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The Effects of Climate Change on Natural Water Resources: A Health Crisis

Sejabaledi Agnes Rankoana
Department of Sociology and Anthropology, University of Limpopo, South Africa
Corresponding Author: Sejabaledi A. Rankoana; Email: sejabaledi.rankoana@ul.ac.za

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ABSTRACT

The provision of sustainable, high-quality, and safe water is imperative for a healthy and good life for all living beings. Limited supply, increased demand, and declining water quality can adversely affect community members' health and well-being. This research investigated the impacts of climate change on local water sources and the subsequent effect of water scarcity on the health of a rural community in Limpopo Province, South Africa. Results from a study involving 53 randomly selected individuals in a rural community indicate that the most severe health issues caused by a lack of water include poor sanitation and hygiene-related disorders such as lice infestations, cholera, malaria, diarrhoea, dysentery, and skin infections. This study recommends that the South African government provide the necessary resources to ensure unrestricted access to sustainable and high-quality water to meet Sustainable Development Goal 6.

INTRODUCTION

Water is a significant component of Section 4.8 of the Sustainable Development Goals (SDGs) and is essential for various changes in systems that are necessary to develop resilience to climate variation. Access to sufficient and reliable water is vital to achieving the Sustainable Development Goals (SDGs) (Ait-Kadi, 2016). Water scarcity refers to the insufficient availability of clean and quality water to meet the established demand for water (World Wildlife Fund, 2020). It is a major impediment to sustainable development (Mekonnen & Hoekstra, 2016). Similarly, in South Africa, establishing a water-secure future is a major obstacle of the 21st century. Water security is crucial for achieving social well-being and sustained economic growth, aligning with the goals of the National Development Plan. South Africa is designated as a water-scarce nation and ranks among the 30 driest countries worldwide, with an average annual precipitation of almost 40% below the global yearly average (Du Plessis, 2017). South Africa has experienced a gradual and sustained change in its climate, marked by a decrease in rainfall events over the last sixty years, as indicated in the National Climate Change Adaptation Strategy (NCCAS, 2019). The country is seeing a rise in water requirements due to the stresses of a fast-growing, urbanising population, evolving lifestyles, and economic expansion (Du Plessis, 2017). Concurrently, climate change drives the nation towards a future marked by elevated temperatures and diminished precipitation, leading to extended and increasingly severe droughts (Muller, 2018).

Water insecurity originates from various sources, including both natural and social influences. Natural causes encompass insufficient freshwater resulting from drought or pollution, as well as excessive water from intense precipitation and flooding, both influenced by climate change (International Panel on Climate Change [IPCC] 2022). Climate change negatively impacts numerous countries, which is evident in their daily lives through diverse water-related effects. This encompasses increased frequency and intensity of heavy rainfall, changes in precipitation patterns, more frequent and severe droughts in specific regions, a decline in underground water storage, a reduction in recharge, and the deterioration of water quality (Douville et al. 2021; Gulzar et al, 2021). These factors have considerably intensified water stress globally, prompting the World Health Organisation to designate climate change as the primary hazard to global health in the 21st century

(Bjornlund et al., 2020; Wanjara & Ogembo, 2023). The African continent predominantly experiences water stress due to variations in precipitation (IPCC, 2022), which presents a significant obstacle to its efforts to secure reliable and uncontaminated water resources (Oluwayemisi et al., 2023). Susceptibility to the effects of climate change and extreme weather on water resources is anticipated to escalate (Bijl et al. 2018).

The consequences of water insecurity in Africa include health, education, agricultural output, sustainable development, and an increased likelihood of water-related conflicts (IPCC, 2022). The literature differentiates between economic scarcity and the physical shortage of water. Economic scarcity refers to the laborious and expensive process of identifying a reliable source of potable water (Fidelis et al., 2021; Chitonge, 2020). Conversely, physical scarcity arises when there is an inadequate supply of water in a particular location (Fidelis et al., 2021; Chitonge, 2020; Lotsmart et al., 2023). The latest report on Sustainable Development Goal 6 (SDG 6) has furnished details concerning physical water scarcity in sub-Saharan Africa (Chersich & Wright, 2019), where physical water scarcity is expected to adversely affect hygienic practices and nutrition, especially in children, due to the increased incidence of infectious diseases (Goyanka, 2021; Grobusch & Grobusch, 2022). This form of water scarcity can exacerbate the incidence and proliferation of waterborne diseases, including malaria, cholera, and dysentery (Muller, 2018; Anderson et al., 2023; Anik et al., 2023). The South African National Water and Sanitation Master Plan (2018) reports that water scarcity adversely impacts the well-being and lifestyle of South Africans. The depletion of water resources, increasing water demand, and deterioration of water quality (Muller 2018) negatively impact societal health and well-being. This study aims to describe the effects of climate change on local water supplies and the implications of water shortage on the health of a rural community in Limpopo Province, South Africa.

MATERIALS AND METHODS

Research Site

The research was conducted in the Maheni community, located within the Thengwe area in the Vhembe District Municipality of Limpopo Province, South Africa. The district boasts proximity to the Kruger National Park as the eastern border and the broader Limpopo River in the northeast. The district experiences a severe lack of rainfall, resulting in intermittent drought episodes (Mutale Local Municipality Integrated Development Plan 2016–2017). Annual temperatures vary from 18°C to over 28°C. The highest temperatures are experienced in January, while the lowest are encountered in July (Mutale Local Municipality Integrated Development Plan 2016–2017). The district has significant challenges with low-quality (high salinity) and groundwater depletion, as well as inadequate financing to address the water scarcity in all affected local municipalities (Statistics South Africa, 2018). Previous research conducted in Vhembe by Kom et al. (2020), Jimoh et al. (2021), and Kom et al. (2022; 2023) reported decreased water levels in the rivers and boreholes. This observation catalysed the researcher to describe the impacts of water insecurity on the health conditions of the members of the Maheni community.

Study Design

The study employed community participatory research to investigate the impacts of water scarcity on the health conditions of the Maheni community. A random sampling method was applied to select 53 participants. There were 21 males and 32 females, whose ages varied between 26 and 72 years. Prospective participants were convened at a collective meeting to exchange insights regarding water scarcity and its impact on community health and well-being. Subsequently, eight focus group discussions were held with a minimum of six participants in each session.

The research utilised community participatory methods to examine the impact of water scarcity on the health conditions of the Maheni community. A random selection technique was employed to choose 53 community members for the study. The group comprised 21 males and 32 females, with ages ranging from 26 to 72 years. Potential participants gathered for a joint meeting to discuss water scarcity and its effects on community health and well-being. Subsequently, eight focus group talks were held, each comprising at least six community members. The main questions asked were about the community perceptions of climate

change effects on water resources and how water scarcity affects household uses of water for consumption (drinking and cooking) and hygiene (bathing, washing clothes, and cleaning). The thematic content approach was used to analyse data. The data were categorised into two primary themes: the impact of climate change on water resources and the impact of water shortages on household water usage and hygiene practices. The data acquired in Tshivenda and Sepedi were expertly translated into English by professionals in the Department of Translation Studies at the host institution.

RESULTS AND DISCUSSION

To the questions relating to the health effects of water insecurity, participants' responses were categorised as follows: The effects of climate change on water resources and the impact of water scarcity on household consumption (drinking and cooking) and hygiene practices (bathing, washing clothes, and cleaning) are significant. Climate change impacts on natural water resources. Participants identified the cause of water scarcity as erratic rainfall. They reported that rainfall is infrequent, leading to decreasing water levels in the springs and reduced output from boreholes and reticulation systems. Here are some participant comments: "Our main water supply is the reticulation system, which supplies water through yard connections. The Mutale Local Municipality operates and maintains the bulk water delivery scheme that serves this system, which sources surface water from the Mutale River in Thengwe. Unfortunately, the design and demands are such that the operating pressure is insufficient to deliver a consistent water supply in the Maheni community due to the current intermittent drought and erratic rainfall that recharges the Mutale River flow.

Climate Variations and Effects on Natural Water Resources

The effects of climate change on water resources and the impact of water scarcity on household water consumption (drinking and cooking) and hygiene uses (bathing, washing clothes, and cleaning) are significant. Participants identified the cause of water scarcity as erratic rainfall. They reported that rainfall is scarce, and as a result, water levels in the springs are decreasing, and the output from boreholes and reticulation systems is reducing.

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Reports about the borehole output were that: “The borehole water output is declining. The time it takes to fill the tank, which supplies the community with water, supports this statistic. The pump operator closes the water supply until the tank is full, which takes more than six hours. We believe that due to erratic rainfall causing intermittent droughts, the borehole water level is dropping. Consequently, we have an insufficient amount of water available for domestic use”.

An analysis of the current water supply in the Maheni community embraces two drivers of physical water scarcity described by Keys and Falkenmark (2018): demand-driven water scarcity and climate-driven water scarcity. In the context of demand-driven water shortage, water demand surpasses the capacity of current water sources. Maheni community members demand water for daily consumption when the borehole water level has dropped and the water supply from the reticulation system is inconsistent. Du Plessis (2017) acknowledges that the mismatch between water supply and water demand is a potential threat and a key concern that could lead to the country experiencing a water crisis. Water scarcity in the Maheni community is climate-driven. Climate-driven water scarcity results from the direct impacts of rainfall on water resources. Climate change worsens water scarcity by causing more unpredictable patterns of rainfall (Rahman et al., 2019; Jurgilevich et al., 2023; Liao et al., 2024). This form of water shortage arises when there is inadequate rainfall and excessive evaporation, resulting in limited water flowing in streams (Bodrud-Doza et al., 2020; Livingstone, 2021) and a restricted water supply. Global climate change, climate variability, and recurring droughts worsen the problem of water scarcity. Du Plessis (2017)

acknowledges that climate change will affect water supplies through heightened fluctuations in rainfall. Changes in precipitation patterns can lead to dry regions with more frequent and severe droughts, thus exacerbating limited access to safe drinking water in areas where most of the population lives (Liao et al., 2024).

The main causes of water shortage in Africa are expected to be rainfall pattern alterations, precipitation and runoff reductions, and elevated evapotranspiration rates resulting from climate change (Gan et al. 2016; Markonis et al. 2021). Livingstone (2021) supports that changing rainfall patterns and the rise in temperatures contribute to sufficient water provision to the rapidly growing populations. (Dione et al., 2023; Haughey et al. 2019). Caretta et al. (2022) found that alterations in rainfall patterns had a detrimental impact on water security, causing a decline in the amount and quality of water. They also observed that a reduction in precipitation would result in a 17% decrease in drainage in the sub-Saharan region. South Africa encounters precipitation that exhibits substantial variation between its western and eastern areas (Botai et al. 2016). The northwestern region often experiences annual rainfall below 200 mm, while the east Highveld gets about 500 mm to 900 mm of yearly rainfall, occasionally surpassing 2000 mm.

Lack of Hygiene

Participants had this to say: “Scarred water supplies in the community make proper hygiene more difficult to achieve. Lack of access to clean water has a detrimental effect on our hygiene. We struggle to get enough water to cook, clean, wash, and do laundry. Adherence to regular hygiene practices, such as cleaning the house daily and bathing, is impossible. Regular hygiene practices may be considered socially unacceptable or disrespectful while posing a health risk”. Participants noted that personal hygiene could enhance health and reduce the risk of illness or disease.

Twenty-two participants reported: “We collect enough water from the taps for future use whenever it is available. The water is stored in containers and sealed to avoid contamination. We use water sparingly for cleaning and washing. Instead, we use the water daily for cooking and bathing”.

These observations are backed by the idea that severe water shortages are connected to extreme weather (Abedin et al. 2019), where not having sustainable clean water supply can be responsible for health problems, increasing the chances of stomach illnesses and other serious diseases like brain issues, liver and kidney damage, cancers (Jones et al. 2016), and diseases spread through water. The underlying vulnerabilities and disparities are worsened by the increased demands for water and hygiene services due to infectious diseases (Armitage & Nellums, 2020a; Bolan et al., 2024).

Diseases Associated with Hygiene

Maintaining proper cleanliness is essential for overall health. Inadequate hygiene elevates the likelihood of illness. These disorders do not generally arise by coincidence; they stem from insufficient personal hygiene.

Participants indicated that: “Despite regular bathing, water scarcity compels us to forgo laundering clothes for four to six weeks." House cleaning is conducted sporadically, with the water used to rinse clothes during laundering. We recognise that this circumstance poses a health hazard due to the infrequent changing of clothing”.

Participants recognized the health hazards associated with the infrequent laundering of clothes and poor sanitation.

Disorderly and unsanitary residences attract flies, mosquitoes, lice, bedbugs, and moulds. These residences serve as their breeding grounds and are likely to proliferate. This circumstance renders us susceptible to illnesses transmitted by flies, mosquitoes, and ticks. These encompass cholera, malaria, diarrhoea, dysentery, and dermatological diseases. Moulds can inhabit wall and floor tiles, as well as shower curtains, potentially leading to illnesses and allergic reactions, degrading surfaces, and producing unpleasant odours.

Restricted access to water constitutes a significant health challenge, especially the need to execute adequate hygiene practices like consistent handwashing and regular sanitation; cleaning and washing are advocated as strategies to avert the transmission of infections (Shrestha et al. 2022). The primary disease-causal factors and restricted supply of quality water may result in recurrent contagious disorders such as intestinal parasites, diarrhea, and COVID-19 (Berihun et al., 2022). Ensuring sufficient water accessibility, sanitation,

and hygiene (WASH) protects human health during infectious disease epidemics (Shrestha et al., 2022; Thomson & Stanberry, 2022; Liao et al., 2023). Water insecurity and insufficiency, poor sanitation, and hygiene are linked to heightened illness risk, stress, and negative mental health outcomes (Wutich et al., 2020). Yuan-Xu (2020) asserts that waterborne infections are generally non-existent in modern nations owing to technological water treatment systems that efficiently filter and disinfect water. Communities in regions with insufficient or absent water infrastructure frequently face disease-causing parasites and bacteria in untreated natural water sources. Although several waterborne diseases can be treated and prevented, they remain a significant cause of illness and death in developing nations (Yuan-Xu 2020). Accessibility of quality water is a crucial factor in controlling and preventing infections (World Health Organisation [WHO], 2007-2017). Poorly constructed water and sanitation systems were identified as a critical component in the swift proliferation of the 2014 Ebola outbreak and contributing to the elevated mortality rate (Lane et al. 2022). In this context, the United Nations International Children's Emergency Fund (UNICEF) cautions that almost one billion individuals globally would be deprived of sustainable quality water supply, hygiene, and sanitation by 2030 (Semenza, 2020; Wutich et al., 2020; Raimi et al., 2021).

Gender Roles, Water Scarcity, and Health

Participants' responses to questions about the health consequences of water scarcity revealed which gender is more prone to hygiene-related diseases. The study's findings show that women and girls bear an uneven burden of water scarcity. Fetching water from the communal standpipes consumes time that may otherwise be spent on a job, school, and taking care of the family. Tomberge et al. (2021) corroborate that African women bear a disproportionate burden due to the paucity of safe drinking water. Women are typically responsible for collecting and protecting water sources to ensure water security and fulfilling household chores (Ngwenya et al., 2017; Sweetman & Medland, 2017; Chaity, 2022). Due to conventional gendered labour roles, women are compelled to allocate their daily time to gathering water, reducing the amount of time available for other household duties (Pahwaringira et al., 2017; Adams et al., 2018).

The health effects of long-distance transportation of water tend to increase stress and recovery times, resulting in a longer period of health problems that affect decision-making and memory abilities (Graham et al. 2016; De Guzman et al. 2023).

CONCLUSION

The study aimed to elucidate the significance of water for human health and well-being. Members of the Maheni community face water scarcity due to inconsistent rainfall, which does not replenish the natural water supplies that provide daily consumption needs. Water scarcity undermines the community's complete cleanliness due to inadequate water for cleaning, washing, bathing, and cooking. Inadequate cleanliness renders society susceptible to diseases. The research advises the South African government to allocate resources to guarantee free access to sustainable and high-quality water to fulfill Sustainable Development Goal 6 (SDG 6).

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