JOURNAL OF BUSINESS MANAGEMENT & INNOVATION
www.jbmij.org
JBMI Insight

Effectiveness of Watershed Catchment Protection on the Provision of Water Services in Mandera County, Kenya

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Publication Date: March 2026

Abstract

The Kenya National Water Policy 2021 was designed to ensure sustainable water resource management and equitable access to clean water. However, key gaps exist in its implementation in Mandera County, where water scarcity remains a persistent challenge. This study thus evaluated the effectiveness of watershed catchment protection on the provision of water services in Mandera County. The study was anchored on transformative approach and adopted pragmatism philosophy, employing a descriptive survey research design. The target population comprised 535 participants drawn from various key stakeholders in Mandera County, including the Water Resources Authority, Mandera Office, Mandera County Companies, community leaders, representatives from the Non- Governmental Organization, County Government of Mandera Water Department, and the National Drought Management Authority. The researcher used Slovin's formula to obtain a sample size of 229 respondents. The study used both descriptive and inferential statistical methods in analysis. The findings were presented on tables. The findings depicted coefficient of determination (R Squared) of 0.506, implying that 50.6% of the variation in the provision of water services in Mandera County is accounted for by watershed catchment protection. The ANOVA results in indicated that the model was statistically significant in explaining the effect of watershed catchment protection on the provision of water services ($p< 0.05$). The regression coefficient results showed a positive and statistically significant relationship between watershed catchment protection and provision of water services ($\beta = 0.694$, $p = 0.007 < 0.05$). The study thus recommends that Mandera county department of water services should invest in the construction, maintenance, and security of water storage infrastructure, with specific attention to underserved rural areas and watershed catchment protection.

Keywords: *Watershed Catchment Protection, Water Services Provision, Environmental Conservation, Mandera County, Groundwater Recharge.*

1.1 Introduction

Implementation of National Water Policy describe the process of translating a country's water-related goals, strategies, and regulations into actionable plans and concrete measures (Magrini & dos Santos, 2024). This comprehensive approach aims to manage water resources effectively, ensure equitable access to water services, and promote sustainable water use across various sectors of the economy (Sivakumar, 2024). National water policies typically encompass a wide range of issues, including water supply and sanitation, irrigation, hydropower, environmental conservation, and climate change adaptation. The success of implementing a national water policy largely depends on the creation of robust institutional frameworks and governance structures. According to the United Nations Water (UN-Water), effective water governance requires political, social, economic, and administrative systems that influence water use and management (UN-Water, 2021).

Capacity building and technology adoption play crucial roles in the effective implementation of national water policies. This includes training water professionals, improving data collection and management systems, and adopting new technologies for water treatment, distribution, and monitoring. The Asian Development Bank reports that many countries in Asia are investing in smart water management systems to improve operational efficiency and reduce water losses (Asian Development Bank, 2020). For instance, India's National Hydrology Project aims to improve the country's ability to forecast floods and droughts by establishing a comprehensive water resources information system (Ministry of Jal Shakti, India, 2021).

Water policies and programs have often been managed in isolation by government institutions and stakeholders, with limited coordination between them. Additionally, developments at river sources have frequently proceeded without sufficient consideration of their downstream effects (Adom & Simatele, 2024). Issues related to water quality are commonly treated separately from water quantity challenges, while groundwater contamination has severely disrupted the natural connection between surface water and underground reserves. The relationship between land and water systems is frequently overlooked, resulting in ecosystem degradation and inequitable access to water resources (Kahinda & Boroto, 2009). In South Africa, the number of major rivers classified as being in poor ecological condition increased fivefold between 1999 and 2015, with many suffering irreversible damage.

Watershed catchment protection plays a crucial role in ensuring the sustainable provision of water services by safeguarding water sources from contamination and degradation. Proper management of catchment areas helps to maintain the quality and quantity of water available for distribution, particularly in regions prone to water scarcity. According to Pimentel et al. (2004), protecting watershed catchments reduces sedimentation and erosion, which can clog water systems and lower water quality. Additionally, catchment protection fosters the replenishment of groundwater reserves, which are vital during dry spells (Aylward et al., 2014). Effective watershed management involves reforestation, soil conservation, and the prevention of land-use changes that could negatively impact the hydrological cycle. These measures not only enhance water quality but also improve the resilience of water systems to climate change, thus contributing to long-term water security (Moges et al., 2015).

Sub-Saharan Africa is considered a water-scarce region in terms of access to clean drinking water. By 2022, nearly 400 million people in the region were without basic drinking water services (WHO, 2023). This acute shortage has profound implications for both public health and economic

progress. According to Lee and Schwab (2005), unreliable water supply where residents receive water for only a limited number of hours each day creates conditions that promote stagnation and microbial growth. They further observed that fluctuations in hydraulic pressure can cause contaminants to be drawn into pipelines from surrounding polluted areas. Additionally, factors such as aging infrastructure, corrosion, and leaks within water distribution networks contribute to bacterial proliferation along the supply channels (Bazaanah & Mothapo, 2024).

The National Water Policy is one of the fundamental social policies that underpins a country's socioeconomic development (Arfan, Ansari, Ullah, Hassan, Siyal, & Jia, 2020). It serves as a crucial framework for managing water resources, ensuring access to clean water, maintaining water quality, and addressing related challenges. Establishing a clear and comprehensive National Water Policy is essential for advancing sustainable development goals and safeguarding water security. The United Nations Development Programme (UNDP) highlights the importance of Integrated Water Resources Management (IWRM) in achieving these objectives (UNDP, "Integrated Water Resources Management"). Effective water policies play a key role in reducing the impact of droughts, floods, and other climate-related threats (Fabian, Kwon, Vithanage, & Lee, 2023). By promoting responsible water use and conservation strategies, these policies strengthen community resilience and long-term sustainability.

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Singapore, a small city-state in Southeast Asia, has implemented a comprehensive and successful National Water Policy, known as the "ABC Waters Program" (Tortajada, Hartley, Ong & Arora, 2024). The program focuses on the principles of Active, Beautiful, and Clean (ABC) waters, aiming to integrate water resources with urban planning and development. Under the ABC Waters Program, Singapore has transformed its water bodies into clean and attractive assets, while also providing multiple benefits to the community (Linh, Ahmed & Loc, 2023). The policy includes initiatives such as the construction of rain gardens, bioswales, and floating wetlands to enhance water quality and reduce flood risks. These initiatives not only contribute to the beautification of urban areas but also provide natural habitats for wildlife.

In Ghana, efforts to protect watershed catchments are influencing the provision of water services by enhancing water quality and stabilizing supply systems. Studies of catchment management practices in areas such as the Owabi River catchment demonstrate that stronger environmental protection and stakeholder involvement contribute to better water management outcomes in local communities, highlighting the link between catchment protection and water service reliability (Agyeman, 2025). Additionally, initiatives by entities like the Ghana Water Company Limited emphasize nature-based solutions such as riparian restoration and forestry best management practices to safeguard raw water sources, reduce pollution, and manage seasonal variability, which in turn supports more sustainable water supply operations (GWCL catchment management efforts,

2023). Local research also shows that downstream communities value watershed conservation, with evidence of willingness to support and pay for catchment protection activities due to the benefits they derive from cleaner and more dependable water services (Ayesu et al., 2024). These perspectives from Ghana illustrate how catchment protection strategies can strengthen the quality and sustainability of water service provision when integrated with broader water resource management frameworks.

Mandera County, situated in northeastern Kenya, experiences severe water scarcity due to its arid climate, receiving an average annual rainfall of just 255 mm, making it one of the driest areas in the country. As of 2022, only 32% of the county's population had access to safe drinking water, far below the national average of 59% (Water Services Regulatory Board, 2021). The population grew from 867,457 in 2019 to approximately 940,000 in 2023, increasing pressure on the already limited water resources (KNBS, 2022). The county's water supply, primarily reliant on boreholes and shallow wells, remains inadequate, with only 15% of households having piped water connections (Kenya National Bureau of Statistics, 2022; Water Services Regulatory Board, 2023). Development of water infrastructure is hindered by limited finances Mandera requires an estimated KES 5 billion (about $46 million USD) to achieve universal water access (Mandera County Government, 2023). Additionally, the county's vast, sparsely populated geography and recurring conflict primarily among pastoralist communities over water access further complicate water provision services.

1.2 Statement of the Problem

The Kenya National Water Policy 2021 was designed to ensure sustainable water resource management and equitable access to clean water. However, key gaps exist in its implementation in Mandera County, where water scarcity remains a persistent challenge (Suda, Sušnik, Masia & Jewitt, 2024). The policy outlines strategies such as decentralized water governance, increased infrastructure investment, stakeholder collaboration, and climate resilience integration, yet these have not been fully realized (Eweet & Muna, 2022). Weak institutional capacity, inadequate funding, and ineffective enforcement mechanisms hinder progress, leaving many communities reliant on unsafe or distant water sources. In Mandera, harsh climatic conditions, coupled with poor water infrastructure and resource mismanagement, makes the crisis worse. Similar challenges are observed in Turkana, Marsabit, and Ethiopia's Afar region, where fragmented policy execution leads to unreliable water access (Hassan, 2025).

The majority of these studies were carried out in diverse geographic locations under different conditions, utilizing distinct methodologies and variables. As a result, this creates contextual, methodological, and conceptual gaps. The current study sought to fill these knowledge gaps by using specific proxies tailored to Mandera's unique challenges, such as the availability and functionality of water infrastructure, stakeholder partnerships, climate change integration, water catmint protection and capacity building. In light of the aforementioned empirical gaps, this study delved into the assessment of the effect of the implementation of the national water policy (2021) on the provision of water services in Mandera County, Kenya. The study has shed light on the gaps, barriers, and opportunities encountered in translating policy objectives into tangible actions and outcomes. The study sought to assess the effectiveness of watershed catchment protection on the provision of water services in Mandera County, Kenya.

1.3 Research Objective

To assess the effect of watershed catchment protection on the provision of water services in Mandera County.

1.4 Research Hypothesis

H_0: There is no significant statistical association between watershed catchment protection and provision of water services in Mandera County, Kenya.

2.1 Empirical Review

A study conducted by Constant, Charrière, Lioeddine and Emsellem (2016) focused on the utilization of modelling techniques to safeguard, plan, and manage water resources within catchment areas in France. The study aimed to assess the effectiveness of modelling in protecting water resources, develop a planning framework for efficient management, and analyse the impacts of different management strategies. The study found that modelling techniques were effective in protecting and managing water resources, providing valuable insights and optimizing water resource management strategies. The research emphasized the importance of considering factors such as land use changes and climate variability in sustainable water management. However, the study did not explicitly address the implications of watershed and catchment area protection on the provision of water services, particularly about Kenya's National Water Policy, 2021. Thus, further research is needed to bridge this gap and explore how watershed and catchment area protection align with the policy objectives.

Taylor and Lindenmayer (2019) conducted a study to assess the spatial impact of logging activities on steep slopes within Special Water Supply Catchment Areas in the Central Highlands of Victoria Australia. It focused on evaluating the compliance of VicForests' logging operations with the FSC Controlled Wood Standard for Forest Management Enterprises. The researchers employed a spatial analysis approach using GIS technology and satellite imagery to map the extent of logging and incorporated environmental and hydrological parameters into their analysis. The findings of the study revealed that logging on steep slopes in the catchment areas posed significant risks to the water supply. It resulted in soil erosion, sediment runoff, and potential landslides, leading to degradation of water quality and loss of water storage capacity. Additionally, the study highlighted non-compliance with the FSC Controlled Wood Standard, including logging in protected areas and inadequate measures to mitigate impacts on water catchment areas. The study's relevance to Kenya lies in the context of implementing the National Water Policy, 2021.

Rolston and Linnane (2020) conducted a study to provide an overview of drinking water source protection in the Republic of Ireland, with a specific focus on the group water scheme sector. Their study encompassed objectives, methodology, and findings, and identified a crucial gap warranting further investigation within the context of the implementation of Kenya's National Water Policy, 2021. The objectives of the study were to examine existing practices and measures for drinking water source protection, identify challenges faced by the sector, and evaluate the effectiveness of implemented protection measures. To achieve these objectives, a mixed-methods approach employed, involving a literature review, surveys, and interviews with key stakeholders. The findings emphasized the importance of robust source protection measures to ensure safe drinking water while identifying challenges such as agricultural pollution, inadequate infrastructure, and limited financial resources.

Mkhonza (2019) examined the legal framework and proposed strategies to enhance the protection of strategic water source areas in South Africa, with a specific focus on the role of catchment areas in water service provision. Employing a qualitative research approach, the author conducted an extensive analysis of the legal framework, including legislation, regulations, and policy documents, along with case studies and best practices from other jurisdictions. The findings emphasized the importance of catchment areas as the primary source of water supply and highlighted the need for robust legal protection. The study identified strengths and weaknesses in the existing legal framework, provided recommendations for improving legislation, enforcement mechanisms, stakeholder engagement, and sustainable management practices, and drew on international experiences to propose strategies adaptable to the South African context.

Lehner, et al (2021) conducted a study titled "Identifying priority areas for surface water protection in data-scarce regions: An integrated spatial analysis for Zambia" published in Aquatic Conservation: Marine and Freshwater Ecosystems. The objective of the study was to identify priority areas for surface water protection in Zambia by developing an integrated spatial analysis approach. The researchers collected and analyzed various data sets using GIS techniques and statistical modelling, assessing vulnerability based on land cover change, population density, and proximity to pollution sources. Findings revealed areas susceptible to surface water degradation, highlighting priority areas for conservation efforts. The study emphasized the importance of incorporating local knowledge and stakeholder consultations in water resource management. In the context of implementing the National Water Policy of 2021 in Kenya, a research gap exists regarding the impact of protecting watershed and catchment areas on water services provision. A comprehensive study in Kenya could assess the current state of these areas, evaluate threats, and explore the relationship between protection measures and water availability and quality, providing a scientific basis for policy implementation.

Massawe, Mvena, Nyoki and Chambile (2019) explored the impact of human activities on water availability in the Uluguru forest catchment areas of Morogoro, Tanzania. The study aims to identify the prevailing anthropogenic activities in the region, examine their influence on water availability and quality, and propose recommendations to mitigate their negative effects. Adopting a mixed-methods approach, the researchers conducted a literature review and collected primary data through surveys, interviews, and observations. The findings indicate that activities such as illegal logging, farming practices, and urban encroachment have led to deforestation, soil erosion, and water pollution, resulting in reduced stream flow, increased sedimentation, and contamination of water bodies. Local communities face challenges in accessing clean and safe water. The study emphasizes the need for policy interventions, stakeholder engagement, and community awareness to address these issues. Moreover, it identifies a research gap calling for a study on the protection of watersheds and catchment areas within the context of Kenya's National Water Policy, 2021.

2.2 Theoretical Literature

The study was underpinned by transformative approach as proposed by Christensen and Laegreid (2018). This approach suggests that bureaucratic decisions and actions are shaped by organizational structures, including the level of power assigned to public leaders, the degree of autonomy within institutions, and the broader environment involving both internal and external stakeholders. Through applying this theory, the study gains an all-round understanding of the structural and cultural elements that either facilitate or hinder the implementation of public policy. For this study, the focus is on Kenya’s National Youth Policy. The transformative approach agrees

closely with the organizational factors under examination, specifically decision-making autonomy, legal frameworks, and organizational culture.

The study variables are supported by the principles advanced by Christensen and Laegreid (2018), who emphasize that government decisions significantly impact citizens' lives and influence the implementation of public policies aimed at promoting social well-being. Public administrators play a crucial role in translating organizational decisions into actionable policies, as they possess the authority to guide, direct, or reshape programs to ensure their effective execution. Public organizations define the responsibilities and authority granted to public leaders, which in turn establishes the boundaries within which government ministries can operate when formulating and implementing public policies. This is particularly relevant in the context of youth policies, as youth-related issues are multifaceted and require effective inter-ministerial collaboration and coordination to achieve policy objectives (Onyango, 2019). The degree of autonomy a ministry has in decision-making is often shaped by institutional structures, legal frameworks, and governance mechanisms (Christensen & Laegreid, 2018).

Even though the implementation of public policy, such as the National Youth Policy, is primarily the responsibility of the government, external factors also play a significant role in shaping its development and execution. International organizations, particularly the United Nations, influence policy formulation through the ratification of treaties, conventions, and global frameworks that set standards for youth development and empowerment (United Nations, 2015). These international commitments require governments to align their national policies with broader global objectives, ensuring that youth-focused initiatives contribute to sustainable development and social inclusion (Onyango, 2019). Additionally, the attitudes, perceptions, and values held by key stakeholders, including government agencies, policymakers, and civil society organizations, significantly impact the successful implementation of youth policies.

For the technical environment, we have the resources that are available to enable decision- making and action taking, if there are inadequate financial resources then some of the youth programs fail the threshold to be actualized and limit the leadership from undertaking the implementation of that project or program. As for the institution environment, we have issues of myths and symbols that as evidenced in the study influence decision-making in public administration (Christensen and Laegreid, 2018). The organizational culture within a public institution plays a crucial role in shaping its operations and decision-making processes. This culture is cultivated and reinforced by both leadership and key stakeholders within the organization. According to the theory, an institution’s history significantly influences how decisions are made and actions are taken. However, leadership has the ability to introduce new traditions and practices that align with and advance the institution’s objectives.

The transformative approach points to the significance of the external environment and stakeholders. Analyzing the interests, priorities, and power relations of both internal and external stakeholders is vital in understanding their influence on policy implementation. In the case of the study, external stakeholders could include water users, community representatives, civil society organizations, and private sector entities. By incorporating the perspectives and engagement of these stakeholders, the study can assess how their involvement contributes to the alignment of the policy implementation with the needs and aspirations of the local community.

2.3 Conceptual Framework

A conceptual framework serves as a theoretical model that defines and categorizes the key constructs of a study while illustrating their relationships. Figure 1 shows the conceptual framework.

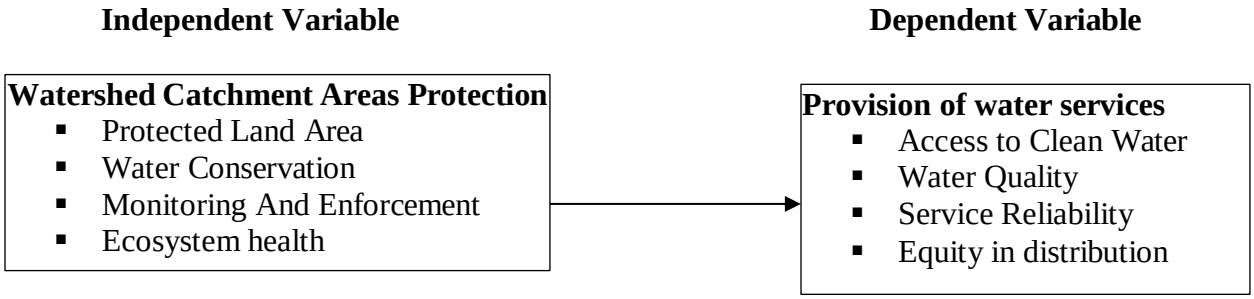

Figure 1: Conceptual Framework

Source: Author (2025)

3.0 Research Methodology

The study adopted the pragmatism philosophy due to the nature of the research questions. The study investigated climate change integration. This required methodological approach to thoroughly understand their impact on water provision. Applying a pragmatic approach allows the researcher to employ both qualitative and quantitative methods, thereby leveraging the strengths of each (Crossan, 2003). This mixed- method approach is important in providing a comprehensive understanding of the relationship between the independent variables and the dependent variable of water provision. According to assertions by Goldkuhl (2012), the flexibility of pragmatism philosophy emphasizes practical solutions and the usefulness of findings, bridging the gap between positivism and interpretivism. Pragmatism philosophy acknowledges the value of both objective, measurable data (consistent with positivism) and subjective information (in line with interpretivism).

This study employed a descriptive survey research design. This design was suitable because it allowed for the systematic collection of data from key stakeholders involved in water services, providing required information regarding the influence of climate change integration (Aquino Lee, Spawn & Bishop-Royse, 2018). The study was carried out in Mandera County, located in the northeastern part of Kenya. The county experiences low and erratic rainfall, with an average annual precipitation of only 255mm, making it one of the driest regions in Kenya (Mandera County Government, 2018). This scarcity of water resources has a profound impact on the lives of its approximately 867,457 residents (Kenya National Bureau of Statistics, 2019).

The study targeted 535 participants drawn from various key stakeholders in Mandera County, including the Water Resources Authority (WRA) Mandera Office, Mandera County Companies, community leaders, representatives from the Non- Governmental Organization (WESCOORD), County Government of Mandera Water Department, and the National Drought Management Authority (NDMA). The study, however excluded the general citizenry of the county as direct respondents, as it focused on policy implementation and institutional effectiveness, which required input from key stakeholders directly involved in water governance and service provision.

The study used Slovin's formula to estimate the sample size (Slovin, 1960) as shown below:

$n = N / (1+Ne^2)$.

Whereas:

n = no. of samples N = total population

e = error margin/margin of error which is approximated at $\alpha=0.05$ $n = 535 / [1+535 (0.05^2)]$

n = 535 / [1+535 (0.0025)]

n = 535 /[1+1.33 5]

n = 535/2.335

n = 228.877 ~229

To select the study sample, the researcher utilized a probability sampling technique. This method guaranteed each member of the population an equal chance of being selected (Quatember, 2019). Questionnaires and key informant interviews were adopted as a means of collecting data from the study participants. Semi-structured questionnaire allowed for both standardized data collection and flexibility, enabling respondents to provide more useful information on specific water policy implementation issues in Mandera County. This approach ensured that important topics are covered while allowing for in-depth responses on complex challenges. Further, they can be administered directly or through representatives where people can read and write (Pandey & Pandey, 2021).

Primary data was collected through the administering of structured questionnaires to the selected officers. The questionnaire was self-administered but in cases where clarification was needed the researcher or research assistants assisted. The researcher obtained a letter of introduction from the Department of Development Studies at Kenyatta University and sought a research permit from the National Commission for Science, Technology, and Innovation of the Republic of Kenya (NACOSTI). Two research assistants were recruited and trained and participated in the pretesting before commencing the data collection exercise. The questionnaires was administered from respective offices on a face-to-face survey and drop- and-pick approach. The study conducted diagnostic tests including multicollinearity, normality, heteroscedasticity, and linearity tests before performing regression analysis. These tests ensured the validity and accuracy of the model assumptions.

Upon collecting the questionnaires, the researcher reviewed them for completeness, accuracy, and consistency. Responses from structured questions were coded and entered into SPSS, a statistical software chosen for its flexibility in handling diverse data formats. Descriptive statistics such as mean, variance, and standard deviation summarized the dataset, while qualitative data was coded and analyzed using the same software. The study applied both Pearson's correlation and linear regression analyses to examine relationships between independent variables and water service provision. Correlation analysis assessed the direction and strength of associations, while regression analysis evaluated the combined influence of stakeholder partnerships, watershed protection, and climate change integration. This approach allowed for controlling external factors and determining the collective and individual effects of each independent variable on the dependent variable.

This study used simple linear regression models to link the independent variable to the dependent variable. The statistical model was structured as follows:

$$\mathbf{Y = \beta_0 + \beta X + \varepsilon}$$

Whereby Y = Provision of Water Services in Mandera County

X= Watershed and Catchment Areas Protection, β_0 =Constant, β= Coefficient.

$\boldsymbol{\varepsilon}$ = Error Term.

Ethical integrity was maintained through adherence to confidentiality, anonymity, and the exclusive academic use of collected data. Respondents' identities were protected, and findings would be shared with relevant stakeholders to promote transparency. Data collection occurred in safe, accessible areas with the support of local authorities, and participation was voluntary, with the option to withdraw at any time. Sensitive data to be securely stored and encrypted, and all safety protocols including travel precautions were followed due to Mandera County's security context.

4.0 Findings and Discussion

The study involved a total of 229 participants who were sampled from the target population comprising staff from Water Resources Authority (WRA) Mandera Office, Mandera County Companies, community leaders, Non-Governmental Organization (WESCOORD), County Government of Mandera Water Department, and National Drought Management Authority (NDMA). Out of the 229 distributed questionnaires, 211 were successfully filled, representing a response rate of 92.1 percent. Therefore, the data collected was considered representative and reliable for drawing valid conclusions on the effect of National Water Policy 2021 implementation in Mandera County.

The study sample was predominantly male (66.8%) and largely composed of young to mid-career professionals aged between 31 and 45 years. Most respondents possessed college or bachelor's qualifications, with a few holding master's or PhD degrees, indicating strong educational diversity. The majority had 6–10 years of work experience in Mandera's water sector and had lived in the county for a similar period, reflecting both institutional familiarity and local insight. Overall, the demographic profile suggests a knowledgeable and experienced group well-positioned to inform climate-integrated water policy implementation in Mandera County.

4.1 Descriptive Statistics

4.1.1 Watershed and Catchment Protection

This section presents and discusses descriptive analysis results on the effect of watershed and catchment protection on the provision of water services in Mandera County. Ten statements were presented to respondents to examine their perceptions on the extent to which watershed and catchment protection strategies have influenced the availability, quality, and sustainability of water services in the region. These statements were framed to capture institutional efforts in land and water resource conservation, environmental health, and ecosystem restoration. Table 1 presents the descriptive statistics results for watershed and catchment protection.

Table 1: Descriptive Statistics on Watershed and Catchment Protection

Statement	Strongly Disagree (%)	Disagree (%)	Neutral (%)	Agree (%)	Strongly Agree (%)	Mean	Std. Dev.
There is increase in protected land area in watersheds and catchments.	3.0	6.0	20.0	49.0	22.0	3.81	0.97
Water conservation efforts in catchment areas have been effective.	4.0	7.0	17.0	47.0	25.0	3.82	1.01
Monitoring and enforcement of catchment protection is rigorous.	5.0	9.0	22.0	44.0	20.0	3.65	1.08
Protection measures have improved ecosystem health in catchments.	3.0	6.0	19.0	50.0	22.0	3.82	0.95
Efforts have reduced soil erosion in watershed areas.	4.0	7.0	18.0	48.0	23.0	3.79	0.99
Catchment protection strategies have enhanced groundwater recharge.	3.0	5.0	20.0	46.0	26.0	3.87	0.93
Watershed management has reduced the impact of droughts.	4.0	6.0	16.0	49.0	25.0	3.85	0.98
Protection measures have improved biodiversity in catchment areas.	2.0	6.0	14.0	50.0	28.0	3.96	0.91
Efforts have reduced pollution in water sources within protected areas.	3.0	6.0	17.0	48.0	26.0	3.88	0.94
Community involvement in catchment protection has increased.	2.0	5.0	15.0	51.0	27.0	3.96	0.89
Overall Mean						**3.86**	

Source: Field Data, 2025

The results from Table 1 indicate that respondents in Mandera County generally have positive perceptions regarding watershed and catchment protection efforts. A significant 78% of respondents agreed that community involvement in catchment protection has increased, with a high mean score of 3.96, indicating strong support for local participation in environmental conservation. Additionally, 78% agreed that protection measures have improved biodiversity in catchment areas, further emphasizing the effectiveness of ecosystem restoration initiatives. Other positive responses included recognition of enhanced groundwater recharge (72% agreement, mean = 3.87) and reduced pollution in protected areas (74% agreement, mean = 3.88). These findings highlight the role of catchment protection in improving environmental health, climate resilience, and water quality in Mandera County, consistent with studies by Constant et al. (2016) and Rolston and Linnane (2020).

However, some concerns were noted, particularly regarding the enforcement of catchment protection measures. While 74% of respondents agreed that watershed management has reduced the impact of droughts (mean = 3.85), the statement “Monitoring and enforcement of catchment protection is rigorous” recorded the lowest agreement (64%) and the highest standard deviation (1.08), suggesting variability in enforcement consistency across the county. This aligns with

findings by Lehner et al. (2021), who identified areas vulnerable to surface water degradation. Overall, the mean score of 3.86 across all items reflects broad support for watershed and catchment protection, affirming its importance in ensuring sustainable water services, particularly in arid regions like Mandera, in line with the National Water Policy (2021).

Thematic Analysis

This section presents findings from interviews with officers from the Water Resources Authority (WRA) Mandera Office and the National Drought Management Authority (NDMA), focusing on the protection of watershed and catchment areas. The discussions explored the implemented measures, their impact on water service provision, existing threats, and strategies for mitigation. The interviews revealed that while Mandera County is predominantly arid with limited surface water catchments, several targeted interventions have been introduced to protect and restore key micro-catchment areas. These include afforestation programs, erosion control programs, and water regulation mechanisms.

The interviews revealed that watershed and catchment protection initiatives in Mandera County have contributed positively to improving water retention and stabilizing seasonal water sources. Respondents noted that interventions such as fencing off vulnerable zones, constructing check dams, and protecting seasonal riverbeds like the Daua had reduced flash floods and enhanced groundwater recharge. These measures helped sustain water availability during dry seasons, particularly in areas where overgrazing and sediment flow had previously caused rapid depletion of water resources.

Community participation emerged as a key theme in the successful implementation of catchment protection activities. Respondents explained that local water user associations in areas such as Guticha and Neboi had taken an active role in restoring degraded landscapes through indigenous tree planting, gabion construction, and soil stabilization. Such community-led initiatives were reported to have increased groundwater recharge and extended the lifespan of shallow wells. Participants attributed improved water access and reduced emergency water trucking to the growing ownership of conservation programs by local residents.

The interviews further highlighted tangible improvements in water service sustainability linked to catchment restoration. Respondents observed that boreholes in rehabilitated zones experienced fewer breakdowns and more stable water tables due to reduced siltation. Projects in Elwak and Lafey, for instance, were cited as examples where enhanced catchment management had lessened dependence on emergency water supply interventions. Overall, respondents agreed that integrating environmental protection with water infrastructure planning had produced visible gains in water reliability across several sub-counties.

Despite these achievements, respondents identified persistent threats to watershed sustainability. Deforestation, charcoal burning, sand harvesting, and overgrazing were cited as major challenges undermining conservation efforts. Climatic factors such as prolonged droughts and erratic rainfall patterns were also reported to intensify land degradation and erosion. Respondents expressed concern that enforcement of existing regulations remained weak due to cross-border trade, population pressures, and the mobility of pastoralist communities, which often led to resource strain in fragile ecosystems.

To mitigate these threats, respondents emphasized the adoption of integrated management strategies combining regulation, community engagement, and technology. Enforcement of

community bylaws, awareness campaigns through public forums and local radio, and participatory zoning maps were cited as ongoing interventions. The integration of drought early warning systems with land degradation alerts by NDMA was also noted as a proactive approach. Additionally, technical measures such as designing water pans and check dams with environmental buffers were being piloted to safeguard recharge areas. Collectively, these efforts aim to build resilience and ensure the long-term sustainability of watershed ecosystems in Mandera County.

4.1.2 Provision of Water Services

The dependent variable in this study was provision of water services in Mandera County. This variable was used to assess the outcomes associated with the implementation of the National Water Policy (2021) in relation to access, quality, reliability, affordability, and overall satisfaction with water service delivery. Table 2 presents the descriptive statistics results for the provision of water services.

Table 2: Descriptive Statistics on Provision of Water Services

Statement	Strongly Disagree (%)	Disagree (%)	Neutral (%)	Agree (%)	Strongly Agree (%)	Mean	Std. Dev.
Access to clean water has significantly improved in our service area.	3.9	7.5	18.6	44.2	25.8	3.81	1.07
The quality of water provided has improved over time.	5.0	9.0	19.3	43.1	23.6	3.71	1.10
Water services are reliable and consistent.	6.4	10.1	21.7	41.0	20.8	3.60	1.12
There is equity in the distribution of water services across different areas.	8.7	12.9	23.1	38.0	17.3	3.42	1.17
Our water infrastructure adequately meets community needs.	5.5	9.3	20.6	42.7	21.9	3.67	1.09
Water service coverage has expanded significantly in recent years.	4.2	6.1	16.8	46.5	26.4	3.85	1.01
Water services are affordable for most community members.	7.1	11.6	22.0	39.0	20.3	3.54	1.15
Water quality meets all relevant health and safety standards.	6.3	9.4	18.9	43.3	22.1	3.65	1.08
Water services have improved community health outcomes.	3.5	6.7	20.2	47.1	22.5	3.79	1.01
Customer satisfaction with our water services has increased.	4.1	8.0	19.7	45.6	22.6	3.75	1.05
Overall Mean						**3.68**	

Source: Field Data, 2025

The descriptive findings revealed a generally positive perception of water service provision in Mandera County, with an overall mean of 3.68, indicating moderate satisfaction among respondents. The highest agreement (72.9%, M = 3.85, SD = 1.01) was for the statement that water service coverage had expanded significantly in recent years, followed by 70.0% affirming improved access to clean water (M = 3.81, SD = 1.07) and 69.6% recognizing better community health outcomes (M = 3.79, SD = 1.01). Increased customer satisfaction was also noted by 68.2%

of respondents (M = 3.75, SD = 1.05), suggesting visible service improvements though with variations across locations. On water quality, 65.4% of participants agreed that quality had improved (M = 3.71, SD = 1.10), and a similar proportion felt that water met safety standards (M = 3.65, SD = 1.08), reflecting progress but with lingering inconsistencies linked to local treatment and maintenance.

However, challenges persist in affordability, reliability, and equity of distribution. Only 59.3% agreed that water services were affordable (M = 3.54, SD = 1.15), while just 55.3% believed that water distribution was equitable (M = 3.42, SD = 1.17), indicating disparities across sub-counties. Reliability was also moderate, with 61.8% agreeing that services were consistent (M = 3.60). These results highlight that while Mandera County has made notable strides in water access, coverage, and quality, significant gaps remain in ensuring affordability, fairness, and reliability of services. The findings call for strengthened infrastructure, equitable allocation of resources, and enhanced quality monitoring to sustain progress and ensure inclusive water service delivery across all communities.

4.2 Correlation Analysis

Correlation analysis aimed to determine the degree of association between the implementation of National Water Policy (2021); watershed catchment protection and the provision of water services in Mandera County. SPSS software was used to compute the Pearson correlation coefficients, and the results are presented in Table 3.

Table 3: Correlation Matrix

		Provision of Water Services
Provision of Water Services	Pearson Correlation Sig. (2-tailed)	1.000
Watershed Catchment Protection	Pearson Correlation	.524**

Source: Field Data, 2025

The study also found a moderate positive and significant correlation between watershed catchment protection and water service provision ($r = 0.524$, $p < 0.01$). This indicates that conservation and protection of water catchment areas directly influences the reliability and quality of water supply. This concurs with the findings of Rolston and Linnane (2020) who noted that water source protection is key to ensuring drinking water safety in Ireland. While their study focused on the group water scheme sector in Ireland, the implications are relevant to Mandera, where watershed degradation is likely to negatively affect water availability.

4.3 Regression Analysis

The study assessed the effect of watershed catchment protection on the provision of water services in Mandera County. Linear regression analysis was conducted to assess the relationship between watershed catchment protection and the provision of water services. Table 4 shows model summary between watershed catchment protection and provision of water services.

Table 4: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.711a	0.506	0.503	0.43151

a Predictors: (Constant), Watershed Catchment Protection

Source: Field Data, 2025

The results in Table 4 depicts coefficient of determination (R Squared) of 0.506, mimplying that 50.6% of the variation in the provision of water services in Mandera County is explained by watershed catchment protection. This reflects a moderately strong relationship in which improved protection of water catchment areas significantly influences water service reliability and quality. The Adjusted R Squared of 0.503 further supports the strength of the model after accounting for the number of predictors, indicating minimal overfitting and a good fit to the data. Table 5 shows the ANOVA results.

Table 5: ANOVA Results

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	44.740	1	44.740	240.092	0.004[b]
	Residual	43.641	209	0.209		
	Total	88.381	210			

a. Dependent Variable: Provision of Water Services
b. Predictors: (Constant), Watershed Catchment Protection

Source: Field Data, 2025

The ANOVA results in Table 5 indicate that the model is statistically significant in explaining the effect of watershed catchment protection on the provision of water services, with an F-value of 240.092 and a p-value of 0.004, which is less than 0.05. This indicates that the model provides a significant explanation of the observed relationship between the variables. Table 6 shows regression coefficient results.

Table 6: Regression Coefficient Results

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.036	0.115	—	9.009	0.000
	Watershed Catchment Protection	0.694	0.045	0.711	15.492	0.000

a. Dependent Variable: Provision of Water Services

Source: Field Data, 2025

$Y = 1.036 + 0.694X$

Where:

Y = Provision of Water Services

X = Watershed Catchment Protection

The regression coefficient results in Table 6 show a positive and statistically significant relationship between watershed catchment protection and provision of water services ($\beta = 0.694$, $p = 0.007 < 0.05$). This suggests that for every one-unit increase in watershed protection efforts, there is an expected increase of 0.694 units in the provision of water services, assuming other variables remain constant. The t-value of 15.492 further supports the predictor's significance in the model. These findings are consistent with the findings of Taylor and Lindenmayer (2019) who demonstrated that poor catchment management, particularly logging on steep slopes, leads to soil erosion, sedimentation, and water quality degradation. Additionally, Rolston and Linnane (2020) revealed the significance of source protection of group water scheme sector. Their findings pointed to challenges such as agricultural runoff, aging infrastructure, and limited financial capacity, which parallel the situation in arid regions like Mandera. They stressed the need for coordinated monitoring and stakeholder involvement, reinforcing the necessity of implementing Kenya's National Water Policy, 2021 in a manner that prioritizes catchment protection.

5.0 Conclusion

Watershed and catchment protection is important in securing water availability, quality, and sustainability in the region. In the context of Mandera County, where water sources are highly vulnerable to environmental degradation and climate variability, conservation efforts such as afforestation, soil stabilization, and riverbank fencing are essential. These actions improves groundwater recharge, prevent sedimentation, and preserve ecosystems that support water resilience. Moreover, community involvement in environmental protection efforts has been a key success factor, indicating that conservation is most effective when rooted in local knowledge and participation. However, disparities in monitoring and enforcement capacity reveal that policy frameworks alone are insufficient without effective implementation. Challenges such as overgrazing, deforestation for charcoal, and lax regulation highlight the need for stronger governance, increased investment in environmental education, and the establishment of localized enforcement mechanisms. Long-term success in catchment protection requires integrated planning, inter-agency coordination, and the consistent empowerment of local communities to serve as stewards of their natural resources.

6.0 Recommendations

The county department of water services should prioritize investments in the construction, maintenance, and security of water storage infrastructure, with specific attention to underserved rural areas. This should include budgetary allocations for the rehabilitation of existing tanks and water pans, installation of tamper-proof solar pumping systems, and procurement of durable piping and control equipment. Public-private partnerships can be explored to finance large-scale infrastructure such as elevated tanks and community-level reservoirs. Additionally, the department should develop a county-wide maintenance and servicing schedule, assigning clear roles to sub-county water officers, community-based organizations, and water users associations. Mechanisms such as infrastructure audit reports and public scorecards can be introduced to ensure transparency, community oversight, and long-term operational sustainability. Capacity-building on maintenance and local fabrication of spare parts should also be integrated into water infrastructure programs.

The ministry of environment and climate change in partnership with the ministry of water and county authorities should deepen climate change integration into water planning processes through targeted institutional reforms and technical capacity enhancement. Climate-smart planning tools, including seasonal rainfall projections and water stress vulnerability maps, should be adopted and

made available at the sub-county level. The National Drought Management Authority (NDMA) and Mandera County's climate change unit should collaborate to mainstream adaptive planning frameworks into all water projects, ensuring that long-term climate scenarios are reflected in infrastructure design, water allocation plans, and early warning systems. Further, county planning departments should engage climate scientists and environmental engineers to support the development of scenario-based project designs that factor in future drought intensity and rainfall patterns. These professionals can also assist in building the capacity of local engineers and planners through structured workshops and on-the-job training modules.

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