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Assessing the state of domestic water sources in rural communities in South Africa

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ABSTRACT

Access to clean drinking water is a fundamental necessity for human health and well-being, yet it remains a challenge in many rural communities. Sustainable Development Goal (SDG) 6, one of the 17 global goals set by the United Nations, seeks to ensure universal access to safe drinking water by 2030, recognising its critical role in sustainable development. This study examines the state and categorisation of domestic water sources in rural communities, focusing on their implications for household water security. A quantitative approach was employed in a local municipality in South Africa, targeting 282 households selected through stratified random sampling across 17 wards. Data was collected using structured survey questionnaires and analysed using descriptive statistics in SPSS. Findings reveal that while piped water infrastructure exists, a significant proportion of households still depend on springs and rivers, raising concerns about reliability, quality, and long-term sustainability. The study concludes that rural water insecurity persists and recommends that local government authorities prioritise the expansion of borehole infrastructure and enhance the reliability of piped water systems to improve household water security in underserved areas.The study is significant in that access to safe and reliable water is a fundamental human right crucial for health, hygiene, and overall well-being. The study provides essential data on the quality and sustainability of rural water sources, enabling policymakers and development agencies to design targeted interventions. The supports better resource allocation, community-based management, and progress towards water security and socio-economic development goals.

Keywords: Domestic water sources, Reliability, Water insecurity, Water security

INTRODUCTION

Access to safe and reliable domestic water is essential for human well-being, yet rural communities globally, particularly in South Africa, continue to face persistent water insecurity.[1] Domestic water sources, which include rivers, springs, boreholes, rainwater harvesting systems, and piped schemes, are

[1] Joan Nyika and Megersa Olumana Dinka, *Water Challenges in Rural and Urban Sub-Saharan Africa and Their Management* (Springer, 2023).

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critical for daily household functions such as drinking, cooking, sanitation, and gardening.[2] Domestic water sources vary considerably in type and reliability, shaped by factors such as geography, climate, and socioeconomic conditions.[3] While urban water challenges often stem from infrastructure issues, rural areas rely heavily on informal or multiple sources, many of which are unsafe or seasonal, increasing vulnerability and limiting consistent access.[4]

In Sub-Saharan Africa, and notably in South Africa's provinces, rural communities face compounded challenges despite the availability of diverse water sources.[5] The local municipality under study exemplifies this situation, where households depend on unprotected sources such as rivers, springs, and shallow wells.[6] Although policies exist to promote universal access to water, studies in the region often overlook the specific types and characteristics of domestic water sources.[7] Most research treats water sources as peripheral to broader themes like water conservation or groundwater potential, leaving a gap in understanding how the nature of these sources affects rural household water security.[8]

The state of domestic water sources in rural South Africa is marked by a complex interplay of environmental, infrastructural, and socio-political challenges that undermine water availability, functionality, and reliability.[9] Climate change has intensified droughts and disrupted rainfall patterns, placing immense pressure on already scarce water resources. Compounding this are ageing and poorly maintained water infrastructure systems, which frequently break down and result in significant water losses.[10] Governance issues, including weak institutional coordination, corruption, and inadequate municipal capacity, further hinder effective water service delivery.[11] Financial constraints, especially in under-resourced rural municipalities, limit the ability to invest in sustainable water infrastructure and maintenance. Social inequalities rooted in historical marginalisation continue to affect access, with women and children disproportionately burdened by the need to collect water from distant or unsafe sources.[12] These challenges collectively compromise household water security, exposing communities to health risks, disrupting education, and exacerbating poverty and social tensions. Addressing these issues requires integrated, community-driven solutions that combine technological innovation, improved governance, and equitable resource allocation.

To address the gap, the present study focuses on categorising and analysing the state of domestic water sources used by rural households in a local municipality, which may give rise to future water challenges. By foregrounding rural water use's diversity and lived realities, the research offers a more nuanced and context-sensitive perspective that can inform targeted interventions.[13] The approach contributes meaningfully to the broader discourse on water insecurity by recognising that sustainable solutions must begin with a detailed understanding of source-specific dynamics in rural settings.[14]

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[2] Olutayo Oyeyemi Oyerinde and Ada Mukanya Dienga, "Immediate and Long-Term Impact of the COVID-19 Pandemic on South African Higher Education," *Tuning Journal for Higher Education* 11, no. 1 (2023): 295–326.

[3] Samuel Kojo Abanyie et al., "Sources and Factors Influencing Groundwater Quality and Associated Health Implications: A Review," *Emerging Contaminants* 9, no. 2 (2023): 100207.

[4] Nyika and Dinka, *Water Challenges in Rural and Urban Sub-Saharan Africa and Their Management*.

[5] Nyika and Dinka, *Water Challenges in Rural and Urban Sub-Saharan Africa and Their Management*.

[6] Estella Mgala et al., "Enhancing Access to Underutilized Ground Water Potential for Improving Livelihoods and Conflict Reduction in Kagera Sub-Basin, Tanzania," *Frontiers in Water* 7 (2025): 1572231.

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LITERATURE REVIEW

Classifying Domestic Water Sources: Foundations for Equitable Access

A significant understanding of domestic water sources is essential for effective planning, equitable policy development, and sustainable service delivery in rural areas.[15] Although global scholarship has extensively examined water access and infrastructure, less attention has been paid to categorising the specific types of domestic water sources, especially in rural settings.[16] Yet, source type is crucial in shaping water quality, reliability, and household accessibility.[17] Scholars elsewhere have identified five primary categories of domestic water sources: piped water, groundwater (boreholes and wells), surface water (rivers and streams), springs, and rainwater harvesting systems.[18] Each type of water source has distinct infrastructural and environmental conditions that affect its usability policy responses, which risk being misaligned with local realities without disaggregating these categories and assessing their performance.[19]

Surface and Groundwater Sources: Traditional Reliance and Emerging Challenges

Surface water, including rivers and streams, remains vital in rural communities lacking formal infrastructure.[20] These sources are often freely accessible but carry significant risks. Streams, for instance, are highly susceptible to seasonal fluctuations and pollution from human and agricultural activities, compromising water safety.[21] Though more permanent, rivers share similar challenges, including contamination and complex access rights, especially in African contexts.[22] In South Africa, some rural-dominated provinces continue to rely on such sources due to gaps in piped water provision.[23]

Groundwater sources like springs and boreholes are often considered safer and more reliable alternatives. Springs, being naturally filtered, typically provide clean water with minimal treatment but are increasingly vulnerable to ecological changes, overuse, and land degradation.[24] Boreholes promoted across Africa as sustainable solutions are standard in South African municipalities.[25] However, their effectiveness is hindered by poor maintenance, weak community management, and aquifer depletion.

Modern Interventions and Persistent Inequalities: Rainwater and Piped Systems

Alternative technologies like rainwater harvesting are gaining renewed attention in rural communities around the study area and formal water provisioning frameworks.[26] In rural areas, rainwater collected from rooftops and stored in tanks helps households cope with droughts and municipal supply failures.[27] This practice is widespread in South African provinces, with state-provided and privately acquired water

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[15] Mgala et al., "Enhancing Access to Underutilized Ground Water Potential for Improving Livelihoods and Conflict Reduction in Kagera Sub-Basin, Tanzania."
[16] Tshona, Lungisa, and Mgweba, "Thirsting for Solutions: Unpacking Inadequate Water Provision in Rural Communities."
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[24] Fahim Un Nisa and Rashid Umar, "Spring Water System Classifications and Their Methods of Study: An Overview of the Current Status and Future Perspectives," *Journal of Earth System Science* 133, no. 1 (2024): 10.
[25] Nisa and Umar, "Spring Water System Classifications and Their Methods of Study: An Overview of the Current Status and Future Perspectives."
[26] Ismaila Rimi Abubakar, "Understanding the Socioeconomic and Environmental Indicators of Household Water Treatment in Nigeria," *Utilities Policy* 70 (2021): 101209.
[27] Samuel Matyanga, "Assessing the Potential of Rainwater Harvesting for Sustaining Small Scale Irrigated Coffee Farming in the Bigasha Watershed, Uganda2023," 2023.

tanks in use. However, infrastructure access and affordability disparities exacerbate water insecurity, as not all households can sustain or maintain these systems.[28]

Piped water, often seen as the most desirable solution, is far from universally reliable in rural South Africa.[29] Though it significantly reduces physical labour and improves hygiene, its benefits are undermined by systemic governance failures, decaying infrastructure, and limited reach.[30] When piped systems fail, communities must revert to informal and often unsafe alternatives, creating a cyclical dependency on inferior sources. While previous South African studies have explored aspects such as groundwater potential, water conservation, and drinking water quality, few have systematically examined the full diversity of domestic water sources within a single rural district.[31] This oversight thus limits the development of targeted, sustainable water interventions, especially in rural communities.

The literature reviewed emphasises the need to categorise and analyse the domestic water sources used in rural communities. In doing so, researchers and policymakers can develop a precise understanding of rural water insecurity. This study responds to that need by focusing on a local municipality dominated by rural communities in South Africa, aiming to offer a comprehensive framework that aligns domestic water source classification with real challenges experienced by rural communities.

THEORETICAL FRAMEWORK

The Sustainable Livelihoods Framework (SLF) was initially developed by the United Kingdom (UK) Department for International Development (DFID) in the late 1990s, with the framework formally published in 1999.[32] SLF, thus, is a suitable theoretical framework for this study since it offers a holistic lens to understand how rural households access, use, and are affected by different domestic water sources.[33] The SLF emphasises the relationship between five types of capital: natural, physical, human, financial, and social and how these influence people's ability to achieve water security and sustain their well-being.[34] In the context of the study area and the rural communities of a local municipality, this framework explores how households mobilise various forms of capital to access water from diverse sources (e.g., rivers, boreholes, rainwater tanks) within infrastructural, environmental, and governance constraints. The SLF offers a practical, context-sensitive way to examine water access challenges in underserved rural communities by recognising domestic water sources as essential assets and potential vulnerabilities within livelihood systems.

METHODOLOGY

This study employed a quantitative research design to examine the categorisation and usage patterns of domestic water sources across rural communities that belong to a local municipality in South Africa. A stratified random sampling strategy was used to ensure representativeness across the district's diverse geographical and administrative divisions. Rural communities were stratified by ward, and random selection within each stratum ensured proportional representation. Participants were chosen within selected communities based on their role in household water management, typically adult members responsible for water sourcing. A total of 282 households from 21 villages participated. This method, grounded in prior demographic data, helped ensure data validity by minimising duplication and focusing on informed respondents.

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[28] Matyanga, "Assessing the Potential of Rainwater Harvesting for Sustaining Small Scale Irrigated Coffee Farming in the Bigasha Watershed, Uganda2023."

[29] Abanyie, Amuah, and Nang, "Water Scarcity and Its Implications on Sanitation: A Perspective Study in an Emerging City in Northern Ghana."

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Data Collection Tool

The data was collected using a structured questionnaire comprising closed-ended questions covering water sources' types, their reliability and accessibility, collection frequency, and perceived challenges. Questionnaires were administered through in-person interviews, with real-time translation into the local language to accommodate varying literacy levels. This inclusive approach enhanced response clarity and accuracy.

Data Analysis

The collected data were coded, cleaned, and analysed using IBM SPSS Statistics Version 27. Hence, descriptive statistics, frequencies, percentages, and cross-tabulations were employed to categorise water sources and evaluate their reliability, availability, and access distance.

Ethical Considerations

The research adhered to all ethical standards. The Faculty Research Ethics Committee granted clearance. No personally identifiable information was collected, and the data was used solely for academic purposes, ensuring confidentiality and ethical integrity throughout the research process.

PRESENTATION OF FINDINGS

Table: Domestic Water Sources

Questions		Frequency	percentage
Domestic water sources	Tap	155	55.0
	Tank	11	3.9
	Stream	10	3.5
	Borehole	47	16.7
	Spring	59	20.9
	Total	282	100.0
Are your water sources protected from contact with animals?	Yes	163	57.8
	No	119	42.2
	Total	282	100.0
Type of Protection material	Fence	69	24.5
	Other	97	34.4
	Not applicable	116	41.1
	Total	282	100.0
In your observation, what is the physical condition of your domestic water source?	Good	131	46.5
	Fair	86	30.5
	Poor	65	23.0
	Total	282	100.0

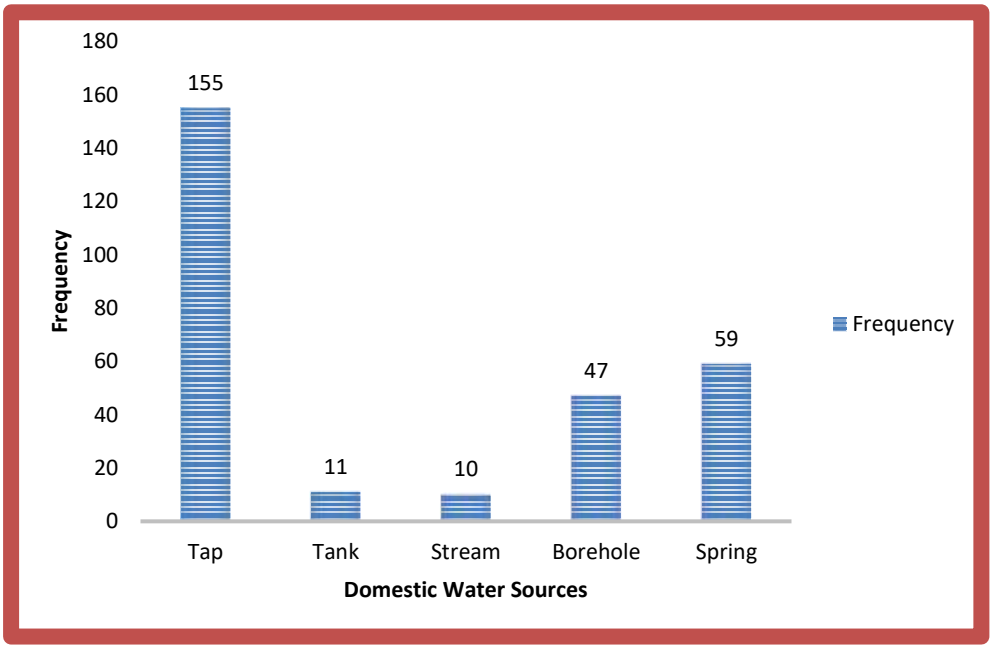

Figure 1 : Domestic Water sources

Figure 2: Domestic Water Sources in rural communities of South Africa

As indicated in Table 1 and Figure 1 above, the findings show that taps are the most used domestic water source in this local municipality, accessed by 55% of households. Other sources include springs (20.9%) and boreholes (16.7%), while streams (3.5%) and water tanks (3.9%) are less frequently used. This reflects a mixed reliance on the area's formal and informal water systems.
Regarding protection, 57.8% of households state that their water sources are protected from animal contact, while 42.2% indicate otherwise. When asked about the type of protection, 24.5% reported using fencing, and 34.4% mentioned other materials, whereas 41.1% noted that no protection was applicable, likely reflecting households without control over the water source. Regarding perceived physical condition, 46.5% of respondents rate their water source as good, 30.5% as fair, and 23% as poor. These findings suggest that while over half of the population has access to protected and relatively well-maintained water sources, a significant portion still relies on vulnerable and potentially unsafe sources.

DISCUSSION

The study's findings provide a detailed empirical account of the distribution and use of various domestic water sources in the rural communities of a local municipality. As quantified in Table 1 and illustrated in Figure 1, community taps are the most frequently used source (55%), followed by springs (20.9%), boreholes (16.7%), tanks (3.9%), and streams (3.5%). The findings highlight the relative progress made by the municipality in expanding access to piped water infrastructure, particularly through communal taps. The observation noted an increasing commitment by South African local municipalities to improve rural water supply systems through piped connections.[35] Nevertheless, despite this apparent progress, a significant portion of the population remains reliant on open and natural sources (Figure 2), highlighting the persistence of infrastructural and equity challenges in rural water provisioning.[36]

The importance of spring water use, which ranks just below communal taps, highlights the local population's ongoing reliance on groundwater-fed natural sources. Springs are often more accessible in certain terrains and are frequently considered cleaner and safer than surface water sources.[37] Similarly, boreholes that are used by 16.7% of households further reflect the strategic reliance on groundwater to meet domestic water needs. These findings validate the suitability of the Sustainable Livelihoods Framework (SLF) as the theoretical underpinning for this study, as it captures how rural households mobilise natural and physical capital, in this case, local water infrastructure and natural hydrological features, to secure daily water access.[38]

Rainwater tanks, although used by only 3.9% of households, serve as critical fallback options, especially during the dry season or when piped systems fail.[39] As rainwater harvesting strategies are increasingly recognised, even in urban contexts, they have become sustainable interventions to manage intermittent supply.[40] Yet, in the context of a local municipality, their limited use may reflect unequal access due to financial constraints, infrastructure availability, or varying awareness levels. This also emphasises the relevance of economic capital within the SLF framework, as only households with sufficient resources can afford to install and maintain these systems.[41]

Interestingly, while only a small percentage (3.5%) of respondents explicitly reported using rivers or streams as water sources, community observations indicated that many households rely on sources like the main river during dry spells (Figure 2).[42] Therefore, the dependence on open water sources is higher than the survey data might initially suggest, especially during winter when alternative sources become unreliable. Furthermore, the usage patterns highlight the vulnerability context outlined

[35] Matyanga, "Assessing the Potential of Rainwater Harvesting for Sustaining Small Scale Irrigated Coffee Farming in the Bigasha Watershed, Uganda2023."
[36] Tshona, Lungisa, and Mgweba, "Thirsting for Solutions: Unpacking Inadequate Water Provision in Rural Communities."
[37] Nisa and Umar, "Spring Water System Classifications and Their Methods of Study: An Overview of the Current Status and Future Perspectives."
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[40] Matyanga, "Assessing the Potential of Rainwater Harvesting for Sustaining Small Scale Irrigated Coffee Farming in the Bigasha Watershed, Uganda2023."
[41] Abubakar, "Understanding the Socioeconomic and Environmental Indicators of Household Water Treatment in Nigeria."
[42] Mishra, "Fresh Water Availability and Its Global Challenge."

in the SLF, where seasonal and environmental stressors force households to adapt their water-sourcing strategies.[43]

Regarding source protection, only 57.8% of the respondents indicated that their water sources were protected from animal contact (Table 1). Such a percentage reflects ongoing exposure to health hazards, particularly those dependent on the surface or unprotected groundwater sources.[44] The study findings are linked to the study's methodology, which used stratified sampling and structured questionnaires to ensure data captured source diversity and participants' experiences across varying demographic and geographic contexts.[45] The results suggest the need for targeted interventions that focus on expanding infrastructure and enhancing the safety and sustainability of existing water sources.

RECOMMENDATIONS

The study recommends that each community must have categories of water sources that are always reliable and available, and the government should intervene by providing sustainable water sources. For short-term relief, the municipality should provide water trucks to deliver water to at-risk communities, those that rely only on rivers and springs, and those with taps not working or broken. More boreholes can be drilled in the area, and taps can be supplied and repaired for long-term relief. The study recommends that the water sources be fenced appropriately to protect them from littering and sharing with animals. This requires active collaboration between communities and the municipality. Regular evaluation and monitoring of existing water infrastructure must be prioritised to rescue the area from water insecurity challenges. Monitoring mechanisms and personnel must be established to report daily to the municipality. The monitoring mechanism will aid in water infrastructure sustainability while ensuring people have adequate water supplies. The study further recommends that stakeholders in the area collaborate to assist with the water challenges. The local communities, the government, non-governmental organisations (NGOs), universities, and businesses should address the water challenge issues by considering potential funding opportunities. These stakeholders must further develop educational programs to empower communities to manage water sources. Possible funding opportunities must be explored to assist in purchasing infrastructure and donations while universities research sustainable water supply and water-saving systems. Local communities are at the core of these challenges; without their involvement and support, the challenges will continue. Local communities must, therefore, be actively involved in any decision-making concerning their communities' water issues. Educational programs and awareness of water conservation also require the local communities to participate.

CONCLUSION

This study has explored how five types of capital (natural, physical, human, financial, and social) shape household water security and overall well-being in South Africa. The study's findings confirm that a complex relationship between socioeconomic status, physical environment, and institutional capacity shapes rural water access in the local municipality. By applying a structured, quantitative approach and grounding the analysis in the Sustainable Livelihoods Framework, the study provides a significant understanding of how domestic water sources are categorised, accessed, and managed. These insights are essential for informing more inclusive and context-responsive water governance strategies in rural South Africa and future studies on the reliability and quality of water sources in rural communities.

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