Analysis of water scarcity: A case of Mkhuhlu, Bushbuckridge local municipality in Mpumalanga Province, South Africa

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Abstract

The purpose of this research is to investigate the factors of water shortage in the households of Mkhuhlu Township in the Mpumalanga Province of Bushbuckridge Municipality, in Mpumalanga Province. For this study, the following techniques were used: Questionnaire survey, simple survey, Observation, and group focus. Data was collected by fieldwork visiting the township members per section who are affected by water shortage, senior managers of the municipality as well as calling individuals . Random sampling was done for this study in Mkhuhlu Township in Bushbuckridge Mpumalanga province to collect data from municipal officials and community members. During the survey, we observed that taps were dry without water and it was even difficult for residents to use the bathrooms. The study results show that water shortage is due to pipe leakage, the illegal connection from residents that stays at Section D &F as well as population increase in Mkhuhlu extension F and small reservoirs. The results of this study can serve as a foundation for investors interested in entering the technological market. Therefore, Bushbuckridge municipality needs to develop a business strategy to assist the municipality in approaching water purification markets as a collective and social responsibility in the long term. The findings of this study can help the local municipality and the Department of water and sanitation to provide a water pipeline and erect a water purification plant to supply more water that will be for the township . The study will demonstrate knowledge and skills to the young generation through research, and residents on water awareness and increase the good health and livelihoods of residents in Mkhuhlu township in Bushbuckridge Municipality.

Keywords: keyword 1; Shortage, 2; leakage 3 Mpumalanga;4 Municipality;5 Water; 6 illegals ;

7 Connection

namely changing weather, excessive water usage, and water pollution. Water shortage on the other hand is the difficulty in obtaining water. And finally, a water crisis would be insufficient supply against the demand from users.

Water shortage is an unpinning issue globally. South Africa, especially in rural areas has challenges of water shortage. The main causes of water scarcity in South Africa and other Sub-Saharan countries are rapid

1. Introduction

According to the [1], by 2025, 1.8 billion people will be living in nations or places with no water at all. Furthermore, they assert that two-thirds of the world's population could be living under water-stressed condition. According to [2], water scarcity can be further elucidated into three subcategories defining it such as its shortage, stress with water, and crisis with water. These three constructs would attribute to water shortage,

registered taverns, one Shopping Complex with one filling station, a Clinic Police station that services the whole township and Mkhuhlu Section F. The two schools, a primary and High school as well as the Hospital and Clinic service Mkhuhlu residents and children and residents from Mkhuhlu section F, MA-RDP houses, and Calcutta areas. Mkhuhlu Township has two boreholes that are carefully used. Mkhuhlu Township's water shortage was further exacerbated by an extension known as Mkhuhlu Section F and Ma-RDP.

Part of Mkhuhlu section F belongs to traditional leader Chief Nkuna. Traditional groups have the right to land and may share it with their communities. Nkuna was approached by community members about the land in 2000, and people began building in 2001. Also, unemployment is a serious challenge for residents of Mkhuhlu Township. Each house in Mkhuhlu Township has a sewage system and water taps, as well as meters. When the township was developed in the 1990s, the municipality collected revenues for water services until 2010. Residents started stopping paying for water services as they normally do. In recent years, water shortages have become a global issue.

Constitutionally, the government must provide this basic social and economic service. Therefore, the purpose of this study was to investigate the causes and impacts of water shortage in Mkhuhlu Township in Bushbuckridge municipality, Mpumalanga Province. The water supply can be cut off for two weeks in a Township where residents wash, bathe, drink, cook, and use the bathroom. Mkhuhlu residents continue to be frustrated by this painful situation, where some families are able to afford JoJo Tanks, which are used for flushing toilets and cooking.

population growth, the impacts of the COVID-19 pandemic, Climate change as well as social and economic scarcity [3-5].

In order to understand regional hotspots of water shortage and scarcity, we must understand both the quantity and quality of water, as both are essential for human use and ecosystem health [6]. Earlier studies used the water poverty index that combines water quality and quantity data or included water pollution drivers in the calculation of threat indices to human water security and biodiversity [3, 7, 8] for Chinese cities and river basins.

The reduction of water scarcity can be accomplished by decreasing sectoral water use and reducing townships' use of water sparingly, and by increasing reservoirs' storage capacity, as documented in earlier studies[9, 10]. According to [11], it is high time that countries start having clean water technologies that will suit the water quantity and water quality demands, like grey water, desalinated water use and treated wastewater reuse, are fast-growing [12]. Both options are considered a key component to reducing water pollution and freshwater scarcity globally.

Bushbuckridge municipality is one of the four municipalities in the Ehlanzeni District. The municipality is committed to providing affordable and sustainable service through good governance. Mkhuhlu township is one of the other townships in Bushbuckridge local municipality with a total population of three thousand people. Mkhuhlu Township is divided into three sections namely: Section A, Section B, and Section C. Currently, Mkhuhlu has been extended to section F. Mkhuhlu Township has one hospital, one Primary school, One High school, five (5) Early Childhood Development Centers, Ten Christian Churches, five (5) informal spaza shops, and 3 formal spaza shops, two

economies at large[16]. Hence, this study is significant since it seeks to address the impact of water shortage on the households of Mkhuhlu Township. The findings may be useful to the Bushbuckridge Local Municipality in making informed decisions related to water supply in the future. The study may also help to contribute to the already existing body of knowledge as well as help inform policy makers in government

Literature Review

This section is discussing the scarcity of water in South Africa and the world at large. The discussion is based on previous research and literature.

Water scarcity

South Africa adopted the National Development Plan (NDP) and Vision 2030 to create a better life for all its citizens in an inclusive society[17]. The problem of physical water scarcity arises when there is not enough water to meet all demands. This is when natural water resources are insufficient to meet all the demands in a region ([18] [19]

The quality of fresh water is depreciating in South Africa because of an alarming pollution rate and the destruction of river catchment which is mostly caused by urbanization, deforestation, mining, Agriculture, destruction of wetlands, accidental water pollution and energy use.[20-23].Population growth, poor governance, deteriorating infrastructure, Pipe linkages and illegal connection also contributes to water shortages in urban and rural communities. [24, 25] . The agriculture sector mostly use water for free.[26, 27]

A study conducted by [28, 29] the author attests to the difference in how residents receive water in villages. Despite being serviced by the same municipality, there are villages that only receive water once a week For residents who are still building their houses, water tankers sell 5000 litres of water for R500, and others buy water for drinking and cooking. In Mkhuhlu, people buy water, but the area surrounding the Township gets free water. The purpose of this study is to investigate the causes and effects of water shortage in Mkhuhlu Township, Mpumalanga Province. The research will address the issue of water shortage in Mkhuhlu township in Bushbuckridge municipality, along with possible solutions.

Water is a scarce and crucial resource globally [3], Prudhomme et al 2014, [5, 12].The expansion of the Mkhuhlu township increased the demand and shortage of water in the area and the entire municipality. People and Industries need water for survival. Mkhuhlu township with the escalating number of residents requires a water supply. There is a need to investigate the water shortage whether it is the municipality problem, the increased population, over-usage by residents, scarcity of water reservoirs, and lack of water treatment chemicals leading to water shortage among Mkhuhlu residents. This will be done with a view to addressing such anomalies.

The objectives that this study aims to achieve are the following: To determine the accessibility of water service to the households in the township. To compare the current water supply trends with the previous four years in the township. To establish what measures should be put in place to alleviate the problem of water shortage.

Water is critical in sustaining life, and crucial to economic growth, social development as well as environmental sustainability [13-15]. Therefore, the problem of water shortage is not just a local, provincial, or national phenomenon but a global issue that affects individuals, industries as well as the

commercial gardening, emergency and recreational purposes [37, 38]

How does water shortage affect the Economy?

Water shortages have a dominion effect on local communities and the country at large. When there is a water shortage in Townships, nearby SMMEs are affected. As incomes and revenues decrease, local commerce suffers. The decline of employment leads to a decline in the population and as such, communities shrink.[39]. Water is critical in sustaining life, crucial to economic growth, economic development, and environmental sustainability[40]. Therefore, the problem of water shortage is not just a local, provincial, or national phenomenon but a global issue that affects individuals' businesses, and as the economies at large.

Boreholes has health risk to people 's live

According to study conducted by[41, 42] attested that boreholes has potential health risk to communities. This was witness in Cholera outbreak in Mpumalanga 2008-2009 where communities drink unclean water[41] .[42] state that water from boreholes has risk towards people. Water from boreholes has chemical and borehole contaminations in the North West Province of South Africa

Importance of Ground Water

Groundwater is widely but variably used in South Africa. Groundwater constitutes 15% of the overall water consumption but a greater proportion which is 64% of the total groundwater is extracted to be used for irrigation purpose [43]. About 400 towns are dependent on the resource for water supply. Some of the towns includes Beaufort West, Prince Albert, Graaf Reinet, Atlantis and Musina [43].

According to [44], there is still high dependence on groundwater in the rural areas as well. Primary cities such as Pretoria and Johannesburg are highly dependent on or after two weeks. Residents that have flush toilets also suffer more than those without. The research for this study aims to establish the causes and impact of water shortage in Mkhuhlu Township of the Bushbuckridge municipality. Mkhuhlu Township and other communities around it are serviced by one water plant. This is because the demand for water is very high, and the supply is low. The plant can only supply 10000 mega litres a day.

[30]stated that problems of water shortage can be solved only if businesses, communities and industries can work together collectively to come up with strategies to alleviate water shortage. He also mentions decreasing water quality, water scarcity, and a lack of coordination among municipalities regarding water municipalities. Humans and animals are negatively affected by all of these factors.[31, 32] . According to study [33] has shown that rural areas and towns in South Africa are currently reliant on groundwater, and that two-thirds of all South Africans depend on groundwater for domestic needs. More than 20 South African towns are largely dependent on groundwater. Many areas in South Africa use groundwater as the sole source of water for irrigation. Groundwater is essential for daily living in towns such as Beaufort West, Prince Albert, Graaff-Reinet, Atlantis and Musina. Even large cities such as Port Elizabeth, Pretoria and Johannesburg are heavily dependent upon groundwater.[34]. About 59% of water is used for irrigation purposes and 6% for watering livestock [35, 36]. The balance is allocated to mining (13%), domestic water supply services (13%), industry (3%) and schedule (6%). Schedule, one permits the use of relatively small quantities of groundwater mainly for domestic purposes including non-

security among the poor, while protecting water resources efficiently.

Climate Change contributing factor for water scarcity

Climate change is one of the contributing factors of water shortage in Africa and in other continents. [52-54]. Extreme weather patterns make it more difficult to access safe drinking water especially for vulnerable children and rural communities. [55]. Emissions of carbon dioxide and other greenhouse gases are changing the earth's climate, potentially imposing a significant global cost that will fall disproportionately on the poor.[56] Rising temperatures, are increasing in Africa with an increased spread of diseases like Malaria and reduction in human and financial from aspect like droughts and flooding. ([52, 57, 58] . The consequences of climate change have an impact on the streamflow which differ from season. [59, 60]

Climate change has the potential to reduce food production and the availability of potable water, with consequences for migration patterns and levels of conflict. South Africa is not only a contributor to greenhouse gas emissions. [52, 61-67]. It is also particularly vulnerable to the effects of climate change on health, livelihoods, water, and food, with a disproportionate impact on the poor, especially women and children. [68, 69].

Recently in 2021 Mpumalanga province has a serious of flooding which increase water pollution for eleven days . It is important that South Africa start preserving water by building more dams for water storage. According to study conducted by [70] they attest that alien invasive plants are also alarming in South Africa, and they contribute to water shortage as they consume more water, cause fire and floods and increases the issue of climate change. [56].

surface water for water supply due to their high demand for water. However, these cities are also heavily dependent on groundwater supply [45]. As a result, there are fluctuation in groundwater recharge rates. The volume of ground water in South African is estimated to be between 10.343 million m3 per annum under drought conditions. However, there are only few primary aquifer and geological formations of South Africa which are mostly fractured hard rock have relatively low yield [46-48]. Only 20% of the groundwater occurring in major aquifers can be used for large scale water supply [46-48).

Groundwater management challenges are not unique to South Africa. According to[49, 50], the key obstacles in the provision of clean water to the South African population are lack of good leadership by elected government officials, lack of awareness about the value of water and sanitation, disrespect for the environment, inability to plan for water strategically, inability to enforce legislation, lack of specialized skills, lack of accurate information on water resources, inability to involve the private sector and stakeholders in the management of water, and failure to include water-related issues into national policies. A similar assessment has been made by [51].

The study by [50] has identified various obstacles to the protection of groundwater resources in developing nations such as South Africa. Examples of such obstacles are failure in the implementation of groundwater schemes, inability to manage groundwater resources optimally, lack of good corporate governance and reluctance to involve the private sector in the management and development of water[26]. There is a need for curbing the over-commercialization of groundwater and the over-abstraction of water resources. The duty of local municipalities should be to ensure water

department must encourage people not to overuse water.[74]

In order to prevent water pollution in rivers, agricultural sectors must come up with innovative solutions. Reuse of grey water should be emphasized, especially for gardening and flushing toilets. The communities should also be educated about rainwater harvesting [75, 76]. The role of water governance and stakeholder engagement in formulating and implementing solutions to the world's critical water challenges is receiving increasing attention[76, 77]

Littering another contributing factor for Water pollution

Water pollution in Mpumalanga is mainly due to human encourage and this affect the ecosystem [78].Lack of waste collection which includes littering like diapers and plastic also contribute towards pollution. It is imperative that a system be implemented to eradicate the littering as a way to eradicate pollution of water

2. Materials and Methods

This chapter covers the research design and research methodology. The study follows a qualitative research design. This research will take a form of a case study focusing on Mkhuhlu Township. The research will use a structured interview questionnaire for data collection.

According to a study conducted by [79] the choice and rationale of design of research design is a plan, or a blueprint used when one intends to conduct research. This study will to a large extent use a qualitative approach since primary data will be collected from the key informants with regard to the water supply in Mkhuhlu. The primary data will be collected through open-ended questionnaires and in-depth interviews to allow for more probing by the researcher and for the

Climate change is disrupting the weather pattern leading to extreme weather events, unpredictable water availability, water scarcity and contaminating water supplies. Such impact can drastically affect water quantity and quality of water that residents need to survive. Plants and animals depend on water, just like people. When a drought occurs, their food supply can shrink, and their habitat can be damaged. Sometimes the damage is only temporary and their habitat and food supply return to normal when the drought is over. The impact of climate change is global in scope and global solutions must be found, with due consideration to regional and national conditions. ([52, 71]

Education on water usage

Educating individuals about this component involves showing who the larger water users are, such as agriculture, residential, and commercial (Williams et al., 2009).[72]) study indicated that learners can grasp how they are also consumers of virtual water because the resources required to produce everyday products are also virtual water. It is crucial for enhancing the urge to conserve that people understand the footprint that simple products can have and their lifecycle. ([72]).

Water issues must be discussed by all stakeholders involved in water management. Communities and schools should be made aware of the importance of water management. ([72]) Residents should conserve water whenever possible. Water recycling needs to be taught to the public, and advanced technology related to water conservation needs to be implemented. Life cannot exist without water.[73]. Hunger and diseases will increase if communities lack access to drinking water, resulting in more deaths and hospitalizations. The water

will be the key people to be interviewed as they have first-hand information and more information about the townships and its challenges faced and their information will answer the research questions without bias.

Sample size and selection method

For the purpose of this study 50 household will be sampled in Mkhuhlu Township in the three sections namely Section A, Section B and Section C. The residents will be sampled randomly through probability sampling

Data Collection methods

A structured interview questionnaire will be used for this study for getting more information from the respondents. The study will use face-to-face interviews for the researcher to arrive at qualitative primary information. Secondary data will be collected through government legislation, journals, academic books, and relevant data from any related materials

3. Results

This section summarized the study's field findings and discussed how the issue of water shortage can be resolved in Mkhuhlu Township and its surroundings. The research suggests strategies and ways to preserve water. The demographics of respondents were documented thoroughly in the research as shown below.

Social Demographic respondents

For this study social demographic was gathered using questionnaires. The following traits were used: Age, Gender, level of Education, and culture

headed family members and in other homes the family is headed Young unemployed orphans.

respondents to freely express their opinions. A qualitative approach will be more useful to arrive at in-depth information from the research population

This section is presenting, the study area, population, sample size, selection method, and structured interview questionnaire. All these elements will be unpacked to show how the methodology for this study will take place. The study will use an interview technique to solicit information, and therefore the research methodology will purely be qualitative.

Study Area

The study area which is Mkhuhlu, in Bushbuckridge Municipality, Mpumalanga South Africa. Mkhuhlu is situated in main road to Kruger National Park. Townships have two schools in Mkhuhlu, one filling station, a Police station, a Complex, and 12 spaza shops. The township consists of three sections namely Section A, Section B, and Section C. Mkhuhlu township has one hospital and clinic which cater to the three sections, MA-RDP, and section F.

Households can be estimated at 3600 according to information from Bushbuckridge municipality, Mkhuhlu. According to[80], (Bless et., al. 2006:98) they define a population is an entire object which is the focus of the research, and the researcher focuses on determining some characteristics. According to data sourced from Bushbuckridge municipality and stats.SA, Mkhuhlu population is estimated to be 3196 people. The population of the study compares male and female inhabitants of Mkhuhlu township and for the purpose of the study resident who first stayed in Mkhuhlu

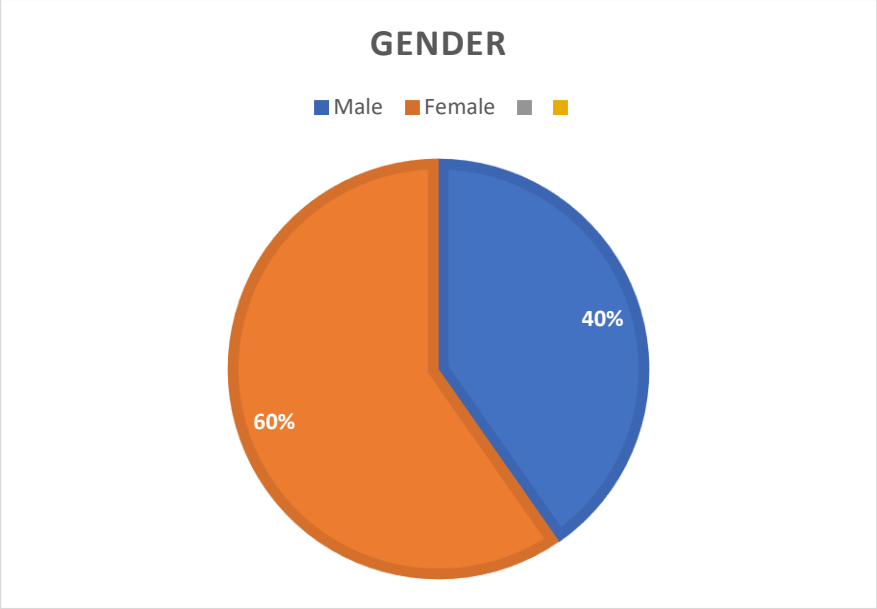

Figure A1: Pie Chart showing the gender of participants. Source: Own source

This resident all need water for survival. Some of the resident are single

This Pie chart illustrate that Mkhuhlu Township has 60 % Female and 40 % Male.

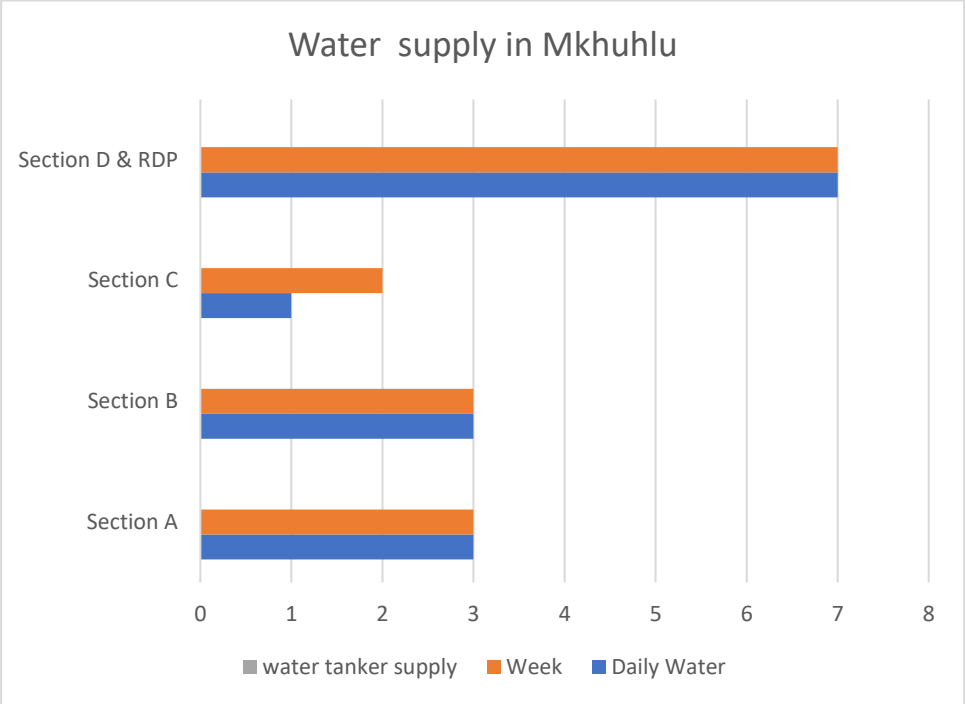

Figure A 2: Water supply in Mkhuhlu, Source: Own source

in a week. But the Section D receive water daily without any challenge.

Residents of Mkhuhlu Township Section A, Section B receive water three times in a week whereas Section C only receive water twice

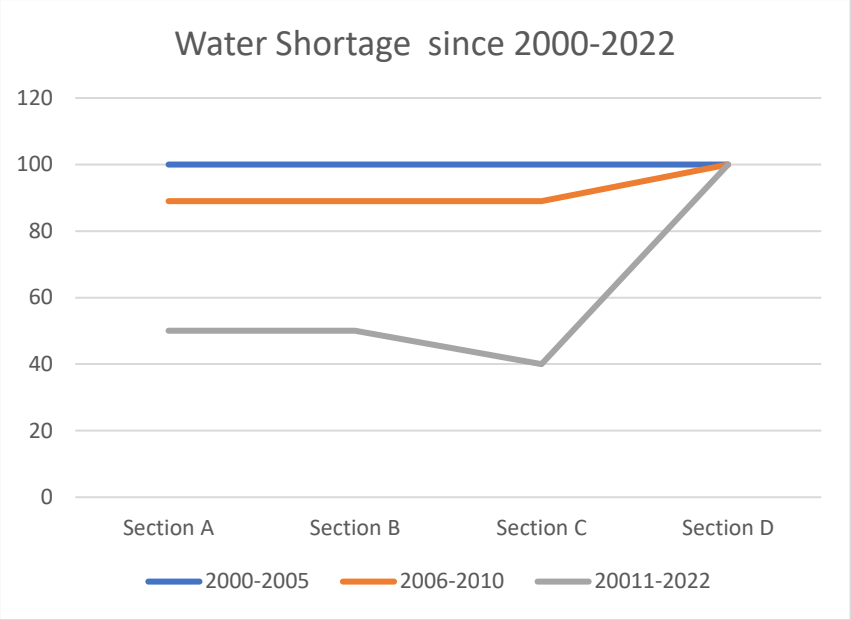

Figure A 3: Water shortage in Mkhuhlu since 2000:Source: Own source

since 2000-2011 the water shortage started after 2011 to 2022.While Section D never experience water shortage.

As indicated on the above diagram, Section A, B and C never experience water shortage

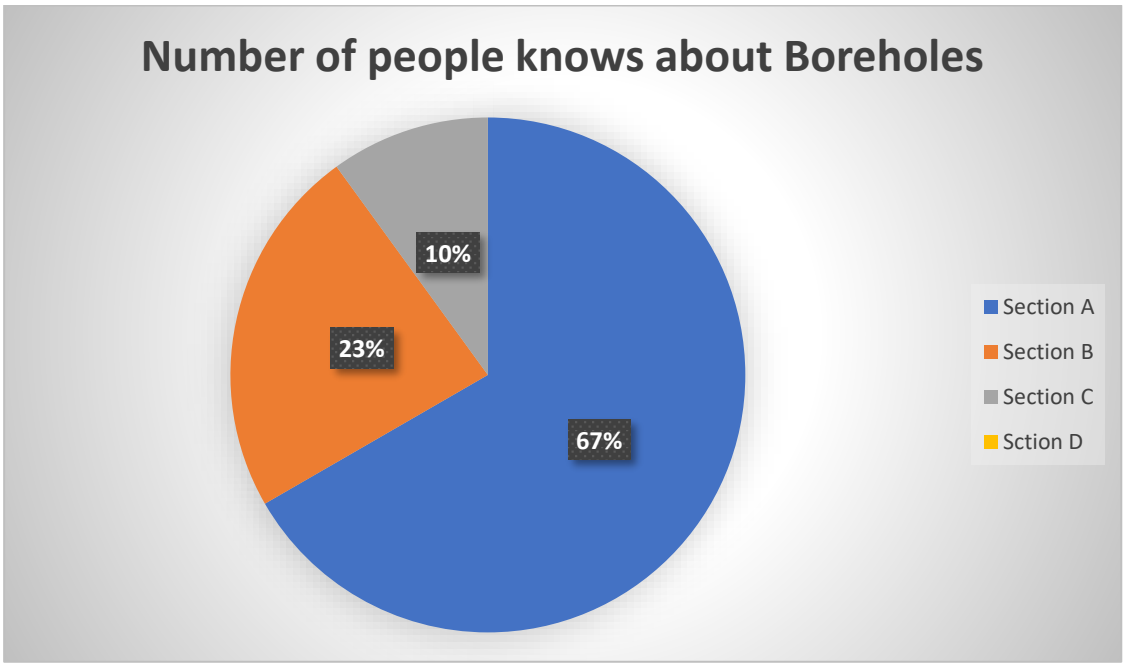

Figure A4:Number of people who know about borehole in Mkhuhlu :Source Own Source

knows about the Borehole and 23% in Section C knows about the Borehole in

Mkhuhlu. Amongst all this section no residents reported that they have receive

In section A, 67% of the people know about the Boreholes in Mkhuhlu, in Section B, 23%

water from the Borehole when there is water shortage in Location.

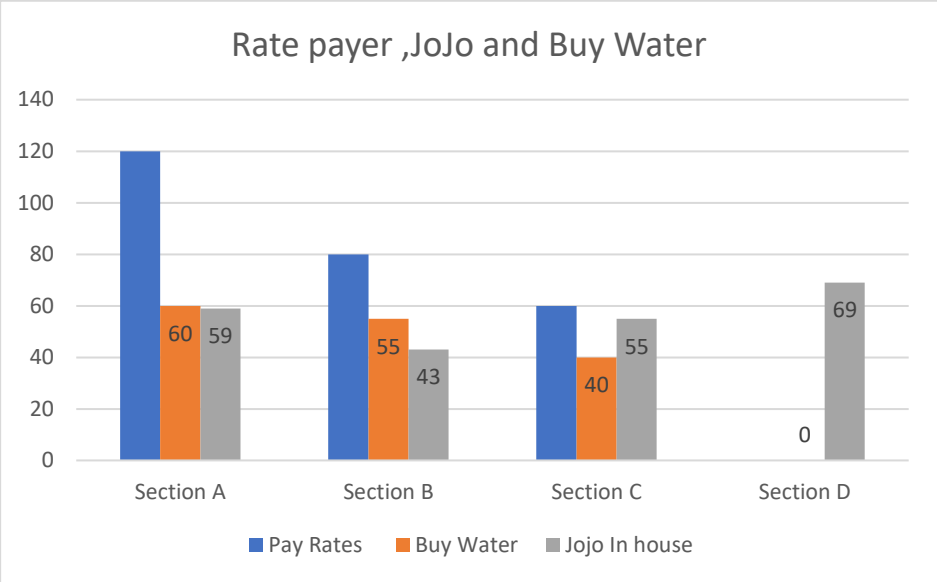

Figure A5: The types of water distributions in Mkhuhlu: Source: Own source

residents buy water, and 55 residents have JoJo Tanks. Section D they don't pay rate and they don't buy water, they have JoJo Tanks to store water and water is not an issue from their section.

In Section A, 120 residents pay rates, 60 buys water, and 59 residents have JoJo tanks in the yard. In Section B, 80 residents pay rates, 40 Buy water and 55 have JoJo Tanks. In Section C, 60 residents pay rates, 40

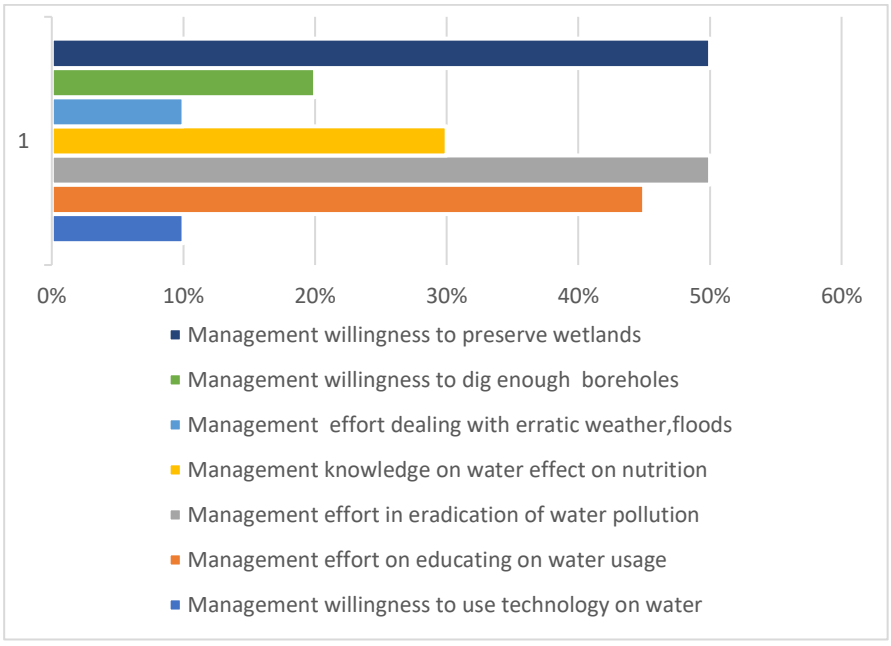

Figure A6. Management perception on water scarcity factors. Source: Own source

value, management need to put more effort on its daily discharge of duty on matters that affect water availability. Management willingness to preserve wetlands is sitting at

4. Discussion

The above figure 6 above shows Mkhuhlu Municipality management perceptions on factors that affect water availability. At face

recorded 45%. Management has a task to educate people on using water sparingly. Water usage sparingly cannot happen without consulting other stakeholders such as industrialists who have companies around, who should use practice water rationing and proper waste disposal, and promote the green environment. Management application of technology in water management is pegged at 10%. Much must be done to implement water management using technology using sensors, and smart meters. Water consumption can be enables by smart meters and monitoring hubs. Water overusage may be controlled due to monitoring in real time. Smart meters may also assist in predicting future water usage.

Automated precision algorithms all assist in managing the water. Regulation and water supply control can also be made easier and possible by employing environmental sensors and machine learning algorithms. These interventions will greatly assist in a constant water supply that is clean and affordable. Much must be done to implement water management using technology using sensors, and smart meters.

5. Conclusions

This section summarized the recommendations for this study. The cause of the water shortage in Mkhuhlu Township is due to the population increase in the Section D extension and RDP house. Secondly, there is a need for a land reservation to increase the water plants that will supply enough water to service every resident daily without challenges in all Sections of Mkhuhlu Township. All pipe leakages around the township and Mkhuhlu extension must be urgently repaired. Residents must be taught how to use water efficiently. Rainwater harvesting and storage tankers must be used in the township. Streams, Wetlands, Dams, 50%. Management need to do more to preserve waterlands because they are the source of water. The artificial wetland is effective to establish urban ecology. It may not only solve the problem of the urban water crisis, but also bring a series of good eco-environmental effects, such as conserving groundwater, regulating climate, extending green areas, purifying air, beautifying the city, and even effectively controlling flood damages

Management willingness to dig boreholes is at 20%. That is evidenced also by only two boreholes present in the area. Boreholes can serve as a safe and alternative source of guaranteed water. More boreholes could be dug in all sections. Management preparedness to deal with erratic weather and floods is 10%.Management should be prepared to deal with floods and erratic weather. Strategies must be in place to ensure a constant supply of safe water. Management can work with relevant government stakeholders on how to tackle such issues because they look slightly above their capacity, although they have a duty to advise the powers that be and get funding for their proposed projects. Management knowledge of the water as vital in providing nutrition to livelihoods is pegged at 10%. If management becomes more aware of the value water adds to nutrition, it would be in a better state to conserve it and make it available in time. Clean and safe water hugely contributes to human being well-being including animals. Management effort on eradication of pollution is at 50%. More effort is needed to ensure water is not polluted and residents receive clean sufficient water. Water is polluted in the area due to industrialization taking place in the vicinity. Locals have a tendency of dumping rubbish in the area as well whilst some people throw diapers in the river. Educating residents on water usage

residents when there is a drinking water shortage in the township.

Boreholes can serve as a safe and alternative source of guaranteed water. More boreholes could be dug in all sections. Management should be prepared to deal with floods and erratic weather. Strategies must be in place to ensure a constant supply of safe water. Management can work with relevant government stakeholders on how to tackle such issues because they look slightly above their capacity, although they have a duty to advise the powers that be and get funding for their proposed projects. More effort is needed to ensure water is not polluted and residents receive clean sufficient water. Management has a task to educate people on using water sparingly. If management becomes more aware of the value water adds to nutrition, it would be in a better state to conserve it and make it available in time.

6. Patents

Not Applicable.

Supplementary Materials: None .

Author Contributions: For research articles with several authors, a short paragraph specifying their individual contributions must be provided. The following statements should be used "Conceptualization, Mafuwane Hluphi Constance . and Mammo Muchie.; methodology, Hluphi Constance Mafuwane.; software, Tshifhiwa Nenzhelele; validation Tshifhiwa Nenzhelele ,Hluphi Constance Mafuwane and Mammo Muchie.; formal analysis, Mammo Muchie ; investigation, Hluphi Constance Mafuwane .; resources, Tshifhiwa Nenzhelele.; data curation, Tshifhiwa Nenzhelele.; writing—original draft preparation, Hluphi Constance Mafuwane ; writing—review and editing, Tshifhiwa Nenzhelele visualization, Mammo Muchie ; supervision, Mammo Muchie; Mafuwane Constance ; Mammo Muchie and rivers that are close to Mkhuhlu Township must be protected for future use. There is a need for technological advancement to ensure water is protected in the household. There must be an increase in awareness to ensure water is used sparingly. Eradication of Alien Invasive plants in the rivers and streams is also recommended as it consumes more water and increases flooding and climate change. Municipal by-laws must be enforced and People must be educated that water is a finite resource and that we are running out of water.

Local municipalities at Bushbuckridge must monitor and evaluate the use of water at the household level by using a community-based programmer. Incentives must be provided to households that use water economically. Accountability mechanisms must be established for communities. Employees working at Bushbuckridge and Mbombela local municipalities on water-related services must be trained on how to promote the effective and economical use of water at the household level. There is a need for collaboration between the Municipality and community leaders regarding the issue of littering. Littering collection systems in rural areas must be taken into consideration and implemented to minimize water pollution. Such employees should also provide health, sanitary, hygiene, water-related, and environmental education at the household level. The municipality must come up with a strategy to convince people to pay rates including other sections that surround Mkhuhlu Township. Illegal water connection must be prohibited by the municipality from the other sections as this affect residents from Mkhuhlu Township. It is recommended that communities and townships look at reusing greywater other than losing it. SMMEs that sell water can open water shops to assist the

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funding acquisition, Mammo Muchie. All authors have read and agreed to the published version of the manuscript." Please turn to the CRediT taxonomy for the term explanation. Authorship must be limited to those who have contributed substantially to the work reported.

Data Availability Statement: "Not applicable"

Acknowledgments: I acknowledge the support from NRF and Tshwane University of Technology for their wavering support .

Conflicts of Interest: I declare no conflicts of interest for this study

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