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ASSESSMENT OF PEOPLE'S PERCEPTION ON GROUNDWATER VARIABILITY IN RANO HARDROCK TERRAIN AREA, KANO STATE, NIGERIA

By

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ABSTRACT

This research assesses people's perception on Groundwater variability in the Hard Rock Terrain Areas of Rano Local Government, Kano State. Focus Group Discussion (FGD) was used as data collection instrument where participants were selected using purposive sampling technique. The data was analysed using thematic analysis. Result revealed that groundwater variability in the area is influenced by climate change resulting in reduced rainfall, increased temperatures and diminished water infiltration which impact aquifer replenishment. It is concluded that, findings emphasize the need for integrated approaches considering geological, geomorphic and hydrological factors to ensure sustainable groundwater development and utilization in the study area. Based on the findings, it is recommended that Government should raise the awareness campaign on climate change impacts by educating the community members and also implement water conservation measures by promoting water-saving practices to reduce water shortage in low groundwater yield areas.

Keywords: People's Perception, Groundwater, Variability, HardRock, Terrain

INTRODUCTION

Groundwater is a hidden resource which people are looking for always to make a living but not equally distributed. Groundwater is a prime source of drinking water due to its good quality and low vulnerability to contamination (Li & Qian, 2018; Rao & Chaudhary, 2019). It is the most valuable natural resource in the world, particularly in the arid and semi-arid climo-morphogenetic regions such as the hilly regions of the Himalayas, the tropical Middle East, and the hard rock topography of Africa where subsurface water is only restricted to aquifer pockets within fractured and weathered horizons in the subsurface (Haque *et al*., 2020). Apart from drinking and public health use, groundwater is used in the sustenance of agriculture, industry, and environmental stability, and has numerous domestic uses. Its urgent need is mostly felt in the Middle East and North Africa where surrogate water resources are inadequate (Sarkar *et al*., 2020; Karunakalage *et al*., 2021).

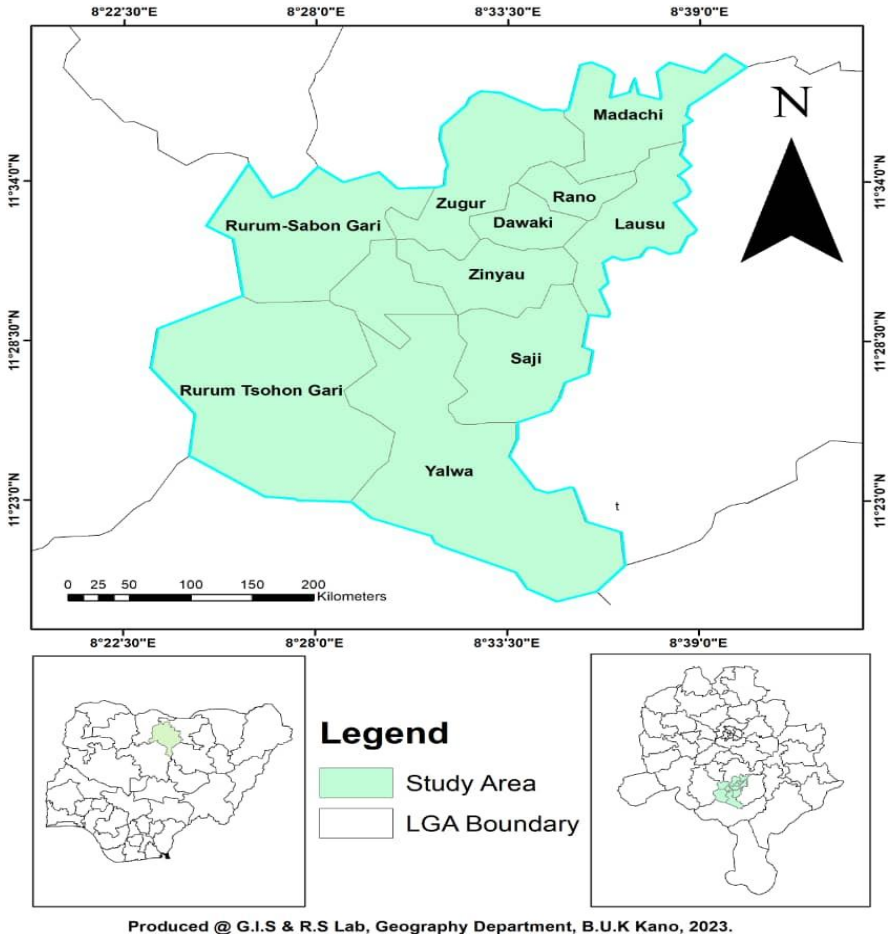
Globally, groundwater is adjudged to be the next scarcest resource, especially in the face of exponential population growth, climatic variability, and rising abstraction from agricultural and industrial uses (Anuforom, 2013). According to resource experts, groundwater management will be an enduring gauge in water and land management (Foster *et al*., 2006; Jha *et al*., 2007; Majumder, 2017). Since major portions of our ecosystem are largely water-dependent and freshwater is a germane ingredient to our ecosystem's stability and sustainability, groundwater research is a national and global concern (Foster *et al*., 2006). The 2012 Report by the Food and Agriculture Organization of the United Nations indicates that growing water scarcity is now one of the leading challenges for sustainable development (Food and Agricultural Organisation, 2012). In Nigeria, some reports have suggested that increase in extreme heat, drought and the shrinking of Lake Chad is causing water shortage and environmental migration that is forcing thousands to migrate to neighbouring Chad and towns (CBP, 2020).The aim of this paper was to assess the people's perception on Groundwater variability in Hardrock terrain Area, Kano State.

RESEARCH METHODS

The research was conducted using the following procedures:-

The Study Area

Rano local government area is located between latitude 11°33′ to 24° 62'N and longitude 8°34' to 50° 34' E respectively (Figure 1). It has an area of 520 km^2 and a population of 145,439 at the 2006 census (Weather Spark.com, 2023).The study area has a unique geology that is characterized by Precambrian Basement Complex rocks, including granite, gneiss, and schist, with sedimentary rocks like sandstone and mudstone deposited during the Cretaceous period. The area has a relatively flat to gently undulating terrain, with an elevation range of 400-600 metres above sea level, featuring low-lying hills and valleys (Kogbe, 1989). The mapped area lies within the tropical savannah climate zone of Nigeria and is characterized by two main seasons, rainy and dry season which is typical of northern Nigeria. The rainy season lasts for six months in a year, from April 10 to October 24 with sliding 31-day rainfall of at least 0.5 inches.



Source: G.I.S & R.S Lab Geography Department, B.U.K, 2023.

Figure 1: Study Area

Sampling Techniques

Participants around the identified open wells were purposively selected for the administration of FGD and it has been conducted in three geomorphic units (High, Moderate and Low areas). The FGD groups were selected, each from the high, moderate and low areas (Krueger and Casey, 2000. Patton, 2002). In each of the groups, eleven (11) participants were selected that are between the age group of 25 to 70 whom are assumed to have knowledge on groundwater fluctuation in the area.

Data Collection

Focus Group Discussion session was conducted to seek for the perception of people with respect to groundwater variability in the study area using FGD (Appendix XI). Thus, three FGD sessions were conducted each from high, moderate and low areas using FGD guide (Appendix XI). In each group, 11 participants were involved for the exercise (Plate 2). Participants for FGD fall between age group of 25 – 70 whom were assumed to have possessed knowledge and experience of groundwater variability and fluctuations in the area.

Data Analysis

With respect to Focus Group Discussion (FGD) data, thematic analysis was done to prepare a comprehensive report detailing the findings, supported by direct quotes and thematic summaries on people's perceptions with respect to groundwater variability and other variables like demographics or locations.

RESULTS AND DISCUSSION

A Focus Group Discussion was conducted in three geomorphic units with the people in order to understand their perception on groundwater variability as proposed by Krueger & Casey (2000), Yin, (2014) ; Patton, (2002), Morgan (1997) and Ritchie & Lewis, (2003). The result is presented as follows:-

Changes in Groundwater Availability over Time

Rano local government has experienced notable changes in groundwater availability over the years, influenced by various factors such as climate variability, population growth, and agricultural practices as revealed by the participants during FGD. Participant 1 of the F**G**D stated that:

> "For long, our community relied on groundwater most especially well for all our agricultural and domestic activities. But few years back these wells started to dry up early unlike before. This makes it very difficult for us to get the required amount of water we need".

Several factors contribute to this decline according to the participant. Climate change is a significant factor involving reduced rainfall patterns and increased temperatures in the area leading to less water infiltration and replenishing aquifers. This is in line with the findings of Mizyed (2018) in his study in Palestine where he also reported that climate change has led to less underground water in the region. Also, population growth in Rano LGA has placed a much strain on groundwater resources. As the number of residents increases, so does the demand of water for domestic purposes. This is also in line with the findings of Toure *et al* (2017) in their work "assessment of groundwater resources in the context of climate change and population growth in Klela Basin in Southern Mali" where they also reported that population growth led to increase in the demand of water thereby making people put pressure on the existing sources of water.

Furthermore, unsustainable agricultural practices can exacerbate the problem. Overreliance on groundwater for irrigation particularly through inefficient methods leads to over-extraction, exceeding the natural rate of aquifer recharge. This imbalance further depletes groundwater reserves and can lead to saltwater intrusion in coastal areas. This corroborates the findings of Grundmann *et al* (2016) where they found that agricultural activities can lead to over-extraction of water resources exceeding the natural rate of aquifer recharge in an affected area. Another factor affecting groundwater availability in Rano LGA as discovered in this study is human

activities. The increasing demand for water by the growing population and the expansion of irrigation schemes has put pressure on groundwater resources. For example, the Kano River Irrigation Project (KRIP) relies heavily on groundwater, which can lead to over-extraction and decreased groundwater levels. The construction of dams like Tiga Dam has altered the hydrological regime of the Kano River, reducing runoff and increasing evaporation losses. These changes further reduce groundwater availability over time in the study area. Participants 7 and 10 of the FGD revealed that:

> "Population increase in our area is among the factors that affecting groundwater availability. Nowadays, there is too much pressure on groundwater unlike before. Our number in this community has increased over the years which make more people to be demanding the water for agricultural and domestic purposes"

Impact of Groundwater Variability on the Community

Groundwater variability likely has a significant impact on the Rano community affecting various aspects of daily life and long-term sustainability. The community's heavy reliance on groundwater for domestic use and agriculture makes it vulnerable to fluctuations in water availability. During periods of scarcity, crop yields may decrease, potentially leading to economic hardship for farmers and food insecurity for the broader population. The following are some of the impact of groundwater variability on the community as revealed by the participants during FGD:

a) Reduced access to clean drinking water: Falling water tables in wells can make it difficult for residents in the study area, to access clean water for basic needs. This can lead to increased reliance on potentially unsafe water sources, raising the risk of waterborne diseases. This is not in line with what Massoud *et al* (2010) discovered in their work the challenges of sustainable access to safe drinking water in rural areas of Southern Lebanon in which they reported that the government of Lebanon provide safe and clean drinking water to rural areas in periods of difficulties. During the FGD participant 11 revealed that:

> "Our wells now dry-up during dry season. This makes us to be getting our drinking water from nearby rivers and ponds. This water from these rivers is mostly dirty because most of our children bathe or urinate inside the river or pond. This makes the water to be dirty, turbid and sometimes even smelling"

b) Declining agricultural productivity: Reduced groundwater for irrigation can significantly impact crop yields. This threatens food security for the community, as farmers struggle to produce enough food for them and for sale. This is consonant with the findings of Wood and Cherry (2021) in which they also discovered that reduced groundwater for irrigation can significantly impact crop yields in any region of the world.

c) Loss of income and livelihoods: For farmers who depend on agriculture for their income, declining crop yields due to water scarcity can lead to economic hardship. This can destabilize the local economy and increase poverty. This supports the discovery of Rahut *et al* (2016) in their work "impact of irrigation water scarcity on rural household food security and income in Pakistan" in which they discovered that water scarcity can lead to economic hardship to many farmers as a result of low crop yields. An elderly participant 8 stated that:

> "What we get from our farm is not as much as what we used to get before, for instance if you plant on 1 hectare of land now, what you will get is not as much as what we used to get some few years back. This reduce our profit which directly have an impact on our livelihood"

d) Health Implications: Variability in groundwater can impact public health. Reduced access to clean water may force communities to rely on alternative, less safe water sources, increasing the risk of waterborne diseases. This is particularly critical for vulnerable populations such as children and the elderly.

Challenges Associated with Groundwater Variability in the Community

Rano area faces a multitude of challenges due to the changing dynamics of groundwater availability. These challenges cascade across various aspects of life, threatening the community's well-being and future sustainability. The community members expressed their concerns during FGD on the various challenges they are facing associated with the groundwater variability.

The primary issue is the inconsistent water supply for both domestic and agricultural use. During periods of low groundwater levels, residents may struggle to access sufficient water for basic needs such as drinking, cooking, and sanitation. This scarcity can lead to increased time and effort spent on water collection, particularly affecting women and children who are often responsible for this task (Plate 1).

Plate 1 School Children Queuing for Water at Rurum
Source: Field Work, (2024)

Moreover, the unpredictability of water availability can disrupt daily routines and long-term planning for households and businesses alike. This is in line with what Graham *et al* (2016) discovered in their study analysis of water collection labour among women and children in 24 sub-Saharan African countries in which they also reported that during periods of low groundwater levels, women and children bear the brunt of water collection, facing increased time and effort due to the scarcity. FGD participants 3 and 6 revealed that:

> "Our children have to travel to long distance to fetch our drinking water as a result of water scarcity especially during dry season. This affects their studies and other important house chores and might be very dangerous to them and their families amid the security challenges. Another problem associated with water scarcity due to groundwater variability in this area is economic challenges where by a person has to spend like 700 to 1000 naira daily to buy water from water vendors, this add additional economic burden to the household amid this economic crisis in the country".

In the agricultural sector, which is crucial to Rano's economy, groundwater variability poses a substantial threat to crop production and livestock management. Farmers are facing difficulties in irrigating their fields consistently, leading to reduced crop yields or crop failures. This situation forces farmers to switch to less water-intensive but potentially less profitable crops, impacting their livelihoods and the local food supply. Livestock keepers also struggle to provide adequate water for their animals, affecting animal health and productivity as discovered in the research. This is not in line with the findings of Ricciardi *et al* (2020) in a research they conducted in low- and middle-income countries such as Bangladesh, Brazil, China, India, Indonesia, Kenya, Mexico, Nigeria, Pakistan, South Africa Tanzania, Uganda, Vietnam among others in which they reported that farmers are provided with alternative source of water during periods of scarcity. This eases their hardship by providing them with the water the needed for their activities.

Public health is another area significantly affected by groundwater variability as learned during the FGD. When groundwater levels fall, residents resort to using alternative water sources that may be unsafe or contaminated, increasing the risk of waterborne diseases such as cholera and diarrhoea (Plate 2).

Plate 2 People fetching water from well in the study area
Source: Field work, (2024)

The strain on water resources also lead to reduced sanitation and hygiene standards, compounding health issues. This corroborates the result of Pal *et al* (2018) in which they also reported that water scarcity increases the risk of waterborne diseases such as cholera and diarrhoea. Participant 2 of FGD stated that:

> "The water we get from rivers and ponds are mostly dirty with a lot of debris in it. That's why most of our children are suffering from water borne diseases like typhoid, cholera, dysentery and others. Water with high sediment levels can cause gastrointestinal issues and may also harbor harmful microorganisms. Drinking or using untreated water from these sources can be risky, so it's important to ensure proper treatment or filtration before consumption".

The Role of Government Policies and Regulations in Addressing Groundwater Variability

Government policies and regulations can play a crucial role in addressing groundwater variability in the study area. As groundwater is a vital resource for both domestic and agricultural use in this area, effective management is essential to ensure sustainable access and prevent depletion. Policies that regulate extraction rates, promote water conservation, and encourage the use of alternative water sources can help mitigate the impacts of groundwater variability. During FGD, the participants suggested several ways government policies can address groundwater variability in the area.

According to the participants, establishing and enforcing regulations on groundwater extraction is crucial. The government can set limits on the amount of water that can be drawn from wells to prevent over-extraction and ensure sustainable use of groundwater resources. There is the need to implement a licensing system for boreholes and wells, along with regular monitoring and

inspections. These regulations should be backed by legal frameworks and enforcement mechanisms to ensure compliance. Participants 4 and 9 stated during FGD stated that:

> "Many people in our community dig wells and boreholes rampantly without following any rules and regulations. Policies can set limits on groundwater extraction to prevent overuse and ensure sustainable use. This can include licensing and permitting systems to monitor and control the amount of water withdrawn. The government can help us by enforcing laws that will prevent this attitude of our people"

Secondly, the government should invest in developing and improving water infrastructure to enhance water storage and distribution. Constructing and maintaining dams, reservoirs, and rainwater harvesting systems can provide alternative water sources during periods of groundwater scarcity. Expanding and upgrading irrigation systems, such as introducing drip irrigation and other water-efficient technologies, can reduce the reliance on groundwater for agriculture as revealed by the participants. This proves the findings of Elmahdi (2024) in which he also reported that government should invest in developing and improving water infrastructure to enhance water storage and distribution.

Engaging and educating the community is vital for the success of groundwater management strategies according to the participants of the FGD. The government should launch public awareness campaigns to educate residents about the importance of sustainable water use and the risks of groundwater depletion. Involving local leaders and stakeholders in these campaigns can ensure the messages are culturally relevant and widely accepted. Moreover, creating platforms for community participation in water management decision-making processes can empower residents and encourage them to adopt water-saving practices. This supports the discovery of Maheshwari *et al* (2014) in their work role of trans-disciplinary approach and community participation in village scale groundwater management in India in which they also reported that public awareness campaigns to educate residents about the importance of sustainable water use and the risks of groundwater depletion can go a long way in mitigating the problem of unsustainable use of water resources. Participant 5 narrated that;

> "The problem is that majority of our people are not aware of the effects of our activities on groundwater availability. An awareness campaign should be introduced which will help in educating our community members to understand the effects of what we are doing on groundwater. Tis will help to minimize the problem of water scarcity in our community and Kano state in general"

Potential Solutions to Groundwater Variability Challenges

Groundwater variability poses several challenges to the people of the study area as discussed earlier. As an agricultural area likely dependent on groundwater for irrigation and domestic use, Rano faces risks from overexploitation, climate change impacts, and potential water quality

issues. The participants of the FGD propose several solutions to this dilemma. Some of these solutions are summarized below:

> Public Awareness Campaigns**, water** conservation, challenges of groundwater variability, reservoirs and dams construction, water distribution networks, irrigation systems, extraction limits, monitoring and enforcement of laws.

In addition to these, an FGD Participant 11 stated that:

> "For these problems to be minimized, government should launch awareness campaign to educate our people, Also the government needs to create another dam to complement the existing one as there is too much pressure on it. Rules on extraction limits should also be enforced as well as monitoring and supervision to make sure that the rules are been followed by our community members"

The participants emphasize the need for a multi-faceted approach, including awareness campaigns, dam construction, extraction limits, and monitoring. Implementing these solutions can help mitigate the challenges of groundwater variability, ensure sustainable water use, and protect the community's water resources.

Some potential benefits of these solutions include: reduced pressure on groundwater resources, improved water availability and security, increased efficiency in water use, enhanced water quality, better preparedness for climate change impacts and empowered communities through education and awareness.

However, potential challenges and limitations may include: High upfront costs for infrastructure development, resistance to change from community members, limited institutional capacity for monitoring and enforcement, climate change impacts on water availability and quality and balancing competing demands for water resources.

Addressing these challenges will require a collaborative effort from government, communities, and stakeholders to ensure the long-term sustainability of groundwater resources in the study area.

CONCLUSION AND RECOMMENDATIONS

The research revealed that groundwater varies in the area which may not be in connected with differences in terrain and other environmental factors. It was established that there is the need for integrated approaches in the area considering geological, geomorphic and hydrological factors to ensure sustainable groundwater development and utilization in the study area. Government and community members should implement water conservation measures by promoting water-saving practices to reduce water shortage in low groundwater

yield areas and also provide alternative sources of water in areas of low yielding wells to avoid drinking water from unsafe sources and avoid wasting time for school children.

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