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Documentation of wells around Lenyenye Greater Tzaneen as a potential water resource to bit water scarcity for sustainable use

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Abstract

This study documented wells around Lenyenye in the Greater Tzaneen Municipality as potential resources to address water scarcity and promote sustainable use. Employing a cross-sectional research design, data were collected using a questionnaire administered to a sample of 310 respondents. The sample was drawn from six local municipality areas using multi-stage sampling techniques. The questionnaire was distributed via simple random sampling to household heads: 55 questionnaires were given to each of two randomly selected communities, while three other communities received 45 each, totaling 310 questionnaires. Data were analyzed using tables and simple percentages. The findings revealed that while wells in Lenyenye and surrounding areas are well-known, they are not widely used for drinking water except by those with limited access when municipal taps are dry. Most water in the area comes from streams and rivers. To prevent waterborne diseases, regular maintenance of wells is necessary. This study addresses the knowledge gap regarding wells, challenging negative perceptions and emphasizing their importance. Recommendations include documenting all wells for future use and incorporating them into municipal water data storage. This research aims to enhance understanding of groundwater resources and underscores the significance of wells alongside other water sources like rivers, wetlands, and surface water.

Keywords: Water, Borne diseases, wells, drinking, rivers

1. Introduction

Water is a critically scarce resource. Approximately two-thirds of the global population, or around 4 billion people, are estimated to experience acute water scarcity at least once a year (Mekonnen and Hoekstra, 2016). In developing countries, women (64%) and girls (8%) spend billions of hours annually fetching water (Hutton and Chase, 2016). Private wells can become contaminated through rainfall and snowmelt, which can introduce pathogens into the well system. Additionally, microorganisms may enter wells from waste leakage from underground storage tanks and septic fields (Mishra and Dubey, 2015; USGS, 2019; UNESCO, 2020). Health issues related to contaminated water are widespread in areas with limited water supplies (Hunter, MacDonald & Carter, 2010; Gusikit & Lar, 2014; Tarrass & Benjelloun, 2012). Water scarcity increases health risks for vulnerable populations by exposing them to contaminated water, poor hygiene, and unsanitary conditions, with Sub-Saharan Africa being especially affected due to inadequate infrastructure (Hunter, MacDonald & Carter, 2010; Tarrass & Benjelloun, 2012; Utsei, 2012; WHO, 2024).

Groundwater resources are significantly impacted by factors such as pollution, climate change, rising population density, and agricultural practices, all of which contribute to increased water demands and contamination. Although groundwater is more resilient to climate change than surface water, it is increasingly stressed by human activities and climate variability (van der Gun, 2012). Modern water wells, though technologically advanced, face challenges from the effects of climate change and other human activities, stressing the 30.1% of Earth's freshwater found in groundwater (Twinomucunguzi et al., 2021). Integrated Water Resources Management (IWRM) offers a comprehensive framework for balancing water use among various stakeholders and the environment, with data, technology, and communication playing vital roles.

The quality of groundwater globally is declining due to urbanization, waste disposal, mining, industrialization, and agriculture (Kazakis & Voudouris, 2015; Moldovan et al., 2020), leading to potential health risks. In South Africa, despite access to safe drinking water through distribution systems and controlled standpipes, many people still rely on well water, particularly in rural and suburban areas. Ensuring groundwater sustainability requires the engagement of all key stakeholders. The complexities of managing internationally shared groundwater resources are compounded by the lack of legal frameworks and limited understanding of transboundary groundwater issues (van der Gun, 2012).

Freshwater is derived from rivers, lakes, wetlands, groundwater, and ice fields, with groundwater being essential for both human and ecological needs. However, groundwater-dependent ecosystems are increasingly threatened by rising human water demands. Pollution from various contaminants, including bacteria, fungi, parasites, inorganic substances, pesticides, herbicides, organic chemicals, ammonia, nitrate, and radioactive materials, poses significant health risks (Annual Drinking Water Quality Report, 2010; Al-Tomi, 2007).

The influx of rural migrants into urban centers has placed substantial pressure on municipalities to provide adequate water supplies (Beckh, 2013). Demographic and socioeconomic factors driving urban water shortages include the search for employment and improved municipal services by rural populations (Cahill et al., 2017). Enhancing municipal services in rural areas and ensuring effective governance can help mitigate urban water demand (Fan, 2015). Contaminated water from poor-quality sources remains a major cause of health issues, such as throat infections (Duke et al., 2006). There is a significant gap in identifying groundwater resources like springs and wells in rural areas since 1994. This study aims to document wells in the Lenyenye Greater Tzaneen area as a potential resource to address water scarcity and promote sustainable use. Access to safe drinking water is crucial for preventing water-related illnesses, and in Africa, around 320 million people still lack clean water sources (Adelana & MacDonald, 2008). The study's main objective is to identify wells and springs in the Lenyenye suburbs of Greater Tzaneen, Limpopo Province.

2. Methodology

2.1. Global Water Scarcity

Currently, 2.3 billion people live in water-stressed countries, with 733 million residing in areas of high or critical water stress (UN-Water, 2021). An additional 3.2 billion people live in agricultural regions facing high to very high water shortages, and 1.2 billion of these individuals, or roughly one-sixth of the world's population, experience severe water constraints in agricultural settings (FAO, 2020). Additionally, 1.42 billion people, including 450 million children, are situated in regions with high or extremely high water vulnerability (UNICEF, 2021). Approximately 4 billion people, nearly two-thirds of the global population, endure severe water scarcity at least once annually (Mekonnen and Hoekstra, 2016). Agriculture accounts for 72% of global water withdrawals, municipalities for 16%, and industries for 12% (UN-Water, 2021). A territory is classified as 'water-stressed' when it withdraws 25% or more of its renewable freshwater resources. Currently, five out of eleven regions exceed this threshold, with two regions experiencing high water stress and one facing extreme stress (UN-Water, 2021).

2.2. Water Projects and Technology Transfer in Developing Countries

Implementing water projects and transferring technology to developing countries is a key strategy for addressing water pollution in Africa. Climate change and water shortages are having severe impacts in the region. One approach to mitigate these issues is transferring water conservation techniques from industrialized nations to areas with severe water scarcity. However, challenges persist due to economic limitations and skill shortages, often involving governmental and corporate stakeholders. The global water crisis is exacerbated by climate change and population growth (Hutton and Chase, 2016). Additionally, human activities are increasingly contaminating water resources, highlighting the need for effective regulatory systems to manage and protect these vital resources (Brookes, 2017; WWAP, 2015).

Groundwater typically forms through secondary porosity, which involves geological processes like fracturing, karstification, and the development of dolerite dyke compartments (Gieske, 1992; Ranganai et al., 2001; Pietersen et al., 2011; Altchenko et al., 2016). Protecting drinking water involves community-based efforts in watershed management, focusing on minimizing potential impacts, assessing contamination sources, and implementing protective measures.

2.3. Understanding Groundwater Recharge

Groundwater recharge is the process by which water enters a groundwater reservoir, replenishing groundwater supplies and influencing variations in groundwater levels (Lerner et al., 1990; Todd and Mays, 2005). Recharge involves the movement of water into the saturated zone in various directions upward, downward, or laterally. Accurate definitions of recharge are crucial for this study, which considers methods such as artificial recharge through infiltration ponds or injection wells, inter-aquifer flow, and enhanced recharge from nearby surface water bodies (Lerner, 1997; de Vries and Simmer, 2002; Healy and Cook, 2002; Scanlon et al., 2002; Xu and Beekman, 2003).

2.4. Collaboration with Water Utilities

Water utilities play a vital role in supporting source water protection by providing information, safety monitoring, and emergency response services. They promote source protection, produce annual reports on water quality (e.g., consumer confidence reports), and offer public engagement opportunities such as water board meetings and open forums. Utilities also identify potential contamination sources, coordinate with stakeholders, and collaborate with property owners and managers of pollution sources.

2.5. Access to Drinking Water and Household Waste Treatment in Rural Areas

In rural areas, most people access drinking water from drilled underground wells on their property. Unlike urban water sources, this water is often untreated before reaching homes, making the location and security of the well crucial. Groundwater pollution, which occurs when contaminants seep into the soil, can compromise water safety. Regular testing and treatment of well water are essential. Household wastewater in rural areas is usually managed through holding tanks or septic systems, with septic fields allowing effluent to percolate into the soil. Regular removal of solids by pump trucks and effective stormwater management are also necessary to prevent pollution and runoff.

2.6. The Water Crisis in Rural South Africa

Disparities in water access between urban and rural areas are significant, with rural households frequently lacking consistent, clean water sources (South African Human Rights Commission, Year). This often forces residents to use unsafe water from streams and open wells (Adelana & MacDonald, 2008).

2.7. Importance of Accessible and Affordable Water Treatment

Inadequate water treatment in rural communities often results in reliance on contaminated water sources, leading to health issues and waterborne diseases. These problems not only affect physical health but also diminish overall quality of life. The prevalence of diseases like cholera and diarrhea is higher in areas with poor water treatment, posing serious risks, particularly for children and the elderly. Accessible and affordable water treatment is crucial for improving health and quality of life in these communities by reducing the risk of waterborne illnesses (WHO, 2024).

2.8. Rural Water Access and Treatment: In rural South Africa, many households rely on untreated well water due to limited access to municipal supplies (Beckh, 2013). The lack of proper water treatment often leads to increased health risks, as untreated water can carry harmful microorganisms (Duke et al., 2006).

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2.9. The Need for Continued Efforts in Rural Water Treatment

Affordable and accessible water treatment in rural South Africa is essential for the health and prosperity of communities. The scarcity of clean water poses serious challenges, and investing in sustainable water treatment solutions is necessary to address these issues. A successful strategy requires government support, innovative technologies, partnerships, and community engagement.

Collaborative efforts are crucial to providing equitable access to clean water and addressing the rural water crisis effectively.

2.10. Cost-Effectiveness of Investing in Rural Water Treatment

Investing in affordable and accessible water treatment for rural areas is both a moral and financially sound decision. Despite the initial costs, the long-term benefits of water treatment systems far outweigh the investment. Improved health outcomes, reduced healthcare costs, increased productivity, and enhanced economic activity are some of the advantages. Sustainable and decentralized water treatment methods can also be cost-effective by utilizing locally available resources and appropriate technologies. Community involvement and capacity building are key to ensuring the long-term success of water treatment programs.

3.Materials and methods

Study Area

The Greater Tzaneen Municipality encompasses the towns of Haenertsburg, Nkowankowa, Lenyenye, Letsitele, and Tzaneen. The study area also includes 125 rural communities, primarily located in the northeast and southeast, where approximately 80 percent of households reside. Lenyenye is a township situated within the Greater Tzaneen Local Municipality in the Mopani District Municipality of Limpopo Province, South Africa. Originally named Ramalema, Lenyenye is located about 20 km southeast of Tzaneen. The neighboring township of Nkowankowa lies directly to the north and is home to the Bakgaga people, with Sekgaga sa ga Maake being the predominant dialect spoken there. Lenyenye is notably recognized as the location where academic and politician Mamphela Ramphele was exiled under the apartheid regime, residing there from 1977 to 1984. The township covers an area of 8.81 km^2 (3.40 sq mi) and had a population of 12,099 in 2011 (Stats SA, 2011). According to the 2011 census, the racial composition was 99.2% Black African, 0.2% Coloured, 0.3% Indian/Asian, 0.1% White, and 0.1% Other.

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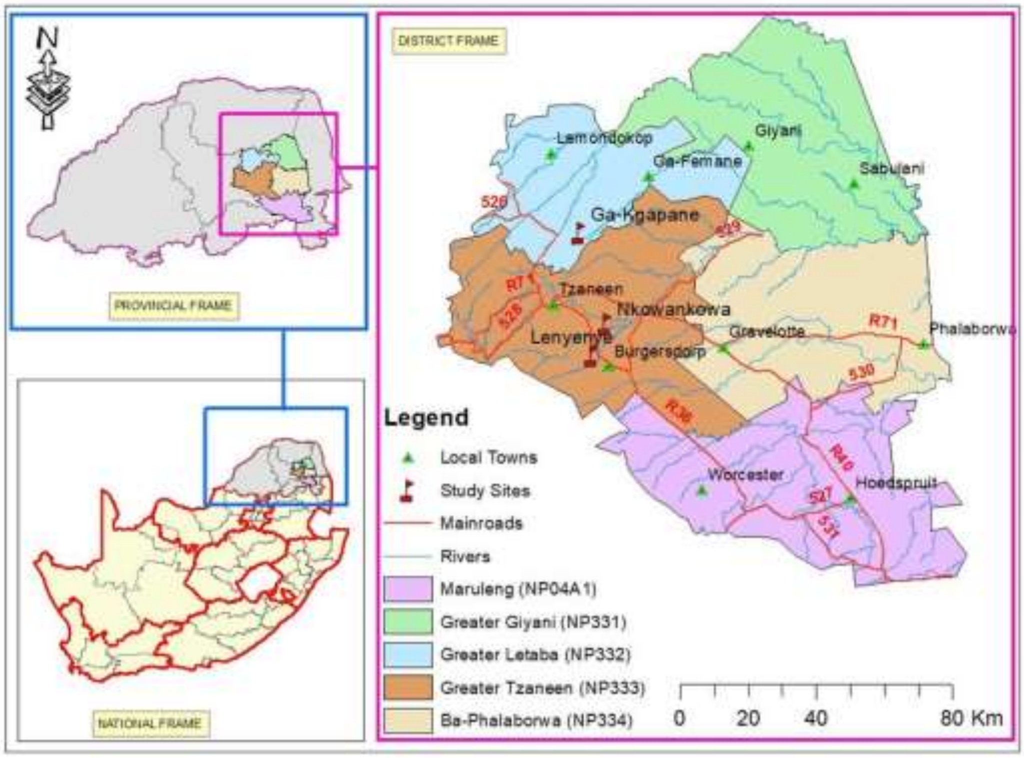

Figure 1: Geographic Location of Wells in Lenyenye, Tzaneen

Materials of the Study

The materials for this study include:

1. Geographic Data: Maps and geographic information systems (GIS) data of the Greater Tzaneen Municipality, including the towns of Haenertsburg, Nkowankowa, Lenyenye, Letsitele, and Tzaneen, as well as the 125 rural communities within the study area.
2. Demographic Data: Population statistics and census data from Stats SA (2011) detailing the racial composition and population size of Lenyenye and surrounding areas.
3. Historical Records: Documents and historical records related to Lenyenye's history, including its original name (Ramalema) and its significance as the location where Mamphela Ramphele was exiled during the apartheid regime.
4. Local Language Information: Data on the predominant languages spoken in the study area, particularly Sekgaga sa ga Maake in Nkowankowa.
5. Infrastructure Data: Information on the existing infrastructure in the towns and rural communities, including water sources, sanitation facilities, and public amenities.

6. Water Quality Reports: Data on water quality and access in the study area, including any available reports or studies on groundwater and surface water sources.
7. Health Data: Information on waterborne diseases and health issues related to water quality in the Greater Tzaneen Municipality and surrounding rural areas.
8. Field Survey Data: Data collected from field surveys and observations in the study area, including site assessments of water sources and infrastructure conditions.

These materials will be used to analyze the current water availability, quality, and infrastructure in the study area, and to assess the impact of these factors on the local communities.

Results and Findings

Our study, aligned with the research by Edokpayi et al. (2018) in rural areas of Limpopo Province, revealed that school children and some adults spend extensive hours collecting water from rivers and other sources due to extended periods without access to tap water. We observed that only a few residents possess water tanks, and these are primarily households from the middle-income bracket. In Lenyenye township, there is a municipal pipeline; however, when municipal taps are non-functional, residents often spend over an hour collecting water. During the survey, we documented twelve operational boreholes. A risk assessment of all identified wells was conducted to evaluate potential pollutants. It was found that eleven wells were contaminated with unwanted vegetation, tree logs, and old scrap metal. Additionally, three wells were covered with corrugated iron to prevent contamination.

Table 1: Table of wells, locations, and boreholes in Lenyenye In Greater Tzaneen

Name of the Location	Name of the Well	Description	Co-ordinates	Number of Borehole	Functional
Bokgaga	Mmanyepo	Still a normal well but mostly with little water during dry seasons	24°02’16” S 30°15’07”E	1	1
Lenyenye	Lerwatong	A normal well during rainy	23°57’41”S 30°16’54”E	1	1

		and dry seasons			
Lefara	Letlhabine	A normal well during rainy and dry seasons	23°56’56”S 30°17’43”E	2	1
Lefara	Kokongwini	Still a normal well but mostly with little water during dry seasons	23°57’08”S 30°19’08”E	3	2
Khopo	Mphukhule	Used to be a well. A dam was built on it, and now it's damaged and polluted.	23°58’06”S 30°17’54”E	2	1
Tickline	Bhafune	It used to be a well, but it has now changed into a small dam-like thing.	23°58’45”S 30°17’02”E	1	1
Mankwene	Phawone	A well during rainy seasons but dry during dry seasons.	23°59’05”S 30°18’40”E	1	1
Bokgaga	Bokgaga	Still a normal well.	24°01’15”S 30°14’37”E	1	1

Table 2: Risk assessment for the wells in Tzaneen

Risk identified	Yes /No	Number of wells affected	Percentage
Dumpers inside the wells	Yes	1	10%
Cow dungs	No	Nil	0
Plastics	No	3	30%
Papers	No	Nil	0%
Clothing	No	Nil	0%
Unwanted plants	Yes	1	10%
Dead animals' skins	No	Nil	0%
Dead animals (Dogs, Chicken)	No	Nil	0%
Tree Logs	Yes	2	20%
Sewage drainage	No	Nil	0%
Old scrap metals inside the water	Yes	1	10%
Covered with Corrugated iron for Pollution	Yes	3	30%
Odor/Bad smelling	No	Nil	0%

Table 3: Number of water sources and quantity collected

The main source of water	Number of Respondents %	Location of water source	Frequency use	Time spend collecting water	Estimation of Quantity of water stored
Rivers	6%	Outside	Sometimes	> 1hour	20 Litres Per person collected without a wheelbarrow
water tanker	98%	Inside Yard	When there is no water	< 10 minutes	1000 Litres
Municipal (piped)	98%	Inside Yard	Always	<5 minutes	
springs/wells	7%	Outside yard	Some times	<30 Minutes	20-40 Litres collected per person without a wheelbarrow and only if wells are functional
Borehole	32%	Outside Yard	Some times	< 20 Minutes	+_60 Liters

Each hamlet has its home borehole that was funded by wealthy respondents and others. In Lenyenye, households (outside the sample) additionally supplemented the water provided by the street taps by building individual polypipes from mountain streams to their homesteads. Since individual electric boreholes account for 32% of respondents' primary water source at homesteads in Bokgakga, as previously mentioned, individual self-supply is particularly prominent in that community. Aside from the fact that the much smaller amounts of water required for residential usage were available, the main incentive was the possibility of making net cash from productive water uses at their yards. Self-supply grafted onto public schemes takes the form of household connections from a common main line of a public system.98% of residents have municipal pipes in all communities of Lenyenye. Only 7% collected water from wells, and people mentioned that wells are most used by certain church members for their cultural and religious beliefs.

Table 4: Age group of the residents

Age Range	**Frequency**	**Percentage %**
18-35	90	23
35-40	70	26
41-50	80	33.5
51-60	54	13.5
60 and above	16	4
Total	310	100

Table 4 shows that 90 respondents are between the age range of 18-30 years, representing 23%. 90 respondents between the age range of 31-40 years represent 26% of the study population, and 70 respondents aged 41-50 years represent 33.5% each. 54 (13.5%) respondents are between the age range of 51-60 years. While respondents of 60 years and above represent only 4%.

Table 5: Gender

Gender	Frequency	Percentage %
Female	200	67.75
Male	110	32.25
Total	310	100

Table 6: Members

Household Members	Frequency	Percentage %
0-3	93	23.3
4-6	180	70
7 and above	37	6.7
Total	310	100

The number of household members is presented in table 5 above, 93 respondents, representing 23.3% have the number of household members between the range of 0-3. 180 (70%) respondents have household members in the range of 4-6, while 37 (6.7%) respondents have household members from 7 and above

Table 7: Education

Education	Frequency	Percentage %
Primary	95	23.7
Secondary	99	47.3
Tertiary	76	19
None	40	10
Total	310	100

Table 6 shows the educational status of respondents. Primary education with a frequency of 95, represents 23.7% of respondents. 99 (47.3%) respondents are educated to the secondary school level while 76 (19%) respondents are educated to the tertiary level. 40 (10%) respondents have no educational background

Income for communities

Response	Frequency	Percentage %
Less than 30,000	210	59.5
30,000 – 50,000	88	30.5
51,000 – 100,000	12	10
Above 100,000	0	0

Total	400	100

Table 8 shows the income level of respondents. 210 respondents, representing 59.5% earn less than R30,000 monthly. 88 (30.5%) respondents earn between R30,000 – R50,000 monthly. 12 respondents, representing 10% earn between R51,000 – R100,000, while none of the respondents (0%) indicated they earn above R100,000

5. Discussion

This study provides a comprehensive analysis of water quality and consumption patterns throughout the year in a low-resource rural community in South Africa. It examines various water sources, including municipal taps and natural sources, noting that a combination of these sources is used when municipal water is unavailable. During the wet season, two localities had consistent access to purified water from public taps or household connections (often a tap within a fenced yard). Although the quality of treated municipal water during the wet season was inferior to that of the dry season, it remained significantly better than most environmental sources. Consumption data indicated that supply interruptions were more frequent and lasted longer during the dry season, leading homeowners to store water for shorter periods. This variation in water availability likely affects home water quality, as evidenced by differences in stored water quality between households with continuous versus intermittent supplies.

Despite evidence that drinking water in these areas does not meet South African standards, survey data suggest that villagers perceive their water as high quality and, therefore, do not consistently use treatment methods. When treatment is applied, it is typically limited to boiling or allowing the water to settle. Additionally, even in households where treated water is stored, using a hand-held cup to retrieve water can increase the risk of recontamination. Municipal tap water often had negligible to no residual chlorine, which could further contribute to recontamination.

6. Conclusions

This study offers a thorough evaluation of well water quality and usage practices in Lenyenye Township, highlighting significant concerns related to microbiological contamination. The findings underscore that natural water sources, without adequate treatment, are likely to adversely affect consumer health. Local assessments of water quality are crucial for understanding variability and developing suitable interventions. Ensuring clean and safe drinking water in rural Limpopo should prioritize addressing microbiological contamination. Risk-assessment studies on the impact of water quality on human health are recommended. Limitations of the study include not assessing the type of water used at schools or the volume of water used for cooking. Further research into groundwater is essential due to the ongoing water scarcity challenges in the country.

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Conflicts of Interest.

The authors declare no conflict of interest.

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