2025, vol. 12, issue 1, 296 - 309

RESEARCH ARTICLE

https://doi.org/10.5281/zenodo.15804564

The effects of water scarcity on rural communities: A case of Ga-Dankie village, Blouberg Municipality

Gracious Mahlodi Mathekgana

Department of Public Administration, University of Limpopo, South Africa,
https://orcid.org/0009-0006-8277-7594

Abstract

The main objective of the study was to examine the effects of water scarcity in rural communities. The democratic South African government introduced services such as food and water provision to eradicate poverty in rural communities. However, to succeed in water supply, the local government must provide services to the area under its jurisdiction. In South Africa, the provision of water is a democratic right of each citizen. According to Section 27 of the Constitution, everyone has the right to have access, among other rights, to sufficient water and food. The first municipal elections were held in 2000, and the municipalities were formed as the third independent sphere of the government to address past injustices in providing portable water, sanitation, and refuse removal electricity through development projects.

The study adopted qualitative research methodology to understand the effect of water scarcity in rural communities. In the study, data collection instruments such as semi-structured questionnaires, interviews, and document study were used. In terms of qualitative research design, semi-structured questionnaires were used to collect data. Furthermore, purposeful and random sampling was used. The research findings revealed that there is water scarcity in the rural area that negatively affects the health of community members, agricultural activities, livestock, and businesses. The water supply in the rural area of the municipality is not satisfactory. As a result, this research advocates that the Blouberg Local Municipality should use the Intergovernmental Relations Forum to address the problem of water provision in the Ga-Dankie village.

Keywords: Water scarcity, rural communities, democratic, municipality

Introduction

Water plays a significant role in people's lives, economic welfare and productivity. It cannot be replaced but can be renewed for a limited quantity (Cosgrove and Loucks, 2015). Water scarcity is an increasing global crisis because the earth is facing a global water dilemma. It is a universal phenomenon that can be natural or human-made and has existed for many years (Chakraborti, Kaur, and Kaur, 2019). Human beings are the key driver of the environment and how it changes depends on them, their actions affect the precipitation distribution on watersheds and its runoff (Cosgrove and Loucks, 2015)

The demands of people are exhausting the water resources of the Earth. Human beings exhaust the earth's water resources before their replenishment (Zhang, Sial, Ahmed Filipe, Thu, Zial-Din, Caleiro, 2020). Globally, four billion human beings face the scarcity of water at a minimum of a month per annum; moreover, 500 million people live in acute water scarcity that is perpetual (Vanham, Alfieri and Feyen, 2022).

According to (European Commission, 2018) 1351 million km^3 of water is contained in the earth and only 3% of this water is considered safe and clean water worthy of human consumption and irrigation. Africa experiences water scarcity due to climate change, rapid population growth, and urbanization, which has added pressure on the use of water by households. In addition, man's projects are the cause of deterioration of water quality in most African countries. Tabutin and Schoumaker (2020) state that it is probable that Africa will remain one of the leading countries with the water scarcity problem around the world due to the continuous increase in population, the water demand that exceeds the water supply, and climate change.

According to Reddick and Kruger (2019), South Africa is classified as the 30th arid country in the world because it is vulnerable to high temperatures and droughts in all seasons. Nephawe, Mwale, Zuwarimwe, and Tjale (2021) state that drought is the most contributing factor to water scarcity in Limpopo, which is a semi-arid province. The study sought to examine the effects of water scarcity in rural communities. The main objective of the study is to determine the nature and extent of water scarcity in the context of rural households. In addition, to establish people's perception of the role of water in the welfare of people and analyse the effects of water scarcity in rural households, to determine the root causes of water scarcity and establish possible solutions to water scarcity.

The educational

Theoretical framework

Theoretical literature is a collection of interconnected ideas and formal theories that give directions for research. Its primary objective is to elucidate the findings of a study. This research was informed by theories in response to water scarcity and was viewed in the context of rural communities. The theories are Basic Human Needs Approach and System Theory.

The Basic Human Needs Theory (BHNT) recognizes the basic needs that households need to survive life. Its claim is about household consumption to improve their standard of living by eradicating poverty and inequality (Kheswa, 2019). The theory focuses on mobilizing local resources to communities. Households in rural areas need more water because they depend on agricultural activities to feed their families (Kheswa, 2019). The theory prescribes that the local government provides the necessities of the household to eradicate poverty. The BHNT links with this research through the provision of basic commodities in this research, the Ga-Dankie village was hypothesized. Following Kheswa (2019), the system theory is intended to address issues that occur in an organization, society, and government departments. Ziervogel (2019) states that a system theory is a theory that benefits issues faced by humans. The underlying principle of the system theory is holism. It is used to accurately explain the root cause and acquire an in-depth understanding of an issue by analysing it. The theory accounts for all probable causes of an issue. In addition, the theory investigates those causes separately and their roles in the system (Shiriyedete, 2022). This theory is adaptable and interdependent. South Africa has different legislative frameworks that govern the supply of water to all citizens of the country. The theory ensures that societal problems are solved holistically. In this case, water scarcity reflects a system with issues that need to be addressed because it adversely affects rural households.

Review of literature

Water is important for human and animal life and strengthens economic growth, rural development, the dignity of households, human health, child development, and education. In both developed and developing countries, the accessibility of adequate water is still a concern that hinders them from reaching development (Shiriyedete, 2022). Ziervogel (2019) affirms that households in rural areas are most vulnerable to water shortages. Different academic sources such as books, academic journals, and legislative frameworks were consulted to review the literature.

The legislative frameworks governing water provision in the republic of South Africa

- The Constitution of the Republic of South Africa of 1996

The Bill of Rights in the Constitution of the Republic of South Africa of 1996 is the linchpin of a democratic nation and asserts human dignity, equality, values, and liberty for all households in the country. According to Section 27 of the Constitution, everyone has the right to have access to, among other rights, sufficient water and food. Moreover, Section 2 of this section stipulates that the government is responsible for ensuring that all rights are realized progressively.

- The Water Service Act 108 of 1997

In Section 3 of the Water Service Act 108 of 1997, all households have access to basic sanitation and water services. Section 3(4) of WSA 108 of 1997 requires the Water Service Authority to provide standards to realize the right to basic water and sanitation in its water service development plan. Maake and Holtzhauzen (2015) assert that the Water Service Act is mandated to provide water to households, and the National Water Act is responsible for dealing with water in its fresh state.

- The National Water Act No. 36 of 1998

The National Water Act 36 of 1998 was created to eliminate the Apartheid Water Act of 1956, which was a result of English law. It categorizes the water use rights as public, regards water as a basic commodity for everyone, and does not allow private ownership of this property. Additionally, it ensures that water resources are protected, used, controlled, conserved, developed, and managed sustainably and equitably for all people in the country.

- The White Paper on Local Government

According to Section A (2) of the White Paper on Local Government, the local government has various powers and functions as defined in the Constitution of South Africa of 1996.

- The Municipal Systems Act 32 of 2000

Section 73(1) of the Municipal Systems Act mandates that the municipality must give effect to the provisions of the constitution, such as priorities to basic needs of the local community, promoting local community development, and ensuring that all community members have access to the basic municipal services, for example, health services and water provision in most rural areas.

- The Municipal Structures Act 117 of 1998

According to Section 84 of the Municipal Structures Act, the district municipality must provide the local municipality with the provision of water and sanitation services.

Water scarcity in the global context

According to WHO (2021), Sustainable Development Goal 6.1 requires that all individuals in this world have access to adequate water that is equitable and safe for all. The SDG 6.1 seeks to address water scarcity, calls for water taps in the homes of households; it mandates that water should always be available and not be polluted (UNESCO,2021). Human beings exhaust the water resources of the Earth before their replenishment; therefore, if people do not change their habits regarding the use of water by maintaining water, this will cause significant disputes among various countries (Zhang, Sial, Ahmed Filipe, Thu, ZiaI-Din, Caleiro, 2020). Globally, water scarcity is caused by insufficient water resources and due to inadequate water management in most countries. Globally, four billion human beings encounter a shortage of water not less than a month in a year; moreover, half a billion individuals live in acute water scarcity that is perpetual (Vanham, Alfieri and Feyen, 2022). Furthermore, more than 1 billion people lack fresh and clean water, which is free of harm. Globally, 80% of the water is used for agricultural activities, which denotes that water is of paramount importance in the agricultural sector for irrigating crops and producing food. Agricultural activities are fundamental in most developing countries because they are considered a means of survival to alleviate poverty through the creation of jobs and the supply of food (Dalezios, Angelakis and Eslamian, 2018).

The scarcity of water in Africa

Africa covers about 20,4% of the land in the world, has fifty-four countries and 1,39 billion people, and is the second driest country after Australia. It is a water-scarce continent due to decreased precipitation, climate change, rapid population growth, and urbanization that has increased pressure on the use of water by households (Markonis, Kumar, Hanel, Rakovec, Máca, AghaKouchak, 2021). According to D'Odorico, Davis, Rosa, Carr, Chiarelli, Dell'Angelo, Gephart, MacDonald, Seekell, Suweis, and Rulli (2018), population growth is the main characteristic that influences water scarcity in Africa.

Tabutin and Schoumaker (2020) state that it is probable that Africa will remain one of the leading countries with the water scarcity problem around the world due to the continuous increase in population, the demand for water that exceeds the water supply, and climate change. About 60% of water is used in the agricultural sector for crop and food production in many African economies and due to decreased rainfall and prolonged droughts, the agricultural sector uses significant amounts of water from groundwater supplies, which reduces water availability, and consequently, the continent experiences water scarcity (Kimaro, Mor, Toribio, 2018).

Water scarcity in the South African context

About 10% of the land generates 50% of the total runoff annually (Le Maitre, Seyler, Holland, Smith-Adao, Nel, Maherry and Witthüser, 2018). The FAO (2018) attests that South Africa is a water-poor country and has an uneven rainfall pattern with an average rainfall per year of 550mm, while the average temperature is 18 ° C. Before 1994, people in rural areas had no access to adequate water and sanitation due to the apartheid system (Mmbadi, 2019). The Water Service Act mandates the government to provide water to households, and the National Water Act is responsible for dealing with water in its fresh state. The country is experiencing water scarcity, even though there are strategies that are implemented to ensure that water is readily available and accessible. In many areas, the available water is polluted and, consequently, endangers human health and livestock (Matlakala, Kallon and Ncube,2023). Rural municipalities that manage rural communities face the problem of water scarcity mainly compared to metropolitan municipalities. Most rural households in Limpopo province experience water shortages almost every day (Mmbadi, 2019). Moreover, due to drought in the province, most rivers and dams have dried out. According to Matlakala and Kalloon (2020), one of the causes of water scarcity in Limpopo province is the lack

of water facilities, the lack of skilled water operators and municipal office bearers to maintain water facilities in rural households.

The challenges of water scarcity in rural areas

Water availability and accessibility are an increasing global challenge in developed and developing countries. Furthermore, the availability of water is forever changing and threatens livestock, humans, and the environment. Countries in North Africa, Southern Asia, Central Asia, the Arabian Peninsula, and Sub-Saharan Africa are adversely affected by water accessibility and availability. Furthermore, the Arabian Peninsula and the Middle East countries are water scarce and lack rivers, lakes, and groundwater to meet the domestic needs of households, agricultural activities, and industrial activities (McAlister, Baggio, Perera, Qadir, Taking and Smakhtin, 2023).

Most households use a large amount of water that often exceeds the available water in their countries, and this results in countries importing water from their neighboring countries to meet their water demands, water becomes limited due to water sources being dried up, and it is always a challenge to have water available for agricultural activities, industrial activities, and domestic use (United World Water Development Report (UNWWDR), 2019). According to the World Health Organization (2017b), there is a gross inequality in the distribution of water in urban and rural areas. Furthermore, there is also an unequal distribution of water within rural areas. Indigenous households enjoy access to safe drinking water more than non-indigenous households.

According to WHO (2017b), many water sources in rural areas are not properly managed. Tshona, Lungisa and Mgweba (2025), affirm that many rural communities in South Africa face financial stress in supplying water and maintaining water resources infrastructures. This issue aggravates the problem of water scarcity. Consequently, the water supply in these rural areas is poor quality. The water sources are not being improved, and rural citizens are experiencing water pollution. Safe and clean water is lacking on a global and national scale due to the toxic chemicals found in water (WHO, 2017b).

The decline in water infrastructure includes dam failures, costs of dam repair and system replacements, and a decrease in dam functionality. Dams' life expectancy can differ because two dams built in the same year can differ in terms of life expectancy based on their framework and conditions. The National Electricity Regulator (2004) states that the maintenance of the water infrastructure is a major challenge faced by South African Water Boards.

Water infrastructure in rural areas

According to Ruiters and Matji (2015), the water infrastructure is poorly managed in South Africa in both urban and rural households. This is due to unqualified labour and the low salaries of government sector employees. Maharjan, Agüero, Lippitt and Moreu (2019) state that South Africa's rural areas are experiencing inadequate water infrastructure, and this is a challenge due to the rapid growth of the population in the areas. The Department of Water Affairs (2013) highlighted that all water infrastructure that is funded by the government or is built to serve the citizens must always be owned by the organ of the state. Water shortages are caused by inadequate maintenance of the water supply systems. Water is lost during the distribution process due to poor maintenance of the water infrastructure (Matlakala, Kallon, Simelane and Mashinini, 2019). However, Mokgobu (2023) affirms that the local and district municipalities can take control of the local water infrastructure if there are adequate resources to implement maintenance and safety measures. Consequently, if the municipality does not have sufficient resources, the water board will then execute functions on its behalf. The provision of water and sanitation became a priority to bridge the gap of unequal distribution during apartheid. As a result, legislation such as the Water Act, the National Water Act, and the basic free water policies were promulgated. The national government considers access to safe drinking water a human right for all citizens. To realise this right, the government has initiated water infrastructure through construction of dams and groundwater supply.

Projections of water demand, resources, and quality by 2050

The availability of water must not be greater than the demand for it. Due to resource depletion and pollution, water availability is decreasing as demand for it rises. At the continental level, the amount of surface water resources is expected to remain roughly the same, but the quality will decline, and the distribution will change both temporally and spatially (Boretti and Rosa, 2019). According to Du Plessis (2022), 70% of the water used worldwide is currently used in the agricultural sector for irrigation and production, and global projections highlight that there will be a need for food, and it will rise by 60% by 2050. By 2050, surface water resources will be less available to many more countries. About 1.9 billion households lived in potentially extremely water-scarce areas in the early to mid-2020s, and by 2050, this figure is expected to increase to 3.2 billion people (Veldkamp, Wada, Aerts, Döll, Gosling, Liu, Masaki, Oki, Ostberg, Pokhrel, and Satoh, 2017). Water pollution is getting worse, especially in the last few decades. Water pollution is associated with both economic growth and population

density. 12% of people on the planet now acquire water from unclean, unsafe sources (Bain, Johnston, and Slaymaker, 2020).

The role of water in the welfare of rural households

Water is regarded as a raw and most important ingredient in petroleum refineries and deliquesces resources (Bichueti, Gomes, Kneipp, Motke, Perlin, and Kruglianskas, 2018). According to Makhubela (2022), water plays an important role in reducing poverty through businesses that can be established in the rural area. The agricultural sector alleviates poverty through agriculture, creating jobs and the supply of food (Note, 2018). Water is of paramount importance in the agricultural sector for the irrigation of crops and the production of food. Water is an important factor in the attainment of basic needs such as food, human health, and shelter. Thus, if all the mentioned are absent, the country will still be regarded as underdeveloped (Sabino and Pulhin, 2021). Most people in rural areas depend on subsistence and commercial farming to feed their families; moreover, they also have livestock for their consumption or commercial purposes. Therefore, water plays an important role in agriculture and food production (Nepomilueva,2017). According to Nieves-Cordones, Garca-Sánchez, Pérez-Pérez, Colmenero-Flores, Rubio, and Rosales, 2019), water plays a vital role in transporting and purifying waste products, supplies fish, and plants.

The effects of water scarcity on rural communities

- The effects of water scarcity on rural development

The lack of water has a huge negative impact on economic progress, eradicating poverty, and sustainable development. Rural households and the poor are most affected by the negative impacts of water shortages (WHO, 2021). About 900 million people still lack access to basic water and sanitation in many rural areas. Most businesses in rural areas are dependent on water and, as a result, water scarcity is a hindrance to economic development in rural areas (UNWDR, 2019). Studies anticipate that around 78% of jobs are water dependent. The United Nations World Development Report (2016) states that it is essential for both developed and developing countries to address the water-jobs nexus through integrated policies and investments. The connection between skills, jobs, and innovation is significant for developing rural economies to encourage improvements in water technology and other water infrastructure. This improves water management to be sustainable and economic development. Therefore, water is a fundamental resource and the cornerstone of development and must be distributed equitably between rural and urban areas (Letley and Turpie, 2023).

- The effect of water scarcity on human health

According to Usman, Gerber, and von Braun (2019), the available water in rural households is often inadequate to meet the health needs of the people. Furthermore, statistics show that about 771 billion people worldwide lack adequate water that endangers their health (WHO, 2021). According to Motoshita, Itsubo, and Inaba (2011), infectious diseases are caused by scarcity of domestic water due to the loss of access to safe and clean water. Shammi and Morshed (2013) state that many "waterborne" diseases are "waterwashed" diseases because of inadequate amounts of water available and accessible for washing clothes, washing hands, cooking utensils, and cooking food. WHO (2021) affirms that people living with HIV need more water, rather than 25 L per household per day because they are adversely affected by water-related infectious diseases. They need water to wash their hands, bathe their bodies, and drink their medicines. Therefore, adequate water should be readily available to people with HIV. Furthermore, 90% of people living with HIV in Africa are prone to chronic diseases. Due to lack of water, women omit to drink their medication due to a lack of water to deal with the side effects of ART (Nutor, Marquez, Slaughter-Acey, Hoffmann, DiMaria-Ghalili, Momplaisir, Opong and Jemmott, 2022).

The water shortage adversely affects the physical health of women because they are daily required to fetch water for their families. They spend a lot of time fetching water for their families and carrying it to their homes, which is mostly long distances. Some spend more than an hour fetching water. The physical burden of fetching water has a negative impact on their physical health. In addition, the physical burden of carrying water can cause miscarriages if a woman is pregnant (WHO, 2019). There is a high demand for water among pregnant women and those who breastfeed, but due to water scarcity, they cannot receive water.

- The effects of water scarcity on agriculture

According to Charlton and Castillo (2021), agriculture often serves as a national security and a priority compared to manufacturing industries. Water scarcity critically affects the agricultural sector, economic growth, and food security in many continents today. Inefficient water supply and availability negatively affect the agricultural sector. When crops are not properly irrigated, this leads to a decrease in production and consequently threatens food security (Msholoolo, 2019).

- The effects of water scarcity on livestock

According to Moyo (2008), livestock is a form of investment and poverty impoverishment. Water shortage affects livestock and livestock production adversely. FAO (2018) affirms that more than 844 million households globally generate income from agriculture and livestock. Most households in rural areas sell their livestock at an auction, for example, Vleissentraal, to generate income for their families. In addition, livestock plays a vital role in food security and food supply, such as meat, eggs, and milk. In most rural areas, donkeys are used to transport water from the dam to their homes, as well as to transport people from village to village (Maluleke, Tshabalala, and Barkhuizen, 2020).

- The effect of water scarcity on health care facilities

Water scarcity adversely affects health care facilities, such as clinics, hospitals, and planned structures used in the case of a health emergency. There was an increase in cholera cases in healthcare facilities due to a lack of water (WHO,2019). The lack of adequate water compromises the safe birth of children. UNICEF (2019) reports that in East African countries, less than 30% of the labor wards had adequate water. In addition, studies show that Tanzania, Bangladesh, and India had a similar problem of not having sufficient water. Pregnant women were required to bring their water to use after giving birth to bathe their babies and themselves (UNICEF,2019). More than 1 million children's deaths are related to uncleanness originating from water scarcity. Municipalities lack sufficient water to provide health care facilities (WHO, 2019). The lack of water in health care facilities is the cornerstone of various infections. WHO (2019) expects that 15/100 patients in South Africa will get infections during their hospital stay.

- The effects of water scarcity on child development

According to Usman et al. (2019), rural households mostly suffer from access to adequate water to meet their basic human needs. In some rural areas, women and children spend about six hours a day fetching water for their homes (UNICEF, 2016). As a result, some girls were raped, and some were abducted while on their way to fetch water. Furthermore, some girls were attacked by wild cats and ferocious animals. The older the child, the more water can be carried. Girls carry about 20L per day on their heads or use a wheelbarrow. Consequently, this damages your body, especially your back. However, UNICEF has initiated the UNICEF Tap project to collect data and fight against gender and age inequality because it is evident that the status of girls usually suffers.

The World Health Organization (2019) reports that in 2018 one-third of children under the age of five were chronically malnourished; additionally, 7% were severely malnourished. According to the Developmental Initiative (2018), malnutrition remains high due to the lack of water. Statistics show that approximately 56% of child deaths are caused by poor food nutrition due to a lack of water to use for cooking. Therefore, this can result in a low life expectancy and a low socioeconomic status in the adult stage. UNICEF (2021) states that 160 million children are vulnerable to chronic malnutrition related to water shortage.

Feeding infants is essential for early development of the child. Infants are at risk of transmission of diarrhea because mothers mix infant formulas with unsafe water. In countries such as Ethiopia, Nigeria, and Malawi, studies show that women cook less food and feed their newborns with fewer meals than required due to lack of water in those countries (Ahmed, Adams, Balogun, Boivin, and Brewis, 2020). Certainly, lack of adequate water is a compelling factor in substandard infant feeding beyond what is discussed in reports on hygiene and sanitation. Therefore, water scarcity increases malnutrition and poor health in infants, which could result in child mortality.

- The effects of water scarcity on education

Education is the key to reducing poverty, but many schools lack access to adequate water and sanitation. Water shortage adversely affects children's ability to get educated. Learners contract water-related illnesses such as diarrhea, typhoid, and guinea worms (Usman *et al*., 2019). Children help their mothers to fetch water because of the water shortage in their homes and some drop out. Citrus paribus, a lack of clean water negatively affects the child's cognitive performance at school. Children stay home to care for their sick parents who have diarrhea due to contaminated water. Therefore, this jeopardizes the time of learners to study and attend classes (Chakkaravarthy and Balakrishnan, 2019). Shikapelo (2020) states that many good teachers avoid schools in rural areas due to the inadequate water supply in rural schools. They are concerned about diseases that they can contract whilst in that area.

- Rural-urban migration

Rural-urban migration often distinguishes poverty, food insecurity, unemployment, adequate working environment, and lack of income-generating activities. Individuals migrate to cities for better education, health services provision, and to improve the standard of living (Mthiyane, Wissink, and Chiwawa, 2022). Research shows that the exhaustion of natural resources, such as water, is the primary factor that causes migration in households (Mthiyane, Wissink and Chiwawa, 2022). A decrease in environmental factors that households depend on, such as natural resources in rural areas, will increase rural-urban migration.

Root causes of water scarcity in rural communities

Water scarcity in rural communities is caused by environmental and human-made causes.

Environmental Causes of Water Scarcity

- Climate Change

Climate change is the root cause of water shortages and leads to global warming and rapid increases in temperatures in tropical countries. The way in which water is distributed to households today is caused by climate change because the availability of water depends on the state of the climate. The high level of weather conditions, the low levels of rainfall and increased temperature are droughts in southern Africa (Wright, Kapwata, Du Preez, Wernecke, Garland, Nkosi, Landman, Dyson, and Norval, 2021).

- Drought

Drought is second after tropical cyclones, responsible for the highest number of deaths in the world and has caused 34% of human deaths. It is one of the most common natural factors that lower lake and stream levels. Extended periods of high temperatures and little precipitation can reduce water intake and increase evaporation, which lowers water levels. Dry winter seasons are the result of empty reservoirs, and therefore this has a huge impact on summer seasons. Drought seasons can occur for a few weeks to a couple of years (Backeberg and Viljoen, 2003). Francis and Jahn (2001) attest that drought affects poor households, of which children and women are mostly affected.

Human-made causes of water scarcity

- Illegal Water Connections

Many households connect illegal water pipes to their homes due to poor water supply systems (Detroz and Silva, 2017). Frauendorfer and Liemberge (2010) state that illegal water connections cost municipalities money because the municipality must maintain water availability for all rural households. Additionally, Waterworth (2017) affirms that illegal water connectivity by households puts water supply systems under pressure, making it one of the root causes of water scarcity.

Consequently, illegal water connections negatively affect innocent community members because sometimes water does not reach their homes due to the heating of the water pipes. Households contract diseases because illegal connections often threaten water quality. Felbab-Brown (2017) highlights that illegal water connections often result in insufficient resources to expand water supply systems, repair costs, and upgrade water infrastructure.

- Poor water resource management

Most municipalities do not manage water resources, and this significantly damages water sources; as a result, this causes water scarcity. Poor water management arises because the government faces the following challenges:

❖ Inadequate infrastructure: In many areas, this prevents effective management and fair distribution of water resources.

❖ Corruption: By allowing unequal access and taking funds away from necessary water services, corruption compromises water governance.

❖ Climate Change: As a result of the changing distribution and availability of water resources, water management is becoming more complex.

❖ Population Growth: As the world's population increases, so does the demand for water resources, which can result in increased rivalry and even conflict.

❖ Fragmented Governance: Effective water management may occasionally be hampered by conflicting stakeholder interests and fragmented governance structures.

- Population growth

The National Population Unit (2010) asserts that around 1,8 billion households will face water shortage by 2050 if the situation worsens due to the significant increase in population growth in most developing countries, the countries are already facing a water crisis. About 21 of the 37 main diseases in developing nations are related to the inadequate supply of water. As population growth increases, domestic water use also increases, and that results in water scarcity. Therefore, inadequate maintenance of supply systems and insufficient investment in water infrastructure with a growing population result in water scarcity (Mosenogi, 2020).

- Polluted Water Resources

Okafor, Ude, Okoh and Eromonsele (2024) Affirm that economic growth and water supply are interconnected, therefore, polluted water supply causes a decrease in economic growth which varies between 0.8 and 2% of the economic expansion. According to Al-Taai (2021), water sources are suffering from pollution due to human activities, which may soon lead to the depletion of these resources. Wang and Zhuan (2020) state that water contamination is the result of industrial activities that discharge toxic substances, agricultural activities, natural factors, microplastics, food containers, and high sodium and saline that threaten water quality. Polluted water is

a threat to humankind and the environment and a major cause of water shortages in both developing and developed countries. It harms human health, animals, and the environment (Lu, Song, Wang, Liu, Meng, Sweetman, Jenkins, Ferrier, Li, Luo, and Wang, 2015).

- Destroyed water infrastructure

Shongwe and Meyer (2023) affirm that many South African municipalities lack adequate resources to provide basic services to the people. However, Mabizela and Matsiliza (2020) argue that municipalities are ineffective in providing services due to corruption and lack of oversight. Some community members destroy water infrastructure due to the apartheid regime and colonial neglect. Community members usually try to communicate with government officials violently by destroying the water infrastructure, which causes water scarcity. The basic right to access freshwater becomes impossible due to the destroyed water infrastructure. Most countries are faced with the challenge of burst pipes, damaged pumping machines, and South Africa is not an exception.

- Lack of qualified professionals in the water sector

Unskilled labour remains one of the causes of water scarcity faced by many rural households because municipalities cannot supply water to households under their jurisdiction (Hussain, Xuetong, and Hussain, 2020). There is a high volume of unskilled engineers, water scientists, and technicians, and this is the main challenge in the water sector. This hinders the rural municipality to provide water services to the community members they are administering (Makhubela, 2022).

- Depletion of Groundwater

The International Groundwater Resources Assessment Centre (2021) defines groundwater as an important freshwater source that is found in aquifers, absorbent rock, and dregs on the surface of the Earth. Sanad, Mouhir, Zouahri, Moussadek, El Azhari, Yachou, Ghanimi, Oueld Lhaj and Dakak (2024) state that groundwater is a basic and imperative water resource which supports human activities such as domestic, industrial and agricultural use. Pointet (2022) indicates that the agricultural sector uses more water than all other sectors, consuming approximately 70% of groundwater withdrawals worldwide. Hartman (2022) enunciates that human activities remove water from aquifers, resulting in lower water levels. Bostic Mendez-Barrientos, Pauloo, Dobbin, and MacClements (2023) state that the depletion of groundwater sources has affected 9000 private domestic wells and 1000 supply wells for the public.

Groundwater depletion is a global problem and is severe in Northern Africa, USA, Southern Africa, Iran, Mexico, and India, and some of these regions are unable to access groundwater from their sources and must adjust to the results of groundwater depletion. Castelvecchi (2023) enunciates that the earth's axis has tilted 4,37 cm annually due to excessively pumped groundwater. Sometimes certain factors that contribute to groundwater depletion are difficult to identify and evaluate. For example, groundwater pumped from confining beds can be primarily drawn from leaks from nearby confining beds; however, low-permeability layer depletion is difficult to gauge, is rarely observed, and is generally disregarded.

The role of the district municipality in water supply

It is the responsibility of the District Municipality to provide clean water to residents (Constitution, 1996). Section 2(a) of the Water Service Act 108 of 1997 agrees with the constitution that the District Municipality is responsible for the provision of water. WSA 108 of 1997 mandates that access to clean safe drinking water that is not harmful to human health is a basic right. CDM may designate if there is a need to renovate and replace existing water systems.

The role of local municipalities in water supply

The Water Service Act 108 of 1997 affirms municipalities to be Water Service Authorities or Water Service Providers. This Act also explains the role that local government plays as water service providers and water service authorities. In addition, it explains attributes of water services, for example, potable water and sanitation supplies to the community by municipalities. On the other hand, the National Water Act affirms that municipalities should provide communities under their jurisdiction with freshwater together with acceptable sanitation to reduce the risks of contradiction of dangerous germs.

The effectiveness of the blue drop in rural households

The Blue Drop Progress Report (2022) states that water quality depends on microbiological and chemical determinants. In Limpopo Province, 41% of the water supply systems comply with microbiological determinants and only 30% comply with chemical determinants. However, most water supply systems harm the health of the public. The BDPR affirms that 59% of water supply systems did not achieve microbiological determinates. Moreover, 70% of water supply systems did not achieve chemical determinants and this usually harms the health of consumers for the long term. According to the Blue Drop Progress Report, 2022 areas in Zebediela, Senwabarwana, Ga- Mashashane, and Alldays fall under the high-risk water supply system and these areas have not achieved microbiological and chemical determinants.

The strategies that municipalities must use to address water scarcity.

- Increase the water supply to rural households.

South African municipalities must supply water regardless of the growing population and economy. Municipalities can reduce water demand by focusing on the possibility of harvesting rainwater in areas with low-income Tzanakakis, Paranychianakis, and Angelakis (2020). Additionally, municipalities must fix and maintain groundwater systems because most rural areas depend on groundwater supply (Hedden, 2016).

- Initiating fines for illegal pipe connections

The municipality must enforce legal actions against households that connect water illegally to their homes or farms although the process can be time-consuming and costly. The municipality must raise awareness of fines for illegal water pipe connections to decrease water theft (Schmidt, De Stefano, Bea, Carmody, van Dyk, Fernández-Lop, Fuentelsaz, Hatcher, Hernandez, O'Donnell, and Rouillard, 2020).

- Build dams and reservoirs

More dams mean that there will be more water supply systems, balancing the water system and distributing water sources (Jozaghi *et al*., 2018). Climate change can have a major impact on the recharge of natural groundwater; therefore, several water storages are required, long-term or short-term.

- Water Sharing

Water sharing is a measure used to solve the problem of water scarcity and usually occurs between villages, households, and countries. Approximately 90% of households live in regions with common river basins. The transboundary is the main solution to the water shortage and prevents the situation from exacerbating in the coming years. Successful negotiations require diplomatic skills, cooperation, and commitment to sustainable resource management. The government can facilitate such negotiations by establishing cooperation and trust, openness, sharing of data collaborative study and evaluation, consent to sustainable use, lawful structure, form a joint commission, public participation, and awareness, investment in infrastructure and regular assessment and modification.

- Maintenance of the water infrastructure and advanced technologies

Water supply systems require maintenance and renovation to maintain their functions over time and restore ecology activities because over time they deteriorate due to swelling and weakening of the concrete caused by high levels of salinity and alkalinity. The municipality can maintain the dams by repairing them to address the safety risk. In addition, it can modify dams and reservoirs to meet social and environmental goals. This includes repairing concrete joints and reforming the water flow release systems of larger dams. Some dams accumulate drags and others are just wearing away, as a result, this needs maintenance and reconstruction to sustain the primary functions of a dam (Kondolf and Yi, 2022).

- Improve the quality of raw water.

Municipalities can improve the quality of raw water by implementing a diffuse pollution source strategy consisting of land use. Municipalities should implement municipal bylaws and adhere to them to preserve the quality of raw water.

- Rainwater Harvesting Systems

Rainwater is becoming popular in rural and urban communities due to water scarcity (Selimolu and Yamaçl 2022). Sifundza and Beckedahl (2025) indicate that rainwater can be harvested in different ways and be used by households during dry season. Water can be collected through a roof system and land harvesting system (Ertop, Kocicka, Atilgan, Liberacki, Niemiec, and Rolbiecki, 2023).

- Educate community members about water conservation and scarcity.

Weaver et al. (2019) affirm that municipalities must educate citizens about water issues through formal and informal sessions. In addition, the topic is bound to enable issues such as the best ways to preserve water, human rights on water, and the roles of communities regarding water. Municipalities should educate households about water conservation.

Municipalities can educate households on the preservation of water by educating them about the water cycle, water sources, water consumption and accessibility, the primary role of water, that is, consumption, domestic water use, large water users, if taught jointly, it can strengthen the perception of households about how water resources are depleted and how to prevent them from being abused in the future.

Municipalities must educate citizens about the water sources, the importance of water and how scarce it is. In addition, they will discover how natural ecology works and various water sources such as groundwater and aquifers. In this phase, households will learn about water extraction methods, target 6 sustainable development goals, and how water is exploited and available for domestic use (Bazaanah and Mothapo, 2023).

- Conduct research and development programs

According to Al-Ansari, Abbas, Laue, and Knutsson (2021), research and development can be conducted in the following manner to solve water scarcity issues. Municipalities must provide sufficient data to researchers on climatology, hydrology, and the environment to come up with possible strategies to address water scarcity. In addition, it must develop and train technicians, engineers, and management on the use of recent technology. This can be implemented by conducting training sessions for employees. Municipalities must develop and implement water programs that increase the availability, development, and production, and decrease the consumption of water by households. Develop areas by investing in structures and increasing public awareness about the use of water in the agricultural sector and by households.

Method

The study adopted a qualitative research method, and the researcher relied more heavily on secondary data, which included books, journals, articles, dissertations, and government publications

Findings

The findings comprise root causes of water scarcity, such as increased population growth, climate change, illegal pipe connection, lack of water infrastructure, and sharing water with livestock. Furthermore, the findings revealed that the community understands the concept of water scarcity with respect to its welfare. The results indicated that most of the participants highlighted that municipal officials did not communicate effectively with households about the importance of water supply

The findings revealed that the Capricorn District Municipality has water according to laws and water policies. Furthermore, it was revealed that municipal policies highlight that all rural households must have access to free water. Additionally, the municipality has a water development plan and community households are consulted during development planning. In addition, it involves the community of Ga-Dankie in planning the development of water services through a steering committee.

The municipality was found to experience challenges that hinder it from providing water according to the water law. Some of the challenges are limited resources and a large population, broken machines and pipes, and illegal pipe connections. In addition, stealing materials, such as pipes and machines, technical failures, aging infrastructure that is not replaced on time, unskilled personnel, and the capacity of the wells in the Ga-Dankie village is insufficient to supply all members of the community with water.

The findings further revealed possible solutions to water scarcity, such as drilling more wells and building more dams in the village, collecting rainwater during the rainy seasons, the municipality must educate households about water conservation and the scarcity of water, and the municipality should lease wells in Eldorado to supply water to Ga-Kibi. Furthermore, the municipality must acquire water from the Mogalakwena River, which is approximately 7,5km from the village, and the municipality must initiate a fine fee for households who connect pipes illegally.

Discussion- Conclusions

The study investigated the effects of water scarcity in rural households. This paper discussed water scarcity in a global context, in an African context, South African context and the legislative framework that governs water provision. Amongst the legislative framework the Water Service Act 108 of 1997 was discussed and it states that all households have a right to access basic sanitation and water services. Section 3(4) of WSA 108 of 1997 requires the Water Service Authority to provide standards to realize the right to basic water and sanitation in its water service development plan. However, the findings revealed that the municipality was found to experience challenges that hinder it from providing water according to the water law

The challenges of water scarcity in rural areas were also discussed. The findings revealed that some of these challenges are unequal distribution of water between urban and rural areas, unequal distribution of water within rural areas, water sources that are poorly managed. These results concur with the United World Water Development Report (2019) and World Health Organization (2017b) that there is a gross inequality in the distribution of water in urban and rural areas.

The study discussed water infrastructure in rural areas because most rural areas in South Africa experience inadequate water supply. This paper discussed the projections of water demand, resources, and quality by 2050. Furthermore, it discussed the role of water in the welfare of rural households. The results show that all respondents know the role that water plays in their welfare. Some participants stated that water plays a vital role in the welfare of people, for example, in small-scale agriculture and the production of their own food. Moreover, others stated that water is a basic need and plays a significant role in the performance of domestic activities, for example, cooking, cleaning, drinking, gardening, and bathing. These findings coincide with Nepomilueva (2017)

and Kılıç (2020) that water is essential to produce food, the health of households, and their standard of living. Makhubela (2022) affirms that agricultural activities contribute significantly to the reduction of poverty in rural communities; therefore, water plays an important role in the welfare of people, because it is the main concern.

The root causes of water scarcity are also discussed in this paper. The results indicate that root causes of water scarcity occurring in this study were increased population growth, climate change and lack of water infrastructure. The findings agree with Skrimizea and Parra (2019) that climate change is one of the causes of water shortages. The results also concur with Mosegoni (2020), that the limited supply of water has a terrible inference on the population of 7 billion people and every 20 years, water demands increase twice due to population growth. In addition, Mosenogi (2020) states that lack of supply systems and insufficient investment in water infrastructure with a growing population result in water scarcity.

The findings revealed that water scarcity has negative effects on human health, child development, livestock, agriculture, rural development, healthcare facilities and education. The results agree with Msholoło (2019) water scarcity negatively affects the agricultural sector and threatens food security. The findings also concur with WHO (2021) and (Usman *et al*., 2019) that lack adequate water that endangers human health and learners contract water-related illnesses such as diarrhea, typhoid, and guinea worms.

The study discussed the role of the district and the local municipality in the provision of water. The effectiveness of the blue drop in rural households was also discussed. The article concluded by discussing the strategies that the municipality must implement to address water scarcity.

Recommendations

Based on key insights extracted from the study findings, the municipality needs to improve water provision in the rural household of Ga-Dankie. The study recommends that the Capricorn District Municipality negotiates water services with Eldorado and Ga-Mashamaite to supply to Ga-Dankie. The study also recommends that the municipality hire engineers to search for underground water available and therefore drill more wells for the increasing population in the village and insufficient water in the current well. Furthermore, the study recommends that community members be educated about the scarcity of water and how to conserve and reuse water in their homes. The municipality must educate them about the water cycle, large water users, the water table, and domestic water usage. The study also recommends that the municipality can provide water to the community by using water tanks due to the scarcity of water in the village. The study also recommends that the municipality acquires water from the Mogalakwena River, which is about 7,5km from the village, and initiates fines on people who connect water pipes illegally. The study recommends that the municipality build more dams where there is water catchment during rainy seasons and that the community households collect rainwater in their homes during the rainy seasons.

References

Ahmed, S. and Ismail, S., 2018. Water pollution and its sources, effects & management: a case study of Delhi. *Shahid Ahmed and Saba Ismail (2018)'Water Pollution and its Sources, Effects & Management: A Case Study of Delhi', International Journal of Current Advanced Research*, *7*(2), pp.10436-10442

Al-Ansari, N., Abbas, N., Laue, J. and Knutsson, S., 2021. Water scarcity: Problems and possible solutions. *Journal of Earth Sciences and Geotechnical Engineering*, *11*(2), pp.243-312.

Al-Taai, S.H.H., 2021, June. Water pollution Its causes and effects. In *IOP Conference Series: Earth and Environmental Science* (Vol. 790, No. 1, p. 012026). IOP Publishing.

Backeberg, G.R and Viljoen, M.F. 2003. Drought management in South Africa. Pretoria: Water Research Commission.

Bain, R., Johnston, R. and Slaymaker, T., 2020. Drinking water quality and the SDGs. *npj Clean Water*, *3*(1), p.37

Bazaanah, P. and Mothapo, R.A., 2023. Sustainability of drinking water and sanitation delivery systems in rural communities of the Lepelle Nkumpi Local Municipality, South Africa. *Environment, Development and Sustainability*, pp.1-33

Bichueti, R.S., Gomes, C.M., Kneipp, J.M., Motke, F.D., Perlin, A.P. and Kruglianskas, I., 2018. Water Use Management in the Mining Industry: A Comparison Based on Company Size. Journal of Environmental Accounting and Management (Tier 3), 6(2), pp.135-147

Boretti, A. and Rosa, L., 2019. Reassessing the projections of the World Water Development Report. *NPJ Clean Water*, *2*(1), p.15.

Castelvecchi, D., 2023. Seeing the galaxy with neutrinos. *Nature*, *620*, p.3

Chakkaravarthy, D.N. and Balakrishnan, T., 2019. Water scarcity-challenging the future. *International Journal of Agriculture, Environment, and Biotechnology*, *12*(3), pp.187-193.

Chakraborti, R.K., Kaur, J. and Kaur, H. 2019. Water Shortage Challenges and a Way Forward in India. *Journal: American Water Works Association*, *111*(5).

Charlton, D. and Castillo, M., 2021. Potential impacts of a pandemic on the US farm labor market. *Applied Economic Perspectives and Policy*, *43*(1), pp.39-57

Cosgrove, W.J. and Loucks, D.P., 2015. Water management: Current and future challenges and research directions. *Water Resources Research*, *51*(6), pp.4823-4839.

Dalezios, N.R., Angelakis, A.N. and Eslamian, S., 2018. Water scarcity management: part 1: methodological framework. *International Journal of Global Environmental Issues*, *17*(1), pp.1-40

Detroz, J.P. and da Silva, A.T., 2017, April. Fraud detection in water meters using pattern recognition techniques. In *Proceedings of the Symposium on Applied Computing* (pp. 77-82).

D'Odorico, P., Davis, K.F., Rosa, L., Carr, J.A., Chiarelli, D., Dell'Angelo, J., Gephart, J., MacDonald, G.K., Seekell, D.A., Suweis, S. and Rulli, M.C., 2018. The global food-energy-water nexus. *Reviews of Geophysics*, *56*(3), pp.456-531.

Du Plessis, A., 2022. Persistent degradation: Global water quality challenges and required actions. *One Earth*, *5*(2), pp.129-131.

Du Plessis, P. and Mestry, R., 2019. Teachers for rural schools–a challenge for South Africa. *South African Journal of Education*, *39*

Ertop, H., Kocięcka, J., Atilgan, A., Liberacki, D., Niemiec, M. and Rolbiecki, R., 2023. The Importance of Rainwater Harvesting and Its Usage Possibilities: Antalya Example (Turkey). *Water*, *15*(12), p.2194

European Commission (EC). Water Is Too Precious to Waste. 2018. Available online: http://ec.europa.eu/environment/water/pdf/water_reuse_factsheet_en.pdf (accessed on 19 April 2022). Food Rural Aff 8. ISSN 1198-712

FAO, F., 2018. Food and Agriculture organization of the United Nations. *Rome, URL: http://faostat. fao. org*.

Felbab-Brown, V., 2017. *Water theft and water smuggling: growing problem or tempest in a teapot?* Brookings

Francis, J. and Jahn, S. 2001. Integrating gender perspectives: realizing new options for improved water management. Bonn: International Conference on Freshwater

Frauendorfer, R. and Liemberger, R., 2010. The issues and challenges of reducing non-revenue water.

Hedden, S., 2016. Parched prospects II revised long-term water supply and demand forecast for South Africa. *Institute for Security Studies Papers*, *2016*(16), p.18

Hussain, S., Xuetong, W. and Hussain, T., 2020. Impact of skilled and unskilled labor on project performance using a structural equation modeling approach. *Sage Open*, *10*(1), p.2158244020914590.

Jozaghi, A., Alizadeh, B., Hatami, M., Flood, I., Khorrami, M., Khodaei, N. and Ghasemi Tousi, E., 2018. A comparative study of the AHP and TOPSIS techniques for dam site selection using GIS: A case study of Sistan and Baluchestan Province, Iran. *Geosciences*, *8*(12), p.494

Kheswa, S.S. 2019. *Investigating the social impact of water shortage on the livelihoods of rural settlements: the case study of KwaNonzila in Mkhambathini Municipality* (Doctoral dissertation

Kılıç, Z. 2020. The importance of water and conscious use of water. *International Journal of Hydrology*, *4*(5), pp.239-241.

Kimaro, E.G., Mor, S.M., Toribio, J.-A.L.M.L., 2018. Climate change perception and impacts on cattle production in pastoral communities of northern Tanzania. Pastoralism 8, 19

Kondolf, M. and Yi, J., 2022. Dam renovation to prolong reservoir life and mitigate dam impacts. *Water*, *14*(9), p.1464.

Le Maitre, D.C., Seyler, H., Holland, M., Smith-Adao, L., Nel, J.L., Maherry, A. and Witthüser, K., 2018. *Identification, Delineation, and Importance of the Strategic Water Source Areas of South Africa, Lesotho, and Swaziland for Surface Water and Groundwater. Report No* (p. 4). TT 743/1/18, Water Research Commission, Pretoria

Letley, G.K. and Turpie, J.K., 2023. Water Research Commission.

Lu, Y., Song, S., Wang, R., Liu, Z., Meng, J., Sweetman, A.J., Jenkins, A., Ferrier, R.C., Li, H., Luo, W. and Wang, T., 2015. Impacts of soil and water pollution on food safety and health risks in China. *Environment International*, *77*, pp.5-15.

Maake, T. and Holtzhausen, N., 2015. Factors affecting the provision of sustainable water services in the Mopani District Municipality, Limpopo Province. *Administratio Publica*, *23*(4), pp.248-271.

Mabizela, H. and Matsiliza, N.S., 2020. Uncovering the gaps in the provision of services in the rural Okhahlamba Municipality of KwaZulu-Natal province. *Africa's Public Service Delivery & Performance Review*, *8*(1), p.9.

Makhubela, O.J., 2022. *Investigating the causes and impact of infrequent water supply on the wellbeing of communities: a case Greater Tzaneen Municipality, Limpopo Province* (Doctoral dissertation).

Maluleke, W., Tshabalala, N.P. and Barkhuizen, J., 2020. The effects of climate change on rural livestock farming: Evidence from Limpopo Province, South Africa. *Asian Journal of Agriculture and Rural Development*, *10*(2), pp.645-658

Markonis, Y., Kumar, R., Hanel, M., Rakovec, O., Máca, P., AghaKouchak, A., 2021. The rise of compound warm-season droughts in Europe. Sci. Adv. 7, eabb9668

Matlakala, M.E., Kallon, D.V.V., Simelane, S.P. and Mashinini, P.M., 2019. Impact of design parameters on the performance of centrifugal pumps. *Procedia Manufacturing*, *35*, pp.197-206.

Matlakala, M.E. and Kallon, D.V.V., 2020. Systems dynamic of potable water shortage in the Limpopo province of South Africa. In *Proceedings of the International Conference on Industrial Engineering and Operations Management* (Vol. 59, pp. 200-207)

MacAlister, C., Baggio, G., Perera, D., Qadir, M., Taing, L. and Smakhtin, V., 2023. Global Water Security 2023 Assessment; United Nations. *University Institute for Water, Environment and Health: Hamilton, ON, Canada*.

Mmbadi, E. 2019. Water security in rural Limpopo in a changing climate: A study of the Greater-Giyani local municipality, South Africa. *Unpublished Dissertation for Master of Environmental Sciences, Department of Geography and Geo-Information Sciences, School of Environmental Sciences, University of Venda: Thohoyandou*

Mokgobu, M.L., 2023. *The application of space technology and the challenges of managing water infrastructure in a selected South African municipality* (Doctoral dissertation)

Mosenogi, J.M., 2020. *Effects of population growth on basic infrastructure for basic services provision in Bojanala Platinum District Municipality: econometric analysis of panel data* (Doctoral dissertation).

Motoshita, M., Itsubo, N. and Inaba, A. 2011. Development of impact factors on damage to health by infectious diseases caused by domestic water scarcity. *The International Journal of Life Cycle Assessment*, *16*(1), pp.65-73

Moyo, S. 2008. Opening address. Satellite symposium on the role of livestock in developing communities. Tenth World Conference on Animal Production (WCAP). 23–26 November, Cape Town, South Africa

Msholoolo, N.Z., 2019. *Water scarcity and citizen welfare in the context of climate change in the case of Engonyameni Village in KwaZulu-Natal* (Doctoral dissertation).

Mthiyane, D.B., Wissink, H. and Chiwawa, N., 2022. The impact ofrural–urban migration in South Africa: A case of KwaDukuza municipality. *Journal of Local Government Research and Innovation*, *3*, p.9

National Population Unit. 2000. Population, poverty, and vulnerability. The state of South Africa's population report. Pretoria: Department of Social Development

Nephawe, N., Mwale, M., Zuwarimwe, J. and Tjale, M.M. 2021. The impact of water-related challenges on rural communities' food security initiatives. *AGRARIS: Journal of Agribusiness and Rural Development Research*, *7*(1), pp.11-23

Nepomilueva, D., 2017. Water scarcity indexes: water availability to satisfy human needs. NER, 2004. South African National electricity distribution infrastructure: Status report. National Electricity Regulator, April 2004

Nieves-Cordones, M., García-Sánchez, F., Pérez-Pérez, J.G., Colmenero-Flores, J.M., Rubio, F. and Rosales, M.A., 2019. Coping with water shortage: an update on the role of K+, Cl-, and water membrane transport mechanisms on drought resistance. Frontiers in plant science, 10, p.1619

Note, A.S., 2018. The role of food and agriculture for job creation and poverty reduction in Jordan and Lebanon. *World Bank Agricultural Sector Note (p166455*

Nutor, J.J., Marquez, S., Slaughter-Acey, J.C., Hoffmann, T.J., DiMaria-Ghalili, R.A., Momplaisir, F., Opong, E. and Jemmott, L.S., 2022. Water Access and Adherence Intention Among HIV-Positive Pregnant Women and New Mothers Receiving Antiretroviral Therapy in Zambia. *Frontiers in Public Health*, *10*, p.758447.

Okafor, C.O., Ude, U.I., Okoh, F.N. and Eromonsele, B.O., 2024. Safe drinking water: The need and challenges in developing countries. In *Water quality-new perspectives*. IntechOpen

Pointet, T., 2022. The United Nations World Water Development Report 2022 on Groundwater, a Synthesis. *LHB*, *108*(1), p.2090867.

Reddick, J. and Kruger, R., 2019. GreenCape 2019 Market Intelligence Report

Republic of South Africa.1996. Constitution of the Republic of South Africa. Pretoria. Government printer

Ruiters, C. and Matji, M.P., 2015. Water institutions and governance models for the funding, financing, and management of water infrastructure in South Africa. *Water Sa*, *41*(5), pp.660-676

Sabino, L.L. and Pulhin, J.M., 2021. Satisfying the Basic Needs: The Material Aspect of Human Security. Climate Change, Disaster Risks, and Human Security: Asian Experience and Perspectives, pp.85-112

Sanad, H., Mouhir, L., Zouahri, A., Moussadek, R., El Azhari, H., Yachou, H., Ghanimi, A., Oueld Lhaj, M. and Dakak, H., 2024. Assessment of groundwater quality using the pollution index of groundwater (pig), nitrate pollution index (npi), water quality index (wqi), multivariate statistical analysis (msa), and gis approaches: A case study of the mnasra region, gharb plain, morocco. *Water*, *16*(9), p.1263

Schmidt, G., De Stefano, L., Bea, M., Carmody, E., van Dyk, G., Fernández-Lop, A., Fuentelsaz, F., Hatcher, C., Hernandez, E., O'Donnell, E. and Rouillard, J., 2020. How to tackle illegal water abstractions: taking stock of experience and lessons learned. *Fundacion Botin, Madrid*

Selimoğlu, P. and Yamaçlı, R., 2022, Structural Study on Sustainable Rainwater Harvesting. *J. Sustain. Eng. Appl. Technol. Dev5*, 210–23

Shammi, M. and Morshed, M. 2013. Assessment of Practices of Sanitation and Hygiene in Rural Bangladesh: A Comparison of a Declared Sanitation Area to a Non-declared Sanitation Area of Sirajganj District, Bangladesh. *Jahangirnagar University Environmental Bulletin*, *2*, pp.50-60.

Shiriyedete, J., 2022. *An analysis of the water crisis and its impact on sustainable development in Cape Town, South Africa* (Doctoral dissertation).

Shongwe, B.R. and Meyer, D.F., 2023. Service Delivery Challenges within Rural Communities: The Case of the Nkomazi Local Municipal Area. *Administratio Publica*, *31*(2), pp.136-159.

Sifundza, L.S. and Beckedahl, H., 2025. Identification of potential sites for rainwater harvesting structures as an adaptation to drought emergencies in Eswatini. *Water SA*, *51*(1), pp.47-57.

Skrimizea, E. and Parra, C. 2019. Social-ecological dynamics and water stress in tourist islands: the case of Rhodes, Greece. *Journal of Sustainable Tourism*, *27*(9), pp.1438-1456

Tabutin, D. and Schoumaker, B. 2020. The demography of Sub-Saharan Africa in the 21st. *Population*, *75*(2), pp.169-295

Tshona, S.S., Lungisa, S. and Mgweba, L., 2025. Thirsting for solutions: Unpacking inadequate water provision in rural communities. *Africa's Public Service Delivery & Performance Review*, *13*(1), p.12.

Tzanakakis, V.A., Paranychianakis, N.V. and Angelakis, A.N., 2020. Water supply and water scarcity. *Water*, *12*(9), p.2347

UNESCO, 2021. *The United Nations World Water Development Report 2021: Valuing Water*. United Nations

United Nations World Water Development Report 2018. United nations educational, scientific and cultural organization, New York, United States

United Nations World Water Development Report 2018. United nations educational, scientific and cultural organization, New York, United States

Usman, M.A., Gerber, N. and von Braun, J., 2019. The impact of drinking water quality and sanitation on child health: Evidence from rural Ethiopia. *The Journal of Development Studies*, *55*(10), pp.2193-2211

Vanham, D., Alfieri, L. and Feyen, L. 2022. National water shortage for low to high environmental flow protection. *Scientific reports*, *12*(1), pp.1-9.

Veldkamp, T.I.E., Wada, Y., Aerts, J.C.J.H., Döll, P., Gosling, S.N., Liu, J., Masaki, Y., Oki, T., Ostberg, S., Pokhrel, Y. and Satoh, Y., 2017. Water scarcity hotspots travel downstream due to human interventions in the 20th and 21st centuries. *Nature communications*, *8*(1), p.15697.

Wang, J. and Zhuan, R., 2020. Degradation of antibiotics by advanced oxidation processes: An overview. *Science of the Total Environment*, *701*, p.135023.

Weaver, M.J.T., 2019. Civil society engagement with water governance at a local government scale in South Africa. *Unpublished Doctoral Thesis. Rhodes University, Grahamstown*

World Health Organization, 2021. Progress on household drinking water, sanitation, and hygiene 2000-2020: five years into the SDGs.

World Health Organization. (2019). "Children reducing mortality."

Wright, C.Y., Kapwata, T., Du Preez, D.J., Wernecke, B., Garland, R.M., Nkosi, V., Landman, W.A., Dyson, L. and Norval, M. 2021. Major climate change-induced risks to human health in South Africa. *Environmental Research*, *196*, p.110973.

Zhang, D., Sial, M.S., Ahmad, N., Filipe, A.J., Thu, P.A., Zia-Ud-Din, M. and Caleiro, A.B. 2020. Water scarcity and sustainability in an emerging economy: a management perspective for future. *Sustainability*, *13*(1), p.144

Ziervogel, G., 2019. Unpacking the Cape Town drought: lessons learned. *Cities support programme| Climate resilience paper. African Centre for Cities, February*