Journal of Public Policy & Governance

Integration of Climate Change Adaptation Strategies and Sustainable Water Service Provision: Evidence from Mandera County, Kenya

Mohamed Ali Omar, Wilson Muna, PhD & Prof. David Minja, PhD

ISSN: 2616-8413

Stratford Peer Reviewed Journals and Book Publishing
Journal of Public Policy & Governance
Volume 10||Issue1||Page 56-74||March||2026|
Email: info@stratfordjournals.org ISSN: 2616-8413

Integration of Climate Change Adaptation Strategies and Sustainable Water Service Provision: Evidence from Mandera County, Kenya

[*1]Mohamed Ali Omar

Department of Public Policy and Administration, Kenyatta University

E-mail of corresponding author: **maqaarwater4@gmail.com**

[2]Wilson Muna, PhD

Department of Public Policy and Administration, Kenyatta University

[3]Prof. David Minja, PhD

Department of Public Policy and Administration, Kenyatta University

***How to cite this article*: Omar, M. A., Muna, W. & Minja, D. (2026). Integration of Climate Change Adaptation Strategies and Sustainable Water Service Provision: Evidence from Mandera County, Kenya, *Journal of Public Policy & Governance, 10*(1), 56-74.** https://doi.org/10.53819/81018102t4375

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. The purpose of this study was therefore to assess the effect of climate change integration on the provision of water services in Mandera County. The study was underpinned by Institutional Theory. The study was informed by pragmatism philosophy and 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 revealed a coefficient of determination ~~(R^2)~~ of 0.541, implying that 54.1% of the change in the provision of water services in Mandera County is attributed to climate change integration strategies. Regression analysis results showed that climate change integration (β = 0.336, p = 0.000) had statistically significant positive effect on service delivery. The study concludes that effective water service delivery in arid regions like Mandera County depends on coordinated efforts across environmental, infrastructural, and climate-focused interventions. In

Stratford Peer Reviewed Journals and Book Publishing
Journal of Public Policy & Governance
Volume 10||Issue1||Page 56-74||March||2026|
Email: info@stratfordjournals.org ISSN: 2616-8413

view of the findings, the study recommends that county governments, water sector agencies, and development partners should consider inclusive, climate-resilient planning in water infrastructure.

Keywords: *Climate Change Integration, Sustainable Water Service Provision, Institutional Theory, Climate-Resilient Planning, Mandera County.*

1.0 Introduction

Water is an important component of the ecosystem, playing a key role in sustaining living organisms and facilitating transformations in nonliving elements (Kumar, Singh, Misra, Singh, Bhardwaj, & Chandra, 2024). As highlighted by Buser (2024), water is a valuable resource when it is available in safe and adequate quantities; however, it can also pose significant risks when it is unsafe or insufficient. The availability of clean and secure water is crucial for survival, as life fundamentally depends on it (Bazaanah & Mothapo, 2024; Lebu, Lee, Salzberg, & Bauza, 2024). Both the supply and quality of water influence the prevalence or prevention of infectious diarrhea and other severe waterborne diseases, which are among the leading causes of infant mortality and malnutrition (Fardowsa, 2024). Beyond health concerns, water-related challenges also have economic consequences, such as increased absenteeism in schools and lost productivity in workplaces. As a result, ensuring access to water in a sustainable and equitable manner has become a global priority. This raises concerns for communities and nations facing unreliable, inadequate, or unsafe water supplies (WHO, 2022).

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).

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). Through the promotion of responsible water use and conservation strategies, these policies strengthen community resilience and long-term sustainability.

Globally, one successful example of a successful implementation of the National Water Policy in is the Netherlands (UNESCO, 2019). The Netherlands, with its extensive water management infrastructure, has implemented a comprehensive National Water Policy that has significantly contributed to its socioeconomic development (Wuijts, Van Rijswick, Driessen & Runhaar, 2023). Netherland's policy approach is rooted in integrated water management, which focuses on balancing the needs of water supply, flood protection, and ecosystem conservation. One notable aspect of the Dutch National Water Policy is its emphasis on spatial planning and land management (Laeni Van den Brink, Trell, & Arts, 2021). In Brazil, the National Water Resources Policy, established in 1997, focuses on decentralized and participatory management, emphasizing the importance of river basin committees and water agencies (ANA, 2019). Despite Brazil having about 12% of the world's freshwater resources, water distribution remains highly uneven (Scanlon, Fakhreddine, Rateb, de Graaf, Famiglietti, Gleeson & Zheng, 2023).

On the regional front, the implementation of the National Water Policy in Nigeria has faced a number of challenges despite the country's abundant water resources. The Nigeria National Water Policy, established in 2004, aims to ensure sustainable access to safe and sufficient water for domestic, agricultural, industrial, and environmental needs (Nwokediegwu, Adefemi, Ayorinde, Ilojianya & Etukudoh, 2024). However, the country struggles with inadequate infrastructure, inefficient water management, and pollution. According to the World Health Organization (2020), approximately 60 million Nigerians still lack access to basic drinking water services, and over 100 million lack access to adequate sanitation. Efforts to improve water provision include the Water, Sanitation, and Hygiene (WASH) program, which focuses on increasing access to clean water and sanitation facilities. However, the implementation has been hindered by issues such as funding shortfalls, governance problems, and climate change impacts, which exacerbate water scarcity in certain regions.

Locally, the Kenya National Water Policy 2021 is a strategic framework designed to guide the sustainable management, development, and use of water resources in the country (Mutschinski & Coles, 2021). It builds upon previous policies and aligns with the objectives of the Kenya Vision 2030, emphasizing water conservation and management. Over the past decade, water provision in Mandera County has deteriorated significantly. Between 2013 and 2023, the number of residents facing acute water scarcity rose by 45%, from 400,000 to 580,000 people (WSRB, 2023). Key water sources, including the Daua River and groundwater aquifers, are depleting groundwater levels have dropped by an average of 2.5 meters annually over the past five years, while the Daua River's flow rate declined by 30% in the same period (WASREB, 2022). The average distance to water points has increased from 5 km in 2015 to 8.7 km in 2023 (Mandera County Government, 2022). Water quality has also worsened, with 68% of sources failing to meet national drinking water standards in 2022, up from 52% in 2018 (Mandera County Government, 2023; Ministry of Water, Sanitation and Irrigation, 2023).

1.1 Statement of the Problem

Effective implementation of national water policies is expected to enhance the provision of water services by enabling improved water resource management, increased access to clean water, development of water infrastructure, protection of water sources, and enhanced water governance. However, evidence from existing empirical studies suggests that the implementation of national water policies provides mixed results with regard to their effect on water service provision. For instance, there is extensive evidence indicating a positive and significant relationship between national water policy implementation and improved water service provision in Tanzania (Nganyanyuka et al. (2018); Marks and Kumpel (2018) in Kenya; Liddle and Fenner (2017) in Uganda; Koehler et al. (2020) in Kenya, Uganda, and Ethiopia; Oates et al. (2019) in Ethiopia).

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 climate change integration on the provision of water services in Mandera County. The study has shed light on the gaps, barriers, and opportunities encountered in translating policy objectives into tangible actions and outcomes.

1.2 Research Objective

To assess the effect of climate change integration on the provision of water services in Mandera County.

1.3 Research Hypothesis

H_0: There is no significant statistical association between climate change integration and the provision of water services in Mandera County.

1.4 Justification of the Study

Mandera County, Kenya, continues to face acute water scarcity driven by poor infrastructure, rapid population growth, and recurring droughts. Its harsh geographic and climatic conditions, compounded by high poverty levels and frequent water-related conflicts, make it uniquely positioned for evaluating the effectiveness of the National Water Policy (2021). Unlike better-resourced counties, Mandera relies on unsustainable water sources and lacks a localized water

policy, highlighting the need to assess how national frameworks promoting equity, infrastructure development, and integrated water resource management are being implemented and whether they improve service delivery in such marginalized regions (World Bank, 2017).

Given that water service delivery is a devolved function under Kenya's Constitution (2010), the influence of national policies like the National Water Policy (2021) is largely regulatory and financial. Mandera's reliance on national directives underscores the importance of studying how these frameworks are operationalized in resource-limited, conflict-prone, and transboundary regions.

2.1 Empirical Review

Hirji, Nicol and Davis (2017) conducted a study to investigate the integration of climate change considerations and the provision of water services in South Asia. Employing a comprehensive research methodology, including literature review, data analysis, and case studies, the authors found that climate change impacts, such as altered precipitation patterns and glacier melting, pose significant risks to water availability and quality in the region. They identified challenges in the existing water management practices, including insufficient infrastructure and weak governance systems. To address these challenges, the study proposed adaptation strategies like improving water infrastructure, promoting water-use efficiency, and enhancing ecosystem resilience, alongside policy recommendations for integrated water resources management and inclusion of climate change considerations. The authors emphasized the importance of regional cooperation in managing shared water resources effectively, calling for collaborative approaches and dialogue among stakeholders. These findings provide valuable insights for policymakers, water managers, and stakeholders involved in climate change and water resource management in South Asia.

Yu, et al. (2019) published in the Journal of Arid Land aim to explore the integration of climate change and its impact on water resources in Central Asia's arid and semi-arid regions, with a focus on sustainable development. Using a multidisciplinary approach, the study combines data analysis, modelling, and case studies to assess changes in climate patterns and water availability. The findings reveal increasing temperatures and altered precipitation patterns, resulting in decreased rainfall and increased variability. Consequently, the hydrological cycle has been affected, leading to reduced water availability and heightened water stress. The study identifies the impacts of these changes on sectors such as agriculture, energy, and human settlements, highlighting challenges in food security, livelihoods, and socio-economic development. To address these issues, the authors propose strategies including efficient irrigation systems, water- saving techniques, water governance mechanisms, and the integration of climate change considerations into policy planning. Ultimately, the study underscores the importance of sustainable water resource management in mitigating climate change impacts and promoting socio-economic development in Central Asia's arid and semi-arid lands.

Awandu, Kanda and Kimokoti (2024) conducted a review examining the water-energy-food (WEF) nexus in Kenya, focusing on climate change impacts and adaptation strategies. The study highlighted the interdependence of water, energy, and food as crucial drivers of sustainable development and human security, emphasizing the need for integrated management to balance synergies, conflicts, and trade-offs inherent in the nexus. In Kenya, achieving sustainable development goals was found to be heavily reliant on the effective management of these three resources, particularly given the challenges posed by climate variability and change. The study noted that over 75% of agricultural activities in Kenya depended on rainfed farming, making food

security highly vulnerable to erratic rainfall patterns and spatial distribution inconsistencies. Similarly, Kenya's energy sector faced reliability challenges due to its dependence on hydropower, which remained susceptible to climate-related risks such as droughts and changing precipitation trends. The review underscored the necessity of climate adaptation mechanisms to enhance resilience in cropping systems, water service delivery, and energy provision. It further emphasized the importance of adopting a holistic and sustainable approach to policy, legal, and institutional frameworks to strengthen the WEF nexus. Additionally, the study highlighted the role of assessment models and tools in tracking progress toward achieving WEF-related sustainability targets. The findings reinforced the need for coordinated strategies to mitigate climate risks while ensuring long-term resource security in Kenya.

2.2 Theoretical Literature

The study was anchored on institutional theory. This theory was first introduced by DiMaggio and Powell in 1983. The theory states that organizational behavior is largely shaped by the established rules, norms, and beliefs within the institutional environment. Organizations adapt to these external influences to maintain legitimacy, ensure stability, and secure necessary resources. This theory emphasizes the role of social and cultural factors in shaping organizational structures and operations. Rather than being solely driven by rational decision-making focused on efficiency, organizations are deeply embedded in broader social and cultural contexts, where institutional pressures play a key role in determining their practices and frameworks (Meyer & Rowan, 1977; Zucker, 1977; Scott, 2001). The theory challenges the idea that organizations are purely rational entities driven by efficiency and competition.

Institutional Theory argues that organizations operate within a social framework of norms, values, and taken-for-granted assumptions about what constitutes appropriate or acceptable economic behavior. These institutional forces lead organizations to adopt similar structures and practices within their field, a process known as institutional isomorphism (DiMaggio & Powell, 1983; Deephouse, 1996; Mizruchi & Fein, 1999). DiMaggio and Powell (1983) identified three mechanisms of institutional isomorphism: coercive (resulting from political influence and legitimacy problems), mimetic (stemming from standard responses to uncertainty), and normative (associated with professionalization).

Institutional Theory has been particularly influential in explaining organizational behavior in public and non-profit sectors, where market pressures may be less intense, and legitimacy concerns more prominent (Frumkin & Galaskiewicz, 2004; Ashworth et al., 2009; Verhoest et al., 2007). In the context of water policy and service provision, the theory can help explain why certain practices or structures are adopted across different regions or countries, even when they may not be the most efficient solutions for local conditions. For example, the widespread adoption of particular water management models or technologies might be better explained by institutional pressures than by their proven effectiveness in each specific context (Fuenfschilling & Truffer, 2014; Mukhtarov & Gerlak, 2013; Ingram & Lejano, 2009).

Institutional Theory has evolved to recognize that organizations are not merely passive recipients of institutional pressures but can also strategically respond to and even shape their institutional environments (Oliver, 1991; Lawrence, 1999; Pache & Santos, 2010). Oliver (1991) proposed a range of strategic responses to institutional processes, from passive conformity to active manipulation. This perspective is particularly relevant in studying how local water management

bodies in places like Mandera County might navigate national policies and international best practices while addressing local needs and constraints.

This theory focuses on how institutions (formal and informal rules, norms, and structures) shape behavior and outcomes. This theory helped explain how institutional arrangements in Mandera County affect water policy implementation and service provision. It's particularly relevant for examining accelerated partnerships and capacity building objectives. Institutional Theory sheds light on how national policies are interpreted and implemented at the local level, how partnerships are formed and sustained, and how capacity building efforts are informed by institutional norms and expectations (Obosi, 2011; Ogendi & Ong'oa, 2009; Nyanchaga, 2016). This theory was integral to this study in explaining both the challenges and opportunities in implementing new water management practices, particularly in areas where traditional methods or existing institutional arrangements may conflict with proposed changes (Mumma, 2007; Gachenga, 2012; Cherlet & Venot, 2013).

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. According to Mugenda and Mugenda (2003). Figure 1 shows the conceptual framework.

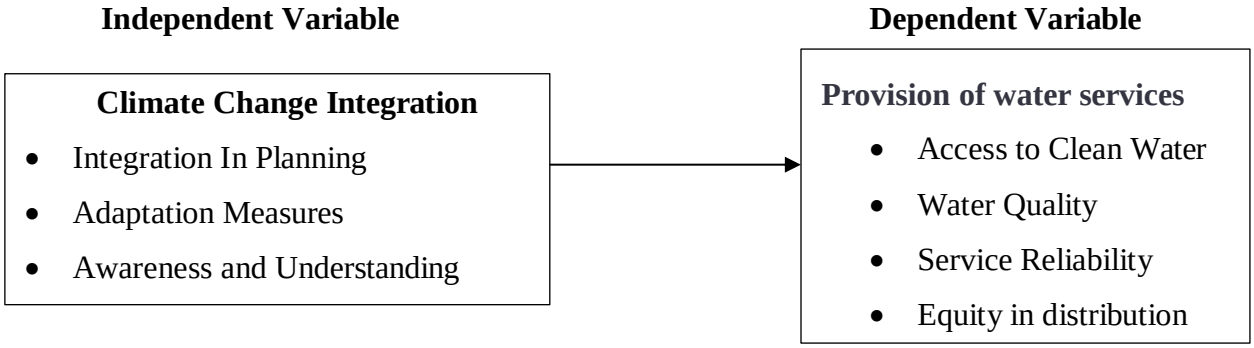

Figure 1: Conceptual Framework

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= Climate Change Integration, 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

A total of 229 participants 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 masters 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.

Stratford Peer Reviewed Journals and Book Publishing
Journal of Public Policy & Governance
Volume 10||Issue1||Page 56-74||March||2026|
Email: info@stratfordjournals.org ISSN: 2616-8413

4.1 Descriptive Statistics

4.1.1 Climate Change Integration

The study sought to assess the effect of climate change integration on the provision of water services in Mandera County. The responses were analyzed using descriptive statistics, specifically the mean and standard deviation, to interpret the central tendency and variability of perceptions. Table 1 presents the descriptive statistics results for the climate change integration variable.

Table 1: Descriptive Statistics on Climate Change Integration

Statement	Strongly Disagree (%)	Disagree (%)	Neutral (%)	Agree (%)	Strongly Agree (%)	Mean	Std. Dev.
Climate change considerations are well integrated into our water planning processes.	4.2	9.6	18.4	41.5	26.3	3.76	1.13
The adaptation measures effectively address climate change impacts on water resources.	3.9	8.3	22.7	38.7	26.4	3.75	1.10
There is a high level of awareness and understanding of climate change in our organization.	6.1	11.0	17.8	41.1	24.0	3.66	1.18
Our water infrastructure is climate-informed and resilient to climate change impacts.	5.5	9.8	21.0	43.0	20.7	3.64	1.14
Our organization effectively uses climate data in water resource planning.	4.9	10.3	25.1	38.2	21.5	3.61	1.09
Climate change awareness programs have improved community preparedness.	3.2	7.4	19.5	44.7	25.2	3.81	1.04
Water conservation measures effectively address climate change challenges.	4.7	8.1	23.3	40.2	23.7	3.70	1.08
Our organization collaborates well with climate experts in water management.	5.0	9.5	27.4	38.9	19.2	3.58	1.07
Climate change integration has improved long-term water resource sustainability.	3.6	6.3	20.7	45.8	23.6	3.80	1.01
Our infrastructure development plans adequately consider future climate scenarios.	6.7	10.1	24.5	39.6	19.1	3.54	1.15
Overall Mean						**3.69**	

Source: Field Data, 2025

The descriptive results indicated that climate change integration in Mandera County's water sector was generally positive, with an overall mean of 3.69. Most respondents (70.5%) agreed that climate considerations are integrated into water planning processes (M = 3.76, SD = 1.13), while 65.1% affirmed that adaptation measures effectively address climate impacts (M = 3.75, SD = 1.10). Awareness of climate issues within organizations was also high (65.1%, M = 3.66, SD =

1.18), though varying awareness levels suggest a need for continuous staff training and sensitization. Regarding infrastructure resilience, 63.7% agreed that water systems are climate-informed (M = 3.64, SD = 1.14), and 59.7% confirmed the use of climate data in planning (M = 3.61, SD = 1.09), revealing partial adoption of data-driven approaches in water management.

Additionally, 69.9% of respondents noted that climate awareness programs enhanced community preparedness (M = 3.81, SD = 1.04), and 63.9% agreed that conservation measures effectively mitigate climate impacts (M = 3.70, SD = 1.08). Collaboration with climate experts, however, remained limited, with only 58.1% in agreement (M = 3.58, SD = 1.07), highlighting the need for stronger institutional partnerships. The highest perceived benefit was improved long-term water resource sustainability (69.4%, M = 3.80, SD = 1.01), while the lowest mean (3.54) related to infrastructure planning for future climate scenarios, reflecting uneven foresight. Overall, findings demonstrate that while climate integration is progressing, inconsistencies persist in data use, expert collaboration, and forward-looking infrastructure planning, calling for enhanced institutional capacity and policy alignment.

Thematic Analysis

This section presents interview findings on the extent to which climate change has been integrated into water resource management strategies in Mandera County. Respondents from the Water Resources Authority (WRA) Mandera Office and the National Drought Management Authority (NDMA) provided insights into planning adjustments, implemented projects, and institutional responses to climate variability. During the interviews, the respondents confirmed that climate change is now a central consideration in water planning due to increasing climate-induced shocks such as prolonged droughts, extreme heat, and flash floods. Agencies have adopted climate risk profiling, mainstreamed adaptation into project design, and developed water management frameworks responsive to climate variability. Interviewee M1 explained:

> *"Climate change is no longer a theoretical risk. It is shaping how we plan borehole spacing, assess groundwater recharge zones, and determine locations for water pans. Our plans now include rainfall variability scenarios, and we routinely use drought monitoring tools in all our quarterly reporting."*

Respondent M2 from NDMA added:

> *"Every water project we approve or fund must now undergo a climate risk screening. We've embedded climate-smart indicators in our project log-frames. For example, water pans are now designed with higher bunds to withstand flash floods, and boreholes are spaced further apart to avoid over-abstraction during extended dry periods."*

Several targeted interventions have been rolled out to address the effects of climate change. These include installation of solar-powered boreholes, climate-resilient designs for water pans and dams, and establishment of early warning systems and community education programs.

As Interviewee M3 shared:

> *"We've solarized more than 60 percent of boreholes to reduce dependence on diesel during emergencies, and these are often paired with elevated tanks to support gravity-fed distribution. It's efficient, cost-effective, and ensures uninterrupted supply during crises."*

Respondent M4 described infrastructure innovation:

> *"In places like Rhamu and Ashabito, we're piloting subsurface dams which reduce evaporation and promote groundwater recharge. These structures are critical in buffering climate extremes and extending water availability into the dry season."*

Respondents also emphasized information systems as a vital tool in their adaptation toolkit.

Interviewee M5 explained:

> *"NDMA has strengthened its drought early warning bulletins. These updates guide water rationing, livestock movement, and seasonal water trucking plans. We also use mobile alerts to warn communities about expected rainfall and coordinate response measures like repositioning storage tanks or fuel reserves."*

Respondents acknowledged that climate change adaptation in water management goes beyond infrastructure and requires collaboration with other sectors and grassroots communities. Programs focusing on behavioral change, water-use efficiency, and gender-responsive programming have been introduced.

Respondent M6 noted:

> *"We work with the education and health sectors to ensure that climate adaptation messages—like efficient water use and hygiene during droughts—reach women, youth, and children. Schools now have roof catchment systems as demonstration models, and some even participate in water-saving competitions."*

Interviewee M7 stated:

> *"Community Water Resource Users Associations (WRUAs) have been trained on climate risk mapping and local adaptation planning. They now monitor environmental indicators and suggest location-specific interventions, such as building sand dams or fencing challenging catchments."*

The responses from the interviews clearly demonstrate that climate change is no longer an afterthought but a mainstreamed consideration in water resource management in Mandera County. Agencies have adopted proactive strategies such as solar-powered water systems, subsurface dams, elevated tanks, and climate-resilient design standards. Early warning systems and cross-sectoral planning further reflect an all-round approach to climate adaptation. While progress is notable, sustaining climate resilience will require ongoing investment in infrastructure, improved data for planning, and consistent community engagement. Strengthening local WRUAs, securing long-term funding for adaptation projects, and aligning county plans with national climate frameworks will be essential for translating strategy into sustained resilience and equitable water access across 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); climate change integration 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	1.000
	Sig. (2-tailed)	
Climate Change Integration	Pearson Correlation	.735**

Source: Field Data, 2025

The results reveal a moderate positive and significant association ($r = 0.735$, $p < 0.01$) between climate change integration and provision of water services. This indicates the importance of aligning water policies with climate-resilient strategies to address water stress, especially in drought-prone regions. This finding is corroborated by Howard et al. (2016) who examined the implications of climate change on water and sanitation systems in the UK. Their study pointed to rising temperatures, droughts, and floods as key risks and emphasized the need for adaptive systems. The same rationale applies to Mandera, where climate-related risks threaten water security and where integrated water resource management is urgently needed.

4.3 Regression Analysis

A simple linear regression analysis was conducted to evaluate how integrating climate change considerations into water resource planning and management influences the delivery of water services. Table 4 presents the model summary for this analysis.

Table 4: Model Summary

Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
1	.735a	0.541	0.538	0.41917

a Predictors: (Constant), Climate Change Integration

Source: Field Data, 2025

As indicated in Table 4, the coefficient of determination (R^2) is 0.541, implying that 54.1% of the change in the provision of water services in Mandera County is explained by climate change integration. This suggests a significant influence, where efforts to incorporate climate resilience and adaptive planning positively affect service provision. The Adjusted R^2 of 0.538 confirms the consistency of the model by accounting for degrees of freedom and preventing overestimation of explanatory power. Table 5 shows the ANOVA results.

Table 5: ANOVA Results

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	47.837	1	47.837	271.985	0.000[b]
	Residual	40.544	209	0.194		
	Total	88.381	210			

a. Dependent Variable: Provision of Water Services
b. Predictors: (Constant), Climate Change Integration

Source: Field Data, 2025

The ANOVA output in Table 5 shows that the model was statistically significant, with an F-value of 271.985 and a p-value of 0.000, which is below the standard significance level of 0.05. This confirms that the observed relationship between climate change integration and the provision of water services is reliable and not due to random variation. Regression coefficient results are shown in Tale 6.

Table 6: Regression Coefficient Results

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	0.982	0.110		8.927	0.001
	Climate Change Integration	0.713	0.043	0.735	16.489	0.000

a. Dependent Variable: Provision of Water Services

Source: Field Data, 2025

Y = 0.982 + 0.713X

Where:

Y = Provision of Water Services

X = Climate Change Integration

The coefficient results in Table 6 show that climate change integration has a strong, positive, and statistically significant effect on the provision of water services ($\beta = 0.713$, $p = 0.006 < 0.05$). This implies that a one-unit improvement in integrating climate change strategies and considerations leads to an expected increase of 0.713 units in the effectiveness of water service delivery in Mandera County. The t-statistic of 16.489 further supports the significance of this relationship. The null hypothesis was rejected. The study adopted the alternative hypothesis that climate change integration is significantly associated with the provision of water services in Mandera County. These results is in line with the findings of Hirji, Nicol, and Davis (2017), who examined climate change integration in South Asia and found that changing precipitation patterns, melting glaciers, and weak governance mechanisms negatively affected water systems.

5.0 Conclusion

Climate change integration into water planning and service delivery frameworks has emerged as a necessary strategy for enhancing system resilience and sustainability. In the face of increasing climate variability, including unpredictable rainfall and recurring droughts, Mandera County's institutions are increasingly incorporating climate risk assessments and adaptation measures into

their programming. These efforts have strengthened long-term sustainability by aligning infrastructure development and service delivery with projected environmental changes.

Programs that include early warning systems, community sensitization, and the use of climate-smart technologies such as solarized boreholes demonstrate growing institutional commitment to adaptive planning. Nonetheless, variability in institutional capacity and access to climate expertise reveals gaps that hinder the uniform application of climate-responsive practices. Some institutions lag in integrating long-term climate scenarios into project designs or maintaining effective partnerships with climate experts. Addressing these gaps requires targeted training, cross-sectoral partnerships, and the institutionalization of climate foresight within planning processes. Going forward, climate resilience should be treated not as a parallel initiative, but as a central pillar of water governance and infrastructure development in arid and semi-arid lands.

6.0 Recommendations

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.

REFERENCES

Aquino, E., Lee, Y. M., Spawn, N., & Bishop-Royse, J. (2018). The impact of burnout on doctorate nursing faculty's intent to leave their academic position: A descriptive survey research design. *Nurse education today*, *69*, 35-40.

Awandu, W., Kanda, E. K., & Kimokoti, S. N. (2024). The water-energy-food nexus in Kenya: Climate change impacts and adaptation strategies—A review. *The Water, Climate, and Food Nexus: Linkages, Challenges and Emerging Solutions*, 59-70.

Bazaanah, P., & Mothapo, R. A. (2024). Sustainability of drinking water and sanitation delivery systems in rural communities of the Lepelle Nkumpi Local Municipality, South Africa. *Environment, Development and Sustainability*, *26*(6), 14223-14255.

Buser, M. (2024). Care and Water Security. *Ecologies of Care in Times of Climate Change*, 18-37.

Cherlet, J., & Venot, J. P. (2013). Structure and agency: Understanding water policy changes in West Africa. *Water Policy*, *15*(3), 479-495.

Cho, W. H. (2019). Role of transfers in the provision of water: An application to public-private partnership and its impact on social welfare.

Constant, T., Charrière, S., Lioeddine, A., & Emsellem, Y. (2016). Use of modelling to protect, plan, and manage water resources in catchment areas. *Environmental Science and Pollution Research*, *23*(16), 15841-15851.

Crossan, F. (2003). Research philosophy: towards an understanding. *Nurse Researcher (through 2013)*, *11*(1), 46.

DiMaggio, P. J. (1988). Interest and agency in institutional theory. *Institutional Patterns and Organizations: Culture and Environment*, 3-21.

DiMaggio, P. J., & Powell, W. W. (1983). The iron cage revisited: Institutional isomorphism and collective rationality in organizational fields. *American Sociological Review*, *48*(2), 147-160.

Eweet, J. T., & Muna, W. (2022). Effects of Water Policy Implementation and Management of Common Pool Resources in Turkana County, Kenya. *Journal of Public Policy & Governance*, *6*(2), 72-85.

Fardowsa, A. (2024). *Assessment of Water Quality in Some Distribution Tankers and Boreholes in Selected Areas of Nairobi County* (Doctoral dissertation, University of Nairobi).

Gachenga, E. W. (2012). Integrating customary and statutory law systems of water governance for sustainable development: The case of the Marakwet of Kenya. University of Western Sydney (Australia).

Hall, R. (1992). The strategic analysis of intangible resources. *Strategic Management Journal*, *13*(2), 135-144.

Hassan, H. A. (2025). Egypt's Water Policy and the Challenges of the Grand Ethiopian Renaissance Dam (GERD). In *Nile Basin Politics* (pp. 65-87). Edward Elgar Publishing.

Hirji, R., Nicol, A., & Davis, R. (2017). South Asia climate change risks in water management. Hirji, R., Nicol, A., & Davis, R. (2017). South Asia climate change risks in water management.

Howard, G., Calow, R., Macdonald, A., & Bartram, J. (2016). Climate change and water and sanitation: likely impacts and emerging trends for action. *Annual review of environment and resources*, *41*, 253-276.

Koehler, J., Rayner, S., Katuva, J., Thomson, P., & Hope, R. (2020). A cultural theory of drinking water risks, values and institutional change. *Global Environmental Change*, *61*, 102061.

Kumar, R., Singh, C. K., Misra, S., Singh, B. P., Bhardwaj, A. K., & Chandra, K. K. (2024). Water biodiversity: Ecosystem services, threats, and conservation. In *Biodiversity and Bioeconomy* (pp. 347-380). Elsevier.

Lebu, S., Lee, A., Salzberg, A., & Bauza, V. (2024). Adaptive strategies to enhance water security and resilience in low-and middle-income countries: A critical review. *Science of the Total Environment*, 171520.

Lee, K. E., Mokhtar, M., Hanafiah, M. M., Halim, A. A., & Badusah, J. (2016). Rainwater harvesting as an alternative water resource in Malaysia: potential, policies and development. *Journal of Cleaner Production, 126*, 218-222.

Liddle, E. S., & Fenner, R. (2017). Water point failure in sub-Saharan Africa: The value of a systems thinking approach. *Waterlines, 36*(2), 140-166.

Marks, S. J., & Kumpel, E. (2018). Understanding user preferences and willingness to pay for water quality improvements in small town water services. *Water Resources and Economics, 24*, 28-45.

Meyer, J. W., & Rowan, B. (1977). Institutionalized organizations: Formal structure as myth and ceremony. *American Journal of Sociology, 83*(2), 340-363.

Mumma, A. (2007). Kenya's new water law: an analysis of the implications of Kenya's Water Act, 2002, for the rural poor. In Community-based water law and water resource management reform in developing countries (pp. 158-172). CABI.

Mutschinski, K., & Coles, N. A. (2021). The African Water Vision 2025: its influence on water governance in the development of Africa's water sector, with an emphasis on rural communities in Kenya: a review. *Water policy, 23*(4), 838-861.

Nganyanyuka, K., Martinez, J., Wesselink, A., Lungo, J. H., & Georgiadou, Y. (2018). Working with the grain: How amenable to digital transformation are the monitoring and repair of rural water points in Tanzania? *Information Technologies & International Development, 14*, 103-121.

Nwokediegwu, Z. Q. S., Adefemi, A., Ayorinde, O. B., Ilojianya, V. I., & Etukudoh, E. A. (2024). Review of water policy and management: Comparing the USA and Africa. *Engineering Science & Technology Journal, 5*(2), 402-411.

Nyanchaga, E. N. (2016). *History of water supply and governance in Kenya (1895-2005): Lessons and futures.* African Books Collective.

Oates, N., Ross, I., Calow, R., Carter, R., & Doczi, J. (2019). Adaptation and resilience in water management: A review of current approaches. *Water and Climate Change, 10*(2), 434- 457.

Obosi, J. O. (2017). Impact of public-private partnership on water service delivery in Kenya. *Open Journal of Political Science, 7*(2), 211-228.

Obosi, O. J. (2011). Decentralized governance in water and sanitation service delivery: A case study of Kisumu municipality, Kenya. *African Journal of Political Science and International Relations, 5*(5), 282-293.

Ogendi, G. M., & Ong'oa, I. M. (2009). *Water policy, accessibility and water ethics in Kenya.*

Pache, A. C., & Santos, F. (2010). When worlds collide: The internal dynamics of organizational responses to conflicting institutional demands. *Academy of Management Review, 35*(3), 455-476.

Pandey, P., & Pandey, M. M. (2021). *Research methodology tools and techniques*. Bridge Center.

Powell, W. W., & DiMaggio, P. J. (Eds.). (1991). *The new institutionalism in organizational analysis.* University of Chicago Press.

Public participation and community engagement in domestic water supply management in Kenya. (2024). Retrieved from https://reachwater.uk/wp-content/uploads/2024/11/Public-participation-and-community-engagement-in-domestic-water-supply-management-v9.pdf

Quatember, A. (2019). A discussion of the two different aspects of privacy protection in indirect questioning designs. *Quality & Quantity*, *53*(1), 269-282.

Scanlon, B. R., Fakhreddine, S., Rateb, A., de Graaf, I., Famiglietti, J., Gleeson, T., & Zheng,

Scott, W. R. (2001). Institutions and organizations (2nd Ed.). Thousand Oaks, CA: Sage. Shamoo, A. E., & Resnik, D. B. (2009). *Responsible conduct of research*. Oxford University

Singh, A. S., & Masuku, M. B. (2014). Sampling techniques & determination of sample size in applied statistics research: An overview. *International Journal of economics, commerce and management*, *2*(11), 1-22.

Slovin, E. (1960). Slovin's formula for sampling technique. *Retrieved on February*, *13*, 2013.

Suda, A. O., Sušnik, J., Masia, S., & Jewitt, G. (2024). Policy coherence assessment of water, energy, and food resources policies in the Tana River Basin, Kenya. *Environmental Science & Policy*, *159*, 103816.

UN-Water. (2007). Coping with water scarcity: Challenge of the twenty-first century. United Nations.

Van der Zaag, P., & Savenije, H. H. (2014). Integrated water resources management: Concepts and issues. Physics and Chemistry of the Earth, Parts A/B/C, 33, 290-298.

Van Vliet, M. T., Wiberg, D., Leduc, S., & Riahi, K. (2016). Power-generation system vulnerability and adaptation to changes in climate and water resources. *Nature Climate Change*, *6*(4), 375-380.

World Water Council. (2000). Vision 21: The shared vision of the water community. World Water Council.

Wuijts, S., Van Rijswick, H. F., Driessen, P. P., & Runhaar, H. A. (2023). Moving forward to achieve the ambitions of the European Water Framework Directive: Lessons learned from the Netherlands. *Journal of Environmental Management*, *333*, 117424.

Zucker, L. G. (1977). The role of institutionalization in cultural persistence. *American Sociological Review, 42*(5), 726-743.

Zucker, L. G. (1987). Institutional theories of organization. *Annual Review of Sociology, 13*(1), 443-464.