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Technological Way of Solving the Issue of Drinking Polluted Water Canal in Chochocho Bushbuckridge Municipality Mpumalanga Province

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Abstract: Purpose: The purpose of this research is to evaluate the social, economic, and political feasibilities of providing water purification technologies to rural areas of Bushbuckridge Municipality specifically Chochocho residents. **Methodology:** For this study, the following techniques were used, Questionnaire survey, simple survey, Observation and group focus, Data was collected by fieldwork visiting the community members drinking polluted water and getting information utilizing calling individuals. Random sampling was done for this study from community members in Chochocho in Mpumalanga, to collect data from known and unknown individuals and municipal officials. During the survey, we observed that residents were drinking polluted water. **Main Findings:** Based on the experiment conducted the results of the study shows that using *Moringa oleifera* powder cleans polluted water quicker and cheaper as compared to using paper filters and homemade filter. **Implications of study:** 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 that will assist the municipality to approach water purification markets as a cooperative and social responsibility in 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 the community with clean water. **The novelty of the study:** The study will knowledge and skills to the young generation through research and residents and the young generation will gain more innovative ways how to treat polluted water in Chochocho and increase the good health and livelihoods of residents in Chochocho in Bushbuckridge Municipality.

Keywords: Polluted water, Water Purification, Chochocho, Mpumalanga.

INTRODUCTION

Water scarcity is a burning issue for South Africa and the world at large. A country with a shortage of water affects the livelihood of people and the environment at large. Water knows no boundaries and as it flows it links communities together through their many uses of this resource. The quality of a stream or river is often a good indication of the way of life within the community through which it flows. Water is one of the indicators of the socio-economic conditions and environmental awareness and attitude of its users. Everything that happens in a catchment area is reflected in the quality of the water that flows through it, because the results of human activity and lifestyle ultimately end up in rivers, through runoff. Many factors contribute to water shortage in the country namely, Drought, alien invasive plants and many more. Due to a shortage of water mostly rural areas leave the community with no option of drinking or utilising contaminated water and as a result majority of people lost their lives or are affected by borne diseases. Without water, life cannot be sustained beyond a few days and the lack of access to adequate water supplies leads to the spread of disease.

Issues with Polluted Water

Water pollution is the contamination of water sources by substances which make the water unusable for drinking, cooking, cleaning, swimming, and other activities. Pollutants include chemicals, trash, bacteria, and parasites. All forms of pollution eventually make their way to the water. The extensive debate about the importance of adequate water quantity, quality, sanitation, and hygiene has been documented for many years by various authors (Cairncross, 1990; Esrey, *et al*., 1985; Esrey, *et al*., 1991). Every person needs at least 20 -50 litres of safe, clean water a day to drink, cook with and bathe. We're still ahead in reaching the global effort to make this a reality. Rivers, Wetlands and Health streams support a variety of water life. Spring water, Rainwater, and tumbling mountain streams contain high levels of oxygen.

The study conducted by Anderson, Woessner and Hunt, (2015) shows that local municipalities must be equipped with adequate capacity for preserving sources of water and natural habitat in rural communities as a means of safeguarding the general environment. Innovative methods of exploiting groundwater and springs must be utilized by the two rural communities to address the severe shortage of water in the two communities (Fan, 2015).

Methods of Water Treatment

Groundwater and Safe water constitute the main source of drinking water worldwide. This water source is polluted by municipal and industrial chemicals. (Gevod, *et al*., 2022). Water treatment plants reduce the concentration of harmful chemicals in the water to non-toxic levels and

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mandatory disinfection renders water non-hazardous from a bacteriological standpoint. However, conventional water treatment technologies using chlorine result in the formation of disinfectant by-products. Chlorine-based organic derivatives have been proven to be strongly carcinogenic. An additional problem arises from water pollution inside the distribution systems. It is due to the reproduction and decay of different microorganisms in water mains. This phenomenon can take place everywhere regardless of the initial water disinfection. There is a need for rural water purification to ensure people drink safe clean water. Water is an essential commodity for human life and indeed all life on earth depends upon it. Water is also a critical input to production in several economic sectors. Every sector of the economy is influenced in some way by water.

Shortage of Water

The world is facing a growing water crisis where half of the world's population is expected to be living in water-stressed areas by 2025. Today, over 2.5 billion people lack access to safely managed, clean drinking water that can be collected in a round trip of 30 minutes according to the World Health Organization (WHO). South Africans were liberated in 1994 with the hope that they will have access to free clean water, roads, and service delivery at large unfortunately it's the opposite for some of the residents in rural areas like Chochocho. Those who have the privilege to clean water ensure they sell water to those less privileged most of them are unemployed. The National Development plan's main aim is to ease poverty and unemployment and to ensure that people receive service delivery like clean water and sanitation.

The reasons for water insecurity are complex. Part of it is due to population growth and the depletion of groundwater supplies Thirty per cent of the earth's freshwater lies in deep aquifers, and it is being extracted at dangerously unsustainable amounts. Dalin, Wada, Kastner and Puma, (2017) have shown that South Africa is currently overexploiting its renewable water resources Water infrastructure in many places is crumbling, and billions of gallons of treated safe drinking water are lost every year. Water is wasted in farming irrigation, the production of energy, and other water-hungry industries. Conserving and eventually Reusing Water and conserving water is the most important way of saving water. Water resources and diminished resources which occur because of drought are driving the need for water conservation, efficiency, and reuse. To create more sustainable water for future use, cities and states are encouraging water conservation to reduce demand. Water reuse technologies have also been implemented in numerous locations in developing global countries and throughout the world. For example, Israel reuses 70 per cent of its domestic wastewater.

Water knows no boundaries and as it flows it links communities together through their many uses of this resource. The quality of a stream or river is often a good indication of the way of life within the community through which it flows. It is an indicator of the socio-economic conditions and environmental awareness and attitude of its users. Everything that happens in a catchment area is reflected in the quality of the water that flows through it, because the results of human activity and lifestyle ultimately end up in rivers, through runoff.

South Africa is one of 16 sub-Saharan countries belonging to the Southern Africa Development Community. Around 40% of the community's population has no access to safe water - that's around 130 million people. South Africa has, in general, a limited supply of water and the quality of this water is being threatened by pollution and the destruction of river catchments. Water is a vital resource, and it is up to all South Africans to act responsibly in their daily lives and look after the available water resources to ensure that this limited supply is usable by all life on earth. Everyone must become Water cautious.

Polluted Water Affects the Health of People

The local health centre or clinic takes care of more than 200 patients every day. Around ten per cent of them suffers from diarrhoea. One of the reasons for most cases of diarrhoea and diarrhoea-related diseases is the quality of the water. It is very, very clear that the better water people have access to, the greater the improvement in the health of the entire population would be.

Cholera is a diarrhoeal disease that is very sudden in onset. It is characterised by a massive loss of body fluids, through diarrhoea and vomiting, leading to severe dehydration, which can be fatal. The stool has the appearance of "rice water". Infants and small children show the most rapid advance of the illness. Untreated cases of cholera can lead to death within 6 hours, depending on the degree of dehydration. The residents of Chochocho in Bushbuckridge Municipality in Mpumalanga are

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facing the issue of borne diseases due to polluted water that is collected from the nearest canal as the only water source they have when there is no rain.

Water-washed (water-scarce) diseases, such as polio, are diseases where the interruption of the transmission is achieved through proper attention to effective sanitation, washing and personal hygiene. Regular washing of hands, especially after going to the toilet, is the most effective measure in preventing many infections, as is proper washing and hygiene during food preparation, together with proper sanitation, waste disposal and fly control, Covid 19 serve as contributing factors towards the shortage of water and Polluted water. People are expected to wear a mask and wash their hands regularly. There is no proper control of managing used masks people dumped them everywhere and some of the used masks landed in streams, rivers and dams and ultimately pollute the drinking water. There is no awareness conducted and no proper waste management and unaware littering.

Water-based diseases are diseases transmitted by contact with water, for example, recreational swimming. Water vector diseases, such as malaria, are diseases that are transmitted by a vector, such as a mosquito, which needs water or moisture to breed. Prevention of transmission is through vector control.

The study aims to provide an innovative way to produce clean safe water by installing equipment that will purify water in the rural community of Chochocho in Bushbuckridge Municipality in Mpumalanga Province, South Africa. With the growing complexity of water system problems, we need to deploy technology and other means available to us to improve our understanding, research, and management of this precious and limited resource. Current science has brought us the ability to better understand and seek solutions for large global issues, but we continue to be limited by our ability to access, use, and organize the large amounts of data produced by new technologies. Due to accelerating climate change, the increasing frequency of natural disasters and declining freshwater resources, there is increasing urgency to solve these problems. It is with these large datasets and collaboration with organizations and information that we may be able to find solutions. The study has the potential for assessing technological ways to be used to purify polluted water into drinkable water. There is a shortage of studies in this area of study. The study aims to fill the gap by collecting data from Bushbuckridge and Mbombela rural communities in Mpumalanga Province.

LITERATURE

Water Act

The new Water Act does require that any well producing more than five litres per second be licensed. Many economic activities are dependent on groundwater, and therefore the unavailability of groundwater, implies that most of the activities will come to a standstill. According to a study conducted by Li, Cheng, Liu, Xiao, Ma, Jin, Che, Liu, Wang, Qi and Wen, (2013), the poor are most vulnerable to a shortage of clean water in all parts of the world, especially in Sub-Saharan African countries. Ensuring easy and affordable access to clean and affordable water for all South Africans is a key aspiration of the South African Government. Rural communities need water for farming and daily livelihood.

The Water Crisis in South Africa

South Africa is a country located at the Southern Tip of Africa. It is a home that houses 49 million people and more. This country has been stricken by effects from the long-standing apartheid to the devastation that diseases such as HIV/AIDS and TB have caused. Now another crisis looms in the distance: Water. As more and more people migrate into cities from rural villages the pressure for the city to meet the water demands is ever increasing.

Many reasons attribute to this growing water crisis in South Africa. Climate change has affected water supplies within the region. Rains that usually come and supply the country's water have come infrequently. Some parts of the main river crocodile are polluted. Currently some of the dams in south Africa like in KwaZulu Natal, the Dams are twenty per cent lower than at the start of 2010. Due to this fact cities are looking to impose water restrictions on communities. In Bushbuckridge municipality some communities buy 20 litres of water for R2,00 for basic needs. Bushbuckridge is also facing the problem of stolen water from residents and some of the community members are not ready to pay their bills in the townships and there is an illegal connection of water to other villages.

Also, preventative measures that were put in place such as the construction of dams in the area have not even started or are still in the process of being built and those structures that are in place now are slowly collapsing. Those in rural areas still lack

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access to water. One report stated that in 2008 about 5 million people lack access to water and 15 million lacked access to basic sanitation. This number has improved greatly since the end of apartheid in 1994, however, these numbers are still too high and not one person should ever lack access to the most necessary of life, which is water.

South Africa boasts one of the cleanest water systems in the world, however, due to the lack of sanitation and access in the country's rural communities the threat of water-borne disease is steadily increasing. The residents of Chochocho in Bushbuckridge depend on polluted canal water from Champaign. The Vaal River, the largest river in South Africa and a popular tourist destination is becoming increasingly contaminated with faecal material due to the lack of sanitation supplies.

Overall, infrastructure is lacking, whether it is old pipes or ignorance the South African water crisis is here and affecting millions. There has been a backlog in services since the end of apartheid and that needs to change. The national and local governments of South Africa need to do a better job of offering services to their people. Supplies need to be given to those most in need. By taking care of the rural population the government will be helping the cities because it is these rural communities where the damage to the water supply is beginning due to lack of access to sanitation supplies and clean water education.

Water Supply in South Africa

Water supply systems in South Africa have not been able to provide and sustain adequate drinking water services, to all people, especially in Bushbuckridge Municipality. The main problem is a lack of sustainable access, to improved water supply services, for the people in an efficient manner. The problems are noticed as a lack of access to water supply and the poor and unsustainable services for people with access to water supply services. A large proportion of the population does not have access to improved services, and those with access, are concerned with the quality of services, such as water quality, adequacy, reliability, and response to consumer complaints. Access to drinking water has increased in the past two years. Around 270, 000 households gained access to safe drinking water (Statistics South Africa, 2018). As South Africans, we have a dream to be in a world without poverty, an equitable world, and a world that respects human rights. The world with increased and improved ethical behaviour, regarding poverty, and natural resources. South Africans need a world that is environmentally, socially, and economically sustainable, and where economic growth, is accomplished within the constraints, of realizing social objectives, poverty, eradication, and social equity within the constraints of nature's life support, carrying capacity, and a world where the challenges, such as climate change, loss of biodiversity, and social inequity have been successfully addressed. This is an achievable dream, but the system is broken, and our current pathway will not realize it.

Water Crisis in Sub Saharan Continent

Ghana’s water crisis: general context and overview Ghana’s population is estimated at 20 million people, with 58% living in rural areas and 42% in urban areas (WHO, 2004). The World Health Organization and Joint Monitoring Program (JMP) for Water Supply and Sanitation define urban areas in Ghana to be areas with populations of 5,000 or more. By contrast, areas with less than 5,000 people are deemed rural (WHO, 2004) More than half of the rural population in Ghana is vulnerable to having contaminated drinking water and water-related diseases like guinea worm and diarrhoea (WHO,2004). In Ghana, the same water is typically used for washing, bathing, cooking, and cleaning. This means that there are numerous ways for pathogens to be introduced into drinking water supplies and subsequently cause infection. Of the overall diseases in Ghana, diarrhoea is the third most reported disease, and it is the most common water-borne infirmity. The diarrheal disease accounts for 25% of cases of infant mortality, which was estimated to be 110 per 1,000 in the year 2000. (WHO, 2004) Water-borne illnesses also affect life expectancy in Ghana. Currently, life expectancy is approximately 56 years.

Water Supply

In rural areas, the central government generally allocates fewer resources to the low population density areas, delaying development and causing a lack of critical infrastructure. Currently, 56% of the population in the rural areas of Ghana’s northern region do not have access to clean drinking water and 92% do not have access to improved sanitation (WHO, 2000).

In Kenya, the Tana River provides water for 95% of Nairobi's residents and generates half of Kenya's hydropower. Excess sediment from eroding soil has been getting into the river, reducing reservoir capacity, and increasing water

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treatment costs. The Upper Tana-Nairobi Water Fund, a public-private partnership involving the Kenyan government, private companies and The Nature Conservancy, invests upstream to help poor communities adapt farming and forestry practices that improve yields while reducing water use and soil erosion. (Mason, *et al*., 2019).

A study conducted by (Mason, *et al*, 2019) mentioned that order to Secure safe drinking water, sanitation and hygiene for all in sub-Saharan Africa would require R35 billion per year in capital costs, just 0.5% of the total spending required for global infrastructure.

Invest in Green

Climate-proofing water systems aren't just about pouring concrete into taller flood defences or bigger dams. Governments and businesses can invest in nature to fill part of the infrastructure gap. Green infrastructure plays a huge role in providing safe, clean, and regular water flows from wetlands that buffer coasts from storms, and aquifers that store water, to forests that reduce erosion and help keep water free of sediment.

South Africa's Water Management

Improving South Africa's water management and infrastructure will reduce the climate vulnerability of people across the continent. Governments have a window of opportunity and a duty to their citizens to act now, and businesses and donors must back their efforts. Existing projects show that these investments pay off, with positive ripple effects across the economy.

On-Site Water Treatment Plants

A variety of technologies can provide on-site treatment, which varies in complexity and size. These solutions typically require capital investment; training and maintenance but have the greatest potential for long-term, sustainable potable water solutions. An on-site facility aims to provide an affordable system that can be maintained by locals, who in many cases will have limited knowledge and ability. Currently, the Ghanaian government does not provide on-site treatment facilities for rural regions due to the high initial investment that is required. However, in the future, the government may be able to create an investment climate that would foster the installation of on-site treatment facilities in rural areas. Groundwater wells: Northern Ghana has shallow groundwater wells, hand-dug wells, boreholes, and piped systems. Groundwater quality is generally potable but can contain high concentrations of fluoride (Dapaah-Siakwan, *et al*., 2000). In many areas, mining has contaminated groundwater. Locally, dug and maintained wells are a potential longer-term solution but usually require planning and outside assistance.

Drought and Climate Change

Poor rural communities often face greater exposure to climate hazards, such as more extreme rainfall or drought conditions, and have fewer resources to cope. By 2030, climate change could drive more than 100 million people globally into extreme poverty. In sub-Saharan Africa, 90% of the rural population depends on agriculture as their main source of income, and over 95% of arable farming relies on rainfall. Rising temperatures and unpredictable rainfall caused by climate change are expected to lower crop yields and raise prices. Governments must establish policies to reduce risks up front and manage those risks that are unavoidable.

METHODS AND MATERIALS

Two experiments were conducted to test the most effective and quicker method to purify polluted water into drinkable water. For this study, different methods were tested to resolve the issue of drinking polluted water in Chochocho Bushbuckridge Municipality through several technological ways,

Experiment 1: For the study, the following materials were used: 100 x *Moringa oleifera* seeds *(*Horse Radish*)*. 750 ml Glass of water, polluted water, 15x15 cm cloth, 10 cm wool for tying cloth, for each household. The process was timed for an hour.

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Figure 1: Moringa seeds powder + Dirty canal water = Clean water

A glass of 750 ml was filled with polluted water from the canal and one powdered seed of moringa was added to 750ml of dirty water and stayed for 1 hour and the water changed from dirty to clean.

Experiment 2: Homemade Water Filter with 2-Litre Bottle

Experiment 2: Water filtration was conducted to see and compare which method is effective to clean polluted water quicker and check which water the community will prefer to drink after being purified.

Materials used: Put 250 ml of concrete rocks, 250 ml Charcoal, 250 ml stones, 250 ml sand and cotton, and timer for an hour.

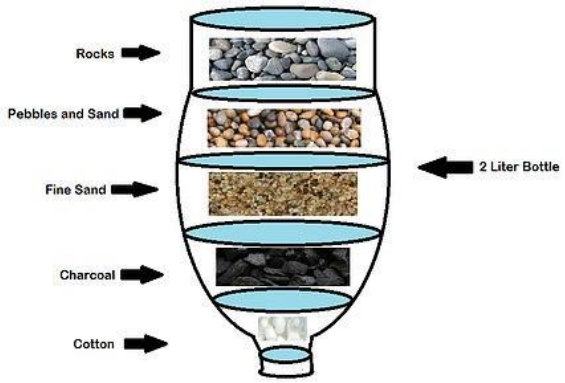

Figure 2: Water filtering with sand, concrete, and charcoal

Table 1: Types of technologies that can be used in rural communities

No.	Type of Technologies to Use in a Rural Area	Cheaper /Expensive	Comments
1	Solar Powered Water Filtration	Expensive to communities	Communities to assist with implementation
2	Moringa powder seeds	Cheaper	Can be done by each person
2	Rainwater Harvesting	Cheaper	Easy to do
4	Water Bottle	Given as part of school nutrition for pupils at school and old age	Only applicable for learners and old age people
5	Water from Air – Zero Mass Water	Expensive	More Technology needed
6	Recycle water	A cheaper way of water conservation	Use it for gardening

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Table 2: Attributes that affect water shortage in Chochocho Bushbuckridge municipality

Item	Title of Subject	Significant factors
1	Factors undermining the proper utilisation of Rainwater harvest	Lack of awareness about the Water Act of 1998 (Act no. 36 of 1998) Inability to expand water infrastructure Ignorance Lack of awareness about methods that are useful for conserving water Lack of good leadership at the municipal level
2	Socioeconomic problems	High unemployment and poverty Inability to expand water infrastructure Lack of participation by the private sector Planting moringa oleifera in each household to purify water
3	Recommended actions	Initiation of awareness campaigns about water conservation methods Repairing leaking water pipes Extending the current water infrastructure Having community water forum meetings Training communities about the importance of water advanced technology The provision of incentives to the private sector Enforcing the Water Act of 1998 effectively Enforcing municipal bylaws effectively

RESULTS AND DISCUSSION

For this study, we have sourced the different technologies that can be applied in to purify the polluted water used by the rural communities of Chochocho that they extract from the canal as their main source of water within one hour.

Table 2: shows a summary of results from the analyses of three key subjects of the study through the individual interview conducted with 30 members of the community selected in Chochocho Bushbuckridge municipality. Three items were discussed for this study. Item 1 was covering the factors undermining the usage of Rainwater harvesting. Item 2 was covering the socio-economic and political aspects faced by the community and the third theme covered the recommendations by respondents to tackle the water crisis faced by the community of Chochocho Bushbuckridge municipality in Mbombel.

Experiment 1: shows that within 50 minutes the polluted water is purified to be drinkable water. This is quicker only if the seeds are crushed into powdered and well prepared.

Experiment 2: Results show that homemade filtering is effective but slowly a glass of water was full for 1h30 minutes. Therefore, all experiments done have proven to be successful and less expensive but consume a lot of time to achieve good results.

It is important that other ways of assisting the community of Chochocho to have access to clean water can be considered. During the survey, we noticed that boreholes are available but there is no water coming out. There is a need for extension of the pipeline from Acornhoek Mall to be extended to the Chochocho community to supply water. Each household has a tap in a yard therefore the water can be channelled to the yard. Routine can be made so that water is supplied to the community at least twice a week. People are aware of harvesting rainwater but when it is raining they are ignorant about storing rainwater for bathing and clothing. Issue of awareness come out strongly where people were mentioning that they are ignorant of harvesting rainwater. Some complaints about water tanks are that they don't have water tanks.

The Bushbuckridge area has good soil for food, only a few households have planted moringa oleifera, the community was taught about the use of moringa powdered seed as a water purification plant and each household was given a plant. The canal water can only be used with a water sachet to purify the water.

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Government must supply the community with sachet when there is no option other than to use the Canal water. Solar water disinfection must be implemented in each household to ensure each community member receives clean water. Operating cost is negligible if water bottles are reused. It is also recommended that communities or schools around Chochocho be assisted with water purifying machines that use solar energy. The community can buy at least 5 litres at a reasonable price. Water awareness raising must be conducted in the community facing a water crisis. Car wash owners must use water sparingly.

CONCLUSIONS

This study analyses the known alternatives for rural people of Mpumalanga. Safe drinking water is needed at present and short-term solutions are important. Of the identified solutions, only the personal water treatment alternatives are available short term. LifeStraw filters are particularly effective for villagers that need to travel throughout the day, allowing them to stop at a water source and drink clean water as needed. The disadvantage of focusing on personal options is that doing so may delay the implementation of longer-term, more sustainable solutions. The disadvantage is the cost; each person needs to spend approximately R2 per straw.

For long-term solutions, the government and other agencies need to focus on creating on-site water treatment facilities. While there are barriers to this long-term solution, such as cost, politics, and cultural adaptability, its emphasis on location-based treatment has the benefit of providing a high quantity of clean water to the community. It is also recommended that to reap the economic and social benefits of a nation with access to clean, potable water, the country's leaders must focus on creating water infrastructure for rural regions.

Future work should focus on reducing the level of waste generated from personal water treatment. Rural areas in Chochocho should have access to a water treatment facility. If drinking water can be obtained through vendors, even at a high cost, the incentives for new treatment plants or wells are reduced. For school children at least each child should receive 5 litres of bottled water as part of school nutrition. The technologies that are not recommended for use in rural Chochocho are water sachets, cloth filters, solar filtration, and water bottles.

These approaches do not meet adequate drinking water standards. Water sachets, generate excessive waste and have been shown not to meet WHO standards for clean water in studies. There is a need for reducing agricultural water demand by increasing the economic productivity of water. The community should reconsider the reuse of water.

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