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Research Article
Challenges and Spatial Distribution of Water Infrastructures (Boreholes) in Okene Town, Kogi State, Nigeria

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Abstract

Background and Objective: Safe and reliable potable water infrastructures is a vital component of human development. Many communities across the world are yet to meet up with their daily water demand especially in developing countries leading to preventable diseases associated with lack of access to safe drinking water. This study was carried out to assess the challenges and distribution of boreholes in Okene town. **Materials and Methods:** A town-wide study was undertaken, geographical coordinates of boreholes were captured at point. A well-structured questionnaire was administered to obtain relevant information on the boreholes ownership, its functionality and challenges. Descriptive statistics was determined for the various variables measured. Chi-square test was used to determine the level of significance in functionality of the boreholes. Spatial distribution map of the boreholes was generated using the coordinates obtained. **Results:** A total of 285 boreholes were examined in Okene town, with 56.5 and 17.2%, by Private and State Government, respectively. About 97.9% of these boreholes were been operated using motorized pumping system and 31.6% were found not functioning. Two factors were responsible for non-functionality of the boreholes; broken/mechanical repair led to 90.7% of the boreholes not functioning while lack of human personal to maintain the boreholes led to 9.3% of the boreholes not functioning. The spatial distribution map revealed uneven distribution of the boreholes. **Conclusion:** A total of 285 boreholes were found in Okene town with uneven distribution. Majority of the boreholes are privately owned. Broken parts/mechanical repairs and lack of human personnel to maintain boreholes were the 2 factors that majorly affect the functionality of boreholes in Okene town.

Key words: Boreholes, Okene, broken/mechanical repair, challenges, boreholes ownership, uneven distribution

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Water is a natural resource of fundamental importance which supports all forms of life[1]. Life as it exists on our planet is impossible without water[2]. Water demand in different parts of the world already exceeds supply. As world population continues to rise, many more areas are expected to experience this imbalance in the near future[2]. The WHO[3] reported that 75 L of water is required daily to protect against household diseases and 50 L daily for basic family sanitation. The international consumption figures released by World Water Forum[4] indicated that a person living in an urban area, uses an average of 250 L/day. Meanwhile, individual consumption of water varies widely around the globe[5].

Bates *et al.*[6] reported that WHO and UNICEF Joint Monitoring Program estimated that 1.1 billion people lack access to water resources globally. They defined access to water as the availability of at least 20 L of water per person daily from an improved water source within a distance of 1 km. Cech[7] reported that limited accessibility to safe drinking water leads to about 3.3 billion cases of illness and 2 million deaths per year. The UN predicts that by 2025, two-thirds of the world population will experience water scarcities. According to the UN World Water Assessment Program, by 2050, 7 billion people in 60 countries may have to cope with water scarcity[8].

Nigeria is known to be endowed with abundant water resources but the availability of potable water is a problem in many parts of the country[9]. The Nigerian Government has long considered the provision of water supply services to be the domain of the Federal, State and Local Governments. Since 1999, a huge amount of public funds have been spent on provision and management of water. However, there is still no potable water and many lack access to adequate sanitation. More than half of the deaths recorded in the nation's health facilities are caused by complications arising from bad water and poor sanitation[10]. In the last 8 years, the Federal Government attempted to develop water infrastructure like dams but these were basically for irrigation purposes, little attention was paid to water for domestic use. Government insists it cannot handle water supply all by itself for lack of funds and have ceded its statutory role to shylock water producers, who do not know or care about safe water standards[11].

The major source of water in Okene Town is borehole water with reliance on borehole water. This pose the challenges of provision of adequate quality and quantity water. Therefore, this study was aimed at assessing the challenges and spatial distribution of boreholes in Okene town, Kogi state.

MATERIALS AND METHODS

Study area: Okene town is located in Okene Local Government Area (LGA), Kogi State, Nigeria. It had an area of 328 km^2 and a population of 325,623 at the 2006 census[12]. Okene is a semi city located between latitude 7°32'18.2" N to 7°35'29.5" N and longitude 6°14'19.8" E to 6°16'19.8" E. The LGA shares boundaries with Adavi, Ajaokuta, Ogori-Magongo LGAs in Kogi state and Okpella in Edo state. It is located in the North Central Geopolitical Zone of Nigeria known as middle belt region.

Study design: A town-wide study was undertaken to determine the spatial distribution of boreholes and to determine the challenges associated with them in Okene town.

Ethical consideration: Ethical approval was collected from the Secretary to the Local Government, Okene. Then visitation to the study area was done to explain the intended study and to seek for permission.

Coordinates of boreholes: Geographical coordinates of each sampled borehole were captured within the premises of the borehole using a handheld Global Positioning System (GPS) device, Garmin 12XL (Garmin Corp, USA) after which it was converted to the decimal system and used in geographic computing.

Questionnaire survey: A well-structured and pre-tested questionnaire was administered to collect demographic information on ownership of the boreholes, status of the boreholes and source of power.

Data analysis: Data obtained were entered using Microsoft Excel version 2013. Descriptive statistics was determined for the various variables measured. The chi-square test was used to determine the level of significance in functionality of the boreholes according to ownership. Analysis was performed using Statistical Package for Social Sciences (SPSS) software (Version 22.0 for Windows; SPSS Inc., Chicago, IL).

Co-ordinate of boreholes sampled were entered using Microsoft Excel version 2013 and then imported into DIVA-GIS version 7.5. This was then used to display the spatial distribution of the boreholes. Map visualization were performed on DIVA-GIS 7.5.0.

RESULTS

Demographic: A total of 285 boreholes were examined in Okene town (Agassa, Agassa G.R.A, Ahache, Bariki, Enyinare, G.R.A, Idoji, Idozumi, Idogido, Idare Okene-eba and Ozuwaya). Out of these 285 boreholes, 161 boreholes (56.5%), 49 boreholes (17.2%), 36 boreholes (12.6%), 18 boreholes (6.3%) and 21 boreholes (7.4%) were owned by Private, State Government, Federal Government, MDGs and others (donations), respectively (Fig. 1, 2). A total of 279 (97.9%) of the boreholes were operated using motorized pumping system with only 2.1% (6 boreholes) operated manually. The boreholes distribution was uneven with large concentration within the town centre.

Functionality of boreholes in Okene: In terms of borehole functionality, 195 boreholes (68.4%) were functioning while 90 boreholes (31.6%) were found non-functional in Okene (Table 1). A total of 67% of the functioning boreholes were privately owned, while 12, 6, 7 and 8% were owned by State Government, Federal Government, MDGs and others (Donations), respectively (Fig. 3).

Challenges encountered: A total of 90 boreholes were found not to be functioning. Two factors were responsible for non-functionality of the boreholes in Okene town, broken/mechanical repair led to 91.1% (82 boreholes) of the boreholes not functioning while lack of human personal to maintain the boreholes led to 8.9% (8 boreholes) of the boreholes not functioning (Fig. 4).

Source of power of the boreholes: A total of 277 boreholes had source of power and were not operated

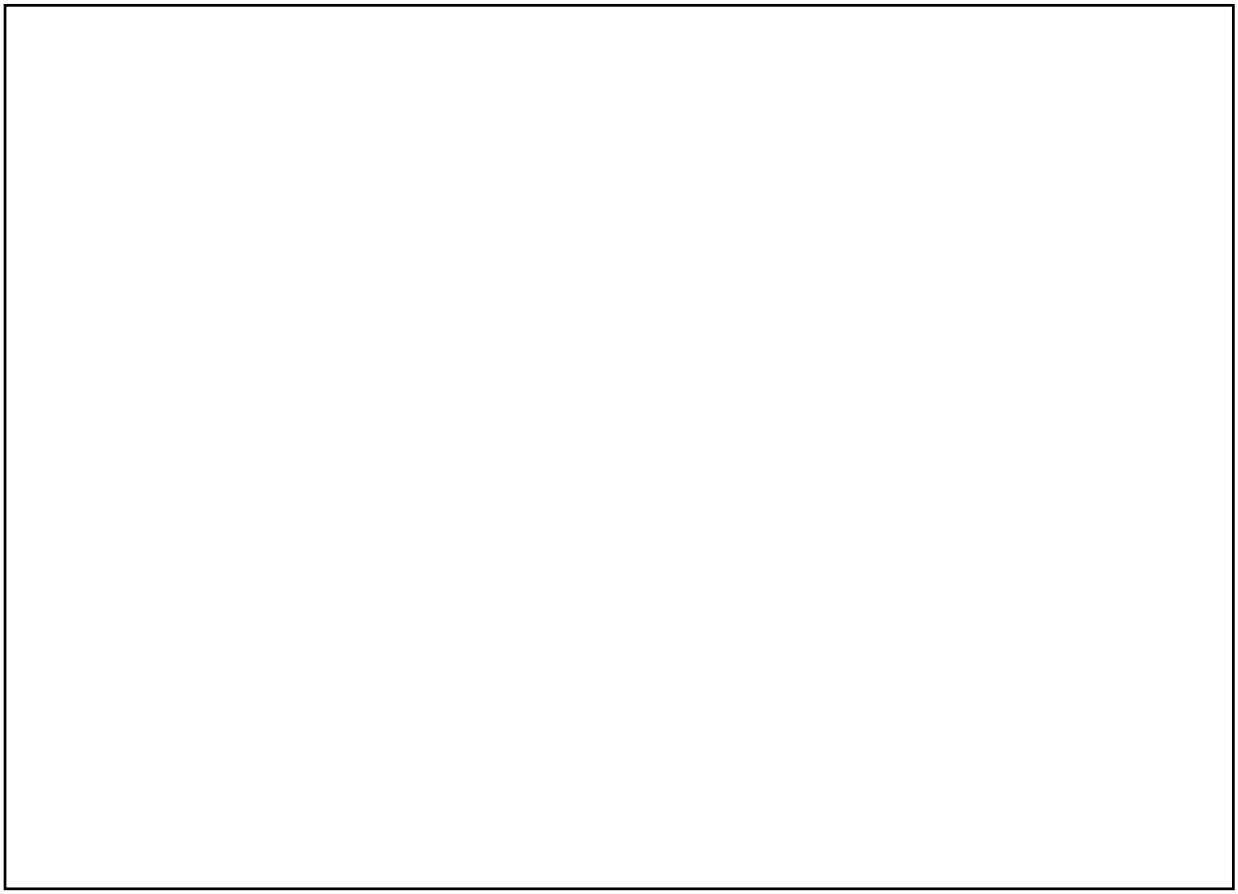

Fig. 1: Spatial distribution of boreholes in Okene town
Source: Authors using DIVA-GIS version 7.5 software

Table 1: Functionality of boreholes

Parameters	Functioning	Not functioning	Total No. of boreholes	χ^2	df	p-value
Ownership						
Private	131 (81.4)	30 (18.6)	161 (56.5)	44.283	4	0.000*
State government	23 (46.9)	26 (53.1)	49 (17.2)			
Federal government	12 (33.3)	24 (66.7)	36 (12.6)			
MDGs	14 (77.8)	4 (22.2)	18 (6.3)			
Others	15 (71.4)	6 (28.6)	21 (7.4)			
	195 (68.4)	90 (31.6)	285 (100.0)			

*Significant at $p \leq 0.05$, ns: Not significant at $p > 0.05$

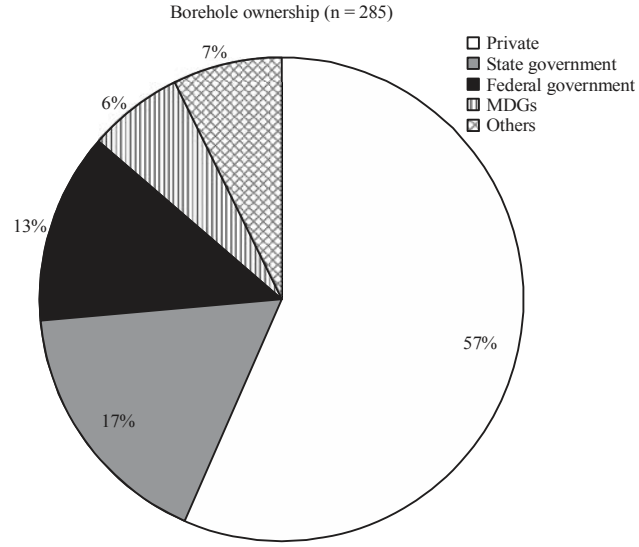

Fig. 2: Distribution (%) of boreholes ownership

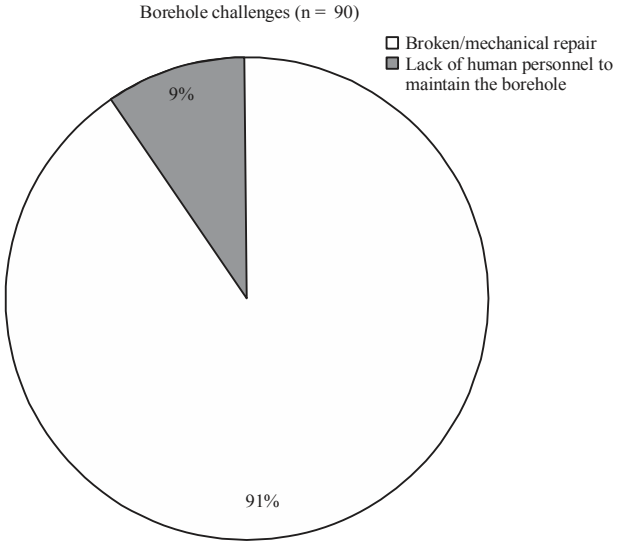

Fig. 4: Distribution (%) of borehole challenges

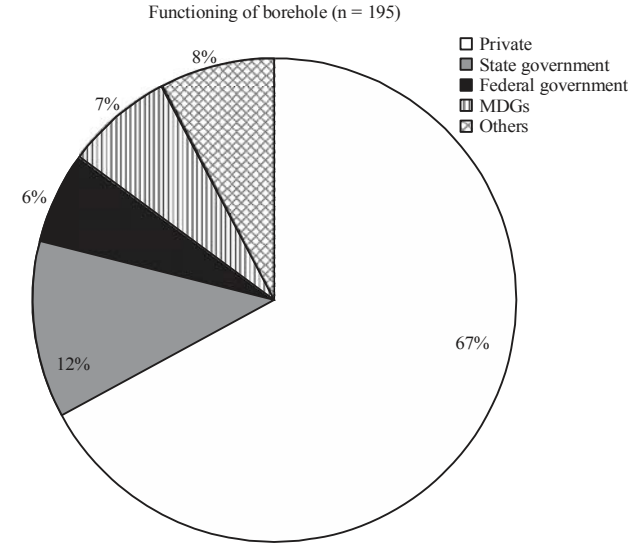

Fig. 3: Distribution (%) of functioning boreholes

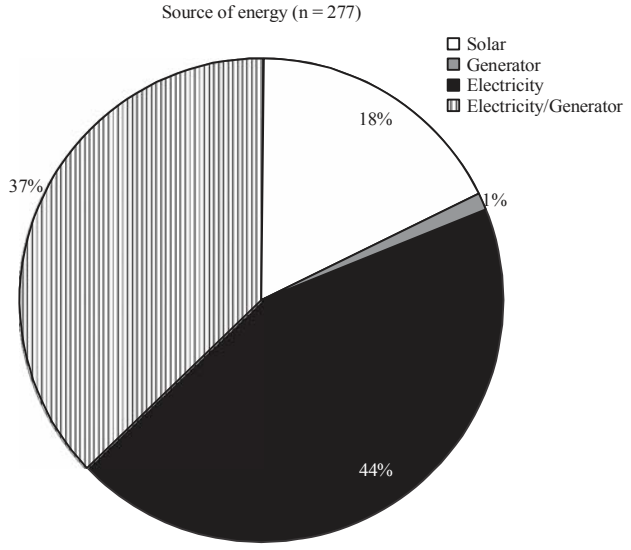

Fig. 5: Distribution (%) of source of energy of the boreholes

manually, 122 boreholes (44.0%) uses electricity only, 103 (37.2%) uses electricity and generator, 49 boreholes (17.7%) uses solar while 3 boreholes (1.1%) uses generator only. Significant difference ($\chi^2 = 54.84$, $p<0.05$) was observed on the power source used by the boreholes (Fig. 5).

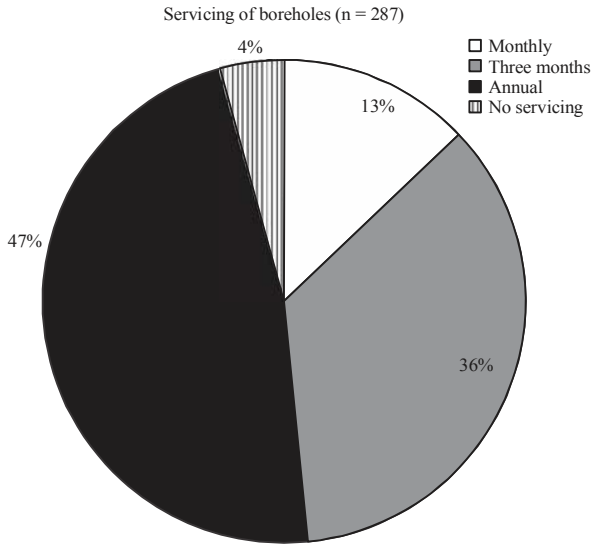

Fig. 6: Distribution (%) of servicing of the boreholes

Servicing of boreholes: Majority of the boreholes were serviced annually (136 boreholes, 47.4%), while 35.5% (102 boreholes) and 12.9% (37 boreholes) were serviced in 3 and 1 month, respectively (Fig. 6). A total of 12 boreholes (4.2%) were not serviced.

DISCUSSION

In Okene town, majority of the boreholes were owned by private individuals and were managed more than those owned by governments, MDGs and others (Donations). In the study area, oral interview revealed that the town lack maintenance policies in the management of publicly owned boreholes. Most of the town members has no monetary, material, advisory and labour contributions towards the sustenance of the publicly owned boreholes especially those owned by the governments. Similar observation was noted in the studies of Akpoveta *et al.*[13] in Edo and Agbor in Nigeria and Toyobo and Muili[14] in Ejigbo, Nigeria. They identified multiple determinants affects the functionality of borehole water sources. These include several largely uncontrollable determinants including number of water sources per community, district and hydrogeological variables coupled with the pump types, access to tools and parts, savings and timely access to services of a mechanic[13,15,16] are responsible for non-functionality of boreholes.

Also the age of some of the boreholes led to its non-functionality. The study area has some water facilities that are provided by the federal and state governments. However, most of these facilities are aging. They have been neglected by both the facilities providers and the local authorities while others under construction have been abandoned. Similar situation is obtainable in other developing regions[17]. The problem of ownership of the water projects has led to the neglect of some water supply facilities. Most of the public boreholes are installed by State Government in partnership with UNICEF while some are installed by the federal government. When these boreholes stop functioning, it takes about 1-2 years before they are repaired depending on the administration's priorities[17,18]. Poor maintenance of water infrastructure is a growing concern for water supply sustainability in developing countries.

Katz and Sara[19] found that the sustainability of boreholes should be improved by the existence of a committee to maintain the community boreholes. The finding of this study revealed the inability of suburbs in Okene town in contributing money to repair long-term use of installed boreholes. In some suburbs, there was a strong feeling that water should be free. The concept of paying to maintain a service, rather than paying to use the water was not appreciated. The level of community participation in water provision is low in the study area and has led to the abandonment of water facilities and projects. The absence of water committee to manage the projects after they have been constructed has left most of the water project dysfunctional. Similar scenario was discovered in Benin Republic, Bolivia, Honduras, Indonesia, Pakistan and Uganda[19].

The uneven distribution of the boreholes was as a result of financial status of people living within the suburbs and the concentration of commercial activities but most government installed boreholes were distributed based on political affiliations of the community leaders. In developing countries especially in Africa, Briscoe[20] acknowledged politicizing of water projects as reflected in where to site the project. Also, the yield of boreholes in an aquifer is constrained to the recharge within the aquifer boreholes[16]. Some areas within the town have a low aquifer recharge.

CONCLUSION AND RECOMMENDATION

A total number of 287 boreholes were found in Okene and are not evenly distributed with about 68.4% functioning. Mechanical/broken repairs and lack of human personnel to maintain boreholes were the major challenges associated with boreholes in Okene town.

Public awareness campaigns on effective water management should be organized coupled with the establishment of water committee that will help in organizing the communities to finance the repair of non-functioning and maintenance of the boreholes.

This study did not relate water infrastructures to water related diseases distribution. Further studies should correlate boreholes distribution to disease distribution.

SIGNIFICANCE STATEMENT

This study discovered that Okene town had an uneven distribution of boreholes and faced with the challenges of repair of broken down boreholes coupled with lack of personnel to maintain the boreholes adequately. The study provided federal and state governments with information that installation of boreholes should be coupled with maintenance policies.

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