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Factors Influencing Reliable Water Supply to Households In Kenya: A Case Study of Turkana North Sub-County.

[1]Naker Mele Fredrick, [2]Dr. Patrick Kasyula & [3]Dr. Godfrey Mwamba

[1]*Public Policy and Administration, Africa International University*

[2,3]*School of business and Economics, Africa International University*

Abstract: Background: Reliable water provision and supply are crucial for the health and economic well-being of humans and animals. Adequate reliable water supply contributes to sustainable environmental outcomes, supporting both domestic consumption and economic activities essential for human well-being. Despite numerous efforts by local and international stakeholders engaged in water supply projects, household health and economic stability remain threatened by unreliable water access. This study evaluates the factors influencing reliable water supply to households, focusing on Turkana North Sub-County.The specific objectives of the study include assessing the influence of water source management and water infrastructure on reliable water supply in Turkana north sub county.

Methodology: A descriptive survey research design was adopted, targeting 13,119 household heads (including men, women, kraal leaders, child-headed households, religious leaders, key informants, opinion leaders, chiefs, and county administrators). A sample size of 388 households was determined using a standard sample determination formula. Data was analyzed using descriptive and inferential statistics.

Results: Water source management ($\beta = 0.170$, $p = 0.001$) had a positive but moderate influence on reliable water supply. Similarly, water infrastructure ($\beta = 0.553$, $p = 0.001$) had a positive and significant influence on reliable water supply.

Implication: There is need to encourage community participation in water management to increase accountability and local stewardship of resources. Implement conservation practices, such as rainwater harvesting and aquifer recharge, to optimize water availability and prevent resource depletion. Implement advanced technologies for leak detection, water loss reduction and remote monitoring to enhance infrastructure efficiency. Improving water storage, distribution systems, and monitoring technologies is critical. Investment in smart water management solutions can significantly enhance supply.

Keywords: *Water source management, water infrastructure, Reliable Water Supply, Households in Kenya, Turkana North Sub-County*

I. Introduction

Reliable water supply is vital because of its sustainability implications. It is one of the essentials of livelihood. Water supply imbalances interference with the survival of animals and plants (Rockstrom et al., 2009). Most developed countries have adequate provision and supply of water. Nonetheless, the situation is completely different in the less developed world such as the case of where access to adequate water for domestic, commercial, and industrial use is a major challenge. Kenya is not spared either as it experiences frequently shifting weather conditions, characterized by long periods of long droughts, which cause loss of lives, both in humans and livestock (Nilsson et al., 2021).

In the United States, several factors influence the reliable water supply to households, reflecting a combination of infrastructure, governance, environmental, and socio-economic considerations (Heyman et al., 2022). One key factor is the quality and adequacy of water infrastructure. For instance, aging water distribution networks in many cities can lead to leaks, breaks, and inefficiencies, reducing the reliability of water supply to households (Mueller & Gasteyer, 2021). In some cases, outdated treatment plants may struggle to meet water quality standards, posing health risks and requiring costly upgrades. Flint, in Michigan, poor water treatment led to contamination, highlighting the importance of investing in modern infrastructure to ensure a reliable and safe water supply for households (Natural Resources Defense Council, 2018).

Another factor influencing reliable water supply is the management of water sources and watersheds (Meehan et al., 2020). In regions prone to drought or water scarcity, effective water resource management practices, such as conservation measures, water re-use, and groundwater management, are essential for maintaining a dependable water supply. For example, in California, the implementation of water conservation measures and groundwater recharge projects has helped mitigate the influence s of drought and ensure reliable water supply to households, agriculture, and industry (Dobbin et al., 2023). Additionally, protection and restoration of natural ecosystems, such, can improve water quality and availability, contributing to reliability among water supply systems.

Investment in water infrastructure is central to ensuring reliable sourcing of safe water and protecting household wellbeing. However, the United States faces significant challenges in this regard, with aging infrastructure, funding gaps, and competing priorities for public resources. For example, the American Society of Civil Engineers' 2021 Infrastructure study reviewed the nation's drinking water sources as a "C-," highlighting an urgent need for investment to address deficiencies and prevent service disruptions (Van Breugel, 2017). Moreover, disparities in infrastructure investment persist, with minorities, suffering more from the inadequate infrastructure and environmental pollution (Szumilas-Kowalczyk et al., 2020).

Eludoyin and Olanrewaju (2021) states that In Sub-Saharan Africa, several factors influence the reliable water supply to households, reflecting a complex interplay of infrastructure challenges, environmental conditions, governance issues, and socio-economic factors. One critical factor is the lack of adequate water infrastructure and service delivery systems. Many communities in the region lack access to piped water networks, relying instead on alternative sources such as communal taps, boreholes, or unprotected wells (Oskam et al., 2021). However, these sources are often unreliable, susceptible to contamination, and prone to seasonal shortages, leading to intermittent or insufficient water supply for households. For example, in marginalized regions of Sub-Saharan Africa, limited investment in water infrastructure can result in breakdowns, leakages, and inefficiencies, compromising the reliability of water supply services (Abubakar, 2019). 51% in Africa representing 300 million people lacking access to a supply of safe reliable water. According to WHO/UNICEF JMP report, (2022) one in three Africans are affected by water scarcity, while 411 million people still lack basic drinking water.

The East African region suffers from water scarcity complexities, based on changing climate patterns. Drought patterns compromise accessibility to water, which reduces the chance of most people accessing any adequate water supply (Haile et al., 2020). The drought pattern and severity are forecasted to rise, where Kenya, Somalia, Sudan and South Sudan will bear the burden of the associated adverse outcomes. The causes of compromised water supply should be evaluated, which will reveal sustainable solutions that will be organized to cushion people from any extended adverse effects.

In Kenya, several factors influence the reliable water supply to households, reflecting a combination of infrastructure challenges, environmental conditions, governance issues, and socio-economic factors (Ocholla et al., 2022). One critical factor is the inadequacy and aging of water infrastructure. Many regions in Kenya, particularly rural areas and informal settlements, lack access to reliable piped water networks. Most parties rely on optional sources such as boreholes, communal taps, or water vendors, which may be unreliable and prone to contamination. For example, in informal settlements like Kibera in Nairobi, limited infrastructure and inadequate maintenance contribute to frequent water shortages and interruptions in supply, affecting the reliability of water supply services for households (Park et al., 2022).

1.1 Problem Statement

Accessibility of reliable, safe and clean water is a major issue, with only 40% of households having access to clean water in Turkana (Practical Action, 2023). This situation highlights a significant disparity in water access within the Turkana North Sub County, underscoring the urgent need to investigate factors influencing reliable water supply to households in Kenya and their influence on households in Turkana North Sub County.

Unreliable clean water exposes severe health risks and socio-economic implications for residents, increasing poverty, food insecurity, and health disparities. The inadequate access to reliable clean water in Turkana North Sub County is linked to various factors, like insufficient investment in water infrastructure, limited water resource development and management and the region's climatic conditions. The absence of reliable water supply systems, such as piped water networks and boreholes, forces many households to rely on unsafe water sources, exposing them to waterborne diseases and health hazards. Moreover, unsustainable water management practices and governance mechanisms exacerbates water scarcity and hinders efforts to improve water access and reliability in the region.

Unreliable Water crisis in Turkana North Sub County perpetuates a cycle of poverty and inequality, disproportionately affecting vulnerable populations who walk for 15km or more to access water source (*Water, Peace and Security*, 2022). The burden of unreliable water scarcity falls heavily on the most vulnerable parties; Women, children and elderly, who often

spend significant time and effort fetching water from distant sources, detracting from educational opportunities and income-generating activities.

Additionally, unreliable clean water limits agricultural productivity, yielding food insecurity, insecurity and impedes economic development, further perpetuating socio-economic disparities and compromising the overall wellbeing of households in the region. Combating the challenges requires a comprehensive evaluation of the factors influencing reliable water supply and their implications to household in Turkana North Sub County, laying the groundwork for evidence-based interventions and policy reforms aimed at improving water access, quality, and sustainability for all residents.

1.2 Research Objectives

i. To analyze the influence of water source management on reliable water supply to households in Turkana North Sub-County.

ii. To examine the influence of water infrastructure on reliable water supply to households in Turkana North Sub County.

II. Literature Review

2.1 Theoretical Review

The theory of sustainability gained significant attention and theoretical development in 1970s and 1980s with publication of the limits to growth in 1970 by club of Rome. It integrates and prioritizes social welfare to various inconveniences in society. The economic perspective bases on optimizing productivity as a result of a fusion among various elements (Enfors, 2009).

Kantabutra (2020) in his study points out that Sustainability, generally implies ability to address current needs without compromising future outcomes. Sustainability shows the fusion between environmental, economic and social deliverables in the long and short-term. An inquiry is launched about whether humans are capable of achieving their goals without compromising natural environments.

The theory of sustainability is grounded on activities that both meet current and future societal needs (Rockstrom et al., 2009). Sustainability models look at sustainability in the context of what have to be sustained. Sustenance from an economic, political, and ecological perspectives can be achieved together, both in the long and short-term for societies.

The study will adopt the theory of sustainability because they are appropriate in examining water supply inefficiencies. The theory will also help in answering the questions on the specific research objectives regarding the effects of water supply projects on wellbeing of households.

The theory of sustainability is essential for the study, as it emphasizes the significance of environmental conservation. In the context of water supply, protection and restoration of ecosystems' productivity is central to sustainable environmental deliverables, is crucial for preserving water resources and maintaining ecological balance in regions like Turkana North Subcounty(Kantabutra ,2020).

The theory is also applicable to this study, as it advocates for social equity and justice, ensuring sustainable development and water supply are achieved. In the context of water supply policies, promoting sustainable water availability, including marginalized and vulnerable populations, is essential for enhancing social cohesion, reducing inequalities, and promoting inclusive development for the area under evaluation.

2.2 Empirical Review

2.2.1 Water Source Management and Reliable Water Supply

According to Li & Wu (2023) elaborates that Water source management exerts a profound effect on the sustainable of water supply arrangements, as evidenced by a wealth of empirical literature. Numerous studies have demonstrated the relationship existing for effective water source management deliverables and the dependability of water provision, highlighting several key arguments. Research consistently demonstrates that proactive management of water sources is essential for ensuring the availability or quality of water for supply. By implementing appropriate sustainable measures, water managers can safeguard the integrity of water sources, reducing the risk of contamination and depletion (Li & Wu, 2023). This, in turn, enhances the reliability of water supply systems by mitigating the potential for disruptions due to source water contamination or scarcity.

Moreover, study by Kalogiannidis et al. (2023) underscored the importance of ideal water resource management milestones that recognize the interconnectedness of various sources. By adopting holistic strategies that consider the

hydrological cycle and ecosystem dynamics, water managers can optimize the consumption of available water resources while minimizing any risk of overexploitation and degradation. Sustainable resource utilization practices, such as groundwater recharge and wetland restoration, contribute to maintaining the resilience and reliability of water supply systems despite cases climate variability and environmental change.

This argument was also analyzed in a study by Ahmed et al. (2021) demonstrated the importance of prudent water resource management and security. Ideally, prudent water management involves allocating water resources efficiently, considering both current and future needs. By prioritizing water allocation based on demand, usage patterns, and environmental considerations, authorities can ensure that water is distributed effectively to meet the needs of various sectors such as agriculture, industry, and households.

2.2.2 Water Infrastructure and Reliable Water Supply

Water infrastructure is indispensable for ensuring reliably availing high quality communities, and this crucial link has been extensively examined in empirical literature. Firstly, studies by Dangui and Jia (2022) emphasized the critical role of infrastructure investment in maintaining and upgrading water supply systems to meet growing demand and address aging infrastructure challenges. Adequate resource allocation for water through notable utilities is vital for ensuring the resilience, in addition to reliability of water supply systems.

Furthermore, research by Bulti and Amelo (2023) underscores the importance of proper maintenance and management of water infrastructure assets to ensure their longevity and operational efficiency. Effective asset management practices, such as condition assessment, rehabilitation planning, and asset performance monitoring, are essential for minimizing the risk of infrastructure failures and service disruptions, thereby enhancing the reliability of water supply systems.

Moreover, empirical evidence from studies such as those by Shin et al. (2018) highlights the essence of incorporating resilience milestones into the implementation and planning of water infrastructure systems. Resilient infrastructure designs that account for climate variability, extreme weather events, and technological uncertainties can enhance the robustness and adaptability of water supply systems, reducing their vulnerability to disruptions and ensuring reliable water provision.

Additionally, research by Palermo et al. (2022) highlights the potential of technological innovations, such as smart meters, sensors, and remote monitoring systems, to optimize the reliability of appropriate infrastructure. Leveraging advances in digital technologies and data analytics, water utilities can optimize system performance, detect leaks and failures in real-time, and improve customer service, thereby ensuring uninterrupted and dependable water supply services.

2.2.3 Reliable Water Supply

As Challa (2011) in the study "*an assessment of urban water supply and sanitation, case of ambo town. Addiss Ababa, Ethiopia*" report indicates that, most households from the less developed countries spend substantial amount of time looking for water, time that can go towards some productive engagements. Due to scarcity of water, the households are forced to move from one point to another, covering long distances. The burden of fetching water does not spare any member of the household but primarily taken care of by girls and women. Men and boys are assigned other responsibilities, including watering the livestock or fending the homesteads. The long distance covered in search for this essential commodity poses a serious health risk in some members of the household, particularly the elderly, the sick, and the expectant mother.

The burden of searching for water over long distances yields considerable tension and stress between family members. Enfors (2009) in his study confirms that most interventions are aimed at connecting poor family households to a safe source of drinking water to improve physical health of the households' members. Nonetheless, beyond identified interventions to improve the physical health of individuals, improved availability of ideal quality of drinking water is a crucial influence of the wellbeing of households. Lessening the amount of time spent in looking for water has a far-reaching implication in the lives of the household, in the sense that they are left with significant time to spend in leisure activities.

According to Mulwa et al. (2021) he asserts that the practice of dedicating some free time away from stressful and strenuous activities highly correlates with improved health status. Quality time spent during leisure helps in removing sources of tension and stress that may eventually lead to ill-health conditions. The ability to have free time is also a way of enhancing welfare. For example, when a woman's time is restricted to collecting water, she may lack sufficient time to socialize with other members of the society. Women love to interact with their peers and others within the home and outside the home. Children hardly get attention from their mothers who are away searching for water to bring back

home; thus, their upbringing and emotional health are curtailed as they need much attention and affection of their parents.

III. Methodology

A descriptive survey research design was adopted, targeting 13,119 household heads (including men, women, kraal leaders, child-headed households, religious leaders, key informants, opinion leaders, chiefs, and county administrators). A sample size of 388 households was determined using a standard sample determination formula. Stratified, purposive, and simple random sampling techniques were applied to identify the participating households. Interviews and questionnaires were used as primary data collection instruments. Descriptive statistics included frequencies, proportions, mean, and standard deviation, while inferential analysis utilized regression to determine the causal effect relationship between independent and dependent variables.

IV. Results

4.1 Descriptive Statistics

4.1.1 Water Source Management and Reliable Water Supply

Table 1: Descriptive Statistics; Water Source Management and Reliable Water Supply

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Sustainable management practices are effectively implemented to conserve and protect water sources.	320	4	5	4.67	.473
Water availability is carefully monitored and managed to ensure equitable distribution and meet the needs of all stakeholders.	320	1	5	4.20	1.181
Groundwater levels are regularly monitored and managed sustainably to prevent over-extraction and maintain aquifer health.	320	1	5	3.98	1.207
Efficient infrastructure and technologies are in place to minimize water losses and maximize resource utilization.	320	1	5	3.36	1.462
Community engagement and stakeholder involvement are prioritized in water management decisions to ensure transparency and inclusivity.	320	2	5	4.07	.886
Valid N (listwise)	320				

The Descriptive Statistics table provided outlines responses from 320 participants across five key indicators related to water management practices and infrastructure in Turkana North Sub-County. Each indicator has a corresponding Mean and Standard Deviation, which offer insight into participants' perceptions regarding the effectiveness and inclusivity of water management efforts.

The information below provides an overview of the descriptive statistics for each indicator:

The findings indicate that respondents strongly agree that sustainable management practices are effectively implemented to conserve and protect water sources, as reflected by a high mean of 4.67 and a low standard deviation of 0.473. The minimal variation in responses suggests a strong consensus among participants, indicating that most believe in the effectiveness of sustainable water management strategies in Turkana North.

Regarding water availability management, the mean score of 4.20 suggests that respondents generally view the monitoring and management of water availability in a positive light. However, the standard deviation of 1.181 is relatively higher compared to sustainable management practices, implying some level of variability in responses. This suggests that while many agree that water availability is well managed, others may have differing experiences, particularly concerning equitable distribution.

For groundwater level management, the mean of 3.98 reflects a moderate to slightly positive perception of efforts aimed at preventing over-extraction. The standard deviation of 1.207 indicates considerable variation in responses, suggesting

that satisfaction with groundwater management practices varies across different regions in Turkana North. This disparity may be attributed to differences in groundwater accessibility, extraction rates, or conservation measures applied in various locations.

Infrastructure efficiency recorded the lowest mean score at 3.36, suggesting that respondents perceive water infrastructure and technology implementation to be less effective in minimizing water losses and maximizing utilization. The high standard deviation of 1.462 further emphasizes the significant variability in responses, pointing to potential inadequacies in water infrastructure across different areas. This variation suggests that while some respondents may have access to well-functioning infrastructure, others experience challenges related to outdated, poorly maintained, or insufficient water distribution systems.

On the aspect of community engagement and stakeholder involvement, the mean score of 4.07 indicates that respondents generally hold positive views regarding transparency and inclusivity in water management decisions. The moderate standard deviation of 0.886 reflects a certain level of agreement among respondents, but it also suggests that there is room for improvement in stakeholder engagement. While many acknowledge that communities have a voice in water management, some may feel excluded or perceive that decision-making processes could be more participatory.

Overall, the findings suggest that sustainable management practices and water availability management are perceived positively by most respondents, while groundwater management and community engagement receive moderate approval. Infrastructure efficiency, however, remains a key area of concern, with notable variability in responses pointing to disparities in water infrastructure effectiveness across Turkana North.

Summary Interpretation

Overall, the descriptive statistics indicate that respondents have a positive perception of sustainable water management practices, water availability management, and community engagement. However, there is room for improvement in infrastructure efficiency, as indicated by the lower mean and higher variability in responses. The data suggests that while efforts are being made to manage water resources effectively, infrastructure gaps and uneven perceptions of groundwater management present challenges to achieving consistent and reliable water access in Turkana North. These insights will be critical in framing recommendations and identifying areas for targeted interventions in subsequent sections of the study.

4.1.2 Water Infrastructure and Reliable Water Supply

Table 2: Descriptive Statistics; Water Infrastructure and Reliable Water Supply

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Water infrastructure is consistently maintained to ensure reliability and longevity.	320	3	5	4.28	.773
Adequate investment is made in water infrastructure to support its expansion, modernization, and resilience to meet current and future demands.	320	1	5	2.36	1.201
Technological innovations are actively embraced and integrated into water infrastructure to enhance efficiency, sustainability, and performance.	320	3	5	4.32	.712
Water infrastructure projects prioritize environmental sustainability and minimize negative impacts on ecosystems and natural habitats.	320	2	5	4.17	.897
Accessibility and affordability of water services are ensured through inclusive planning and equitable distribution of infrastructure investments.	320	2	5	4.33	.971
Valid N (listwise)	320				

The descriptive statistics table provides an analysis of respondents' perceptions regarding various aspects of water infrastructure, investment, technology integration, environmental sustainability, and accessibility in Turkana North Sub-County. The mean and standard deviation for each item reflects the overall sentiment and the consistency of responses.

Maintenance of Water Infrastructure: Mean: 4.28, Std. Deviation: 0.773. Respondents largely agree that water infrastructure is consistently maintained to ensure reliability and longevity. The high mean score indicates a positive perception of infrastructure maintenance efforts, with a relatively low standard deviation suggesting general consensus.

Adequate Investment in Water Infrastructure. Mean: 2.36, Std. Deviation: 1.201. This item has a notably low mean, indicating that respondents feel there is insufficient investment in expanding, modernizing, and making water infrastructure resilient to meet current and future demands. The higher standard deviation reflects variability in opinions, suggesting differing experiences with infrastructure investment across the sub-county.

Technological Innovation Integration: Mean: 4.32, Std. Deviation: 0.712. There is strong agreement among respondents that technological innovations are being integrated into water infrastructure to improve efficiency, sustainability, and performance. A high mean and low standard deviation indicate consistent positive views about the role of technology in enhancing water services.

Environmental Sustainability in Water Projects: Mean: 4.17, Std. Deviation: 0.897. Respondents generally agree that water infrastructure projects are designed with environmental sustainability in mind, aiming to minimize negative influence son ecosystems and natural habitats. The mean close to 4.2 indicates a positive perception, though the standard deviation shows some variability, possibly due to differing regional practices or project implementations.

Accessibility and Affordability of Water Services: Mean: 4.33, Std. Deviation: 0.971. This item has the highest mean score, reflecting a strong consensus that accessibility and affordability of water services are prioritized through inclusive planning and equitable distribution. A relatively low standard deviation supports the interpretation that there is widespread agreement on this aspect.

Summary Interpretation

The descriptive statistics reveal generally positive perceptions among respondents regarding the maintenance of water infrastructure, integration of technological innovations, environmental sustainability, and accessibility and affordability of water services. However, the low mean for adequate investment highlights a significant area of concern, indicating that respondents believe more resources are needed to improve and expand infrastructure to meet the growing water demand in Turkana North.

These insights suggest a need for increased investment in water infrastructure to address gaps in expansion and modernization. The overall positive feedback on technology integration and environmental focus points to areas where the existing efforts are effective and should be continued or even enhanced.

4.1.3 Reliable Water Supply

Table 3: Descriptive Statistics; Reliable Water Supply

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
The consistency of water availability in my household meets our daily needs.	320	3	5	4.43	.635
The quality of water supplied to my household is satisfactory for drinking and domestic use.	320	1	5	3.88	1.245
The infrastructure for water distribution in my area is sufficient to ensure reliable supply.	320	2	5	4.08	.882
The frequency of water interruptions in my household is minimal.	320	4	5	4.78	.416
The reliability of water sources in my locality is not affected by seasonal changes or environmental factors.	320	3	5	4.58	.613
Valid N (listwise)	320				

The Descriptive Statistics table provided presents the perceptions of 320 respondents on various aspects of water supply reliability, including availability, quality, infrastructure sufficiency, frequency of interruptions, and the resilience of water sources to environmental factors in Turkana North Sub-County. Each item's Mean and Standard Deviation give insight into the general sentiment and variability in responses.

Consistency of Water Availability:

Mean: 4.43, Std. Deviation: 0.635. Respondents generally agree that the consistency of water availability meets their daily needs, as indicated by the high mean score. The relatively low standard deviation suggests a strong consensus on this view, implying that most households find water availability fairly reliable for meeting daily demands.

Quality of Water Supplied: Mean: 3.88, Std. Deviation: 1.245. This item has a lower mean compared to others, indicating mixed responses regarding water quality for drinking and domestic use. The high standard deviation suggests considerable variability, reflecting differing perceptions or experiences with water quality across households.

Infrastructure Sufficiency for Water Distribution: Mean: 4.08, Std. Deviation: 0.882. The mean score indicates a moderately positive perception of the sufficiency of water distribution infrastructure in ensuring reliable supply. However, the higher standard deviation suggests some variation in experiences, possibly due to regional disparities in infrastructure quality or adequacy.

Frequency of Water Interruptions: Mean: 4.78, Std. Deviation: 0.416. This item has the highest mean score, indicating that respondents experience minimal water interruptions in their households. The very low standard deviation indicates strong consensus, suggesting that interruptions are rare and not a significant concern for most respondents.

Reliability of Water Sources Against Seasonal or Environmental Factors: Mean: 4.58, Std. Deviation: 0.613. Respondents perceive that the reliability of water sources is not significantly affected by seasonal changes or environmental factors. The high mean and low standard deviation indicate a positive view and a general agreement on the resilience of local water sources.

Summary Interpretation

The descriptive statistics reveal a positive overall perception of water supply reliability among respondents in Turkana North. Minimal interruptions and consistency in meeting daily water needs highlight a generally stable water supply

system. However, the lower mean and higher variability in responses regarding water quality suggest that water quality may be a concern for some households.

These findings indicate strengths in the continuity and resilience of the water supply, while pointing to potential areas for improvement, particularly in water quality. This analysis provides a foundation for identifying specific issues that need attention in ensuring sustainable and equitable water access in the region.

4.2 Regression Analysis

Table 4 shows regression results on the influence of water source management, and water infrastructure on reliable water supply.

Table 4: Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.848	.062		45.701	<.001
	Water source management	.080	.024	.170	3.317	.001
	Water infrastructure	.237	.029	.553	8.113	<.001

Dependent Variable: Reliable water supply

Water Source Management: Unstandardized Coefficient (B): 0.080. This means that for each one-unit increase in Water Source Management, Reliable Water Supply is expected to increase by 0.080 units, holding all other variables constant. Standardized Coefficient (Beta): 0.170.

The standardized coefficient allows for comparison between predictors by removing the effect of units. Here, Water Source Management has a moderate positive influence on Reliable Water Supply relative to the other variables. t-value: 3.317. Significance (p-value): 0.001. The p-value indicates that the relationship between Water Source Management and Reliable Water Supply is statistically significant at the 0.01 level.

Water Infrastructure: Unstandardized Coefficient (B): 0.237. For each one-unit increase in Water Infrastructure, Reliable Water Supply is expected to increase by 0.237 units, holding other variables constant. This is the highest unstandardized coefficient, suggesting that Water Infrastructure has a substantial influence on reliable water supply. Standardized Coefficient (Beta): 0.553. The high standardized coefficient indicates that Water Infrastructure has the strongest influence on Reliable Water Supply among the predictors in the model. t-value: 8.113. Significance (p-value): < 0.001. The p-value shows that this relationship is highly statistically significant, supporting the importance of Water Infrastructure in achieving reliable water supply.

V. Discussion

5.1 Influence of water source management on reliable water supply

The findings indicate that Water Source Management has a statistically significant, moderate positive relationship with Reliable Water Supply (Standardized Beta = 0.170, p = 0.001). This result underscores the importance of effective management practices, such as conservation, maintenance, and sustainable water extraction, in supporting the stability of water resources. Thus, an improvement in the condition or quality of water resource management will have a desirable effect, but not significantly solve the water shortage issue in the study area.

Previous studies have illustrated the role of water source management in improving the availability of water in regions facing scarcity. Li & Wu (2023) elaborate that Water source management exerts a profound effect on the sustainable of water supply arrangements, as evidenced by a wealth of empirical literature. The findings support insights from this study, which shows the importance of water source management in improving household's welfare sustainably.

By implementing appropriate sustainable measures, water managers can safeguard the integrity of water sources, reducing the risk of contamination and depletion (Li & Wu, 2023). This, in turn, enhances the reliability of water supply systems by mitigating the potential for disruptions due to source water contamination or scarcity. Moreover, study by Kalogiannidis et al. (2023) underscored the importance of ideal water resource management milestones that recognize the interconnectedness of various sources. By adopting holistic strategies that consider the hydrological cycle and ecosystem dynamics, water managers can optimize the consumption of available water resources while minimizing any

risk of overexploitation and degradation. Sustainable resource utilization practices, such as groundwater recharge and wetland restoration, contribute to maintaining the resilience and reliability of water supply systems despite cases climate variability and environmental change.

This argument was also analyzed in a study by Ahmed et al. (2021) demonstrated the importance of prudent water resource management and security. Ideally, prudent water management involves allocating water resources efficiently, considering both current and future needs. By prioritizing water allocation based on demand, usage patterns, and environmental considerations, authorities can ensure that water is distributed effectively to meet the needs of various sectors such as agriculture, industry, and households.

Similarly, study by Li et al. (2022) reiterated that effective water management emphasize the importance of conservation and preservation of water resources. This includes measures like enhanced water-saving innovations, adoption of water recycles and reuse programs, and protecting natural habitats like wetlands and watersheds. By conserving water and minimizing wastage, communities can sustainably manage their water resources and maintain a reliable water supply even during periods of scarcity.

5.2 Influence of water infrastructure on reliable water supply

Water Infrastructure emerged as the most influential factor affecting reliable water supply, with the highest standardized coefficient (Beta = 0.553, $p < 0.001$). This suggests that well-developed and maintained infrastructure, such as pipelines, storage facilities, and distribution systems, is crucial for ensuring consistent and uninterrupted water access. The significance of water infrastructure in the findings aligns strongly with other studies that emphasize the pivotal role of infrastructure in water service delivery.

Water infrastructure is indispensable for ensuring reliably availing high quality communities, and this crucial link has been extensively examined in empirical literature. Firstly, studies by Dangui and Jia (2022) emphasized the critical role of infrastructure investment in maintaining and upgrading water supply systems to meet growing demand and address aging infrastructure challenges. Adequate resource allocation for water through notable utilities is vital for ensuring the resilience, in addition to reliability of water supply systems.

Furthermore, research by Bulti and Amelo (2023) underscores the importance of proper maintenance and management of water infrastructure assets to ensure their longevity and operational efficiency. Effective asset management practices, such as condition assessment, rehabilitation planning, and asset performance monitoring, are essential for minimizing the risk of infrastructure failures and service disruptions, thereby enhancing the reliability of water supply systems.

Moreover, empirical evidence from studies such as those by Shin et al. (2018) highlights the essence of incorporating resilience milestones into the implementation and planning of water infrastructure systems. Resilient infrastructure designs that account for climate variability, extreme weather events, and technological uncertainties can enhance the robustness and adaptability of water supply systems, reducing their vulnerability to disruptions and ensuring reliable water provision.

VI. Conclusion

This result underscores the importance of effective water source management practices such as conservation, maintenance, and sustainable water extraction, in supporting the stability of water resources. This positive value suggests a weak but positive correlation between the two variables, indicating that improvements in water source management are associated with slight increases in the reliability of water supply. The quality, maintenance, and accessibility of infrastructure directly influences water availability and reduce interruptions. This suggests that well-developed and maintained infrastructure, such as pipelines, storage facilities, and distribution systems, is crucial for ensuring consistent and uninterrupted water access.

VII. Recommendations

7.1 Influence of Water source management on reliable water supply

Encourage community participation in water management to increase accountability and local stewardship of resources.Implement conservation practices, such as rainwater harvesting and aquifer recharge, to optimize water availability and prevent resource depletion.Develop educational programs for communities on sustainable water usage practices and the importance of resource conservation.Ensure equitable distribution of water resources through regulatory oversight, especially for marginalized communities in Turkana North.The county government should Implement water source management guidelines to increase the sustainability of various water utilities. Adherence to water source management guidelines by all responsible stakeholders will reduce wastage and promote responsible usage, which will lead to availability of enough water among households within Turkana North sub-county. Implement

water source management guidelines to increase the sustainability of various water utilities. Adherence to water source management guidelines by all responsible stakeholders will reduce wastage and promote responsible usage, which will lead to availability of enough water among households within Turkana North sub-county.

7.2 Influence of Water infrastructure on reliable water supply

Implement advanced technologies for leak detection, water loss reduction and remote monitoring to enhance infrastructure efficiency.Improving water storage, distribution systems, and monitoring technologies is critical.Investment in smart water management solutions can significantly enhance supply.Increase investment in water infrastructure to build resilient and climate-adaptive systems, including pipelines, reservoirs, and water storage facilities.Establish routine maintenance schedules to ensure that existing infrastructure remains functional and efficient, reducing the risk of supply interruptions.The county Government should Build and maintain adequate water infrastructure in Turkana North sub-county. Water infrastructure is critical for ensuring availability of enough water for households through all seasons of the year. Water infrastructure is the most essential intervention because it has the highest positive correlation with the availability and satisfaction f households' water needs.

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