia River is about 257 km Long, the entire catchment traverses the six Counties of Elgeyo Marakwet, Trans Nzoia, Uasin, Gishu, Bungoma, Kakamega, and Siaya. River Nzoia is one of the largest rivers in Western Kenya. The main stream of the river flows from the western side of the Elgeyo Escarpment (Sergoi, Sosiani and Kipkelion Tributaries) the Cherangani Hills (Chepkotet and Kaisungur Tributaries) from an elevation of approximately 2,286 m above mean sea level. Its tributaries which flow from the high slopes of Mount Elgon, attain maximum elevation in the river's basin and are estimated at about 4,300 m above mean sea level (Agnes, 2019). The river has a discharge of about 118 m³/s or about 3.721×10^9 m³ annually, making it the second biggest river in the country by discharge.

Nzoia River can be divided into three zones, the upper zone, the Middle zone, and the lower zone, the upper zone which is also known as mountain zone is forested, with natural vegetation covers consisting of high altitude forest and high altitude savannas, this zone but suffers severe land degradation. The middle zone also known as plateau zone is the major farming zone, also Kakamega forest, which is the only remnants of the equatorial Congolese/Guinean forest, is in this zone. The lower zone also known as low land zone is generally flat and is prone to flooding. The wider River Nzoia watershed, including the main water catchment (Figure 2).