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Groundwater Use in Yenagoa: Impact on Residential Development and Investment

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Abstract:

In the oil-producing metropolis of Yenagoa and its surroundings in Bayelsa State, Nigeria's Yenagoa Local Government Area (YELGA), groundwater is the main and only safe source of water. As the capital of Bayelsa State, the city experienced rapid development, resulting in an influx of people and a subsequent freshwater deficit due to increased oil production and groundwater pollution. For the sustainable growth of water resources, preventing water or piezometer level fluctuations and quantitatively estimating the area's available water supplies are crucial. To meet the water needs of the population, boreholes are dug using rotary technology and cable devices. The size of the borehole, the type of construction, the type of material used (casing and screen), and the availability of sachet water are some of the many factors that affect the cost of constructing a water borehole in Yenagoa and its environs. This study shows that the location of the study area in the riverine Niger Delta area of Nigeria makes the construction of boreholes more expensive. Data on the cost of drilling boreholes in the exhibited area shows a significant increase over time. It is shown that the long economic life of drilled borehole depends on monitoring of aquifers and wells, as well as maintenance of wells, pumps, and accessories, all of which prove inadequate

Keywords: Borehole Drilling, Groundwater Reservoirs, Maintenance, Piezometric Level.

Introduction

In many regions of the world, especially in developing countries where efficient development and management of groundwater resources is critical, groundwater serves as the main source of water supply. Of the 23,400,000 km3 of groundwater on Earth, 12 percent (12,636,000 km^3) is salt water and 10 percent (10,764,000 km^3) is freshwater (WaterScienceSchool., 2019; Gleick, 1996). Groundwater is an essential resource for sustaining human life and promoting economic progress in drought-prone areas of sub-Saharan Africa (Foster, et al., 2012; Lapworth, et al., 2018; Gaye & Tindimugaye, 2019). Groundwater generally refers to water that fills all the gaps in a geological layer. To ensure the continued availability of vital natural resources, it is crucial to manage and protect them and ensure proper growth. The main sources of water supply for the study region are precipitation, surface water (rivers, seas, oceans, and streams), and subsurface water (groundwater). Rainwater is considered a supplement to land and surface water.

In contrast to groundwater, the functional value of surface water is limited by the high level of treatment required to remove pollutants before it can be made drinkable and delivered to users. Therefore, in most of the regions studied, groundwater is used more frequently than surface water as a source of water supply. Based on static water levels calculated from boreholes in the Yenagoa and its surroundings, it appears to be possible to access groundwater at comparatively shallow depths. This also explains its use as a primary source of water supply in the research area. However, several obstacles are affecting Yenagoa's groundwater. One of the most notable of these obstacles is high iron content, which is a serious problem in the research areas. Other disadvantages include seawater intrusion into coastal aquifers and the presence of underground saltwater reserves (Stein, et al., 2023).

This study provides a comprehensive discussion of aquifers and well monitoring as conducted in the research region and highlights the lack of attention given to these issues. In addition, maintenance tasks are rarely given sufficient thought. Overall, after a complete failure, repair becomes the primary work due to poor maintenance, which in some cases is neglected. One of the most important aspects of groundwater assessment is the estimation of investment costs for the use of groundwater services (Chakraborty, et al., 2022). Boreholes are used in this locality to access groundwater reserves. Therefore, this study considers the cost of drilling a borewell and the factors affecting the cost. To assist in the development of the borehole price schedule and operating costs, this document also provides an overview of borehole material and labor costs. These two are based on what is feasible in the study area. Finally, despite the obvious fact that groundwater plays an important role in the development of agriculture and trade in the study region, it is highlighted that it is an underdeveloped resource (Mark, 2009; Ngene, et al., 2021). There is an obvious benefit that would result from the optimal use of groundwater resources. Like all natural resources, groundwater reserves also have their limits. Therefore, they must be handled and protected from excessive exploitation.

1. Associated Problems of Rural Groundwater Supplies

Rural water supply entails the free supply of clean drinkable water to rural communities through the drilling of a borehole, a hand-dug, concrete-walled well, or an artificial pond. For impoverished urban residents to have access to portable water, easy access to groundwater is typically required (Stephen, 2022). Policymakers can gain valuable insights from assessing groundwater resources for alternative uses that can help them develop fair and effective groundwater management strategies. Problems with groundwater supply in rural areas include high initial and ongoing costs, a lack of skilled labor in rural areas for the operation and maintenance of boreholes, accessibility, inaccessibility of motor and pump spare parts, a lack of electricity, and the contamination of the aquifer. Groundwater resources can be broadly classified into extractive and non-extractive resources, which greatly benefit society (Ross, 2022; Carrard, et al., 2019). Groundwater assessment is a crucial first step on the path to sustainable groundwater extraction. These values are typically expressed in monetary terms. Compared to tiny rural communities, urban settlements, larger urban centers such as Yenagoa, are faced with significant challenges associated with the use of groundwater for domestic water supply (Arnaud, 2021; Koinyan, et al., 2013; Lapworth, et al., 2017).

2. Groundwater Abstraction

One of the most common and readily available sources of water for humans is groundwater, which is obtained from underground boreholes (boreholes). Water is one of the most important human needs. Groundwater extraction can reduce surface water flows, damage ecosystems, and reduce the amount or quality of water available for other uses. Since the 1930s, deep boreholes and springs have been the primary sources of rural water supplies across Africa (Gaye & Tindimugaye, 2019). According to Carrard, et al., (2019), Marcus and Schonberger, (2018), and Danert and Healy, (2021), groundwater resource production in Africa is currently limited, except in a few large cities, towns, and some rural communities. The lifespan of a fountain depends on how often it is regularly maintained when it is constructed. Wells, boreholes, seepage tunnels, and springs (a natural process) can be used to obtain water from beneath the earth's surface.

The highlights of the study by Onugha and Yaya, (2008), show that groundwater is the preferred source to meet the majority of water supply needs, despite its hydrogeological challenges, inherent limitations in well yields and efficiency, and institutional deficiencies.

3. Boreholes

The cost of drilling a borehole is typically higher than drilling a well, and the process is typically carried out scientifically. A borehole (typically 15 – 60cm in diameter) is a thin hole drilled to determine the composition of soil, bedrock, or trapped fluids and gases, or to extract water or minerals. Boreholes are a useful method for extracting groundwater in arid and semi-arid areas. Water is pumped from boreholes using high-quality pumps.

4. Problems with Borehole

A new well that is constructed, drilled, and cast correctly will perform well for many years and require little to no maintenance. However, it is unusual for a well-constructed borehole to fail or for its water abstraction level to drop significantly over time. Poor construction often results in a borehole failure. In this case, poorly designed poreholes include elements such as misplaced wells (Mohammed, 2017). However, the failed borehole can be repaired depending on the level of damage and specific circumstances. Additionally, the screen or casing surrounding a well can give way or collapse, completely or partially closing the hole. Due to this problem, the panel or case would need to be replaced. However, a complete waiver can be assumed if the material through which the hole is drilled is not solidified. Another reason for well collapse is corrosion of the perforated sections of the casing. The direct chemical action of groundwater can cause corrosion in a hostile environment. The corrosion effect can be reduced by choosing metal screens made of corrosion-resistant materials such as copper, nickel, or stainless steel

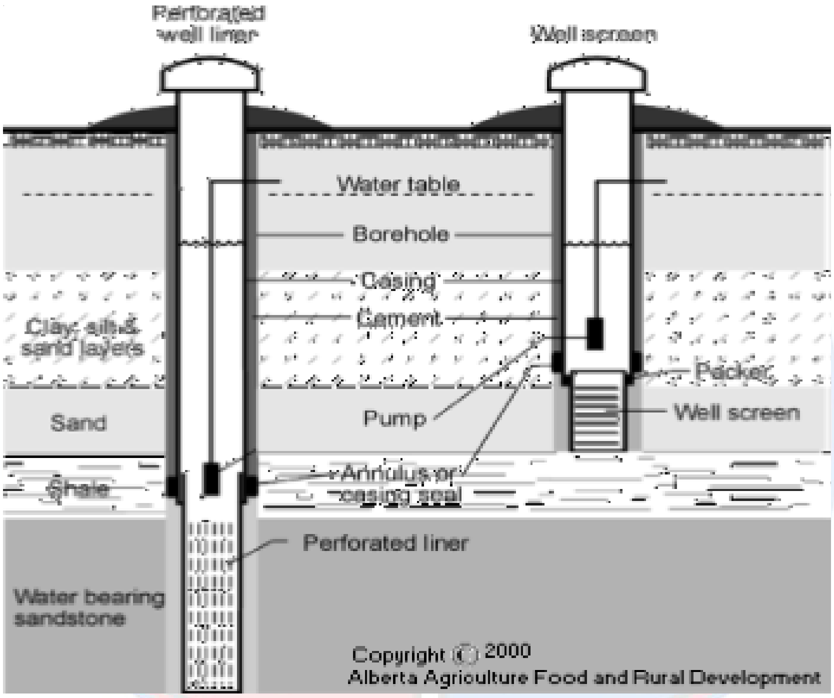

Figure. 1. Perforated Well Liner and Well Screen
Adapted from Mohammed (2017)

5. The Groundwater Quality

Depending on the source of the raw water (groundwater or surface water) and the intended use, different levels and types of treatment are typically required. Groundwater typically does not contain any microbiological pollutants (Vincent, et al., 2009; Al-Hashimi, et al., 2021). It is impossible to find completely pure water in nature. In pure water (H_2O) there are only two parts hydrogen and one part oxygen. Additionally, since some dissolved salts support nutritional absorption, taste, and health, there is no need to completely purify the water. When we talk about water purification, we mean that treatment should only remove impurities that are harmful to human health. During treatment, it is not necessary to remove harmless impurities. When it comes to portable water, water is defined as water that is either safe for consumption or does not contain any added salts or contaminants.

Drinking water must meet certain basic requirements, such as being free of pollutants and bacteria (which cause disease). (i.e. low turbidity, no color) and must be fairly clear. It should be non-salty, and it shouldn't taste or smell bad nor contain any chemicals that cause this to happen. It cannot damage or be corrosive to the clothes washed in it. Given that groundwater supplies a large part of rural and partly urban Africa, Gaye and Tindimugaye, (2019) pointed out that groundwater is essential for achieving the Sustainable Development Goals (SDGs), particularly SDG6 on water.

6. Cost of Borehole Development in Ekowe

The borehole used for this project was drilled in February 2024 by a private developer in Akenfa Village by Aloha Ventures Nigeria Ltd. The experiment ran for five days starting February 21, 2024. The project aims to improve the general standard of living of the population, provide relief, and reduce the prevalence of water-borne diseases by providing potable water, both directly and indirectly (through visitors and neighbors), to tenants occupying properties within the community. The available drilling data was as follows:

Table 1: Borehole Data

S/No	Description	Dimension
1	Depth of borehole	30' (9m).
2	Casing type	PVC.
3	Casing length	20' (6m)
4	The total length of casing required	7.6m
5	Casing size	9'5/8" (0.24m)
6	Bit size	12'4" (0.31m)
7	Casing reducer	8" (0.2m)
8	Screen type	PVC
9	Screen size	8" (0.2m)
10	Screen length	10' (3m)
11	Total length of screen required	15' (4.6m)
12	Length of bottom bung	5' (1.5m)

Table 2: Bill of quantity

Item	Description	Quantity	Unit	Rate (₦)	Amount (₦)
1	Mobilization and demobilization	Lumpsum			50, 000
2	Rig up & rig down	Lumpsum			35,000.00
3	Drill to accommodate 5/8" casing	7.6	M	7,100	53,960.00
4	Construction of the bottom bung	Lumpsum			16, 500.00
5	Supply & installation of 5/8" casing	7.6	M	8,710	66,196.00
6	Supply & installation of an 8" Johnson screen	4.6	M	14,760	67,896.00

7	Supply & installation of an 8" casing reducer	Lumpsum			18,000.00
8	Supply & gravel pack the annular space around the casing & bottom surface	0.558	m^3	9,660	5,390.28
9	Cement grout 5m deep around the casing	0.24	m^3	17,550	4,212.00
10	Flush & develop well to give a yield of not less than 50 gallons per hour	Lumpsum			100,000.00
11	Provide & fix protruding steel well cap	Lumpsum			75,000.00
		Total (#)			442,154.00

7. The Trends in Borehole Drilling Cost

The cost of drilling boreholes in Ekowe and surrounding communities is increasing with the changing economy. Information from drilling companies in the study area (including Aloha Ventures Nig. Ltd) indicates that in 1998 the average cost of drilling an 8" (203 mm) well to a depth of 40 feet (12 m) was approximately $60,000 next exactly) there were a thousand). However, this does not include the pump costs and other accessories. The distributions of average drilling costs over the years are shown in Table 3.0 below.

Table 3: Average Cost Variations in Water Well Drilling

Borehole Dimension	**Size**	**Depth**						
	8" (203 mm)	40ft (12m)						
Year	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
Average Cost (₦)	135,000	140,000	150,000	195,000	235,000	260,000	275,000	442,000

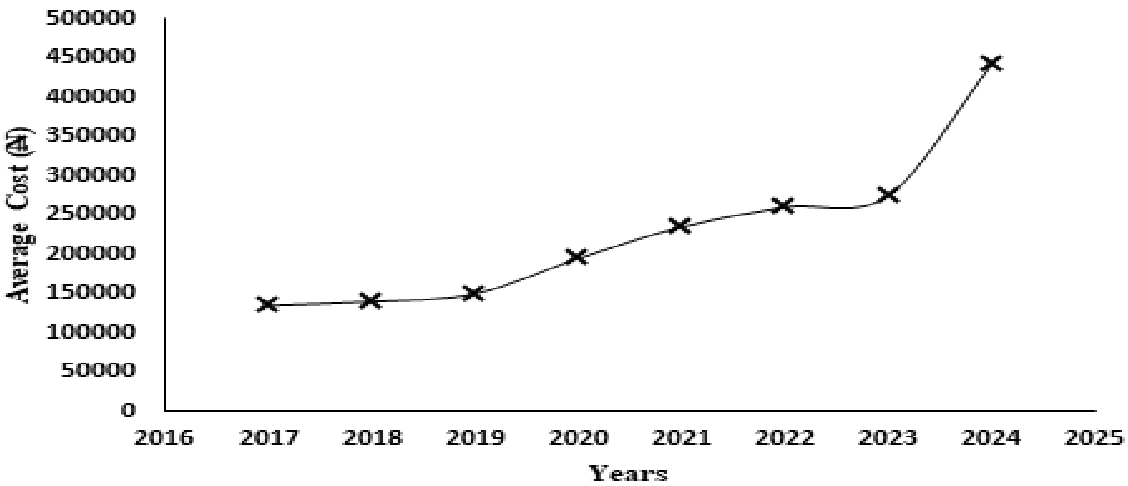

Figure 2. Plot of the average cost of a borehole in the study area

The cost of digging boreholes varies over time, as can be seen from the cost chart (Table 3) over the years. It is recognized that there is a clear relationship between costs and years. It can be shown that the costs increased almost linearly from around ₦135,000 to around ₦235,000 between 2017 and 2021. However, there will be an exceptionally strong price increase from ₦ 260,000 to ₦ 442,000 between 2022 and 2024. This is most likely due to the slowdown of our economy and the devaluation of the Naira, Nigeria's legal tender.

8. Conclusion

Because aquifers have limited capacity and natural recharge often exceeds extraction rates, groundwater is a limited resource. And as a result of the depletion and contamination of aquifers by crude oil in many of the oil-producing villages in the Niger Delta. To make optimal use of groundwater resources, an awareness of the hydrological properties and extractive value of groundwater is required. The estimation and detection of groundwater values can be supported by the total cost of underground water extraction through the installation of the borehole, as described in this study. According to this study, aquifers and boreholes in Ekowe and surrounding towns are not adequately maintained or monitored. The price of wells has increased over time and reached unreasonably high values, ranging between ₦ 135,000 and ₦ 442,000 in 2022-2024. Other reasons include the fact that drilling wells in riverine areas is more expensive than in upland areas, including the presence of saltwater regions in most underground water formations and accessibility problems.

.Conflicts of interest

There are no conflicts to declare.

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