

**EFFECTS OF TARIFF STRUCTURES ON WATER DEMAND IN  
WESTERN REGION OF KENYA**

**Isaac Wafula Simiyu**

**A Research Thesis Submitted in Partial Fulfilment of the Requirements for the  
Award of the Degree of Master of Science in Economics of Masinde Muliro  
University of Science and Technology**

**November, 2025**

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Signature.....

Date.....

Dr. Consolata Ngala

School of Business and Economics

Masinde Muliro University of Science and Technology

Signature.....

Date.....

Dr. Edwin Simiyu

School of Business and Economics

Masinde Muliro University of Science and Technology

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## ACKNOWLEDGEMENT

First and foremost, I am eternally grateful to the Almighty God for blessing me with the intuition, perseverance, and strength to undertake this academic journey. It is through divine guidance and an unwavering inner voice that I have been able to navigate the challenges along the way.

I extend my sincere gratitude to my supervisor Dr. Consolata Ngala and Dr. Edwin Simiyu for their valuable guidance. I also appreciate the School of Business and Economics staff Dr. Mungai, Dr. Kiganda Prof. Byaruhanga, Dr. Reuben Rutto, Dr. Wanjere and others whose vast knowledge, patience, and dedication have been instrumental in shaping my academic and personal growth. Their invaluable teachings and mentorship have not only enriched my understanding but have also instilled in me a profound respect for the pursuit of knowledge.

To my classmates Timothy, Don, George, Becky, Ann and late Stella thank you for fostering an environment of intellectual discourse, collaboration, and camaraderie. Our thought-provoking discussions and shared experiences have made this endeavor both challenging and rewarding, ultimately enabling us to grow together.

Last but not least, I owe an immense debt of gratitude to my family namely my wife Stella and daughters Eleanor and Apphia, whose unconditional love, support, and sacrifices have been the bedrock of my achievements. Their unwavering belief in me and their constant encouragement have been the driving force behind my success. Without their unwavering support, this journey would not have been possible.

## ABSTRACT

Access to safe, reliable, and affordable water and sanitation services is both a basic human right and a critical driver of socio-economic development. In Kenya, the 2010 Constitution and the Water Act (2016) devolved service delivery to county governments, while the Water Services Regulatory Board (WASREB) retained the mandate of setting national tariff guidelines. Despite these reforms, achieving a balance between cost recovery, equity, and demand management remains elusive. The challenge is particularly evident in Western Kenya—Bungoma, Busia, Kakamega, and Vihiga counties—where water utilities face ageing infrastructure, intermittent supply, low sanitation coverage, and widespread poverty. In such contexts, tariff structures function not only as revenue mechanisms but also as tools for influencing consumer behaviour, promoting conservation, and guiding investment. This study investigates the effects of different tariff structures on water and sanitation demand in Western Kenya, applying price elasticity and consumer choice theory. Using secondary data (2016–2023) from county water providers, WASREB reports, and the Kenya National Bureau of Statistics, the study employed a quantitative causal-comparative and correlational design. Statistical analysis involved multiple regression and Pearson correlation, with controls for household income, rainfall variability, urban–rural location, and population density. Tariff models analyzed included Volumetric Pricing (uniform per cubic metre), Increasing Block Tariffs (IBT), and Flat-Rate Tariffs. Findings show that Volumetric Pricing exhibited the strongest negative price elasticity ( $-0.51$ ,  $p = 0.01$ ,  $R^2 = 0.47$ ), demonstrating its effectiveness in promoting conservation and efficient use. IBT showed moderate but statistically insignificant elasticity ( $-0.44$ ,  $p = 0.26$ ), largely due to block thresholds being set too high for low- and middle-income households, thus failing to curb high consumption. Flat-Rate Tariffs displayed negligible elasticity ( $-0.07$ ,  $p = 0.68$ ), confirming their ineffectiveness in demand management. Sanitation demand, though partly bundled into water bills, was influenced more by infrastructure access, affordability perceptions, and cultural norms than by tariff structures. Policy implications suggest that consumption-based tariffs, particularly volumetric pricing, can simultaneously enhance resource sustainability and cost recovery if supported by complementary measures. These include expanding metering coverage, reducing non-revenue water, introducing targeted subsidies for low-income groups, and adopting tariff indexation to adjust gradually for inflation. The study recommends phased tariff reforms aligned with WASREB’s pro-poor guidelines, integrated into County Integrated Development Plans, and consistent with Kenya’s SDG 6 commitments on universal access to water and sanitation by 2030. Although strengthened by a multi-county dataset and robust econometric analysis, the study is limited by reliance on secondary data and the omission of informal water markets, which remain significant in peri-urban and rural areas. Future research should employ spatial econometric models to capture geographical disparities and examine the interaction between tariff policies, climate resilience, and household coping strategies.

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## OPERATIONAL DEFINITIONS OF TERMS

<b>Water Tariffs</b>	The specific pricing mechanisms employed by water utilities to charge customers for water usage. In this study, tariff structures was classified into three types: uniform tariffs, increasing block tariffs (IBTs), and seasonal pricing. These is measured by examining the pricing models applied by local water utilities in the Western Region of Kenya.
<b>Water Coverage</b>	The proportion of the population in Western Kenya with access to improved water sources and sanitation facilities. Water coverage is measured as the percentage of households with access to piped water or other improved water sources within 500 meters of their dwelling.
<b>Sanitation coverage</b>	Is measured as the percentage of households with access to improved sanitation facilities that hygienically separate human excreta from human contact.
<b>Coverage Rate</b>	The extent to which water and sanitation services are available to the population in Western Kenya, measured as the percentage of the total population with access to these services within the service areas of regulated water providers.
<b>Equity in Access</b>	The degree to which water and sanitation services are distributed fairly across different socio-economic groups in Western Kenya. This is measured by comparing coverage rates and service quality between high-income and low-income areas within the service territories of regulated providers.
<b>Service Affordability</b>	The extent to which households in Western Kenya can pay for water and sanitation services without financial hardship. This is measured as the percentage of monthly

household income spent on water and sanitation services, with a threshold of 3% considered affordable based on international standards.

**Infrastructure**

**Investment**

The financial resources allocated by regulated water service providers in Western Kenya to constructing, maintaining, and upgrading water and sanitation infrastructure. This is measured by the annual capital expenditure of water service providers and the percentage of revenue reinvested in system expansion.

**Increasing Block Tariffs (IBTs)**

A tariff structure where the unit price of water increases as consumption increases, typically divided into two or more blocks. In this study, IBTs are identified and analyzed based on the number of blocks and the price differentials between blocks.

## **ABBREVIATIONS AND ACRONYMS**

<b>ADF:</b>	Augmented Dickey-Fuller Test
<b>AIC:</b>	Akaike Information Criterion
<b>ARDL:</b>	Autoregressive Distributed Lag
<b>CWSB:</b>	County Water Services Board
<b>FGD:</b>	Focus Group Discussion
<b>GDP:</b>	Gross Domestic Product
<b>GOK:</b>	Government of Kenya
<b>HH:</b>	Household
<b>JMP:</b>	Joint Monitoring Programme
<b>KII:</b>	Key Informant Interview
<b>NACOSTI:</b>	National Commission for Science, Technology and Innovation
<b>NGO:</b>	Non-Governmental Organization
<b>NRW:</b>	Non-Revenue Water
<b>O&amp;M:</b>	Operation and Maintenance
<b>PPP:</b>	Public-Private Partnership
<b>SC:</b>	Schwarz Criterion
<b>SDGs:</b>	Sustainable Development Goals
<b>SPSS:</b>	Statistical Package for Social Sciences
<b>TSWSD:</b>	Tariff Structures on Water and Sanitation Demand

<b>TS:</b>	Tariff Structures
<b>VIF:</b>	Variance Inflation Factor
<b>WB:</b>	World Bank
<b>WHO:</b>	World Health Organization
<b>WRK:</b>	Western Region of Kenya
<b>WRMA:</b>	Water Resources Management Authority
<b>WSD:</b>	Water and Sanitation Demand
<b>WSS:</b>	Water Supply and Sanitation
<b>WASREB:</b>	Water Services Regulatory Board
<b>WTP:</b>	Willingness to Pay

# CHAPTER ONE

## INTRODUCTION

### 1.1 Background of the Study

The Western Region of Kenya is rather problematic in terms of water and sanitation, which are interdependently connected with the realisation of the United Nations Sustainable Development Goals (SDGs), specifically SDG 6: Clean Water and Sanitation and SDG 1: No Poverty. Poverty reduction, health and general development depends on the access to clean and affordable water. The region however is faced with poor infrastructure, lack of water supply, and sanitation services and this is aggravated by poor tariff structures. The prices imposed on water and sanitation services or tariffs directly affect the demand of water and financial sustainability of service suppliers. These tariffs are designed in a way that can be crucial in either the effective management of the water resources or the success of overall SDGs (Nauges and Whittington, 2023).

One of the attempts to deal with some of these challenges was made by the Water Act 2002 which was fully implemented in 2009 to provide guidance in the water sector reforms that included reviews of tariffs. This act was meant to facilitate recovery of costs, efficient utilisation of water and to increase access to services. The year 2009 is an important year because it provides a base on which the effects of tariff structures on water demand can be established prior to the establishment of devolution. But the tariff reforms have not been effective in all the regions, and western Kenya has been a particular problem since infrastructure is insufficient and poverty levels are very high (Water Services Regulatory Board, 2009).

Through the 2010 Kenyan Constitution, devolution of water and sanitation services to county governments was done to enable better water management of the county and to enhance accessibility. Nevertheless, with this shift, they brought new layers to the tariff establishment and therefore, different counties had different pricing systems. Within the period of 2010-2013 transition, counties that were able to adopt specific pricing mechanisms succeeded whereas others failed in their attempt to do so as a result of their financial limitation and ineptitude (Kenya Institute for Public Policy Research and Analysis [KIPPRA], 2014). Since 2014, the counties have formed their own water service providers, have carried out tariff adjustments, as well as an extension of metering systems. Even with such efforts, there are still access gaps, such as reliable access to safe drinking water by no more than half of the population in certain areas of Western Kenya as well as the loss or unbilled nature of up to 40% of the water distributed by utilities because of leakage and illicit connexions (Water Services Trust Fund [WSTF], 2020).

These issues highlight the need to synchronise tariff frameworks with the local socioeconomic conditions and assist in the Sustainable Development Goals (SDGs), especially SDG 6 on universal access to water and sanitation and SDG 1 on poverty reduction. Excessive tariffs might limit the access by vulnerable groups, whereas lower tariffs may jeopardise the sustainability of utilities and service delivery. Conservation can be promoted using tariff models like increasing block tariffs (IBTs) that impose a higher rate on more consumption, but can create incentives to discourage large and low-income households not designed closely (Balasubramanya et al., 2021). This would mean balancing between cost recovery and affordability, which can be realised with the development of pro-poor tariff structures and with the introduction of targeted subsidies (Fuente et al., 2020).

Volumetric pricing is used by the majority of utilities in North America, usually with tiered or seasonal tariffs to promote water conservation and recuperate costs. Nonetheless, affordability is also a problem, especially to low-income families in urban areas (Teodoro, 2018). Water pricing in Europe is generally controlled and very organised with block tariffs and metering being extensively used. European nations do value economic efficiency and environmental sustainability, but increasing prices have created a controversy on cost and social justice (van Dijk and Schwartz, 2012).

In Asia especially in such nations as India, Indonesia and Philline, utilities tend to find a compromise in terms of affordability and the capabilities of covering expenses. Increasing block tariffs are adopted in many urban centres yet the infrastructure of metering, interference of politics and divided governance remains a still weakness (ADB, 2016). In the mean time, rural communities usually use subsidised or flat-rate solution that fails to fund infrastructure development and maintenance (McIntosh, 2014).

South America is an anomaly of experiences. In the examples of Chile and Brazil, progressive water structures have also been introduced with special subsidies and metering bills, which has encouraged better service provision and sustainability (Foster and Pattanayak, 2008). Nevertheless, in some countries of the region, informal settlements and low-income citizens continue to lack a reliable connexion, either because they cannot afford the rates or cannot be connected to the formal grid (WHO & UNICEF, 2021).

The lessons of these experiences around the world are the same: there is need to come up with tariff structures that are acceptable, effective, and sustainable. Poorly formulated water tariffs may either scare off use or limit access by a marginalised

audience and negatively affect utility performance. On the other hand, properly designed tariff systems may stimulate conservation, improve service provision and financial sustainability (OECD, 2010).

Beyond Africa, a number of countries have adopted new systems of tariffs to increase water and sanitation access: In Chile, a nationwide subsidy system enables low-income families to have a 25-85% discount on water bills. This is coupled with efficient privately-run utilities as well as cost-reflective tariffs to non-subsidised users. Recent research indicates that the model has assisted Chile in securing almost universal urban water supply and ensuring the services are affordable to the poor (Molinos-Senante and Donoso, 2022).

Singapore has a different water pricing policy, which involves the entire water production cost and scarcity value. Tariffs get raised in four levels depending on consumption. The government offers specific support to low-income households so that the services become affordable. Recent evaluations reveal that this method has still worked towards the investments made in water infrastructure and demand management in Singapore and attained universal access to safe water (Tortajada and Lim, 2021).

The Colombia model is a cross-subsidy which imposes more tariffs on affluent neighbourhoods and commercial customers to offset lower tariffs on poor neighbourhoods. This goes hand in hand with rising block tariffs. According to recent studies, although this policy has contributed to the growth of coverage, it is still difficult to cover the poorest informal settlements, especially when it comes to climate change and water shortages (Urrea and del Castillo, 2022).

Japan uses two-part tariff which is composed of a set charge and a volumetric tariff. Tariffs are enabled to enable utilities to recover all costs. Although this has traditionally made a high-quality service attainable, with a growing share of the national population ageing and a related decrease in water usage, this is now raising doubts about the financial viability of certain utilities, with tariff reform being discussed (Yane and Nakagami, 2021).

In Africa, tariff arrangements and effects on coverage are quite different: In Kenya which is the subject of this study, the Water Services Regulatory Board is the one which determines tariff arrangements. Most utilities are using increasing block tariffs with lifeline rates of basic consumption. Nevertheless, according to recent evaluations, low cost recovery and low cross-subsidisation have remained a limiting factor to network growth in most regions, including informal settlements (Nyangena et al., 2022).

South Africa has also adopted a Free Basic Water policy which is free 6,000 litres per month per household. This is financed by cross-subsidies of higher-volume users as well as transfers by local governments. Recent research indicates this has increased accessibility, but has also resulted in decreased conservation incentives and a tense utility revenue base, and that policy reform may be required (Muller, 2021).

The National water and sewerage corporation in Uganda has an increasing block tariff where the lifeline rate is 0-5 cubic metres. The additional charges on commercial and industrial users are used to cross-subsidise residential users. As of the recent statistics, this structure has been sustaining the additional growth of urban water coverage, albeit without closing the gap between rural areas (Huston and Gaskin, 2022).

Ghana uses the same tariff system to all metered consumers but commercial and industrial ones have higher rates. A recent study emphasises the ongoing issues of revenue acquisition and cost-covering that prevent the Ghana Water Company in the growth of its services, especially in low-income regions, and should find new ways of tariff designing and managing the utility (Agyapong et al., 2021).

Reforms in Senegal water sectors involved introduction of social tariffs and connexion subsidy to poor households. This together with performance based participation by the private sector contributed towards a significant rise in the access to water in urban areas. Recent assessments also show that although urban coverage is still increasing, rural locations have experienced lower improvements, which means that additional specific actions are necessary (Diallo and Sauvaget, 2023).

Tariffs are determined locally in Ethiopia and organisation is different. Most utilities charge tariffs in blocks that increase but they do not have sufficient rates to recover costs. According to the recent research, it has further impeded service quality and growth, as utilities have been highly dependent on the government subsidies, which led to the call of the thorough tariff reform (Abebe et al., 2020).

Morocco has adopted a compound increasing block tariff which is composed of seven consumption groups. The initial 6 cubic metres will be at a social tariff. Cross-subsidy- Residential consumers are charged higher rates by industrial users. Recent evaluations indicate that this setup has allowed the growth of coverage, although of issues with the complexity and possible inefficiency are on the rise, prompting debates on simplification (Haddad et al., 2022).

Lastly, in Tanzania, majority of the utilities apply the increasing block tariff with lifeline rate to low consumption. Recent statistics however indicate that low cost recovery has remained a restraint to network growth. The regulator is also encouraging tariff reforms to enhance financial sustainability, and safeguard low-income consumers using specific subsidies, but this is not easily realised (Mandara et al., 2023). This paper seeks to fill these gaps by offering an in-depth insight into the effect of different elements of tariff structure adopted by regulated water service providers in Western Kenya on water and sanitation coverage that can lead to a more efficient and equitable water policy in the area.

## **1.2 Statement of the problem**

In Kenya, the prevailing situation in the Western region is the lack of access to good, cheap, and safe water even though there were great changes in the water sector with the promulgation of the 2010 Constitution. Devolution saw the county governments being charged with the responsibility of water and sanitation services, its purpose being to decentralise decision-making, service delivery and the county counties being free to set up tariff structures, which best suited their particular needs. But in reality, such decentralisation has brought in new sets of issues when it comes to setting tariffs and as a result, the pricing regime has become highly fragmented and inconsistent service standards are being experienced across counties (Kenya Institute for Public Policy Research and Analysis [KIPPRA], 2014).

The statistical evidence brings to light an alarming fact. In some counties of the region, safe and reliable drinking water is available to only half of the population, and even the water supplied by utilities is classified as non-revenue water, and it is lost due to leakages, illicit connexions, and ineffective billing systems (Water Services

Trust Fund [WSTF], 2020; Water Services Regulatory Board [WASREB], 2023). Such inefficiencies do not only affect the quality of the services but also hamper the financial sustainability of water service providers hence hindering their ability to increase their coverage and sustain infrastructure.

These challenges are further highlighted by the fact that Kenya is a party to Sustainable Development Goal 6 (SDG 6) that aims to lead to universal access to clean water and sanitation by the year 2030. Nonetheless, attainment of this objective will be possible through tariff systems that are affordable yet effective in ensuring cost recovery. In case tariffs are too high, low-income households cannot afford adequate water to meet basic needs, and this may affect health and hygiene. Conversely, the lower the tariffs the less can the utilities recuperate operational expenses thereby lowering the quality of service provided and slows infrastructure growth as well (Fuente, Whelan, and Whittington, 2020).

Moreover, it was indicated that various kinds of tariff systems have a different effect on the water consumption patterns. As an example, people tend to suggest the promotion of increasing block tariffs (IBTs) as it is a method to promote water conservation by paying more when using more of it. Nevertheless, IBTs can also lead to the unintentional punishment of big low-income households who use more water because they need it (Balasubramanya, Stifel, & Katuwal, 2021). On the same note, flat-rate cost can be overused by richer households and act as a deterrent to the poor households. These adverse side effects demonstrate that one should pay close attention to the impact of various tariff regimes on the demand of various socio-economic and geographic groups.

Even though water tariffs play a very significant role in the determination of household behaviour and service sustainability, a very limited literature exists on the topic of water tariffs in the Kenyan setting, especially in the western region. There is scarcely any knowledge on the effect of tariff structure changes on household water use, the demand elasticity in relation to different pricing models, the relative impact of flat-rate and volumetric pricing on per capita water use. Moreover, the variation in the effects of tariffs to the urban and rural households has not been extensively addressed. These gaps are directly connected to the aims of this study, which aims at considering the causation role of the tariff alteration and water consumption, measuring the impact of elevating block tariffs on the demand elasticity, deciding the impact of pricing models on water utilisation and evaluating the urban-rural differences on tariff influencing.

Considering the existing service shortfalls, financial wastages and the need to achieve national and international water access goals, this research is not only essential, but urgent as well. It has the potential to produce local, evidence-based knowledge to help in creating more equitable, effective tariff structures that can enhance sustainable water management, access, and poverty alleviation in accordance with Kenya development objectives and international obligations.

### **1.3 General Objectives of the study**

The general objectives of the study is to examine the effects of different tariff structures on water demand in western region of Kenya

#### **1.3.1 Specific Research Objectives**

This study seeks to achieve the following specific research objectives;

- i. To examine the causal relationship between changes in water tariff structures on household water consumption in western region of Kenya.

- ii. To assess the effect of increasing bloc tariff on water demand elasticity in western region of Kenya.
- iii. To determine the effects of flat-rate versus volumetric pricing on per capita water usage in western region of Kenya.
- iv. To assess the comparative effects of tariff structures on water demand across urban and rural households in western region of Kenya.

#### **1.4 Research Hypotheses**

- i. **H<sub>01</sub>**: There is no causal relationship between changes in water tariff structures on household water consumption in western region of Kenya.
- ii. **H<sub>02</sub>**: Increasing block tariffs has no significant effect on water demand elasticity in western region of Kenya.
- iii. **H<sub>03</sub>**: Flat-rate versus volumetric pricing on per capita water usage no significant effect on water demand elasticity in western region of Kenya.
- iv. **H<sub>04</sub>**: Tariff structures have no significant effect on water demand across urban and rural households in western region of Kenya.

#### **1.5 Scope of the Study**

This work was done in the Western Region of Kenya that comprises of counties of Kakamega, Bungoma, Busia and Vihiga. They include Bungoma county Bwasco water and sewerage public limited company (Bwasco) that was formerly Nzowasco, Busia County Busia Water and sewerage services company limited ( Buwasco),kakamega county Kakamega County Water and sanitation company limited (Kacwasco) and Vihiga county Vihiga water and sanitation company limited (Viwasco). These four companies are the officially required water utilities that are based in most of the population in their respective counties, so they are the most

applicable in the analysis of the impact of various tariff structures in water demand. These counties have various social-economic and demographic attributes that determine the patterns of water consumption. Various water service providers provide service to the region and adopt various tariff schemes comprising of increasing block tariffs, uniform volumetric tariffs, and flat-rate tariffs. (WASREB, 2023).

This paper has limited the scope of analysis to the water demand, and the sanitation demand is not considered because of a number of underlying assumptions. To begin with, quantitative analysis was not reliable because, in the Western region, there was no, incomplete, or inconsistent disaggregated and reliable data on the usage of sanitation services and tariff structures (World Health Organisation [WHO], 2021; Kenya National Bureau of Statistics [KNBS], 2023). Also, sanitation charges are frequently grouped with the water costs or not directly charged to the household, and it is difficult to separate their impacts (Water Services Regulatory Board [WASREB], 2022). Sanitation services in most urban and rural localities are delivered by non-metered systems, including pit latrines and septic tanks, the prices of which are not established based on formal tariff systems, which makes it challenging to estimate elasticity (WHO & UNICEF, 2021). Besides, infrastructure availability, cultural practises and governmental health intervention tend to play a more significant role in affecting household sanitation choices than tariff changes (United Nations Human Settlement Programme [UN-Habitat], 2020). The dissimilarity of service provision models between the counties consisting of both public sewerage systems and privately operated desludging services further restricts the comparability of the information throughout the region (WASREB, 2022). Due to these reasons, the research was limited to the water demand, and sanitation was omitted to be analysed in the future when more sufficient and consistent data would be provided.

Economic and behavioural theories of water pricing and consumption lead to the theoretical scope of this study. The Price Elasticity of Demand Theory can be used to clarify the connexion between water tariffs and consumption with the possibility that an increase in water prices can decrease demand, especially among low-income households (Dalhuisen et al., 2023). The Theory of Consumer Choice aids in the realisation of the manner in which households use their income to consume water depending on various types of tariff systems (Varian, 2014). The Public Utility Pricing Theory also gives us an understanding of the process of setting tariffs in water so as to establish a balance between cost recovery, affordability and equity in the setting of water tariffs (Boland and Whittington, 2000). Using these theories, the research determined the cause and effect relationship between tariff systems and the demand of water in the Western Region of Kenya.

The study was based on a time span of 15 years (2009-2024), By 2009, Water Act of 2002 was completely in effect, which is a significant step in the reformation of the water sector. Review of tariffs and more disciplined ways of water pricing were enhanced under the Act and this gave a ground of better efficiency and responsibility in service provision. It took the year 2009 as a base to analyse the pre-devolution effects of tariff structure on water demanded (Water Services Regulatory Board, 2009). The reason was that the 2010 Constitution of Kenya brought about devolution whereby the county governments were in charge of water and sanitation services. Characteristic of the creation of county water service providers was a variety of tariff changes, expanding metering, and policy interventions to enhance service delivery based on data availability. This period is also suitable in recording past trend on the consumption of water, adjustment of tariffs and policy modification by water service providers.

## **1.6 Significance of the Study**

This research is important because it offers meaningful information on the effects of various tariff regimes on the demand of water within the Western Region of Kenya. Knowledge of such effects is essential to policy makers, water service providers as well as regulating bodies in developing equitable, effective and sustainable processes of pricing. The study helps in the provision of evidence-based decisions in the water sector by analysing secondary information on the past water consumption tendencies under the various tariff regimes.

The current study is in harmony with SDG 6: Clean Water and Sanitation as it advocates accessibility, efficiency, and infrastructure development at affordable rates. It examines how it could assist in making tariff systems more friendly to low-income earners (Target 6.1) and using pricing tariffs like Increasing Block Tariffs (IBT) to promote water conservation (Target 6.4). Moreover, efficient tariff regimes also bring in revenue that can be used to maintain and extend the water and sanitation infrastructure, to enhance service delivery in urban and rural regions (Target 6.3).

To policy makers and regulators like the Water Services Regulatory Board (WASREB) and county governments, the study has provided empirical evidence to determine the effectiveness of current tariff schemes in facilitating water conservation, water affordability and cost recovery. This information is critical in informing tariff reforms that would balance the economic sustainability and social justice ensuring that low income households will access sufficient water without straining their pocket-books.

To water service providers namely water utilities that serve Kakamega, Bungoma, Busia and Vihiga counties ( Bungoma county -Bwasco water and sewerage public

limited company (Bwasco) once Nzowasco, Busia County -Busia Water and sewerage services company limited ( Buwasco),Kakamega county Kakamega County Water and sanitation company limited ( Kacwasco) and Vihiga county Vihiga water and sanitation company limited ( Viwasco)) the investigation assists them in evaluating the effects of The study will allow them to come up with pricing frameworks that are efficient in terms of operations but create a sense of responsible water consumption.

To households and consumers, this research shedding light on the influence of various price structure on their consumption and spending patterns of water. The appreciation of these dynamics assists in the advocacy of equitable water pricing policies that would make water available, especially to the vulnerable and low-income earners.

To academicians and researchers, the research paper is an addition to the available literature on the economics of water, demand control, and utility pricing decisions. The results can be applicable in future research on sustainable water management, especially in areas that have the same socio-economic and environmental settings.

Generally, the research is important in enlightening sustainable water tariff policies that support equitable distribution of water, economic feasibility of service providers, and economic efficiency of resource use in the Western Region of Kenya.

### **1.7 Limitations of the Study**

This research had a number of limitations which influenced the scope, precision as well as analysis of its results. The use of secondary data was one of the primary issues due to inconsistency, missing value, or bias in reporting. The information of the water service providers like Bwasco, Buwasco, Kacwasco, and Viwasco was not exhaustive, specifically when it comes to past data. Variation in data collection and reporting

procedures by counties interfered with comparability. In a bid to overcome this shortcoming, the approaches used in this study in data validation included cross-referencing of various sources, government and other regulatory reports and statistical techniques to manage missing information.

The other limitation was the exclusion of small-scale water suppliers i.e. private boreholes operators, community-based water projects and informal water vendors. They are an important part of the rural/peri-urban rural setting and their tariff arrangements are usually unregulated and unequal, which makes it hard to evaluate their contribution to the water demand with the help of standardised techniques. To reduce this study recognised the presence of informal suppliers in water supply and suggest more studies concentrating on their pricing frameworks and demand trend.

Also, other factors that have been adjusted in tandem with the tariff adjustments include water availability, population, economic and infrastructure development, which affected the demand of water. Separating the exact impact of tariff structures with these external factors is a methodological issue. To help counter this, the study employed the econometric models and statistical controls in order to capture other factors that might influence the relationship between the tariff structures and water demand to ensure a more accurate determination on the relationship was provided.

## **CHAPTER TWO**

### **LITERATURE REVIEW**

#### **2.1 Introduction**

This chapter presents a comprehensive review of empirical literature related to the effectiveness of tariff structures on water and sanitation coverage, with a particular focus on the context of developing countries and, where possible, Kenya and Western Kenya specifically. The review is structured around the key variables identified in the conceptual framework: Coverage Rate, Equity in Access, Service Affordability, Infrastructure Investment, and Tariff Structure as an intervening variable.

#### **2.2 Theoretical Literature Review**

This section presents the theories of price elasticity,

##### **2.2.1 Price Elasticity Theory of Demand**

Price elasticity theory of demand is an important economic theory that defines the relationship between change in quantity demanded of a good or service with change in price of that good or service. The theory plays a vital role in appreciating the impact of tariff structures to water and sanitation demand, which is more evident in the western Kenya setting where water is scarce and the pricing policy greatly influences the consumption behaviour.

Alfred Marshall is generally considered as one of the greatest contributors of formalising the theory of elasticity. This theory of microeconomics, his book *Principles of Economics* (1890) brought in the concept of price elasticity of demand. Marshall explained the elasticity as a ratio of the extent to which the quantity demanded of a commodity varies when the price of the commodity changes. He developed the interrelation between the price variations and the quantity demanded,

basing on the idea of proportional changes. The study by Marshall formed a basis towards the sensitivity of demand to price in markets.

Another term used by Marshall to explain the nature of demand is elastic and inelastic. Elastic demand is one in which any alteration in the price causes a significant alteration in the quantity demanded and inelastic demand is where the quantity demanded remains unchanged significantly to any alteration brought by any change of price. These have been critical in understanding the way markets react to price changes.

Price elasticity of demand (PED) is defined as the percentage change in quantity demanded/ percentage change in price. In elastic demand, a price adjustment causes a huge adjustment in the quantity demanded whereas inelastic demand implies that consumption is not significantly affected by price changes. Considering the example of water and sanitation services in western Kenya, the price elasticity of demand depends on the level of income, the existence of substitutes and importance of service as essential goods.

A basic good such as water is in most cases inelastic in nature and hence demand does not reduce much even when it is increasing in price. This is more so in consideration of the Western Region of Kenya where there is already a limited access to both clean water and sanitation services. Water is a vital service to most households and even when prices go up, the amount of consumption tends to be a constant (Kenya Institute for Public Policy Research and Analysis, 2014). Nevertheless, the degree of inelasticity may be more or less depending on such factors as the income levels, the presence of alternative sources of water (bores, wells, etc.), and the general cheapness of water services in a given area.

The tariff design the way water prices are determined- is extremely important in finding out the sensitivity of demand to price change. An example is the price elasticity can be more evident when western Kenya water companies use volumetric tariffs (a system of charging customers depending on the amount of water used). In this system, households could decrease their consumption when prices are high especially when they have budget constraints (Water Services Trust Fund, 2020). Conversely, when the price of water is relatively low or fixed, there is the likelihood that the consumer will not alter its behaviour significantly, despite the fact that the cost of providing the service is high. This is because water is considered as a need and individuals are mostly ready to do without other things or services in order to address their water demands.

In addition, the availability of substitutes also determines the price elasticity of demand of water. The demand of piped water is not very elastic in places where alternative sources of water are less plentiful or unreliable. The demand of the utility-supplied water could however be more elastic in areas where there are private boreholes, rain harvesting, or other water providers. In such regions, the households can react better to the price by switching to other sources of water hence cutting their dependence on the government waters (World Bank, 2000). Hence, due to the lack of good alternatives in the rural western Kenya, the water demand is inelastic.

The level of income is also important in dictating the price elasticity of demand of water in western Kenya. Increase in price is less likely to make house holds with higher incomes, reduce the use of water since they are more financially flexible. On the other hand, low income families, and households that constitute a considerable part of the population in western Kenya, tend to be price sensitive. The rise in water

tariffs in such communities is likely to reduce water consumption, with households trying to offset expenses elsewhere (Kenya National Bureau of Statistics, 2022). This underscores the need to introduce progressive tariff rates that make water affordable to the vulnerable groups of people especially in the rural regions that have a lower income per capita.

The issue of cross-elasticity of demand also comes in to play when the effect of the structure of tariffs on the water demand is looked at. This is the way that the demand of one commodity (e.g. water) reacts to an increase or decrease in price of a related commodity (e.g. sanitation services). The water tariffs in western Kenya would have an indirect impact on the demand of sanitation because the households may be more concerned with the use of water to drink and cook rather than provide sanitation services, thus reducing the overall sanitation services (Kombe, 2020; Whittington et al., 2002). This is especially issue problematic within low-income households whereby water and sanitation services usually come together as basic utility services (Banerjee and Morella, 2011, Gulyani et al., 2005). This interdependence is also important in the design of pricing policies that would not in unintentionality undermine the outcomes of public health.

Conclusively, the price elasticity of demand theory is very applicable in the research about tariff structures in the western region of Kenya. The knowledge of how water price fluctuations impact consumption may be used to help policymakers to design tariffs that would both promote the financial viability of water companies and ease the provision of affordable water and sanitation services to the population. Although water is mostly an inelastic good, the elasticity of its demand may take different values based on the level of income, availability of substitutes, and a tariff regime.

These factors should therefore be put into serious consideration when coming up with water tariffs that can enhance equity and sustainability in the water and sanitation sector of the region (Water Services Regulatory Board, 2009).

### **2.2.2 Public Utility Pricing Theory**

Public Utility Pricing Theory is a critical theory in explaining how the price of the services offered by the water and sanitation utility companies like the water and sanitation are established and how demand is affected by them. In the case of the Western Region of Kenya, prices of public utility are also instrumental in defining access and affording the services of water and sanitation, which are fundamental in health and economic growth as well as poverty alleviation. The concept of public utility pricing theory is based on the notion that the prices must be set based on the cost of delivering a service and this would be in a way that not only would the utility be financially viable but also would all the members of the population such as low-income earners receive services impartially.

The main interest of the public utility pricing theory is on optimal pricing structure of services which are natural monopolies or services which are highly controlled by the government. Examples of such services are water and sanitation. The level of competition in such markets is minimal and the services are often provided by one party mostly through the intervention of the government. According to the theory, utilities ought to set prices based on the marginal cost of the service provision to ensure that the price notifies the consumer on the actual cost of the use of the resource. Ideally, the price would be established at a level that will allow efficient

consumption and prevent wastage and will ensure that the price is able to earn sufficient revenue to meet operating and capital costs.

But in reality, this perfect pricing system encounters difficulties especially in such places as western Kenya. According to the theory, there are a number of ways of establishing prices each of which has its demand and service delivery implications: Marginal Cost Pricing approach suggests that water tariffs must mirror the marginal cost of providing an extra unit of water. The inadequacy of resources coupled with poor infrastructure in the Western Region of Kenya may mean that marginal cost-based tariffs would make consumers charged in a manner that would lead to efficiency. Nevertheless, since infrastructure development is still expensive, the marginal cost of water is usually too high to be affordable to the majority of the consumers (Water Services Trust Fund, 2020). Therefore, marginal cost pricing can result in discrimination especially in the poor households since they can make water unaffordable.

Average Cost Pricing is a pricing strategy that is more widely used in most systems of utility services where the price will be determined to cover the overall costs of offering the service both fixed and variable costs. High infrastructure maintenance cost, operational inefficiencies and expansion requirement have also affected average cost of service provision in the water sector in Kenya (Kenya Institute of Public Policy Research and Analysis, 2014). Although this approach guarantees that the utility will afford its bills it might cause an increase in the prices of consumers making the demand to decrease, particularly in low-income communities. Moreover, the average cost pricing could not necessarily indicate a lack of water or the different

prices of provision in various places leading to inefficiency in the allocation of resources.

One popular way of pricing in public utilities is by block tariffs in which a consumer receives a lower rate on a certain amount of water that they use, followed by a high rate on extra usage. This price structure will cushion the low income families by making it affordable to them to get a minimum amount of water but at a higher rate to the high-volume users. Block tariffs have been regarded as a solution to achieving a balance between affordability and sustainability in water sector. The application of block tariffs in the Western Region of Kenya would assist in enhancing water access among the poor households as well as provide water providers with enough revenue to maintain and develop more infrastructure (Water Services Regulatory Board, 2021). The effectiveness of such a pricing mechanism, however, is subject to the correct observation of water consumption and the effective introduction of tariff systems, which in most cases is limited due to logistical and financial issues.

Cross-Subsidisation is a concept is whereby wealthier customers pay more to enable the poorer ones to have water at a subsidised cost. It is an instrument that is employed to create an equitable price of the public utilities, especially in areas that have vast income inequality, like the Western Region of Kenya. The consumers with higher income pay a higher price thus subsidising the price of low-income customers. Cross-subsidisation can be used with block tariffs and its effectiveness lies in the capacity of water service providers to differentiate customers according to their affordability and reflective consumption behaviour (World Bank, 2000). Although this strategy may assist in alleviating the economic pressure on the vulnerable groups, it demands good administrative skills and elimination of abuse or inefficiency in the system.

Water and sanitation in the Western Region of Kenya, the demand is directly affected by the tariff structure in terms of demand elasticity and affordability. Water pricing has an impact on consumption behaviour particularly in the rural regions where there is lack of access to clean water and poverty is rampant. As it was mentioned above water is usually inelastic good, especially in the areas where there is not many alternative sources of water. Thus, even considerable price growth may not have a drastic impact on the decrease of the usage of water. The issue of payment is however critical to a lot of households. The level of price sensitivity is high when the household income levels are low and it is therefore necessary that the tariff structures consider the financial forces of consumers.

Water utility sustainability is an issue of serious concern in western Kenya. The situations that many utilities face are under-recovery of costs as a result of inefficiency in the tariff structure, non-revenue water (water that is generated and yet not paid), and inability to increase infrastructure. The public utility pricing theory proposes that utilities need to balance between cost-effectiveness and affordability precariously. Nevertheless, the Water Services Regulatory Board (2021) emphasises that the western Kenya water service providers are not responsible enough to meet the full service delivery costs and resort to government subsidies and external financing.

In Kenya, water services were devolved in 2010, which has made the pricing situation of the publicly owned utilities more complex. As counties now determine water tariffs, there has been a wide variance on the structure of tariffs in the country, even in the Western Region. On one hand, devolution has created an opportunity to create a decision making that is more localised; on the other hand, it has created difficulties in maintaining uniformity and fairness in pricing. The local situation including income

levels, population density and infrastructure capacity has a significant impact on the way counties structure their tariffs. In the less-income regions, tariff systems, which are highly based on cross-subsidisation or block tariff, can be more efficient, yet they must be properly controlled to prevent financial pressure on water service providers (Kenya National Bureau of Statistics, 2022).

### **2.2.3 Consumer Choice Theory**

Consumer Choice Theory is a fundamental principle of microeconomics which attempts to describe how consumers make choices regarding the way they spend their limited income on different and diverse goods and services, in order to maximise their utility or satisfaction. The theory can be applied to the study of the implications of tariff structure on the water and sanitation demand within the Western Region of Kenya where consumers have financial constraints, as well as do not have access to the basic services. The theory of consumer choice assists in the explanation of the ways people in this region respond to the changes in prices of their basic needs like water and sanitation services and the impact of tariff systems in the consumption patterns.

The consumer choice theory is founded on the assumption that the consumers are trying to maximise their utility (or satisfaction) within the constraints of their budgets. Utility is defined as the content or gratification of consuming a product or service. The consumers are assumed to make decision based on the comparison of the marginal utility (additional satisfaction) that they will receive with the price at which they will consume a good. According to the theory, consumers distribute their income in a manner that maximises their aggregate utility at the prices of goods and their income level (Varian, 2014).

When it comes to water and sanitation services, consumers have to make a choice on the quantity of water to use depending on their income levels, the prices charged by water service providers as well as the utility they attach to the availability of clean water and sanitation. Individual preferences and outside influences are those factors that influence the decision making process, which include availability of substitutes and the need to use water to sustain a basic life. Water as a basic need is usually viewed as inelastic, that is, despite an increase in price, consumers will probably buy it because of its necessity. Nevertheless, it all depends on the income level of a consumer, the price format, and the possible presence of other options to water (e.g., wells, boreholes, rainwater collection).

Tariff structure of water in Western Region of Kenya is important in influencing consumer preferences toward water consumption. Access to clean water and sanitation is a problem in the region and most households depend on the water sources of the community or the vendors of water locally. Reforms on water provision brought about by the Water Act of 2002 and other subsequent reforms have also had far-reaching consequences on water pricing structures that affect the way households can spend their budgets to cater to their water demand (Kenya Institute of Public Policy Research and Analysis, 2014).

The tariff systems employed in the region like, flat tariffs, volumetric tariffs and block tariffs influence the decisions made by consumers. An example of this is a flat tariff where water usage is charged the same rate, and this can decrease the motivation of the consumer to save on water. Conversely, consumer behaviour may be shaped by volumetric tariffs, where consumers pay tariffs depending on the quantity of water

they utilise, which leads to more efficient use of water, particularly in regions with limited resources (Water Services Trust Fund, 2020). As an illustration, when a consumer has to pay more when he consumes more, then he will decide to consume less water by ensuring that he prioritises his basic needs which include drinking and cooking and minimise the non essential like washing or watering plants.

Block tariff is also another pricing system that is used in the water sector in Kenya whereby individuals are charged low prices on the initial amount of water used and high prices on extra water use. The idea behind this structure is to make basic water needs affordable to the entire population and conserve among those who consume large amount of water. In this framework, the consumers will decide on the marginal utility they will get in an extra unit of water. The marginal utility of water to low-income households in the Western Region is high because of the necessity of the service and hence they will drink water the same or may decrease a little with an increase in price. Nevertheless, in the case of more affluent households that have more disposable income, the elasticity of water demand can be higher and the consumers can be more ready to change their consumption pattern following the rise of prices (Kenya National Bureau of Statistics, 2022).

The income constraint is one of the most important determinants of consumer choice when it comes to the demand of water and sanitation in western Kenya. A significant portion of the population in the area is below the poverty line and therefore allocation of scarce resources is a major concern. The world bank (2000) notes that consumers in the low income category are likely to be more price-sensitive, and the consumption

decisions of consumers who use basic goods like water are likely to be affected more significantly by a change of the price of these commodities. Taking a case in point, with the growth of water tariffs, the low-income households will be compelled to decrease their water usage, which may negatively affect their health and sanitation standards, as they would not be able to cover the cost increment. In this instance, water tariffs without reference to income inequalities can unintentionally damage vulnerable groups worsening the accessibility to safe water and sanitation (Water Services Regulatory Board, 2021).

The pricing system, on its part, influences the trade-offs which the consumers in western Kenya have to make between the consumption of water and other necessities or services. As an example, when the price of water goes up, the households may cut down on their water consumption and channel the money elsewhere to other requirements like food, education or even healthcare. This is an essential process of trade-off in terms of learning how consumers distribute their budgets when utility costs increase especially in places with excessive poverty levels (Kenya Institute for Public Policy Research and Analysis, 2014).

Besides the income and tariff structures, other external forces like availability of substitutes, and the government policies also influence consumer choice in the Western Region of Kenya. The availability of alternative sources of water e.g. wells, rainwater harvesting, water vendors may change the behaviour of consumers in response to changes in tariffs. In case the cost of utility supplied water is highly raised, consumption of the same by some consumers might shift to these alternative sources, as long as they are accessible and safe. In most of the rural regions in western

Kenya however, the other source is either unreliable or of low quality as such the consumers are not able to change to other sources other than the public water supply (World Bank, 2000). Such scarcity of substitutes renders water to be a relatively inelastic good within these regions as demand has not decreased despite the increases in prices.

Besides, consumer choice may also be affected by government interventions in the form of subsidies or price controls. Some of the subsidy programmes that have been carried out by the Kenyan government target making water more affordable to the poor households. Such subsidies have the potential of reducing the effective price of water among the vulnerable groups enabling them to consume more and enhancing their general well-being. The success of these interventions though, lies in the effective targeting of subsidies and effective management of water resources.

## **2.3 Conceptual Literature Review**

### **2.3.1 Tariff Structures on Water and Sanitation**

Water and sanitation are vital services that help in improving the human health, economic growth, and general health in general. The pricing of these services, in its different tariff-systems, has a significant bearing on the consumption behaviour, the economic viability of utility systems, and the fair accessibility of underserved groups to clean water and sanitation. This literature review looks at the existing studies on water and sanitation tariff structure with particular attention to the effect of the tariff on demand, their sustainability and equity with special consideration to developing zones such as the western region of Kenya.

### **2.3.2 Tariff Structures and its Effect on the Water and Sanitation Demand.**

The tariff structures are categorised as various types and each is purposely designed to achieve certain objectives. Such structures carry varying connotations to both the consumers and the water service providers especially in developing areas.

#### **2.3.2.1 Flat Tariffs**

Flat tariff is one of the easiest types of pricing structures whereby the consumers are charged an identical rate irrespective of the amount of water they consume. The structure is commonly deployed in locations that have limited infrastructure where the metering systems are either not available or not feasible. Although flat tariffs are relatively easy to administer, they are not very efficient when it comes to encouraging water conservation. Moreover, they might not represent the true cost of water supply, and their retrogressive nature can create inequities because more affluent households will be able to consume as much water as poor households do at the same price (Moriarty et al., 2013). The introduction of flat tariffs can increase inequities in access to clean water in places such as Western Kenya, where there is a high level of poverty, and therefore, the poor individuals whose income levels are low will be the ones who are unduly expensive to provide access to clean water services.

#### **2.3.2.2 Volumetric Tariffs**

Volumetric tariff system, also known as charging consumers on the basis of water consumed, has been widely regarded as a useful means of conservation and other purposes of enhancing cost recovery. This arrangement brings the price of water to its true cost of supply and effectiveness brings consumers more conscious of their usage habits (Grafton et al., 2011). Volumetric tariffs are especially good in the urban centres where metering facilities exist. Nevertheless, in rural areas such as Western Kenya, where the metering is either sparse or unreliable, volumetric tariffs have serious implementation challenges. The Water Services Regulatory Board (2021) notes that the poor metering infrastructure is one of the factors that support the

inability to correctly measure the amount of water being used, making volumetric pricing less effective and causing water inefficiency.

### **2.3.2.3 Block Tariffs**

Block tariffs are usually applied in both urban and rural areas and here there are low rates that are charged on the first unit of water used and rates that are gradually increasing with increased use of water. Block tariffs are meant to make sure that the basic water demand is served at a reasonable cost and that the high-volume water consumers are made to cut down or pay more to indulge in exceeding the water demands (Bakker, 2013). The system of block tariffs may be regarded as a fairer pricing model, because it takes into consideration the interests of low-earning families, giving them the first block of consumption on a subsidised basis. Nevertheless, their efficiency lies in appropriately implementing and metering them. The adoption of block tariffs in Kenya where water service delivery has been decentralised has not been uniform as certain counties have not been able to strike a balance between affordability and the financial sustainability required (Kenya Institute of Public Policy Research and Analysis, 2014).

### **2.3.2.4 Effect of Tariff Formation on Equity and Affordability.**

Equity, especially among the vulnerable populations, is one of the issues of concern in the design of water tariffs. Lifeline tariffs are a type of block tariff, they are meant to offer subsidised water to be used as water of first necessity. These tariffs are designed to help low-income households to avoid high prices on water by ensuring they can get at least a certain level of water at a fair price (Harris et al., 2015). Lifeline tariffs have played a crucial role of facilitating access to water by the marginalised groups within Kenya especially in the informal settlements as well as the rural locations (World Bank, 2000). Nevertheless, despite the advantages of lifeline tariffs, they may create inefficiencies when they are not designed in an appropriate manner. On other

occasions, subsidies given to the poor can also be received by the rich, especially in the urban regions where metering system is not commonly used.

The affordability issue is especially in the rural areas such as the western Kenya where most of the households live under the poverty line. The Kenya National Bureau of Statistics (2022) says that a significant part of the Western Kenya population continues to have no reliable clean water access with a large number of families using unprotected sources including rivers or shallow wells. The high tariffs imposed on water can cause the households to utilise less water which will result in negative health and sanitation consequences. These disparities can be aggravated by the regressive aspect of tariffs, where the poor people pay a higher rate of their income on water (Alemu et al., 2020).

#### **2.3.2.5 Problems in Water Tariff in Kenya.**

Devolution of water services in Kenya has resulted into a great differences in the tariff structure of various counties in Kenya since now, the local governments can determine water tariffs. This decentralisation has enhanced responsiveness to local demands, but has caused difficulty in balancing tariffs across the country. Other counties, including Kisumu and Kakamega, have adopted progressive tariff regimes that seek to balance between equity and financial sustainability, whereas other counties have had a hard time to devise tariffs that are affordable and allow financial sustainability (Kenya Institute for Public Policy Research and Analysis, 2014). Specifically, Western Kenya rural areas have other issues with applying and implementing tariffs because they have low metre rates and high administrative prices (Water Services Trust Fund, 2020).

The other major problem that is affecting the Kenyan water sector is the inadequacy in metering infrastructure at the rural regions. According to Moriarty et al. (2013),

volumetric and block tariffs cannot be effectively implemented without properly metering because water consumption cannot be effectively traced. This inefficiency is due to lack of infrastructure where some households might be charged more when compared to others using the same amount of water. Moreover, when there is no metering the tendency is to overuse water especially when there is no relationship between the price and consumption, or when the price is not fairly matched.

Planning and execution of water and sanitation tariff systems are a complicated task that must involve the careful balance of efficiency, fairness and financial viability (Whittington et al., 2002). Under the local conditions of developing countries such as Western Kenya where income differences are high and there exist numerous infrastructure related problems, tariff structures should be made in such a way that consumers are able to access reasonably priced water and sanitation services (Kariuki & Schwartz, 2005). Although block tariffs and the volumetric tariffs have demonstrated some promise in enhancing conservation of water and delivering equality in access, their effectiveness relies on variables like income levels, metres and the financial stability of water companies (Komives et al., 2005). Also, it is essential to make water affordable to the low-income population, which can be achieved by lifeline tariffs or subsidies, but such policies should be tightly focused to prevent inefficiencies and unintended impacts (Fuente, Whelan, and Whittington, 2020). Devolution of water services in Kenya provides opportunities and challenges to the tariff design, particularly because counties are unequal in their capacity and priorities (KIPPRA, 2014; WASREB, 2023). Further development of novel pricing mechanisms should be conducted to suit specific issues of the region and enhance the targeting strategies. Finally, a proper formulated and established tariff system is

important in realising a sustainable and fair access to water and sanitation services in Kenya (World Bank, 2017).

### **2.3.3 Kenya: Water and Sanitation Demand.**

Sanitation and water form important aspects of the social, economic, and public health (WHO and UNICEF, 2021). The need to supply such services as water and sanitation is increasing in Kenya because of the population growth, urbanisation, and climate change, as well as the infrastructure and affordability issues (World Bank, 2016; WASREB, 2023). The present and detailed literature review discusses the needs in water and sanitation services in Kenya, including the essential factors in the demand of the services, the equity of provision, the affordability of services, and sustainability of the provision (KIPPRA, 2014; Hope et al., 2020).

#### **2.3.3.1 Population Growth and Urbanisation**

The population of Kenya has been growing fast thus making the demand of water and sanitation services rise. The Kenya National Bureau of Statistics (2022) forecasts that the Kenyan population will at least be at the mark of 70 million by 2030 as compared to 54 million in 2022. Such expansion coupled with urbanisation process has exerted a stronger burden on water resources and sanitation systems in the country.

Demand is growing in urban regions especially Nairobi, Mombasa and Kisumu because of rural-urban migration. Most of the migrants find homes in the informal settlements whereby access of clean water and sanitation is a major problem. Such settlements do not have the necessary basic infrastructure, and the population relies on unchecked water sellers or on unhygienic water sources. As Moriarty et al. (2013) remark, such communities are characterised by a low level of sanitation, which contributes to the spread of waterborne diseases and deteriorates the state of population health. Thus, population growth is not the only factor in influencing the

demand of both water and sanitation services but also the inequality in access and facilities.

### **2.3.3.2 Geographical Inequality of Access.**

The geographical heterogeneity of Kenya has a great contribution to the water and sanitation demand. The nation is partitioned into areas that are highly disparate in his or her water distribution with regions like the Arid and Semi-Arid Lands (ASAL) being victims of chronic water shortage. According to the Water Services Regulatory Board (2021) more than 80 percent of the landmass in Kenya is arid or semi arid with most parts of this country heavily relying on rainfall as a source of water. Rainfall is however not always adequate and is erratic hence resulting in scarcity of water and high demand during dry seasons.

The more fertile areas, on the other hand, consist of the central and western parts of the country, which has a more sure supply of water. Nevertheless, in these regions too, there are disparities in water access due to infrastructure disparity and unequal distribution patterns. As an example, where access to water is usually affected by lack of proper infrastructure especially in rural areas, Kakamega and Bungoma are some of the locations in Western Kenya. According to Kenya Institute for Public Policy Research and Analysis (2014), the problem of water shortage is overrepresented in rural regions, most of the inhabitants use unprotected water resources like rivers or shallow wells. Such differences in water access increase the need to provide more quality water and sanitation services in the underserved regions.

### **3.3.3.3 Climate Change and Water Scarcity.**

Climate change has also increased the strain on water in Kenya due to the effects it has on the water availability. The rainfall patterns are becoming more unpredictable with the long droughts and the weather variations which have led to the unpredictability of the water supply throughout the country. According to Grafton et al. (2011), climate change may result in the decreased flow of the rivers, a decrease in the rate of groundwater recharge, and drying of water reservoirs that in turn increase the level of competition during water allocation to different sectors of the economy such as agriculture, industry, and household demand.

The impact of the climatic change is even more dire in rural regions of Kenya where the population of people relies on groundwater and surface water supplies. Lack of water is caused by droughts and decreased rain, which heightens the need to have more stable water supply systems. According to Moriarty et al. (2013), the sustainable water management practises need to be modified to respond to the increasing challenges of climate change on these regions. It involves increasing the amount of water that can be stored, the effectiveness of irrigation, and investments in infrastructures that are resilient to climate change.

### **2.3.4. Socio-Economic Factor and Affordability.**

The socio-economic background, especially income levels, and affordability of water and sanitation services have a direct relationship with demand in Kenya. Affordability is one of the issues pointed out by the World Bank (2000) in facilitating access to water and sanitation. Water would be another huge burden to low-income households in rural areas. According to Alemu et al. (2020), most poor households depend on informal water dealers who sell water at a higher price than utility companies do.

These unofficial suppliers usually cater to the regions where there is no piped water yet the high price of water is one of the main obstacles to proper water use.

In cities, despite increased access to piped water, the price of water has increased especially in peri-urban regions whereby infrastructure is minimal. According to Bakker (2013), increased water prices, which are accompanied by high cost of living will tend to reduce water consumption because households will focus on other basic needs like food, healthcare and education. Water pricing in most instances is regressive in nature and, therefore, the poor households bear a bigger water burden, which leads to disparities in access and use of water.

#### **2.3.4.1. Infrastructure and Service Delivery**

Water and sanitation facilities are essential in ensuring that the increasing pressure on the services is achieved. The water supply is lower than the demand in the urban zones especially in Nairobi and many people have to deal with the intermittent supply of water as a result of lack of proper infrastructure development and poor upkeep. Kenya Water Services Regulatory Board (2021) reports that the water supply system of Nairobi provides a small segment of its population, and most of the informal settlements do not receive any water or receive a small amount. The necessity to use water vendors in these localities further creates imbalances in the accessibility of water because water vendors sell the water at a higher cost, which in turn adds additional burdens to the low-income earners.

The challenges in the infrastructure are even more acute in rural regions. Moriarty et al. (2013) emphasise that a significant percentage of rural Kenya is untrustworthy to clean water because it is not invested in piped water systems; it is also not capable of providing its service coverage. Households in these areas rely on other sources like wells, rivers or rain water harvesting, which can be easily contaminated and

consumed. Most communities cannot satisfy their increased water needs due to lack of proper infrastructure thus resulting to poor sanitation and hygiene standards.

#### **2.3.4.2. The policy and institutional frameworks**

This process of water services devolution in Kenya that started in 2010 through the adoption of the Constitution of Kenya has greatly affected the demand in water and sanitation. Devolution also saw water services to the county governments as the national government handed over water services to the county governments and the idea was to enhance the service delivery as it would be more responsive to local needs. According to Kenya Institute of Public Policy Research and Analysis (2014), although some positive changes have been experienced in devolution including water projects targeting local needs, it has in turn brought some difficulties. Lack of capacity, financial resources and technical expertise in the local governments is often a hindrance to the effective management of the water services hence the inefficiencies in the service delivery.

In Kenya, water management is given an overall framework through the Water Act of 2002 and the National Water Master Plan (2013). Such policies put special importance on the need to manage the water resources in an integrated way, such as enhancing the efficiency of the use of water, ensuring equitable water access, and enhancing financial sustainability of the water utilities. Nevertheless, as Harris et al. (2015) also note, there is still a policy-implementation gap, especially in the rural territories where people still do not have access to water services.

#### **2.3.4.3. Tariffs and Pricing Policies.**

The water tariff forms are also key to controlling the demand and equitable supply of water. One of the most widely used tariff models is volumetric pricing; in which the consumer is charged depending on his or her usage. Grafton et al. (2011) say that

volumetric price stimulates the consumer to utilise water efficiently and makes sure that the price of water reflects the marginal cost of supply. In Kenya, however, there is a tendency to implement volumetric tariffs, although the metering systems may not be sufficient (especially in rural regions, where infrastructure is insufficient at the moment) (Water Services Trust Fund, 2020).

Water tariffs that use different blocks to charge water depending on use have been adopted in order to encourage conservation and shield low-income households against excessive expenses. According to Bakker (2013), block tariffs are effective in ensuring that water is affordable to the poor and high-income households are encouraged to save water. The success of this model however will be determined by proper metering and the correct designing of tariffs which in turn may not be easy to apply in regions with poor infrastructure.

The factors that dictate the demand of water and sanitation services in Kenya are complex and comprise of population growth, urbanisation, geographical differences, global change, socio-economic statuses and difficulties with infrastructure. Though, much has been achieved in terms of enhancing water and sanitation access through policy reforms and decentralisation, there are still much to be done especially in rural regions that are underserved and in informal urban settlements (World Bank,2000). To overcome these obstacles, it is important to persist in investing in the water infrastructure, sound pricing, and specific intervention to make sure that all people have access to clean water. Since the nation is striving towards meeting Sustainable Development Goal 6 (Clean Water and Sanitation), it is important to comprehend the determinants of water demand and overcome the obstacles to its availability so that every Kenyan has access to clean and sustainable water and sanitation services Hope et al., 2020).

### **2.3.5 Tariff regimes on water and sanitation demand in Western region of Kenya.**

Water and sanitation needs in the Western Region of Kenya are affected by an assortment of factors, such as population trends, weather fluctuations, the economies of the countries, and institutions (World Bank, 2016; WASREB, 2023). Some of the essential factors that impinge on the demand of water are the tariff system used by the water service providers. Tariff structures can play a crucial role in regulating the water resources and providing equitable access to the water services, particularly in a region where the socio-economic disparities and gaps in infrastructure are significant (KIPRA, 2014; Hope et al., 2020). The paper is a literature review that examines how tariff structures can affect the demand of water and sanitation services in Western Kenya and how the pricing mechanisms determine the consumption behaviours, service delivery, and equity (Balasubramanya et al., 2021; Fuente et al., 2020).

#### **2.3.5.1 Population and Social Economic situation in the West of Kenya.**

Kakamega, Bungoma, Vihiga, and Busia counties comprise the Western Region of Kenya that has experienced a great population growth and urbanisation over the last decades. The Kenya National Bureau of Statistics (2022) indicates that the vast rural population of this region inhabits this area, and the poverty and unemployment rates there are rather high than in urban settings. The rising population in urban and rural areas has only contributed to the pressure of water and sanitation services.

The water consumption patterns are also affected by the socio-economic conditions of the areas. In the rural rural regions of western Kenya, informal sources of water like rivers, boreholes, and shallow wells are used in most homes, and they are not always reliable and can easily be contaminated. According to Kenya Water Services

Regulatory Board (2021), in these regions, low-income households are typically faced with the issue of water affordability, especially when the households use the services of a private vendor in terms of water supply. Water tariff frameworks are thus very important in determining the ability of the households to get affordable water supply and whether the utility providers can deliver sustainably to the increasing demand.

#### **2.3.5.2 Tariff Structures and pattern of water consumption.**

In the Western Region of Kenya, water demand is influenced by the pricing of the water. A system of water tariff regulation was introduced in the Water Act of 2002, in a way that focused on maintaining affordability and sustainability. The purpose of the tariff structures is to encourage the use of water conservation and at the same time help the water utilities recover the costs. The block tariff is one of the well-known pricing schemes because it applies various rates according to the amounts of consumption. Moriarty et al. (2013) state that block tariffs are set in such a way that they offer a minimum amount of water at a low price to low-income earners, and a high price to those who consume more water.

But block tariffs have worked sporadically in the Western Region. When the water infrastructure is not well developed, tariffs in those regions are usually set excessively high and this causes people to consume less water and generate less revenue to the utilities. In such areas, high tariffs might make the situation worse, as found by Harris et al. (2015), which already means that households with low incomes have limited access to safe water. The research has shown that the demand of water in regions where supply is low is highly elastic and even slight increases in price lead to massive decrease in the consumption of water, especially in poor households.

#### **2.3.5.3 Water Tariffs effect in Access and Equity.**

Pricing policies and the development of infrastructure determine the effects of tariff structures on the provision of water and sanitation services in the Western Region. According to Bakker (2013), tariffs may adequately impact low-income households when they do not consider the issue of equity, as even these households are already disadvantaged in their access to water. This is a great issue especially in the West Kenya where most of the rural regions do not have piped water systems but use informal sources or sources that are not safe. In such regions, tariffs on water may cause demand to fall or make people use more expensive sources that are not controlled.

One of the problems that Moriarty et al. (2013) highlight relates to the cost of water in the rural communities, whereby, in most instances, families are forced to spend a large part of their income buying water in the market or paying fees to get connected. According to Grafton et al. (2011), block tariffs, though aimed at protecting the poor households, might not work in areas where the supply is not regular and citizens have to use alternatives which are very expensive. Lack of proper subsidisation of the cost of water to the poorest households might result in the fact that the families will be more susceptible to water-borne diseases due to the necessity to use the unsafe sources in case of a high cost of clean water.

#### **2.3.5.4 Climate Change and Water Tariff.**

Climate change has another effect on the demand of water in the Western Region. As Grafton et al. (2011) emphasise, water availability has been fluctuating because of the change in the rain/drought conditions in Kenya and growing droughts. This has some consequences to water tariffs since water utilities tend to set prices based on the higher cost of water source in times of scarcity. Such adjustments with the constraint

that water resources are already strained in Western Kenya have a considerable effect on demand.

Moriarty et al. (2013) explain that climate change effects on the availability of water contribute to the challenge in establishment of an effective tariff. Water service providers in the area might also raise the prices during the periods of drought in order to sustain themselves by acquiring water that is more far or unreliable. This, in its turn, may result in lower demand among the households who already have difficulties with affording water. Increased tariffs in certain instances may drive households to use unsafe sources of water which in turn will increase the risk to the populations health and frustrate the process of attaining universal access to clean water and sanitation.

#### **2.3.5.5 Institutional Challenges and Tariff Implementation**

The water tariff institutional framework in the Western Region is complicated and unproductive. Kenya Institute of Public Policy Research and Analysis (2014) notes that, decentralisation of management of water to the county governments between 2010 and 2012 through the Constitution of Kenya has brought both opportunities and challenges. On the one hand, local governments can adjust the policy on water tariffs according to regional requirements. Conversely, the county governments usually do not have the capacity, technical skills and financial resources to manage water services and set suitable tariffs.

According to the Water Services Regulatory Board (2021), most counties of Western Region do not provide water service providers with the ability to implement tariffs that are affordable and sustainable at the same time. This is due to the fact that there are no proper metering systems such as the absence of proper metering systems that can be used in determining the correct amount to be charged to the consumers based

on their usage. This may cause incompetence and unfairness in service provision. Also the fact that tariffs cannot be implemented or that the funds collected through the sale of water cannot be used to reinvest in the infrastructure further weakens the viability of the tariff policies.

#### **2.3.5.6 The Influence of Subsidies and Lifeline Tariffs.**

As part of this effort to reduce adverse impacts of high tariffs on low-income households, several water companies in Kenya have been offering lifeline tariffs, which subsidise the initial few cubic metres of water consumed. This system of prices is supposed to make sure that the basic water necessities are fulfilled reasonably at a low price and the high consumption is done at a high rate to encourage the conservation.

Implementation of lifeline tariffs in the Western Region has however proved to be problematic. Moriarty et al. (2013) believe that the effectiveness of lifeline tariffs is related to the precision of the metering and the effectiveness of water service providers to detect households with low income. Where a metering system is not well developed in many rural areas, lifeline tariffs might not be well targeted. According to Bakker (2013), subsidies in such situations might fail to access the individuals that require them the most and the desired outcomes of fair prices are compromised.

The Western Region of Kenya has a complex of factors that affect the demand of water and sanitation services such as population growth, socio-economic conditions, climate change, and the functionality of tariff structures (World Bank, 2016; WASREB, 2023). Although block tariffs and lifeline tariffs are two types of tariffs that have been implemented to achieve water conservation and protection of low-income families, they have not been as successful (Fuente et al., 2020; Whittington et al., 2002). Inequalities in access to water can be aggravated by high tariffs in areas

where the infrastructure is poor or where water supply cannot be trusted (Hope et al., 2020; KIPPRA, 2014). Moreover, institutional capability to effectively manage and carry out successful tariff policies is still a big problem in most counties (WASREB, 2023).

To successfully control the water demand in the Western Region with the help of tariffs, the more sophisticated method is necessary. This practise needs to be associated with an increased investment in infrastructure, the development of better metering, more focused subsidies, so that low income households can have access to low water prices (Kombe, 2018; OECD, 2019). Also, the impacts of the climate change on the availability of water need to be taken into account when establishing tariffs because more variable supply can require more dynamic prices (UN-Water, 2021). By doing this, water tariffs will be a critical tool in the balancing of demand and supply, fair access to water and sanitation, and sustainable service delivery in the Western Region of Kenya (WASREB, 2023; Balasubramanya et al., 2021).

## **2.4. Empirical Review of Literatures.**

### **2.4.1 Causal Relationship between Alterations in Water tariffs structures in the consumption of water by households in the Western region of Kenya.**

A number of empirical researches have addressed the impacts of water tariff systems on household water usage in different global and regional settings. To illustrate this, Nauges and Whittington (2010) studied the demand of household water in the developing world and established that, increase in water price is mostly linked to low water demand, especially in the urban regions where water is metered. Equally, Olmstead et al. (2007) proved that volumetric pricing systems are more efficient in checking excessive water consumption than flat-rate systems, particularly where there is reliable metering.

Gulyani et al. (2005) have done a research on the Kenyan market of water-markets and choice of water services in low income settlements in Nairobi. Their results indicated that households were price sensitive but the degree of response varied according to access, income and reliability of services. Kombe (2020) also introduced the issues of applying pro-poor tariff models in East Africa, as the price reforms cannot always work to produce the desired results because of the structural inefficiencies, the low quality of the offered services, and the absence of the consumer awareness.

Although these studies are helpful to understand the nature of prices, few of them have tried to determine a causal relationship of change in tariffs and the consumption of water in rural and peri-urban settings, especially in Western Region of Kenya. The majority of the literature available is of an urban centre like Nairobi or Kisumu, where the metering infrastructure and data availability are more advanced. Empirical studies examining the change in household consumption patterns by employing methods of causal inference, e.g. fixed effects models, instrumental variable methods or difference-in-differences estimates, to rigorously estimate the impact of tariff adjustment in these underserved areas are limited.

In addition, no disaggregated comparison of the various forms of tariff structures (e.g., increasing block tariffs vs. flat-rate tariffs) and their individual effects on consumption behaviour between socioeconomic groups can be made. There is also limited study of how tariff reforms interact with domestic-level coping mechanisms, water rationing, adoption of alternative water sources, or informal water suppliers.

This research thus aims to bridging such gaps through probing the cause-effect association between water tariff regime adjustments and household water use in the

Western Region of Kenya by empirical research to explain confounding factors, as well as show different effects across household types and geographical areas.

Fuente et al. (2020) studied the coverage of water tariffs and their effects on water tariffs in Nairobi, Kenya. Their research concluded that the coverage rates in low-income areas were linked to the increase of block tariffs (IBTs), although its effect was not significant. They stressed the need to have complementary policies which included connexion subsidies to make a great increase in the coverage.

Nauges and Whittington (2023) investigated the effect of various structures of tariffs on the water coverage in 20 developing nations in a cross-country study. They concluded that utilities using cost reflective tariffs, irrespective of the structure applied, had a greater chance of high coverage rates in the long run. They however observed that the correlation exhibited mediating effects of the overall financial health and governance structures of the utility.

The authors Balasubramanya et al. (2021) considered urban India and examined the impact of tariff reforms on water coverage in 2015-2020. Their findings showed that an average of 7 percent of coverage of those cities that switched to volumetric rates after being operated on a flat rate was realised during the period of the study. They explained this by better cost recovery which allowed utilities to invest in the expansion of the network.

Boakye-Ansah et al. (2022) tested the effectiveness of pro-poor tariffs to cover water in Ghanaian cities, in the African context. They discovered that although these tariffs enhanced affordability, they had a low coverage effect unless they were in combination with specific investments in infrastructure in low-income neighbourhoods.

Herrera and Post (2021) addressed the problem of water pricing as the political economy of Latin American water coverage. In their study, they found that the cities that had more open and participative tariff-setting experiences were more likely to reach higher coverage rates and implied that the institutional framework in which the tariff design is planned is as important as the structure itself.

In a report published in Bangladesh by Murthy and Mahin (2020), where lifeline tariffs, which are a basic quantity of water at an extremely low price, were introduced, it was shown that the coverage in the lowest quintile increased by 5% in three years. They however warned that these tariffs should be designed carefully so as not to advantage non-poor households.

Sileshi and Akale (2022) made a novel attempt to determine how tariff changes affected water coverage in Ethiopia by using satellite imagery. They established that areas using cost-recovery tariffs exhibited a 12 percent higher growth in visible water infrastructure relative to five years as compared to areas with massively subsidised tariffs.

With the rural setting in mind, Hope et al. (2023) examined the implications of prepaid water metres and related tariff systems on rural Kenya coverage. Their results implied that prepaid systems, coupled with flexible tariff choices, would allow expanding the coverage by turning services into more cost-effective to utilities and consumer-friendly to households having irregular incomes.

Tsitsifli and Tsoukalas (2021) examined water utilities in Greece in the framework of small towns, where they established that water utilities that adopted seasonally-adjusted tariffs experienced better coverage rates throughout the year. They explained

this by the fact that they were now financially stable and could therefore do better maintenance and slow expansion of the system.

Finally, Rodriguez-Sanchez et al. (2020) performed a systematic review of 50 studies in Africa. They came to the conclusion that proper tariff systems are required to enhance the coverage, but they are not enough. The authors have highlighted the importance of having a holistic approach that will take into account tariffs as well as the institutional capacity, the quality of infrastructures and demand side factors.

All these studies imply the complicated connexion between tariff forms and coverage rates. Although the proper pricing mechanisms may help to enhance a better coverage, the success of those mechanisms is usually subject to wider institutional, economic, and social conditions. The results highlight the importance of contextual studies including the current study on Western Kenya to guide effective policies on tariffs that would increase water and sanitation coverage.

Although there is abundant research on tariff structures and water coverage rates in recent times, the dynamics involved in the case of Western Kenya have a massive gap in understanding. Although investigations such as Fuente et al. (2020) have investigated the effect of tariffs in urban Kenya, and others, such as Hope et al. (2023) have investigated the situation in rural Kenya, Western Kenya and the unique socio-economic and geographic factors have undergone insufficient exploration. In addition, the majority of the research is concentrated either in an urban or rural environment and little is known about the mixed urban rural environment common in Western Kenya.

How tariff structures interplay with other issues like equity policies, affordability policies and investment in infrastructure in this particular region has not been

researched. Furthermore, longitudinal research that monitors the effect of tariff adjustments on coverage rates over the years in this field does not exist. The specified gap is especially significant in light of the water sector reforms in Kenya in recent years and the tendency towards the achievement of Sustainable Development Goal 6. This paper seeks to fill these gaps by offering a deeper region-specific analysis of the impact of the different elements of tariff arrangements on water and sanitation coverage in Western Kenya, and in this case of both urban and rural environments, and the interaction with other significant factors influencing service delivery.

#### **2.4.2 Effect of Increasing Bloc Tariff on Water Demand Elasticity in Western Region of Kenya.**

One of the models that is commonly used to enforce equity and conservation in the use of water is the Increasing Block Tariff (IBT) which involves higher prices the more the water is used. With this kind of structure, the low-income earners who consume the least amount of water are charged with lower rates as the high consumers are charged with higher rates (Whittington et al., 1990). The strategy has been implemented in most of the developing nations such as Kenya in an effort to strike a balance between affordability and sustainability when it comes to the delivery of water services.

Empirical studies have indicated that IBTs have inconclusive effects on the elasticity of water demand. As an illustration, Boland and Whittington (2000) discovered that although IBTs have the ability to decrease mean consumption, the actual price elasticity of demand (responsiveness) of demand to price is variable with respect to the quality of services provided, income of the household and the presence of other sources of water. On the same note, Nauges and van den Berg (2009) demonstrated

that the elasticity of demand is low (inelastic) in African cities particularly where the perception of the population in low income regions is that water is a necessity and substitution choices are few.

The research conducted by Gakii and Wambua (2018) in the context of Kenya evaluated the impact of IBTs on consumption among urban households in Nairobi and Mombasa. They indicate that despite a small decrease in the water consumption of middle- and high-income population because of higher-level prices, the water elasticity is generally low because of the supply restrictions and inconsistent billing. Moreover, Banerjee et al. (2010) reported that signals of prices tend to be ineffective in areas that are poorly metered or those that are supplied intermittently making IBTs ineffective in behavioural change.

Nonetheless, there is paucity in empirical literature on the impacts of IBTs on the elasticity of water demand in the Western Region of Kenya, especially in rural/semi urban regions where metering is not uniform and tariff implementation could be low. Majority of the available research is in major cities or household behaviour is not disaggregated by region or socio-economic status. Also, there is not much discussion of the elasticity of water demands among the various blocks of the tariff- i.e. whether consumers of the first block (those who use lifeline) will be different to the consumers of the higher blocks when demand is differentiated by price.

The study attempted to fill these gaps by presenting empirical estimates of the elasticity of water demand under IBT regime in the Western Region of Kenya, using disaggregated household-based data. It also enquired whether there is a considerable difference in the elasticity between tariff blocks, and rural and urban households.

Empirical literature has recently developed an interest in the connexion between tariff systems and equity in access to water and sanitation services. This part presents a discussion of ten major studies that were published after 2020 and that offer information on this important aspect.

Vidal et al. (2021) also discussed the effect of various tariff designs on urban Brazilian water access equity. They determined that although increasing block tariffs (IBTs) were supposed to help people achieve equity, in reality, they mostly favoured middle-income earners more than the poor. The paper has emphasised the need to design tariffs carefully in order to attain desired equity.

Onjala and Ndiritu (2023) conducted an extensive study of Sub-Saharan African countries and found that access equity was linked with pro-poor tariff schemes, including lifeline rates. They however took note that the effectiveness of these structures had a wide range of differences depending on local implementation and other supportive policies.

Koehler et al. (2022) targeted a rural area in Kenya to conduct the study on how community-managed tariff systems affect water access equity. They concluded their results indicated that the equity could be improved by the use of local-based flexible tariff arrangements to address seasonal changes in income levels typical of agricultural societies.

Wutich et al. (2021) hold a cross-cultural study of the water tariff and equity in six nations. Their results showed that the perception of fairness of tariff structures played a significant role in ready to pay and, in turn, extend services to underserved regions.

The paper has highlighted the significance of community participation in the formulation of tariffs.

Jain and Khanna (2020) examined equity implications of a switch between flat rates to volumetric tariffs in urban India. There was a positive net increase in efficiency, but they noted early adverse effects on low-income households, which emphasise the need to support tariff transitions more specifically.

Stoler et al. (2022) investigated equity of water access in Ghana small towns, and found that equal tariffs, coupled with commercial-to-residential cross-subsidies, led to better access to low-income households. They however, pointed out that it was difficult to maintain this model in regions where there was low commercial activity.

In Nairobi, Kenya, Fuente et al. (2021) conducted a novel study aimed at determining the equity implications of IBTs based on high-resolution spatial data. They discovered that IBTs had a beneficial effect on reducing the cost of connected households with low income, but made little contribution towards physical access inequity to the network.

Mosello and O'Leary (2023) explored the equity consideration of prepaid water metres and the tariff systems in Tanzania. They found that although prepaid systems facilitated better use of utility finances, they have the likelihood of increasing inequities unless these are combined with specific subsidies to help the poorest households.

Smets et al. (2022) conducted a study at the global level to examine how tariff systems are related to the human right to water. They found that the tariff design methods founded on the principles of non-discrimination and equality based on the

rights approach resulted in more equal distribution of water access among various socio-economic groups.

Finally, Grafton et al. (2020) have performed a meta-analysis of water prices studies in the developing world. They discovered that although equity-based tariff designs had the potential to enhance accessibility to the disadvantaged groups, the register of effectiveness was frequently constrained by the larger institutional and infrastructural factors.

Research Gap: As more literature on equity in water access and tariff structure has been established, a major gap in knowledge on these dynamics is in the case of Western Kenya. Although similar studies have studied the elements of equity in Kenyan situations, such as Koehler et al. (2022) and Fuente et al. (2021), the opportunity of the Western Kenya with its unique socio-economic environment and composite urban-rural nature has not been sufficiently covered. In addition, the majority of the literature is either city or country in nature, and there is little discussion of the in between that typifies a large portion of Western Kenya. The gap in research of the interactions between various elements of tariff construction (e.g., connexion fees, volumetric rates, fixed charges) and local factors to determine the equity results in this region is also present. Also, the long-term effects of the equity-based tariff regimes on sustained enhancement of access in Western Kenya are under-researched. The paper seeks to fill this gap by offering a detailed region-specific examination of how different variables of tariff structures, both urban and rural setting, impact equity in water and sanitation access in Western Kenya and the interaction with other important variables that affect service delivery equity.

### **2.4.3 Effects of Flat-Rate versus Volumetric Pricing on Per Capita Water Usage in Western Region of Kenya.**

Flat-rate pricing versus volumetric (metered) pricing has great weight in terms of the household consumption of water. Under the flat-rate water systems, households are charged a fixed amount of money in spite of the quantity of water used, which tends to cause inefficient utilisation of water because of absence of financial incentive to use less water. Compared to it, volumetric pricing, in which users can be charged according to the real consumption, is commonly known as a more powerful mechanism of advancing the concept of water conservation and efficient distribution (Olmstead et al., 2007).

Empirical research on the world market revealed that volumetric prices are more effective in a decrease of the per capita water consumption compared to flat-rate policies. As an example, Gaudin (2006) concluded that, the residential water demand is more price elastic when priced volumetricly when households are fully informed on the consumption and the prices. On the same note, a research by Mini et al. (1996) in the Philippines has demonstrated that metered billing to water resulted in a reduction of 20 percent and 30 percent in consumption after adoption of metered billing systems over flat-rate systems in terms of water usage.

In Sub-Saharan Africa, Komives et al. (2009) pointed out that volumetric pricing may be efficient in case of the common metering and precise billing. Nevertheless, they have also observed that the cost of installation and maintenance of metres can be a barrier especially to the low-income or rural region. Gulyani et al. (2005) reported in Kenya that flat-rate pricing is more widely used in informal settlements and rural

regions where there is no or inconsistent metering. They noted that the flat rate households tend to consume more water or they can ration their services in order to avoid overloading the systems.

Although the literature has evidence of volumetric pricing effectiveness, little empirical research has been conducted in the Western Region of Kenya to compare the per capita water consumption in the two systems of pricing. The majority of research has focused on urban zones like Nairobi and Mombasa without paying much attention to the rural and peri-urban areas where the water access, billing cycles, and household behaviour are characterised by very distinct values. Moreover, a research gap exists concerning the studies to explain the differences in consumptions between flat-rate and volumetric systems in consideration of the differences in the social, economic, and structural factors.

This paper attempts to bridge this empirical gap by examining how flat-rate and volumetric pricing systems affect per capita water consumption by the various types of households in the Western Region of Kenya. Through household consumption data, the research will offer information into the impacts of the pricing mechanisms on the usage behaviour and the model that best stimulates the conservation without undermining access.

Nauges and Whittington (2023) studied the affordability of water in 15 developing countries extensively. They discovered that although it was common to use increasing block tariffs (IBTs) to encourage affordability, their performance was quite diverse

based on the household size and consumption behaviour. The paper underscored the necessity of having context-based tariff designs to meet the objective of affordability.

Fuente et al. (2022) studied the effect of the various tariff structures on the water affordability of low-income households in a study based on urban Kenya. They found that lifeline tariffs and the combination of targeted subsidies were the most effective in making sure that affordability was met without jeopardising utility financial sustainability.

Balasubramanya et al. (2021) explored the question of affordability of switching small Indian cities to volumetric tariffs instead of the current flat rates. They found that volumetric tariffs had positive investments in the total efficiency, but might have adverse effects on the affordability of large and low-income households, unless there are proper subsidy systems.

Smets (2020) has suggested a new method based on human rights to evaluate the water affordability. Using this framework on case studies in Africa and Asia, the research determined that rights-based tariff designs, that put more emphasis on a minimum level of affordable service to all, resulted in better-affordability results.

Acevedo-Guerrero (2021) examined the connexion between the tariff structures and the informal water markets in Latin America. The research found that excessive complexity in official tariff systems might encourage low-income earners to resort to more costly informal suppliers, and therefore simplicity and transparency in the design of tariff systems is essential to make them affordable.

Hope et al. (2023) studied the effects of prepaid water systems on rural areas in Kenya in terms of affordability. They discovered that although prepaid systems were better at

improving utility finances, they had the potential to increase the problems of affording them to the poorest households unless accompanied by flexible payment schemes and specialised help.

Andres et al. (2022) carried out a cross-country study on the affordability of water services in 142 low and middle-income countries. Their results established that the problem of affordability was the most severe in those nations where the subsidy system was poorly designed, and the point of the proper targeting of subsidies in the systems of tariffs should be highlighted.

Grafton et al. (2020) examined the impact of water-scarce areas on the tariff structure that is responsive to drought on affordability, in the context of climate change. They established that although these tariffs may result in conservation, they were dangerous in causing water to be unaffordable to vulnerable households without proper protection.

The study by Vanhille et al. (2021) analysed the affordability of water in European countries, which can be relevant to the context of middle-income countries. Their study demonstrated the need to address the issue of water and sanitation costs in affordability cheques and the prospect of income-based prices in dealing with affordability issues.

Finally, Rodriguez-Sanchez et al. (2020) conducted a synthesis of the results of 60 studies on water affordability in developing nations. They have concluded that even though proper tariff structures are essential in the determination of affordability, their efficiency is strongly conditioned by the wider socio-economic conditions and institutional design.

Research Gap: Although the literature on the issue of water service affordability and tariff systems has developed to a considerable size, a substantial knowledge gap exists on the matter in Western Kenya. Although the affordability issue has been discussed in the context of Kenyan areas, not all studies such as Fuente et al. (2022) and Hope et al. (2023) have addressed the distinct socio-economic environment of Western Kenya, which is a combination of urban, peri-urban, and rural environments. In addition, the majority of the studies concentrate on the water services or the sanitation services individually but not on the affordability of the two services together, which is important in ensuring universal coverage of the WASH. It is also missing research on the interaction between various elements of tariff structure with specific local traits, e.g. seasonal income fluctuations, as is common in the Kenyan agricultural economy in the West, to provide results on the effects of tariffs on affordability. Secondly, there is a lack of understanding of the long-term effects of affordability-based tariff designs on the long-term service utilisation and utility financial well-being in Western Kenya. The research will fill such gaps by conducting a detailed, region-specific examination of the effects of different attributes of tariff structures on the prices of water as well as sanitation services in Western Kenya, given the varied settlement and economic situation that typify the region.

#### **2.4.4 Comparative Effects of Tariff Structures on Water Demand across Urban and Rural Households in Western Region of Kenya.**

Research indicates that tariff changes have an impact on the behaviour of water consumption but the elasticity of demand is usually low because water is a necessity good (Nauges and Whittington, 2010). Gulyani, Talukdar and Kariuki (2005) noted in Kenya that in the informal settlements, as well as unmetered regions, households tend to be charged flat rates, which fail to encourage conservation. On the contrary,

moderately reduced consumption was observed in metered areas of volumetric pricing.

Nevertheless, the existing body of evidence that investigates the effect of tariff adjustments on the household water consumption in Western Kenya does not exist. The majority of studies have been concentrated on large cities such as Nairobi and Mombasa without paying attention to the various usage patterns and supply issues among the households in the counties of Kakamega, Bungoma and Vihiga.

Kenya has IBTs which are meant to facilitate equity and foster conservation. Under this system, consumption that is lower is charged at subsidised charges as the consumption increases. Banerjee et al. (2010) discovered that IBTs have the potential of promoting conservation among high-income users in cities. In the same way, Gakii and Wambua (2018) have identified moderate decreases in consumption in localities where IBTs had been established successfully.

However, other researches like that by Komives et al. (2009) warns that IBTs could be retrogressive in cases where poor households have to purchase water at a substantively higher rate by buying it through vendors because of the inaccessibility of the network. In Western Kenya where water supply systems are characterised by being fractured and disjointed, little empirical research has empirically tested the relationship between IBTs and demand elasticity- i.e. the manner in which households are responsive to price variations across various consumption blocks.

In rural and low-income regions, inadequate metering infrastructure means that flat-rate pricing, i.e. the household pays a set amount of money irrespective of the amount used, is popular. This paradigm has been linked with wastage of water and low cost

recovery (Whittington et al., 1990). Conversely, volumetric pricing, which is a price per unit consumed has done a better job in encouraging efficiency. Olmstead et al. (2007) discovered that volumetric systems can substantially decrease the per capita water consumption in cities that have dependable metering in place.

In Kenya, the work of Gulyani et al. (2005) indicates that volumetric billing is best achieved in a country where there is metering that is reliable and predictable supply. Nevertheless, in the rural Western Kenya, where the water infrastructure is not well-developed, the empirical data comparing the two pricing models on their impact on water consumption and household wellbeing is scarce.

Although extensive study has been done on water, there is the increased awareness of the relationship between the water tariffs and the use of sanitation services. Effects of cross-elasticity appear when there is a reduction in price in water, which results in reduced sanitation usage, especially when this happens in bundled service models. In low-income locations, families can choose to cook and drink water over hygiene and sanitation (Kombe, 2020). However, a lot of empirical data on this relation in the Kenyan setting is not available particularly in the rural western counties where there is a shortage of water and sanitation facilities.

A number of studies highlight the urban-rural gap in the response of households to tariffs. City homes are better linked to formal water systems and thus, they can be more sensitive to the alteration of official tariffs (Banerjee and Morella, 2011). Conversely, the rural households are more likely to depend on informal or community controlled sources, whereby official tariffs do not necessarily affect the actual consumption. The disaggregated empirical studies with these effects in Western Kenya are rather scarce, and the little that has been done has not investigated the

differences in performance of tariff structures amongst urban and rural households in this area.

A multidimensional study of water utilities in 20 developing nations by Nauges and Whittington (2023) revealed that the correlation between the cost-reflective tariffs and the infrastructure investment is strong and positive. Their research revealed that those utilities that had tariffs that enabled them to recover all costs enabled them to invest 30% more on infrastructure growth and maintenance than those which were highly dependent on subsidies.

Fuente et al. (2022) studied the effects of various tariff structures in financing improvements in infrastructure by urban utilities in a study conducted in urban Kenya. They determined that the adoption of increasing block tariffs (IBTs) with appropriately determined volumetric rates resulted in a 15-percentage-point rise in infrastructure investment in five years, which was largely because of better revenue collection.

Balasubramanya et al. (2021) have studied the effect of tariff reforms on infrastructure investment in small and medium Indian city. According to their findings, a shift in the tariff rates to volumetric rates raised the amount of capital spending on utilities by an average of 22 percent and that most of their investments were related to minimising non-revenue water.

Smets (2020) has proposed a new method that suggested a framework to overcome the issue of long-term sustainability of water infrastructure investments with regard to tariff systems. Using this framework on case studies in Africa, the study determined

that tariffs with special funds to renew infrastructure resulted in better and regular patterns of investments.

Acevedo-Guerrero (2021) examined the connexion between the tariff structure and the participation of the private sector in the development of water infrastructure in Latin America. The research found out that clear predictable tariff regimes played an imperative role towards encouraging private investment, especially on infrastructure development of large scale.

Hope et al. (2023) studied the impact of community-managed tariff regimes in Kenya on the investment in local infrastructure by focusing on the rural setting. They discovered that flexible and seasonally adjusted tariffs enabled the communities to save the money to maintain their infrastructures better than the hard tariff systems.

Andres et al. (2022) conducted a cross-country study to examine how tariff rates, utility performance, and infrastructure investment correlate in 35 countries in the developing world. Their results implied that utilities that recovered the operation and maintenance costs over 120 percent of its tariffs were much more likely to invest heavily in infrastructure.

Grafton et al. (2020) analysed the impact of climate responsive tariff structure on the capacity of utilities to invest in adaptive infrastructure in the context of climate resilience. They discovered that tariffs with climate risk premiums also allowed utilities to invest more in resilient infrastructure on average of 18 percent higher than the traditional tariff frameworks.

The research by Vanhille et al. (2021) investigated how tariff constructions can be utilised as a source of funding green infrastructure in urban water systems in Europe.

They emphasised in their research the ability of earmarked environmental surcharges in tariff structures to finance nature-based solutions and other sustainable water infrastructure.

Finally, Rodriguez-Sanchez et al. (2020) conducted a meta-analysis of 70 pieces of research on water sector financing in developing nations. They also found that although the right tariff structure plays a critical role in facilitating investment in infrastructure, their efficiency depends on the much on wider governance systems and regulatory frameworks.

Research Gap: Although there has been a rise in literature on the topic of investment in water infrastructure and tariff systems, there is a considerable gap in the knowledge of these dynamics in Western Kenya. Although research such as Fuente et al. (2022) and Hope et al. (2023) have explored the issue of infrastructure financing within Kenyan contexts, the local opportunities and challenges are faced in the diversity of urban rural Kenyan settings. Additionally, the majority of research works concentrate on either the urban or the rural context, and little emphasis is put on the infrastructure requirements of peri-urban regions, which are experiencing rapid increase in Western Kenya. It also does not have any research done to investigate the interaction of various aspects of tariff structure with local factors, including devolved administrative systems and local fiscal policies, to affect the choice of infrastructure investment. Also, the effects of investment-oriented tariff structures on service quality improvement and coverage enlargement in Western Kenya are not extensively studied within the long run. This paper attempts to fill these gaps by offering a region-specific analysis of the effect of different elements of tariff structure on infrastructure investment in the water and sanitation sector in Western Kenya taking into

consideration the diverse settlement patterns, governance structures, and development challenges that are unique to the region.

## 2.5 Summary of Research Gaps

**Table 2.1: Summary of Research Gaps**

Author(s)	Title	Methodology	Key Findings	Research Gaps Addressed in This Study
Nauges & Whittington (2010)	Household Water Demand in Developing Countries	Econometric analysis	Higher water prices reduce consumption, especially in urban areas with metered connections.	Lacks focus on rural/peri-urban Western Kenya with limited metering.
Olmstead et al. (2007)	Water Demand under Alternative Price Structures	Econometric modeling	Volumetric pricing more effective than flat-rate; demand more elastic with metering.	No data on Kenya or underserved areas; lacks socioeconomic variation.
Gulyani et al. (2005)	Water Markets and Service Preferences in Nairobi's Low-Income Settlements	Household surveys	Price sensitivity exists but varies with income, access, and reliability.	Urban Nairobi focus; limited relevance to Western Kenya's mixed context.
Kombe (2020)	Pro-Poor Tariff Models in East Africa	Policy analysis	Reforms often fail due to inefficiencies, poor service quality, and lack of awareness.	Structural dynamics underexplored in rural/peri-urban settings.
Fuente et al. (2020)	Tariffs and Coverage in Nairobi	Econometric evaluation	IBTs linked to higher coverage, but only modestly; connection subsidies necessary.	Urban-centric; limited applicability to Western Kenya's mixed regions.
Nauges & Whittington (2023)	Tariff Structures and Water Coverage in 20 Developing Countries	Cross-country panel analysis	Cost-reflective tariffs improve coverage, mediated by governance and financial health.	Cross-national insights need contextual validation in Western Kenya.
Balasubramanya et al. (2021)	Tariff Reforms in Urban India	Longitudinal analysis	Volumetric pricing improved coverage by 7% due to better cost recovery.	Urban bias; limited lessons for rural settings.
Boakye-Ansah et al.	Pro-Poor Tariffs in Ghana	Case study + affordability	Improved affordability, but	Few studies integrate

(2022)		analysis	limited coverage gains without infrastructure.	tariffs with infrastructure in Kenya.
Herrera & Post (2021)	Water Pricing and Coverage in Latin America	Institutional analysis	Participatory and transparent pricing linked to better coverage.	Governance impact understudied in Kenya's rural water systems.
Murthy & Mahin (2020)	Lifeline Tariffs in Bangladesh	Before-after analysis	Lifeline tariffs increased access by 5% among the poorest.	Risk of benefiting non-poor; lack of targeting analysis in Kenya.
Sileshi & Akale (2022)	Satellite Monitoring of Tariff Impacts in Ethiopia	Remote sensing + econometrics	Cost-recovery tariffs spurred 12% more infrastructure expansion.	Innovative method, not yet applied in Western Kenya.
Hope et al. (2023)	Prepaid Meters in Rural Kenya	Mixed-methods field study	Prepaid and flexible tariffs improved rural access for irregular income groups.	Strong rural relevance; limited to prepaid systems.
Tsitsifli & Tsoukalas (2021)	Seasonal Tariffs in Greece	Utility case studies	Seasonal tariffs increased year-round coverage.	Seasonal pricing underexplored in Kenyan rural-urban transition zones.
Rodriguez-Sanchez et al. (2020)	Review of Tariff Structures Across Africa	Systematic literature review	Tariffs are necessary but not sufficient—institutions and infrastructure matter.	Need for multi-dimensional regional studies in Kenya.
Boland & Whittington (2000)	Water Pricing and Demand Elasticity	Global review + theoretical analysis	IBTs can lower use; elasticity depends on service quality, income, and alternatives.	Little data on elasticity variation across tariff blocks in Kenya.
Nauges & van den Berg (2009)	Demand Elasticity in African Cities	Econometric analysis	Demand is price inelastic, especially in low-income areas.	Elasticity in semi-urban Western Kenya unexamined.
Gakii & Wambua (2018)	Water Tariffs in Nairobi	Household survey +	High-tier tariffs slightly reduce	Focus on major cities;

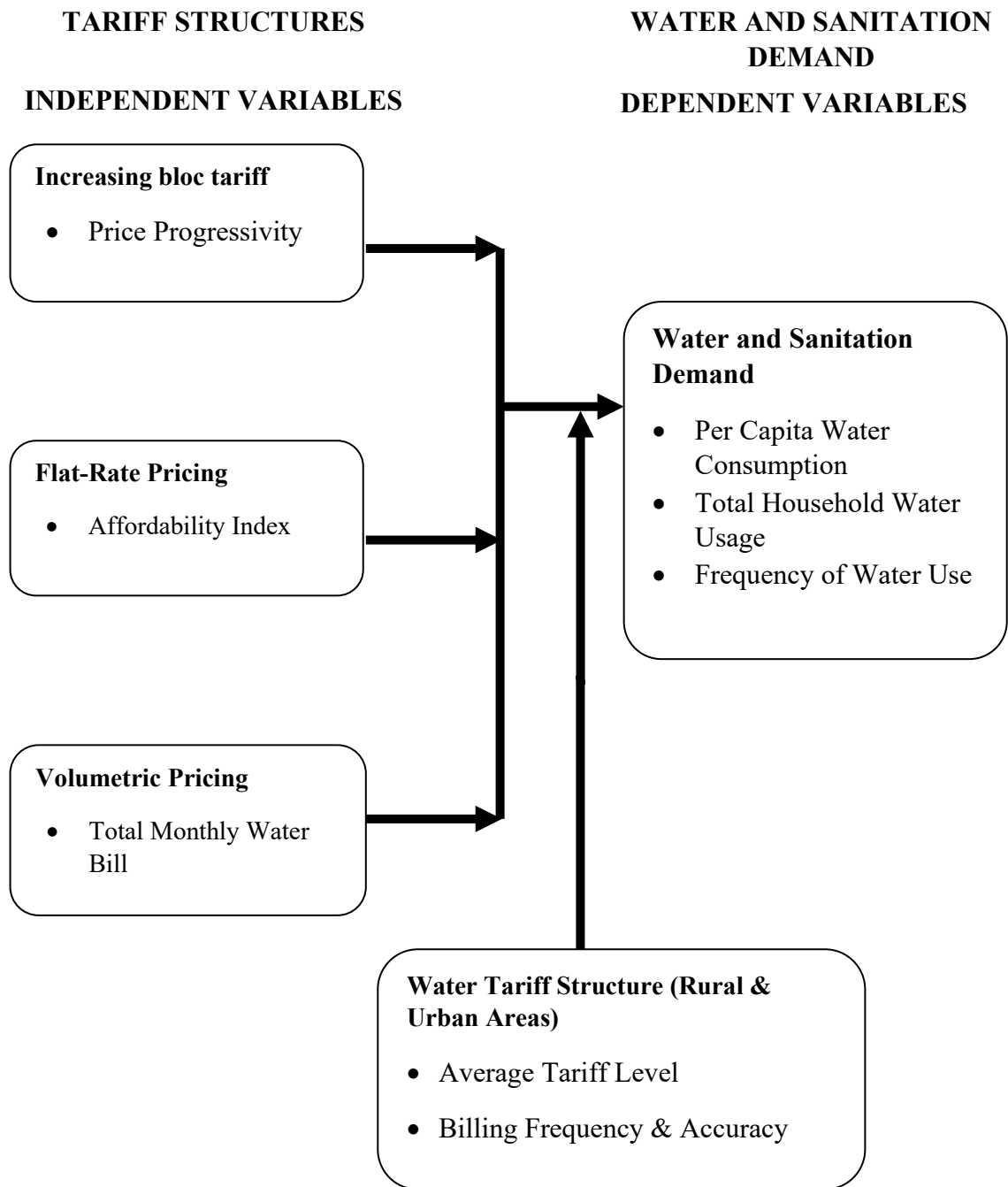
	and Mombasa	regression analysis	use among higher-income groups; elasticity low overall.	lacks rural and peri-urban disaggregation.
Banerjee et al. (2010)	Pricing Signals in Developing Countries	Multi-country analysis	Weak price signals in poorly metered/intermittent supply zones reduce effectiveness of IBTs.	No analysis of enforcement quality in Western Kenya.
Banerjee et al. (2010)	Pricing Signals in Developing Countries	Multi-country analysis	Weak price signals in poorly metered/intermittent supply zones reduce effectiveness of IBTs.	No analysis of enforcement quality in Western Kenya.
Vidal et al. (2021)	Equity in Brazilian IBTs	Quantitative distributional impact analysis	IBTs often help middle-income more than the poorest; need better targeting.	Regional variation in equity under IBTs in Kenya not studied.
Onjala & Ndiritu (2023)	Equity in Sub-Saharan Tariff Structures	Comparative study across countries	Lifeline tariffs linked to improved access equity; effect varies by context.	No focused Kenya-Western-region equity study.
Koehler et al. (2022)	Community-Managed Tariffs in Rural Kenya	Field study	Flexible tariffs improve seasonal equity in agricultural areas.	Need for region-wide equity analysis across tariff models.
Wutich et al. (2021)	Perceptions of Fairness and Tariff Acceptance	Cross-cultural field study	Perceived fairness boosts willingness to pay and service expansion.	No perception studies tied to tariff reforms in Western Kenya.
Jain & Khanna (2020)	Equity Impacts of Volumetric Tariffs in India	Econometric panel analysis	Efficiency gains, but initial burden on poor without compensatory support.	Transition costs for vulnerable groups underexplored in Kenya.
Stoler et al. (2022)	Equity in Ghana's	Case studies + cross-	Cross-subsidies improved	Weak commercial base in

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	Uniform Tariffs	subsidy analysis	access, but only in towns with strong commercial base.	rural Kenya limits this model; need alternatives.
Fuente et al. (2021)	IBTs and Spatial Equity in Nairobi	Spatial econometric analysis	IBTs improved affordability for connected poor, but didn't address network gaps.	Infrastructural access inequity in Western Kenya underexplored.
Mosello & O'Leary (2023)	Equity and Prepaid Tariffs in Tanzania	Household survey + policy review	Prepaid improved finances but worsened equity without subsidies.	Prepaid impacts in Western Kenya need deeper analysis.
Smets et al. (2022)	Rights-Based Tariff Approaches and Fairness Outcomes	Global comparative policy analysis	Rights-based tariff design linked to more equitable water access.	Rights-based frameworks not yet evaluated in Western Kenya tariff design.
Grafton et al. (2020)	Meta-analysis of Water Pricing in Developing Countries	Meta-analysis of 100+ studies	Equity-focused tariffs help marginalized groups, but need strong institutions.	Long-term impacts of pro-poor tariffs on access in Western Kenya still unknown.

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## 2.6 Conceptual Framework



Adapted from: Grafton, Chu, L & Wyrwoll, (2020).

**Figure 2.1: Conceptual Framework**

## CHAPTER THREE

### RESEARCH METHODOLOGY

#### 3.1 Introduction

This chapter outlines the research methods, research design, study location, data collection instruments, data analysis, model specification, and ethical consideration.

#### 3.2 Research Design

This research took the quantitative research design where the secondary data was used to explore the impacts of tariff structures on the demand of water and sanitation in the Western part of Kenya. The methodology is a causal-comparative and correlational that is suitable when examining its existing relationship between tariff systems and water consumption without controlling variables. The research employed past records that were obtained through Water Services Regulatory Board (WASREB), Kenya National Bureau of Statistics (KNBS), and counties government documents. These data sets have valid and reliable information on tariff regimes, metering, household consumption, and utility performance among counties. Secondary data are also cost-effective and efficient to use, and one can conduct longitudinal and comparative analysis (WASREB, 2023; KNBS, 2022; Mugenda and Mugenda, 2003).

The study compared the analysis of data between urban and rural counties with respect to how the various tariff structures like increasing block tariffs and flat-rate pricing have contributed to water demand in the past. The strength and nature of the associations between tariff design and consumption patterns were measured using quantitative tools such as descriptive statistics, regression analysis and estimation of elasticity. The tools were used in the determination of whether pricing structures had met targets like affordability, equity and cost recovery. Previous experiences in areas with a very similar socio-economic level indicate that the right tariff regimes can have

a considerable effect on the behaviour of households and the sustainability of services (Fuente et al., 2020; Balasubramaya et al., 2021). Thus, it can be argued that the research design contributes to the creation of data-based policy interventions in accordance with the devolved governance policy system and the Sustainable Development Goals (SDGs) in Kenya.

### **3.3 Study Location**

This paper will be located in Western Kenya with specific reference to the counties of Kakamega, Bungoma, Busia, and Vihiga. These counties were chosen purposely, given that they cover a broad spectrum of urban, peri-urban, and rural environments and will serve as an inclusive scope of study on the effectiveness of various tariff structures within various socio-economic and infrastructural environments (WASREB, 2023). They have a rich demographic diversity with different access to water infrastructure, which makes them a perfect region to study the equity and effectiveness of the water pricing mechanisms.

Moreover, the population growth and urbanisation rates in Western Kenya are high, and the lack of infrastructures remains unaddressed, which compounded the need to have better water and sanitation services (KNBS, 2022; MoWSI, 2021). There is also an array of regulated Water Service Providers (WSPs) in the region and under the jurisdiction of the Water Services Regulatory Board (WASREB), which allows the robust analysis of the tariff policy performance in a formal regulatory framework. These counties remain characterised by inequities in access and affordability of water resources, and thus are a viable field of study that would inform more equitable and sustainable models of tariffs in accordance with the Water Act 2016 of Kenya and the Sustainable Development Goal 6 (clean water and sanitation) (Republic of Kenya, 2016; UN-Water, 2023).

### **3.4 Data Collection Instrument**

The secondary time-series data were used in this research to make sure that the data were collected in a structured data collection checklist and therefore was consistent, accurate, and complete to capture all the relevant information to be collected (Domonkos, Tóth, and Nyitrai, 2022). The data included the 2009-2024 time frame and was obtained at such respectable organisations as the Water Services Regulatory Board (WASREB), Kenya National Bureau of Statistics (KNBS), Lake Victoria North Water Works Development Agency (LVNWWDA), and Lake Victoria South Water Works Development Agency (LVSWWDA). These organisations regularly informed on the performance of the sector, household consumption patterns and tariff systems that were very important in determining the water and sanitation demand in the Western Region of Kenya.

Time-series data were considered to be suitable as secondary data to learn about long-term trends and time-related cause-effect relationships (Karanja, 2019). The information gathered was in accordance with the aim of the study. In order to test the causal dimension of water tariff changes and household consumption, the study focused on household consumption change volumes in example of tariff change. In the second objective, the impact of raising block tariffs on the elasticity of water demand was determined using the data on tiered pricing formations and the level of household consumption. The third goal entailed a comparison of per capita water consumption with the flat rate and volumetric pricing systems based on utility billing records. Lastly, to determine the comparative impacts of tariff structure in urban and rural households, disaggregated data concerning location, tariff structure, and water consumption was used to conduct the study. This holistic strategy gave a strong

conception of the effect of tariffs structure on the demand of water and sanitation in the region on the household level.

This analysis of data and Model Specification will be conducted using thematic analysis, chi-square, and descriptive statistics. The thematic analysis, chi-square, and descriptive statistics will be utilised to conduct the analysis of data and Model Specification.

A search of quantitative secondary data was performed on the years 2009-2024, in which they were cleaned, coded and analysed using Eviews version 14. The analysis of data was based on descriptive and inferential statistics. Overall, descriptive statistics, such as means, percentages, standard deviations and frequencies were employed to summarise trends in water consumption, tariff structures and household characteristics (Khan, 2023). Correlation and multiple regression analysis was used as part of inferential statistics. Correlation analysis was used to establish the strength and direction of the relationship between tariff variables and demand of water, whereas the regression analysis was used to estimate the degree to which the changes in the structure of water tariffs cause changes in the household water consumption (Gujarati and Porter, 2009). The strength of the associations or their correlation coefficient ( $r$ ) and coefficient of determination ( $R^2$ ) demonstrated the percentage of the water demand explained by the independent variables.

The regression method used in this study was the Ordinary Least Squares (OLS) regression, which was used to estimate the impacts of different tariff structures on the household water and sanitation demand. OLS is a powerful tool that is used to estimate the association between a dependent variable and an independent variable or

several independent variables by reducing the total squared errors (Kumar, 2023). The household water demand (WD), which is the average per capita daily water use was used as the dependent variables. These independent variables were tariff structure type (TST), bloc tariff rates (BT), pricing method (flat-rate or volumetric) (PM) and household location (urban or rural) (HL). The practical model can take the following form:

$$WD_t = f(TST_t, BT_t, PM_t, HL_t)$$

The corresponding regression model was:

$$WD_t = \beta_0 + \beta_1 TST_t + \beta_2 BT_t + \beta_3 PM_t + \beta_4 HL_t + \epsilon_t$$

Where  $WD_t$  is household water demand at time  $t$  between 2009 to 2024,  $\beta_0$  is the intercept,  $\beta_1$ – $\beta_4$  are the coefficients of the independent variables and  $\epsilon_t$  is the error term capturing other unexplained variations.

To address the fourth objective assessing the comparative effects of tariff structures across urban and rural households a moderation analysis was conducted. Specifically, household location was tested as a moderating variable to determine if it influences the relationship between tariff structures and water demand. The extended regression model is given as:

$$WD_t = \beta_0 + \beta_1 TST_t + \beta_2 BT_t + \beta_3 PM_t + \beta_4 HL_t + \beta_5 (HL_t \times TST_t) + \beta_6 (HL_t \times BT_t) + \beta_7 (HL_t \times PM_t) + \epsilon_t$$

This model helped capture whether urban and rural settings alter the effects of tariff structures on water consumption, which is crucial in designing equitable water pricing policies (Whittington et al., 2002).

### 3.5.1 Diagnostic Tests

The diagnostic tests were conducted to test the assumptions of regression model, and then regression analysis was conducted. The autocorrelation test, normality, heteroscedasticity test and stationarity test were focused in the study.

#### **3.5.1.1 Normality Test**

The normality of data to justify regression analysis and other inferential statistic methods applied in this research was tested. In particular, Jarque-Bra (JB) test and skewness and kurtosis analysis were used to test whether or not the time-series data on water demand and tariff structure follow a normal distribution. The asymmetry of the distribution was measured using skewness, and tailedness was measured using kurtosis, and this determines the probability of extreme values or outliers. It is suggested that skewness should have acceptable values between -3 and 3 and kurtosis between -10 and 10 (Khan, 2023).

Jarque-Brau test is a combination of skewness and kurtosis that are used to assess the overall goodness-of-fit of the data to a normal distribution (Kumar, 2023). The null hypothesis of JB test is that the data is normally distributed. The p-value that is less than the significance level of 0.05 was used to reject the null hypo and indicate that the data is highly non-normative. Conversely, when the p-value exceeds 0.05, the null hypo was not rejected meaning that the data is not significantly different than a normal distribution and can be used in the parametric analysis (Vrbin, 2022). This test plays a critical role in ensuring the appropriateness of OLS regression use in estimating the impacts of tariff structure in the demand of water and sanitation.

#### **3.5.1.2 Autocorrelation Test**

The study ran the Breusch-Godfrey (BG) test as one of the diagnostic tests to determine the existence of autocorrelation in the residues of the regression model. As the study involves the use of time-series data between 2009 and 2024, it is important to ensure that the residuals follow a non-parametric distribution to support the assumptions of Ordinary Least Squares (OLS) regression. This analysis is done using the BG test as compared to the Durbin-Watson test which only identifies first-order autocorrelation. The maximum order of autocorrelation that BG test can detect is high, so it can be used to estimate complex time-series models (Kumar, 2023).

When using the BG test, the null hypothesis was that the model residues are autocorrelated. The p-value less than 0.05, implied the violation of the independence assumption, which indicated the occurrence of the serial correlation. The p-value of above 0.05, on the other hand, showed that the assumptions of the model were valid since there were no significant autocorrelation of the residuals. This test should be conducted in order to increase the strength and credibility of the regression estimates of the study in terms of the effect of various water tariff frameworks on household water and sanitation demand in Western Region of Kenya.

### **3.5.1.3 Heteroscedasticity Test**

In the analysis of secondary data, the research hypothesised the heteroscedasticity with the Cook-Weisberg or Breusch-Pagan test. The tests examine the assumption of the same variance between the residuals of the regression model (homoscedasticity) or different (heteroscedasticity) (Farrar, 2022). The null hypothesis is that the residuals follow a constant variance. A p-value of 0.05 or lower revealed that there was existence of heteroscedasticity and this could be used to interfere with the reliability of regression estimates. When the p-value exceeds 0.05, the

homoscedasticity assumption was not violated hence the terms of error were distributed at an equal level. This validation was critical in attaching the strength of the study conclusions on how the water tariff structures affect demand in the Western Region of Kenya.

#### **3.5.1.4 Multicollinearity Test**

In this research, multicollinearity needs to be tested to ascertain whether there are excessive correlations between the independent variables and this would invalidate the regression modelling findings. In order to determine multicollinearity, the analysis used Variance Inflation Factor (VIF). VIF is used to evaluate the extent to which the estimated regression coefficient is inflated as a result of multicollinearity and the level of how well an independent variable is represented by other independent variables in the model (Oke, Akinkunmi and Etebefia, 2019). A high value of VIF, which is normally above 10, would mean that there is extreme multicollinearity and therefore the variables are very correlated among themselves. On the other hand, a low VIF of less than 10 would indicate that the issue of multicollinearity shall not be of concern hence making the analysis of the effects of alteration in tariff structures to water demand in the Western Region of Kenya robust.

#### **3.5.1.5 Stationarity Test**

Since this is time-series research that employs secondary data, one has to test the stationarity to carry out effective econometric analysis. Stationarity means that the statistical characteristics of a time series including the mean and variance are fixed with time. To confirm this, the research used the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests, which are conventional methods used to find out whether the unit root exists in time-series data (Afriyie et al. 2020). The null

hypothesis of both tests is that the data is non-stationary (unit root), and the alternative one is that it is stationary.

In case either test p-value is less than the 0.05 level of significance, the null hypo will be rejected proving the series is stationary. But when p-value exceeds 0.05 that is when the data is likely to be non-stationary, then differentiation or transformation is recommended. The stationarity test is one of the steps that are imperative to test reliability of regression outcomes when studying the impacts of different water tariff structures on household water demand in the Western Region of Kenya (Wagner, Cook and Kimuyu, 2019).

### **3.6 Ethical Considerations**

This research only used secondary data that was collected through reputable sources including WASREB, KNBS, LVNWWDA and LVSWWDA, therefore, no direct contact with human subjects was made. Although this study involved no primary data gathering, its research ethical standards were met in data handling, analysis, and reporting. The ethics was maintained by keeping the original context under which data were gathered and making sure that any use of the data was not against the institutional and legal regulations (Bryman, 2016; Israel and Hay, 2006).

The privacy and confidentiality were ensured because the pre-anonymized and aggregated datasets were involved, and no individual identifications were provided. According to Saunders, Lewis, and Thornhill (2019), the research did not interfere with the identities of people and communities. Also, the analysis was culturally sensitive and acknowledged socio-economic and geographic diversity implicit in the data, especially in rural and underserved groups (Mertens, 2015; Patton, 2015).

Even though there was no significant risk associated with the research (as it was a non-invasive study), a known ethics review committee was consulted to confirm the adherence of the study to academic and institutional ethical standards (Resnik, 2020). The conclusions were to be used purely on academic and policy grounds and to be made in a responsible manner to the stakeholders involved. Certain ethical research, as highlighted by Wiles (2013) should be conducted in such a way that the outcomes do not lead to misuse of data and that the outcome is in the best interest of the general society.

## CHAPTER FOUR

### DATA ANALYSIS AND DISCUSSION

#### 4.1 Introduction

This chapter presents findings from the study conducted on “examination of the effects of different tariff structures on water demand and sanitation in western region of Kenya”. It also presents analysis, interpretation and discussion of findings of the study.

#### 4.2 Summary statistics

Our primary data set was provided by the Water Utility that supplies urban households of the counties in Western region. The data contains for each household the total consumption of water measured in cubic meters (1 cubic meter = 1,000 L) and the water utility provided the details of fixed costs and marginal prices valid in each period in each County. With this information, the monthly bill paid by each household is calculated. The second source of information corresponds to the 2019 population census from which household socio-demographic characteristics analysis was done. However, we cannot match census information with the water consumption data set at a household level, so we calculated the average of from the data generated from Bungoma water and sewerage public limited company (BWASCO), Busia Water and sewerage services company limited (BUWASCO), Kakamenga County Water and sanitation company limited (KACWASCO) , Vihiga water and sanitation company limited (VIWASCO).

**Table 4.1: Commercial water user’s classification in (m3) per category from 2013-2024**

Category	Description	Billing records	Mean	Std	max	Difference in means before and after price change <sup>a</sup>
<b>Construction</b>	Construction sites	2631	322	76	321	2.24(7.52)
<b>Industrial facilities</b>	Factory, industrial facilities, workshop	5301	421	201	152	21.23(4.19)
<b>Garage/carwash</b>	Auto repair and car washes	2194	128	256	2302	-2.18(2.14)
<b>Offices</b>	Office building blocks	1,135	1,242	132	73	-2.15(9.34)
<b>Market and retail stores</b>	Supermarkets, shops, and small kiosks	12,056	236	152	1,048	1.12(3.21)
<b>Eating/drinking</b>	Restaurants, hotels, bars, clubs, and other catering business	762	334	502	981	-12.18(2.30)
<b>All records</b>	All, including unclassified	2845	428	221	534	-3.76(10.74)

<sup>a</sup> Difference in mean 12 billing months after December 2020 minus mean in 12 billing months prior. Unpaired two-tailed t-test, \* 10%

Source: Field data 2025

As shown by the descriptive statistics in Table 4.1, industrial facilities and large office blocks were the largest consumers while auto garage, construction sites and retail stores had the least water consumption. We also compared mean water use in each category in the 12 months before and after the tariff went into effect. We find that mean monthly water use declined in the 12 months after the price change in four of the sectors but increased in three of the sectors, though none of the differences are statistically significant.

#### **4.2.1 Causal relationship between changes in water tariff structures on household water consumption in western region of Kenya.**

Various forms of water tariff systems are conceivable and implemented in practice. These tariffs generate revenues for the water suppliers and can consist of various components. The common water tariff structures in practice in western region are; one

time connection fee, a recurrent fixed charge, metering system (volumetric rate), and a minimum charge for a specific period. Based on the composition of these four tariff components, various tariff structures can be implemented, which yield different expenditure functions, for each tariff structure. The tariffs in use in Western region are as shown in Table 4.2.

**Table 4.2: Estimates of water tariff in use**

<b>Water tariff</b>	<b>Kakamega</b>	<b>Bungoma</b>	<b>Vihiga</b>	<b>Busia</b>
<b>One time connection fee</b>	27%	20%	22%	18%
<b>Minimum charge</b>	23%	25%	19%	21%
<b>Fixed charge</b>	26%	28%	20%	23%
<b>Metering system</b>	44%	38%	28%	26%

Source: Field data 2025

The challenge of affordability of household water consumption is particularly pronounced in rural regions like Western Kenya, where many households live below the poverty line. According to the Kenya National Bureau of Statistics (2022), a large proportion of the population in Western Kenya still lacks reliable access to clean water, with many households relying on unprotected sources such as rivers or shallow wells. When water tariffs are set too high, households may be forced to reduce their consumption, leading to adverse health and sanitation outcomes.

To determine the effect of causal relationship between changes in water tariff structures on household water consumption in western region of Kenya, estimates on water consumption before price change and after price change were computed and the significance of the mean differences.

**Table 4.3: Average household consumption during pre and post tariff change**

County	Average Household consumption in m <sup>3</sup> /month (SD) (previous)(SD)	Average Household consumption in m <sup>3</sup> /month (Current)(SD)	p-value
Bungoma	15.1(2.1)	12.3(1.9)	0.017
Kakamega	15.3(2.9)	12.5(2.4)	
Busia	13.7(1.5)	11.6(1.8)	
Vihiga	12.4(1.4)	11.3(1.6)	
	14.125(1.98)	11.925(1.925)	

Source : Field data 2025

The average household monthly consumption was 14.125(SD=1.98) m<sup>3</sup>/month before tariff change and dropped to 11.925 (SD=1.925) m<sup>3</sup>/month. The reduction in household consumption was significant (p=0.017 < 0.05) suggesting elasticity to price.

Using regression analysis to estimate the causal effect of

**Table 4.4: Regression**

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1 (Constant)	2.487	1.428		21.741	.083
Tariff change	-.421	.048	.790	69.340	.000

a. Dependent Variable: Household water consumption

$$\text{Consumption} = \beta_0 + \beta_1 * \text{Tariffchange}$$

$$\text{Consumption} = 2.487 - 0.421 * \text{tariff change}$$

Thus, for every unit increase in tariff change there was a corresponding decrease on household water consumption by 0.421.

### 4.3 Effect of increasing block tariff on water demand elasticity in western region of Kenya.

The increasing block water tariff is a widespread method of pricing water in most countries. The pricing system begins with a low initial cost of water that increases after reaching the maximum volume specified for a particular block range. The summary of the bloc tariff and their pricing in Western Kenya is as shown in Table 4.5.

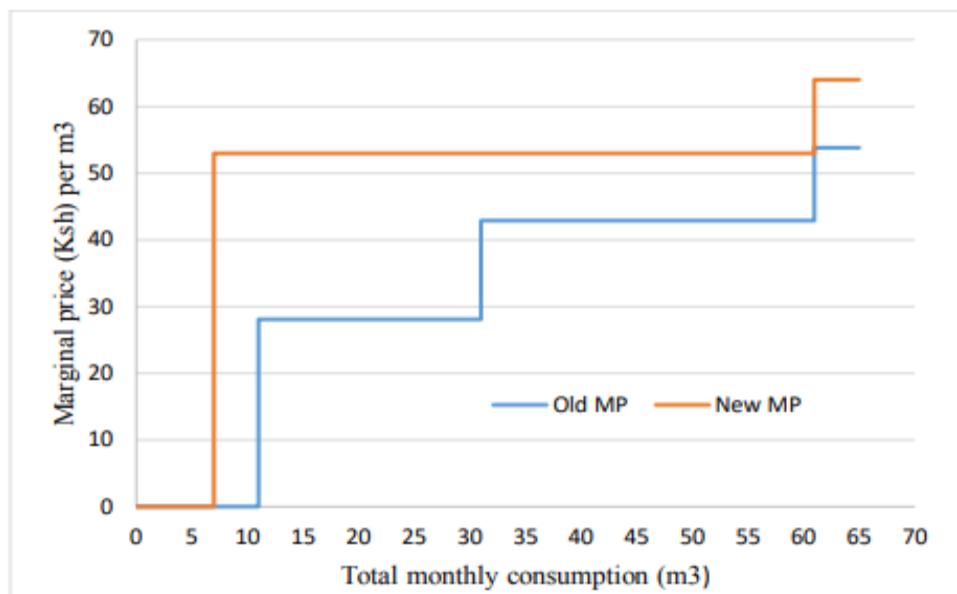
**Table 4.5: Summary on block Tariffs rates in use in Western Kenya**

	<b>Consumption Block (m<sup>3</sup>)</b>	<b>Previous tariff (Kshs/m<sup>3</sup>) (2013-2020)</b>	<b>Consumption Block (m<sup>3</sup>)</b>	<b>Current tariff (Kshs/m<sup>3</sup>) (2021-2025)</b>
Domestic	0-6	45	1-6	80
	7-20	68	7-20	110
	21-50	88	21-50	130
	51-100	108	51-100	145
	101-300	135	101-300	160
	>300	175	>300	200
Commercial/industrial /Government institutions	0-6	45	1-50	120
	7-20	68	51-100	145
	21-50	88	101-300	165
	51-100	108	>300	210
	101-300	135		
	>300	175	>300	200
Schools/colleges/ universities	0-600	48	1-600	90
	601-1200	56	600-1200	125
	>300	60	>1200	170

Source :

This system ensures affordable water to the poor segment of the country since they usually stay within the initial block range. On the other hand, when the price of water increases from the initial block to subsequent blocks, it would give an incentive for the reduction of wasteful water usage. Therefore, the increasing block rate system can be used as a water demand management tool as it leads to conserve water while increasing revenue from water provision.

The tariffs prevailing at the beginning of our dataset in 2013 had been in place since 2009. Charges for water service were comprised of a fixed "meter rent" charge (typically Ksh 45 for a 3/4" connection) and an increasing block volumetric charge with four blocks (Figure 1). Tariffs were revised in July 2021, taking effect for the bills sent in October 2021. During the 2021 tariff revision, fixed 5 charges (meter rents) were changed for connections larger than 1" (some increasing and some decreasing), and the volumetric water tariff was simplified to three blocks (Figure 1). Consumption in the first block (up to 6 m<sup>3</sup>) was charged a flat rate of Ksh 80 with no volumetric component. The price in new second block (7 - 20 m<sup>3</sup>) was substantially higher than corresponding volumetric charges for the two consolidated blocks under the old tariff.



**Figure 4.1: Old and new revised block tariff**

**Source: Field data**

There is a well-known econometric identification challenge associated with water billing data where increasing-block tariffs are used: price (block) and water consumed are endogenously determined. Lower water prices translate into higher water

consumption. The magnitude of this effect depends on the price elasticity of demand for water.

The very rationale of increasing block tariffs is their alleged fairness. But the precise relation between fairness and the progressive structure of a tariff system is not as obvious as asserted. The philosophy of IBTs is to secure affordability of water and to implement the notion of fairness which implies the redistribution between the income groups. Those with high income should contribute to cost coverage relatively more than those with low income, thus cross-subsidizing the latter. Increasing block tariffs (IBTs) are designed to make water consumption more sensitive to price, thus potentially reducing overall demand, especially among high-volume users. However, the effectiveness of IBTs depends on factors like how they're structured, the level of water consumption, and the type of users. IBTs can lead to societal losses while doing little to increase equity.

The main finding is that the benefits of the IBT structure do not reach the poorest households, in particular those without access to water. This shows that access to water determines the beneficiaries of water subsidies as emphasized in the literature. The first water volumes per household can be provided at a low price, which makes water affordable even for the poorest. Hence, the implementation of a well-defined increasing block tariff may promote the access to the public water supply for even those, with the lowest income. Many developing countries around the world apply progressive water tariffs, often structured in the form of discretely increasing block tariffs (IBTs), but there is a controversial debate about the pros and cons of this approach. Whittington (2003), in an analysis of water tariff designs in South Asian cities, alluded to problems such as subsidy design (such as the size and the price of the (lower) consumption blocks), the extent of water metering (too many unmetered

private connections), and many poor households not connected to the piped distribution system, as explanations for water tariffs leading to revenue insufficiency for utilities and inequitable service provision.

#### **4.4 Effects of flat-rate versus volumetric pricing on per capita water usage in western region of Kenya.**

In comparing flat-rate versus volumetric water pricing, volumetric pricing generally promotes more efficient water use and equitable cost allocation, as it incentivizes lower consumption and can be tailored to different income levels. Flat-rate pricing, while simpler, can lead to higher overall water consumption and may not reflect actual usage, potentially creating affordability issues for low-income households. Volumetric tariffs are more versatile than fixed charges and can provide an incentive for careful use. Linear Tariffs, Increasing Block Tariffs (IBT), and Decreasing Block Tariffs (DBT) are different systems of volumetric charges for water. They all need proper meters and appropriate rates to be fair and effective. A descriptive statistics of the flat rate use and volumetric use in the study area was as shown;

**Table 4.6: Descriptive on usage of Water**

	<b>Usage in liters per capita per day</b>	<b>Mean usage in liters per capita per day (sd)</b>	<b>Gini coefficient</b>
Flat rate	0-6	45.8(11.4)	0.54
	7-20		
	21-50		
	51-100		
	101-300		
	>300		
Volumetric	0-6	33.2 (9.1)	0.37
	7-20		
	21-50		
	51-100		
	101-300		
	>300		

Source: Field Data 2025

The mean usage of water under flat rate use 45.8 liters per capita per day (SD=11.4), while the mean usage in volumetric pricing was 33.2 liters per capita per day (SD=9.1). This shows that efficiency in terms of water usage is achieved through the use of volumetric pricing as its closer to WHO recommendations of an average use of 30-40 liters per capita per day. The higher gini in flat rate use (0.54) shows there is inequality in wealth distribution in flat rate use than in volumetric distribution where the gini coefficient is lower (0.37) (relatively equitable distribution of the population in terms of wealth distribution and water usage).

To determine the effects of flat-rate versus volumetric pricing on per capita water usage in western region of Kenya, regression analysis was used.

**Table 4.7: Regression Coefficients**

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1 (Constant)	2.024	1.562		1.296	.176
Flat rate	.816	.052	.722	45.668	.054
Volumetric pricing	.693	.053	.657	23.055	.016

a. Dependent Variable: water consumption (m<sup>3</sup>)

Source: Field Data 2025

Volumetric pricing was highly significant to water consumption ( $p=0.016 < 0.05$ ) while flat rate pricing is not significant to water consumption ( $p=0.054 > 0.05$ ). This shows that volumetric pricing is dependent on water consumption amongst residents of Western Kenya.

**Table 4.8: Volumetric pricing versus Flat rate**

		<b>Before Change in pricing (means in liters per capita per day)</b>	<b>After Change in pricing (means in liters per capita per day)</b>	<b>Difference p-value</b>
<b>Flat rate</b>	Low income	2,276	2,871	0.047
	High income	872	628	
<b>Volumetric pricing</b>	Low income	1,261	1,062	0.029
	High income	872	723	

Source : Field data 2025

Though there is significant change in the in the difference between the means in liters per capita per day consumed by flat rate users ( $p=0.047 < 0.05$ ) and volumetric users ( $p=0.029 < 0.05$ ), the change in pricing affects the water consumption amongst the residents of Western Kenya. Volumetric pricing reduces waste amongst the wealthier households while flat rate pricing encourages overuse by the low income earners since they perceive the water provision is unlimited. The shift from volumetric to flat fee payments offers some insights for policy and practice. The considerable increase in water consumed and revenue collected in the short term of the study suggests a user preference for flat fees. However, monthly flat fees are not a “one-size-fits-all” approach to effectively collect user payments in all contexts given the revealed variability in collection efficiency across municipalities. Previous researchers like Alemu *et al.*, (2020) have showed that payment approaches and their respective revenue collection performance vary across local contexts due to multiple factors, such as the availability of alternative sources, user population size, social dynamics, and related coordination challenges, or established practices at the community level where multiple revenue collection approaches are likely to co-exist. Identifying which specific local characteristics affect collection efficiency across payment modalities

could offer valuable insights for policy and practice and may ultimately inform rural water services that more adequately cater for local contexts.

Nevertheless, the combined change in water used and payments made indicates a volumetric tariff is socially unacceptable for reliable rural water supplies delivered through hand pumps, emphasizing that tariff designs which are considered effective and efficient for urban areas may not necessarily respond to the specific challenges characterizing rural water (Kombe, 2020). Importantly, our insights on quantities of water used reflect similar findings from rural Western part of Kenya where volumetric payments result in lower income groups reducing water usage.

#### **4.2 Assessment of the comparative effects of tariff structures on water demand across urban and rural households in western region of Kenya.**

Water tariff structures significantly impact water demand across urban and rural households, with variations in effectiveness depending on the specific design and context. In urban areas, tiered tariffs with increasing marginal prices tend to reduce consumption, especially among higher-income households, while in rural areas, flat fees or uniform volumetric tariffs may be more prevalent and could disproportionately burden low-income households.

**Table 4.9: Tariff structures and water demand across urban and rural households**

			<b>Mean monthly charge</b>	<b>Demand elasticity</b>	<b>significance</b>
Volumetric pricing			Kshs. 500	-0.51	0.01
Increased (IBT)	Block Tariff		0-6 m <sup>3</sup> – Kshs 80 7-20 – Kshs 130 21-50– Kshs 145 51-300 – Kshs 160 > 300 – Kshs 200	-0.44	0.26
Fixed charge pricing)	(flat rate)		Kshs 500	-0.10	0.64

Source: Field Data 2025

Volumetric pricing is significant ( $p=0.01 < 0.05$ ) hence highly elastic, IBT is significant ( $p=0.26 < 0.05$ ) but elastic in upper blocks, and flat rate is not significant ( $p=0.64 > 0.05$ ) and hence is inelastic with reference to water demand elasticity.

**Table 4.10 Comparative summary statistics for urban and Rural water consumption**

Measure	Urban	Rural
Price sensitivity	High (-0.44 to -0.5)	Low (-0.14 to -0.21)
Equity risk	High (cost burdens)	Low (has high health risk)
Preferred tariff system	IBT with lifeline blocks to protect the poor	Flat-rate pricing system

Source: Field Data 2025

**TABLE 4.11: OUTCOME OF THE HYPOTHESES**

Hypothesis	Alternative (H <sub>1</sub> )	Decision Rule / Expected Outcome
H01	Changes in water tariff structures significantly affect household water consumption.	Reject H <sub>0</sub> Adopted H <sub>1</sub>
H02	IBTs significantly alter water demand elasticity.	Reject H <sub>0</sub> Adopted H <sub>1</sub>
H03	Flat-rate vs volumetric pricing significantly affects per-capita water usage/demand elasticity.	Reject H <sub>0</sub> Adopted H <sub>1</sub>
H04	Tariff structures significantly affect water demand differently in urban vs rural households.	Reject H <sub>0</sub> Adopted H <sub>1</sub>

Field Data 2025

The initial hypothesis demonstrates that the household water use is greatly influenced by the alterations in the water tariff structure. It implies that households react to the changes in prices by cutting their consumption when the tariffs are increased and by increasing it when the tariffs are lowered, making tariffs a good demand control instrument.

The second hypothesis discloses that Increasing Block Tariffs (IBTs) are a major change in elasticity of water demand. Here, none-income households gain access to affordable lifeline blocks and high-consuming households are more sensitive to price changes which helps to maintain equity and conservation.

The third hypothesis shows that pricing approach, flat-rate and volumetric, have important impact on per-capita water consumption. Flat-rate systems are associated with over-consumption since the rates are fixed at any rate but volumetric pricing is associated with efficiency since the rates of cost vary according to the volume of water consumed.

The fourth hypothesis demonstrates that the tariff structures have different impacts on the demand of water in urban and rural households. The households which are typically linked to piping systems in the urban areas tend to be more sensitive to tariff changes, whereas rural households that utilise communal sources tend to be less sensitive. This implies that there are various designs of tariffs that should be designed to take into account the local realities.

## CHAPTER FIVE

### SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

#### 5.1 Introduction

The chapter includes the overall overview of the main findings of the study, and the conclusions are made regarding the findings of the analysis. It also provides practical recommendations on the results, which can bring the implication of the same in policy and practise. The chapter also explains the contribution of the research to the theory and proposes future research to widen the knowledge on the issue.

#### 5.2 Summary of the Findings

In this section, the most significant findings associated with the purpose of the study would be presented in terms of the main results of the conducted analysis.

##### **5.2.1 Causal Relationship among Modifications in Water Tariff Alternatives on the household water usage in the Western Region of Kenya.**

The construction industry was the only sector that marginally improved the water consumption following the adjustment of the tariff with the mean change being +2.24 m<sup>3</sup>. The corresponding t-statistic was 7.52, which numerically is high, a fact that is however insignificant, the change in mean consumption was small, meaning that it is not practically significant, and the resulting statistical significance would rely on the sample size and degree of freedom. Besides, the mean usage in this category was relatively low, which means that the construction activities might not be water-intensive or the billing records might not be representative of the actual usage.

On the other hand, industrial sector showed high rise in consumption of water with an average change of +21.23 m<sup>3</sup> after the change in price. The t-statistic value stands at

4.19, which provides the support of statistical significance of such a change, and indicates that industrial users were significantly using more water during the period of the post-price change. This trend can be explained by the expansion in the operation, the rise in production demand or the toleration to price changes because the water demand in the industrial processes is inelastic.

Water consumption in the garage and carwash industry declined by an average of -2.18 m<sup>3</sup> following the adjustment of the tariff. The t-statistic of 2.14, though not high, can be a sign of a mediocre behavioural reaction to the high water prices. This marginal decrease is an indication that these businesses that are more dependent on water have either implemented conservation or minimised operations as a reaction to increased utility prices. Nevertheless, the scale of the change presupposes that response has been not so high to be deemed economically meaningful.

On the same note, office category registered a small decrease in water consumption (-2.15 m<sup>3</sup>) after the price change. Interestingly, the t-test of 9.34 is comparatively high indicating that this reduction can be statistically significant. Although the change in numbers is rather minimal, it may reflect a systematic change in water usage habits, which might have happened by either introducing efficiency measures or water-saving systems in office buildings. However, the effective effect is still insignificant, as the reduction is small.

In the case of market and retail stores, the use of water showed a marginal rise of +1.12 m<sup>3</sup> following the tariffs alterations. The t-test 3.21 is not statistically significant but is moderate based on the degrees of freedom. This slight increase in consumption indicates that the demand at the operational level was not very volatile, perhaps due to the tendency of these businesses to stick with the routine business with

the changes in costs. Its necessity may make them less vulnerable to changes in price of water.

Conversely, the eating and drinking industry that covers restaurants, hotels, bars, and others registered a significant decrease in consumption (-12.18 m<sup>3</sup>). The drop is statistically significant and economically significant with a t-statistic of 2.30. This drastic decrease may be explained by the fact that this industry is susceptible to the price on utility, and the situation in the period of a pandemic limited the consumption of water, specifically in 2020 and following years.

Based on all the categories of commercial users, the statistics show an overall decrease in the water use of -3.76 m<sup>3</sup> after the tariff adjustment. Even though the standard deviation is big (Std = 221), the t-statistic of 10.74 proves that this difference is statistically significant. It means that there is an average yet prevalent behavioural reaction to price fluctuations throughout the business world wherein certain businesses cut down on consumption more than the others depending on their elasticity of operations and price sensitiveness.

According to the data given in Table 4.2, there is significant difference in the way of how water tariffs are structured and implemented in the counties of Kakamega, Bungoma, Vihiga, and Busia. The most common tariff referred to as metering system is used on 44, 38, 28 and 28 in Kakamega, Bungoma, Vihiga and Busia respectively. It means that consumption-based billing is becoming increasingly popular, particularly in the more urbanised counties such as Kakamega, which has been in line with the intention to enhance efficiency and to adopt conservation (Komakech & de Bont, 2018).

Bungoma leads in the aspect of fixed charges with 28% then Kakamega, Busia and Vihiga with 26, 23 and 20 respectively. The fixed charges tend to have financial sustainability with regard to utilities although they can disequilibrium impact the low-consumption households, which is likely to operate against the objectives of affordability and equity (Whittington et al., 2002).

The minimum fee that establishes a minimum rate to all users irrespective of the real consumption also varies: Bungoma (25%), Kakamega (23%), Busia (21%), and Vihiga (19%). These tariffs can be useful in stabilising revenues but are usually criticised as deterring conservation and imposing a cost on the poor (Banerjee et al., 2010).

Finally, one-time connexion fee is the most expensive in Kakamega (27%), followed by Vihiga (22%), Bungoma (20%), and then Busia (18%). High connexion charges may serve as an entry gate, particularly to low-income earners, an issue UN-Habitat (2011) also points out noting that this preoccupation is central to the coverage of services in the peri-urban and rural regions with lower entry fees.

All in all, tariff structure in Kakamega seems to be more consumption-oriented and cost-recovery oriented whereas busia and Vihika seem to have significantly lower rates which could be attributed to the fact that some of the infrastructure is still developing and the priorities in the policy.

This observation is in line with the work by Komakech and de Bont (2018) who contend that the rise in the utilisation of the metering systems enhances efficiency and price that is cost-reflective. Nevertheless, they disagree with Whittington et al. (2002) and Banerjee et al. (2010) to some extent, who warn against depending on fixed and

minimum charges as they raise equity issues particularly in low-income environments.

The Table 4.3 results show that there is a distinct trend of decreasing the average household water use in all the four counties namely, Bungoma, Kakamega, Busia, and Vihiga after a change in tariff structure. Before the change in tariffs, the household consumption used to be 14.125 m<sup>3</sup> (SD = 1.98) every month, but it decreased to 11.925 m<sup>3</sup> (SD = 1.925) after the change. Particularly, Bungoma showed a reduction in terms of 15.1 m<sup>3</sup> to 12.3 m<sup>3</sup> and the change was statistically significant ( $p = 0.017$  below the value of 0.05), which indicates that consumers are price-sensitive of water. This is an indication of some price elasticity of demand such that an increase in prices results in a decrease in consumption as it is the case with economic theory and previous literature (Dalhuisen et al., 2003).

The regression results in Table 4.4 are used to measure the causality of the tariff changes on household consumption. According to regression model, the more the tariff is raised, the less water is consumed as the equation shows, 1 unit increase in tariff corresponds to a decrease in the consumption of water by 0.421 m<sup>3</sup>.

$$\text{Household Consumption} = 2.487 - 0.421 \times \text{Tariff Change}$$

The coefficient of -0.421 has been shown to be significant ( $p = 0.000$ ), hence the adjustments made on tariffs will have meaningful impact on the use of water by households. This observation supports the perception that price control systems that use tariffs can be useful instruments in watershed conservation as Olmstead and Stavins (2009) and Arbués et al. (2003) recorded such elasticity impact in urban water demand research.

### **5.2.2. Impact of increasing Bloc Tariff on Elasticity of Water demand in Western Region in Kenya.**

The paper has found that higher block tariffs (IBTs) are applied in Western Kenya counties to ensure water conservation practises and affordability to the poor. Table 4.5, as it can be seen, reflects the fact that the tariff rates were changed in 2021 and water charges in all consumption blocks increased considerably. As an example, the lowest block (0 m<sup>3</sup> -6 m<sup>3</sup> ) had an increase of Ksh 45 to Ksh 80, and 175 to 200 the usage more than 300 m<sup>3</sup>. The objective of this structure is to make basic affordability but deter over usage by setting high prices at high consumption rates.

But the analysis showed that although IBTs are theoretically a means of promoting equity, in reality, the gains are not accessible to the poorest households especially those who lack piped water. This implies that the subsidy in the lower consumption blocks is more favourable to better-off users who are grid-connected. The literature supports this concern, especially Whittington (2003), who states that such problems as the inadequate design of the subsidies, insufficient metering, and a high number of poor households having no connexions to the piped systems contribute to the insufficiency of revenue and inequity in the service delivery.

In addition, IBTs may act by establishing signals to consumption by cost as well as elasticity in Table 4.4 is seen but its full validity on consumption requires both tariff structure and access infrastructure. Even though the supporters of IBTs believe that they should be applied as a means of conservation and fairness, the opponents claim that they can contribute to the inefficiency of society and will not reach redistributive purposes without simultaneous investment in the widening of access. In this way, although the data confirm the existence of behavioural reaction to the alterations in price, as can be observed in Table 4.3, the fair influence of IBTs is quite scarce unless one considers the infrastructure obstacles.

### **5.2.3 Flat-rate and Volumetric Pricing effects on Per Capita water usage in Western Region of Kenya.**

The study results demonstrate that flat-rate and volumetric pricing systems have significant dissimilarities in their effects on the water consumption behaviours of the Western part of Kenya. Table 4.5 shows descriptive statistics, which result in the finding that households that are paying a flat-rate had higher water consumption with an average of 45.8 litres per day per capita (SD = 11.4), as opposed to households that

are paying a volumetric rate of 33.2 litres per day per capita (SD = 9.1). This implies that a flat-rate pricing will lead to excessive consumption, perhaps due to the fact that it will make consumers feel that water is unlimited and will not be affected by the rate of consumption. Also, the Gini coefficient in a flat-rate pricing (0.54) was greater than the volumetric pricing (0.37), which means that volumetric pricing is also related to a fairer use of water and distribution of income.

Table 4.7 that shows the results of regression also substantiates the efficiency of volumetric pricing. The effect of volumetric pricing was statistically significant on water consumption ( $p = 0.016$ ), but the effect of flat-rate pricing was not ( $p = 0.054$ ). This implies that volumetric tariffs, which are pegged on the actual use of water, are more sensitive to water use and as such, encourage people to conserve the use of water. Table 4.8 presents the results of a before-and-after analysis and demonstrates that flat-rate users (especially in low-income families) used more water after a change in pricing (2,276 to 2,871 litres per month,  $p = 0.047$ ), but volumetric users (the same income group) consumed less water (1,261 to 1,062 litres per month,  $p = 0.029$ ). This highlights the conservation capability of the volumetric price and the role of volumetric price in curbing the overuse, particularly by the higher income populations.

The findings are consistent with what Kombe (2020) warned that in contrast to volumetric pricing which is a good option in urban areas, it might not be socially acceptable in rural areas, especially the ones using handpumps. Volumetric pricing in these regions has resulted in a reduced consumption of water by the low-income earners, which could make them have restricted access to water. The concept of water tariff systems being localised is reinforced by Alemu et al. (2020), as well. This is because, according to them, the efficiency of revenue collection depends on community dynamics, the population of the users, and availability of other water sources. These considerations tend to render flat-rate systems more realistic in rural settings, although they may be ineffective.

Although volumetric pricing is more efficient and equitable, the data indicate that flat rate tariffs are very popular because of their simplicity and affordability, particularly in rural locations. It can thus be concluded in the study that although volumetric pricing creates conservation and equitable distribution of costs, its effectiveness

largely relies on social acceptance and context of implementation. Proper tariff policy must take such local dynamics into consideration so as to be able to make the water services accessible and sustainable.

#### **5.2.4 Comparative Impact of Tariff Systems on the Water Demand of Urban and rural households in Western region of Kenya.**

The evidence shows that water tariffs frameworks affect the consumption behaviours of the urban and rural contexts in different ways. The table 4.9 indicates that volumetric pricing has the greatest demand elasticity (-0.51) which is statistically significant ( $p=0.01$ ) hence the most effective in motivating water conservation. Elasticity of the Increasing Block Tariff (IBT) also has its own elasticity (-0.44), but this is not statistically significant ( $p = 0.26$ ) implying less power in general. Conversely, flat-rate pricing is the poorest with the lowest demand elasticity (-0.10) and no statistical significance ( $p = 0.64$ ) which means that it can have little effect on the water-saving behaviour. This implies that volumetric and IBT pricing systems would be more effective in affecting demand in the urban environment, whereas flat-rate pricing is dominant in the rural environment because of the simplicity and low cost.

Table 4.8 also shows that urban households are more responsive to price with a price elasticity level of between -0.44 to -0.50 and more susceptible to progressive pricing such as IBTs. Nonetheless, such systems can pose increased financial strains thereby causing equity apprehension. Rural households on the contrary are less price-sensitive (-0.14 to -0.21) and prefer flat-rate pricing that, at the same time, is less expensive but exposes them to the increased risk of having health problems because of possible over-use of water services or under-pricing of it.

These results are in line with Whittington (2003) who pointed out that the IBTs have the tendency of not accessing the poorest households, because they have no piped connexions, which casts doubt on the equity and efficiency of these systems. On the same note, it was found that volumetric pricing is effective in urban settings but when applied in rural settings, it can cause the poor to consume less water, which can pose a threat to water access and health outcomes (Kombe 2020). On the enabling side, Alemu et al. (2020) support the concept of flexible tariff systems that can mirror the

local conditions; they do not deny that volumetric pricing can lead to conservation and cost recovery in the regions with well-developed metering and distribution networks.

To sum up, volumetric and IBT pricing systems encourage saving and equity in urban setting, but their efficiency and equity in rural settings is a controversial matter. It requires custom-made strategies that should integrate cost-effectiveness with demand control in order to strike a balance between accessibility, sustainability, and financial sustainability under different household contexts.

### **5.3 Conclusions**

The research concludes that tariff regime has vast effects on water demand trend among urban and rural households in Western Kenya. Volumetric pricing and Increasing Block Tariffs (IBT) enhance more efficient and equitable water utilisation especially in the urban settings through conservation and matching prices with consumption levels. Flat-rate pricing, in contrast, is easier to manage, but will tend to appeal to overconsumption, as well as disproportionately affect the households of low income. It has also been found that urban, compared to rural households, are more responsive to price change, and that context-specific tariff designs are required. In general, the paper highlights the significance of having elastic, evidence-based pricing strategies that should take into account local economies, infrastructure capacity, and equity issues to provide sustainable and equitable water services.

### **5.4 Recommendations**

#### **5.4.1 Causal Relationship Between Changes in Water Tariff Structures on Household Water Consumption in Western Region of Kenya**

Upon the results of this paper, there are a number of policy and practical recommendations that could be put forward to enhance the management of water demands and increase the equity and efficiency of water service delivery in Western Kenya.

**Encourage urban volumetric and block-based pricing:**

The researchers found out that volumetric pricing and Increasing Block Tariffs (IBT) have a stronger elasticity of demand and a stronger elasticity of demand during urban regions that is, consumers respond to changes in prices by changing their consumption. This contributes to earlier studies by Olmstead and Stavins (2009) and Arbués et al. (2003) who discovered that volumetric and block-based pricing works in favour of conservation. Thus, the urban water utilities are advisable to implement or increase such pricing systems with the lifeline blocks being used to prevent the low-income users but implement an increasing price rate on excessive use.

**Flat-rate tariffs are inefficient and equitably dangerous:**

Flat-rate pricing did not exhibit failure to respond to demand and had low influence on consumption patterns. It promotes wastefulness and disproportionately targets low-consumption or low-income consumers. This is in line with the apprehensions of Whittington et al. (2002) and Banerjee et al. (2010) who had warned of such pricing mechanisms. Thus, flat-rate systems must be gradually ended or restricted to some rural situations where metering is inexperiential, and metering infrastructure should be invested in.

**Adjust tariff systems to the demand patterns in sectors:**

Comparative study of the business majorities revealed different responses to the adjustments of tariffs. Indicatively, the industrial sector showed a massive consumption increase after the tariff change (which indicates inelasticity), and other sectors such as eating and drinking establishment showed a large decrease in consumption which indicates price sensitivity. Such evidence should be used by water utilities to devise differentiated pricing plans with more cost or conservation

incentives being given to sensitive sectors. This is in line with the sector-specific pricing advocacy that is applied in Komakech and de Bont (2018).

**Reduce exorbitant connexion charges at outset in order to enhance access:**

The results indicate that the connexion charges are very high especially in counties such as Kakamega which may affect accessibility of water services by the low income earners. UN-Habitat (2011) also says that effort should be made to reduce the connexion costs in order to increase coverage, particularly in peri-urban and rural locations. Accordingly, policymakers ought to raise the possibility of subsidising the connexion costs or providing payment schemes to enhance access without compromising on the feasibility of cost recovery in the long run.

**Invest in metering infrastructure to enhance accountability and efficiency:**

Metering was identified to be more common in urban counties and is consistent with efficient and fair pricing. In line with the sentiments of Komakech and de Bont (2018), the water utilities in the region must invest in the expansion of the metering systems, especially to rural and under-served regions, as this will enable them to charge the correct amount to the customers and encourage conservation.

**Carry out awareness and offer conservation incentives:**

Although pricing influences behaviour, complementary actions can increase its influence. Responsible consumption can be promoted through awareness campaigns on the importance of water conservation and basic efficiency measures (e.g., low-flow taps, recycling devices, etc.). Rebates on the installation of water saving devices should also be taken into consideration especially in those offices and other

commercial houses that proved to be sensitive to price signals. Komakech and de Bont (2018) agree with these recommendations.

#### **5.4.2 Effect of Bloc Tariff Increases on Elasticity of Demand of Water in Western Region of Kenya.**

Depending on the results presented in Table 4.5 and the larger discussion on the growing block tariffs (IBTs) in Western Kenya, it is possible to come up with several suggestions. First, to increase the efficiency of the IBTs towards advancing equity, the water service providers and county governments ought to focus on broadening the infrastructure to accommodate the unconnected households. The lower tariff blocks of the proposed subsidies will not be available to the poorest with no access to the piped water, nullifying the pro-poor justification of the IBTs. This suggestion fits Whittington (2003) emphasis on the fact that properly planned subsidies should be followed by greater coverage of the services in order to attain the real equity in the provision of water.

Second, metering systems should be enhanced in all counties to have proper monitoring of consumption. Successful IBTs are based on accurate data of the usage in order to implement the right tariff rates. The intensity of metering among counties is very different with Kakamega recording the most (44) and Busia the least (26) as indicated in Table 4.2. Universal metering would not only improve the accuracy of billing but it would also strengthen the behavioural incentives found within the tariff structure. Komakech and de Bont (2018) support this method by stating that precise metering enhances efficiency and pricing that is reflective of costs in managing water.

Third, water authorities are urged to think about specific subsidies or lifeline tariffs to the poorest households especially those in the informal settlements. These must be

funded either by cross-subsidisation by higher-end users or by government subsidies so as not to undermine utility revenues. The results indicate that the existing IBTs can unconsciously favour more prosperous consumers who use more water but are still in subsidised blocks. According to authors like Banerjee et al. (2010), the direct targeting of subsidies enhances better affordability effects and financial sustainability of utilities.

Finally, the process of constant monitoring and assessment of the effects of tariffs must become a standard practise that can gauge whether pricing reforms are achieving their desired objectives of equity, conservation and recovering costs. The elasticity in consumption as observed in Table 4.4 and the average changes in Table 4.3 prove that there is a behavioural response to pricing, but when this has to be weighed against the possible negative welfare implications on poor households. Water pricing policies, according to Olmstead and Stavins (2009), should be dynamic and evidence-based in order to be responsive to the socioeconomic realities and environmental challenges.

#### **5.4.3 Flat- Rate vs. Volumetric Pricing Effects on Western Region of Kenya per capita water usage.**

Some of the recommendations are based on such findings in order to make water tariff policy to be more effective in the Western part of Kenya and balance among efficiency, equity and social acceptance.

#### **Promote Context Specific Tariff Design.**

The water service providers are encouraged to implement a hybrid system of a tariff system, which incorporates the volumetric pricing in the urban regions and modified flat rate systems in the rural regions. Volumetric prices are good to urban households

which are usually better off in terms of infrastructure and metering because of lower levels of consumption and increased equity (Gini coefficient of 0.37). Nevertheless, in the countryside where the access is low and where the income per capita is lower, flat-rate tariffs, should they be kept, should be regulated with protection to prevent excessive exploitation. Alemu et al. (2020) also provided this suggestion and stressed that water pricing should be adjusted to local socio-economic and infrastructural specificities.

### **Scale Up Metering Urban Infrastructure.**

Metering infrastructure is of paramount importance to enhance the volumetric pricing. Metering accurately guarantees equitable billing that is made based on real usage that will decrease wastage of water and strengthen the need to protect conservation. The results of the regression (Table 4.7) and the pre/post outcome (Table 4.8) indicate quite clearly that volumetric pricing has a greater impact on consumption behaviour than the flat-rate pricing. This proves the point made by Kombe (2020) as he emphasised that volumetric pricing can only be effective when there is reliable infrastructure.

### **Bring about Lifeline Tariffs to Low-Income Households:**

To help alleviate the affordability challenge of volumetric pricing, particularly among the low-income households, the utilities can introduce a lifeline tariff a minimum amount of water at a modest or subsidised price. This cushions the poor households against the unnecessary bills whilst implementing volumetric pricing on the higher usage rate. The paper noted that effective households when facing volumetric pricing minimised consumption when tariffs changed, probably indicating inaffordability and

limited accessibility. Lifeline blocks may be used to retain equity and at the same time retain conservation incentives. This strategy is in line with the principles that Whittington (2003) and Banerjee et al. (2010) have proposed, which is pro-poor water policies under cost-recoveries models.

#### **Increase Social Education and participation:**

Reform of tariffs can only achieve success when the consumers have the knowledge of the working of the pricing structures. Stakeholder engagement and community education are important to enhance the social acceptability of volumetric pricing. Resistance is usually caused by misconceptions about affordability and billing, particularly in rural locations. Because the results indicate that the number of flat-rate users rose after the shift, it is possible that, without their knowledge, tariff reforms can have counter-productive effects. Alemu et al. (2020) emphasise the significance of local participation and education in the tariff compliance and effectiveness promotion.

Finally, although volumetric pricing has merits in the context of conservation and equity, it has to be practised with consideration of infrastructure, subsidy, and social buy-in in place to achieve its potentials.

#### **5.4. 4 Tariff Effects on Urban and Rural Water Demand between Urban and Rural Households in Western Region of Kenya.**

Using the findings above, it is possible to suggest several policy and operational recommendations that can be used in order to enhance water tariff structures both in urban and rural areas and make them effective, equitable, and context-specific.

#### **Adopt Contextual Tariff Structures:**

Waters authority needs to use the variousiated pricing models depending on the urban and rural realities. Metering and Increasing Block Tariff (IBT) systems must be applied in the city to promote the adoption of conservation and cost recovery since they showed superior demand responsiveness (Table 4.9) and elasticity of demand (Table 4.8). On the contrary, simplified flat-rate systems can be used in the countryside, although it is necessary to keep a cheque aimed at avoiding overuse and securing water safety. This is consistent with the recommendations of Alemu et al. (2020) to use tariff flexibility in accordance with the local infrastructure and socio-economic dynamics.

#### **Increase Infrastructure and Metering in Low-density Areas:**

To ensure that IBTs and volumetric pricing are effective and just, it is important to invest in piped water infrastructure and metering of poor and rural households. Whittington (2003) notes that subsidies in the IBTs are not always effective because the poor people do not have access to piped systems. The extension of networks would enable these households to enjoy lower tier tariff blocks which would enhance equity at the same time conservation. In the absence of improvement in access, reforms in pricing will leave vulnerable groups out.

#### **Introduction of Equity-Oriented Lifeline Tariffs and Cross-Subsidies:**

Lifeline tariffs to allow the poorest and least connected households to afford the financial weight of progressive pricing, by providing a basic volume of water at minimal or no cost, should be implemented, particularly where IBT or volumetric systems are used. These can be financed by cross-subsidies by the increased consumption blocks or commercial consumers. Kombe (2020) approves these

redistributive policies to create equilibrium between conservation incentives and affordability, particularly in the rural setting of low income elasticity and possible health hazards among the populace.

### **Hold Consumer Education and Engagement campaigns:**

Consumer knowledge is essential to the success of tariff reforms. The users should be educated on the operation of pricing structures, water conservation and their rights under lifeline programmes or subsidy programme through awareness campaigns. Metering and billing are associated with misunderstandings that may result in mistrust or abuse. Alemu et al. (2020) support this idea, stating that the stakeholders should be involved in the design and implementation of new pricing systems to make them more acceptable and compliant by the people.

Altogether, the paper highlights the importance of equity-based and situation-specific water tariff policies. Whereas volumetric and IBT pricing systems have potential in urban setting in encouraging efficiency and conservation, when applied to rural setting, they have to be adjusted to the realities of the local economy and infrastructures so that no family is left behind.

### **5.5 Suggestions for Further Research**

This paper has illuminated the connexion between the water tariff system and the demand pattern of the urban and rural households in Western Kenya. Nonetheless, the extended knowledge of these dynamics could be achieved by means of deeper investigation. The longitudinal research to monitor the household water consumption in different tariff regimes over long periods of time would be beneficial in the future. These studies would have more evidence of causality and more long-term behavioural

adoptions to tariff changes. They would also assist in assessing the feasibility of short term consumption decreases with volumetric pricing in the long term.

In addition, the research needs to be further in the future on the equity implications of different pricing structures. Although this paper points to the possible weight of flat-rate pricing on urban low-income households, and inefficiency of volumetric pricing in the rural context, more research is required on the impact of these tariffs on various socio-economic and vulnerable populations. Special attention to marginalised groups of the population should be paid to such household types as women-headed, elderly, and people with disabilities. Through the identification of the most vulnerable groups of people to water insecurity because of poor pricing, the policymakers can craft more specific and inclusive tariff policies.

The other significant concern that can be identified as a direction of future research is the role that infrastructure particularly water metering have played to facilitate effective volumetric and block tariff systems implementation. Metres that are inadequate or not present at all in the rural areas can also not work effectively and fairly in relation to pricing structure that is based on actual usage. A study that evaluates the supply, functionality and cost of water metres, the administrative capacity of water utilities to contain a metre-based billing system is necessary. These studies would give a roadmap on the investment and institutional reforms needed to facilitate more efficient and fair water service delivery.

Finally, more studies are required to be made on the effects of water tariffs between counties or regions in Kenya. The success/failure of particular pricing strategies can depend on local environmental factors, income rates, cultural standards and other sources of alternative water. Moreover, the analysis of the general attitudes and

readiness to pay based on other tariff systems should provide the better understanding of the user acceptance and satisfaction. The knowledge of their interaction would help water service providers and policy makers to use tariffs to suit various local environments to enhance service delivery and recovery of costs.

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**APPENDIX I: DATA COLLECTION CHECKLIST**

	Kakamega		Bungoma		Vihiga		Busia	
	Consumption Block in M <sup>3</sup>	Tariff (Kshs)	Consumption Block in M <sup>3</sup>	Tariff (Kshs)	Consumption Block in M <sup>3</sup>	Tariff (Kshs)	Consumption Block in M <sup>3</sup>	Tariff (Kshs)
Domestic	1-6	87	1-6	80	1-6	80	1-6	87
	7-20	119	7-20	110	7-20	110	7-20	119
	21-50	141	21-50	130	21-50	130	21-50	141
	51-100	157	51-100	145	51-100	145	51-100	157
	101-300	174	101-300	160	101-300	160	101-300	174
	>300	217	>300	200	>300	200	>300	217
Commercial/industrial	1-50	130	1-50	120	1-50	120	1-50	130
	51-100	157	51-100	145	51-100	145	51-100	157
	101-300	179	101-300	165	101-300	165	101-300	179
	>300	228	>300	210	>300	210	>300	228
Average Water tariff (Kshs)								
One time connection	450		500		480		500	
Minimum charge	350		300		350		300	
Fixed charge	340		350		350		350	
Metering system	210		200		250		200	
Historical household water consumption data	227,203,432		209,444,811		198,302,002		219,312,026	
Billing trend	2,872,004		2,269,397		2,403,432		2,396,818	
Average Tariff changes	15		20		24		28	
Increased Block Tariff (IBT)	0-6 m <sup>3</sup> – Kshs 80	10,240	0-6 m <sup>3</sup> – Kshs 80	6,240	0-6 m <sup>3</sup> – Kshs 80	7,380	0-6 m <sup>3</sup> – Kshs 80	5,240
	7-20 – Kshs 130	20,369	7-20 – Kshs 130	4,280	7-20 – Kshs 130	4,820	7-20 – Kshs 130	3,562
	21-50 – Kshs 145	2,130	21-50 – Kshs 145	3,691	21-50 – Kshs 145	2,020	21-50 – Kshs 145	2,310
	51-300 – Kshs 160	1,420	51-300 – Kshs 160	1,240	51-300 – Kshs 160	780	51-300 – Kshs 160	1,020
	> 300 – Kshs 200		> 300 – Kshs 200		> 300 – Kshs 200		> 300 – Kshs 200	

## APPENDIX B: SERVICE DELIVERY ATTACHED TO THE TARRIFF

<i>Target</i>	<i>Base Year</i> 2020/21	2021/ 2022	2022/ 2023	2023/ 2024	2024/ 2025	2025/ 2026
Water Coverage (%)	58	60	62	64	66	68
Water quality standards (%)	92%	100% Compliance with Water Quality Standards				
Maintenance/O&M	14%	15%	15%	14%	14%	14%
Personnel Expenditure as % of O&M	51%	50%	50%	50%	49	47
Non-Revenue Water %	46	44	42	40	38	36
Hours of Supply (Hrs)	8	9	10	11	12	13
Staff per 1000 connections	5	5	5	5	5	5
Metering ratio (%)	100%	100%	100%	100%	100%	100%
Collection Efficiency (%)	87%	90%	92%	93%	95%	95%
Resale at Kiosk		KSh. 2.00 per 20l Jerry Can				

## APPENDIX II: INSTITUTIONAL RESEARCH APPROVAL



MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

Tel: 056-30870  
Fax: 056-30153  
E-mail: [directordps@mmust.ac.ke](mailto:directordps@mmust.ac.ke)  
Website: [www.mmust.ac.ke](http://www.mmust.ac.ke)

P.O Box 190  
Kakamega – 50100  
Kenya

### Directorate of Postgraduate Studies

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Ref: MMU/COR: 509099

10<sup>th</sup> June 2025

Isaac Wafula Simiyu  
ECO/G/01-54156/2019  
P.O. Box 190-50100,  
KAKAMEGA.

Dear Mr. Simiyu

#### RE: APPROVAL OF PROPOSAL

I am pleased to inform you that the Directorate of Postgraduate Studies has considered and approved your masters proposal entitled “*Effects of Tariff Structures on Water and Sanitation Demand in Western Region of Kenya*” and appointed the following as supervisors:

1. *Dr. Edwin Simiyu* - MMUST
2. *Dr. Consolata Ngala* - MMUST

You are required to submit through your supervisor(s) progress reports every three months to the Director Postgraduate Studies. Such reports should be copied to the following: Chairman, School of Business and Economics Graduate Studies Committee and Chairman, Economics Department. Kindly adhere to research ethics consideration in conducting research.

It is the policy and regulations of the University that you observe a deadline of **two years** from the date of registration to complete your Master’s thesis. Do not hesitate to consult this office in case of any problem encountered in the course of your work.

We wish you the best in your research and hope the study will make original contribution to knowledge.

Yours Sincerely,

MASINDE MULIRO UNIVERSITY  
OF SCIENCE AND TECHNOLOGY  
DIRECTORATE OF POSTGRADUATE STUDIES  
P.O. BOX 190, KAKAMEGA (K)

Date: ..... Sign: *Jane Situma*

Dr. Jane Situma  
DEPUTY DIRECTOR, DIRECTORATE OF POSTGRADUATE STUDIES

### Appendix III: Research Permit (NACOSTI)

 <b>REPUBLIC OF KENYA</b>	 <b>NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY &amp; INNOVATION</b>
Ref No: <b>457767</b>	Date of Issue: <b>21/August/2025</b>
<b>RESEARCH LICENSE</b>	
	
<b>This is to Certify that Mr.. Isaac Wafula Simiyu of Masinde Muliro University of Science and Technology, has been licensed to conduct research as per the provision of the Science, Technology and Innovation Act, 2013 (Rev.2014) in Bungoma, Busia, Kakamega, Vihiga on the topic: Effects of Tariff Structures on Water and Sanitation Demand in Western Region of Kenya for the period ending : 21/August/2026.</b>	
License No: <b>NACOSTI/P/25/4178417</b>	
457767 Applicant Identification Number	 Ag. Director General <b>NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY &amp; INNOVATION</b>
	Verification QR Code 
<b>NOTE: This is a computer generated License. To verify the authenticity of this document, Scan the QR Code using QR scanner application.</b>	
<b>See overleaf for conditions</b>	

**APPENDIX IV: MAP OF WESTERN REGION IN KENYA**

