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Accessibility to safe drinking water in selected urban communities in southwest Nigeria

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Abstract

Water is an important part of the human life. Sustainable management of water is a major component of the Sustainable Delopment Goal 6, United Nations. Many residents of the middle and low economic countries are not adequately supplied with this important commodity, however, but information is scanty about the specifics of the state of drinking water in many relatively small urban areas. This paper is focused on one of the countries within the sub-Saharan Africa such that the selected locations are four important states (Oyo, Ondo, Osun and Ekiti) in the southwest region of Nigeria. The objectives of the study are to evaluate the water supply for drinking purposes and assess the quality of samples from sources of household drinking water in the region. The results showed the comparable differences in water accessibility due to socio-economic structure of the selected areas. Also, there is an extensively poor household drinking water quality in the region, and a support from the public facilities is either inadequate or non-existent. The study recommends the improved and sustainable household water schemes across the region to meet a higher water productivity.

Keywords: Drinking Water Resources; Water Accessibility; Water Quality; Socio-Economic Status; Water Productivity

INTRODUCTION

A major component of the United Nations' Sustainable Development Goals (SDGs) is to ensure access to water and sanitation (SDG 6) (Woodbridge, 2015). Adequate water supply at required quality is an indicator of development. Many countries in the sub-Saharan Africa, however, lack the sufficient water supply. Banerjee *et al*. (2014), among others reported that the water scarcity affects over 40% of the people around the world as at present, and this will likely be exacerbated by climate change and poor water infrastructure in many African countries. Nigeria ranks among the countries with the lowest level of water supply in the world, despite being a signatory to the International Water Decade (1981-1990). Urban and rural water supplies are characterized by low coverage, a condition that has been attributed to weak the political commitment, lack of operation and maintenance culture for existing facilities, poor workmanship by contractors, among others (Adepoju and Omonona, 2009).

Main sources of the household water supplies include piped water from the treated and untreated sources, groundwater, shallow and deep boreholes, surface water and rainwater harvesting. Over 40% of the people, globally, are threatened by severe scarcity of water or poor access to quality water, and this is worse off in the developing countries, including Nigeria. Adekola (2018), in a study of a typical urban area in the southwestern Nigeria showed that most residents do not have access to pipe-borne water supply but source water through

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supplies from groundwater resources, purchasing packaged water and rainfall harvesting. Groundwater resources include the hand dug wells and drilled boreholes; the choice of either often depends on the cost and availability. Hand dug wells are usually shallower (less than 30m) and its water has the lesser quality than that mechanical drilled boreholes (Muyibi, 1992).

Rainfall harvesting, especially as the main domestic water resource, is more common to the certain regions of sub-Saharan Africa than others and the practice varies globally based on purposes, methods and preference for domestic uses (Helmreich and Horn, 2008). Many argued that efficient rainwater harvesting may be an important response to the growing water scarcity and ever-increasing demand, probably because it typically involves a simple and low cost technique (Chukwuma *et al*., 2012), and is adequate alternative and a form of replacement for other water resources 'in times of scarcity or when water-table drops and wells go dry, as experienced in many arid locations (Olaniyi *et al*., 2013). Rainwater harvesting presents an additional source by which local water requirements can be met, especially in the dry season; where it offers the short–term security against the failure of many surface, groundwater and pipe-borne water resources (Abdul *et al*., 2009). Whereas rainwater can be important to residents only in the rainy season, groundwater supply is often abundant throughout the year, especially with increased number of drilled boreholes (Elaigwu *et al*., 2007; Oluyemi *et al*, 2010).

Over 1.2 billion people worldwide live more than a 15-minutes' walk from a safe water source, and most of these people are in Africa (Jones and Van der Walt, 2004; Rodda, 2009). More than 5 million water borne-related deaths also occur on annual basis globally, because people have a limited access to safe water and adequate sanitation (Deregt *et al*., 2005). Water-related problems have been projected to escalate in many parts of the world (Eludoyin, 2016), partly due to the effect of extreme climate, particularly drought, poor water infrastructure in many developing countries, population increase, and unsustainable increase in urbanization. In many parts of Africa, Asia and Latin America, over 80% of all the illnesses are caused by water-borne diseases. Steady population increase and community growth have also exacerbated in many countries with poor planning and policy on water development and maintenance (Bos, 2004).

Problem

Urban areas in southwestern Nigeria are typically clustered into core, transition and outskirts as described in the core-periphery concept. The concept which was based on the differences between regions and development policy (Friedmann, 1966) also explains structural growth of hierarchical urban systems, and the distribution of public utilities, including the water and sewerage systems. The cluster is typically defined by socio-economic and demographic characteristics of households. Whereas the core often contains aged households where there had been well-laid water pipelines, most of which have now become non-functional due to poor management system, the outskirts are characterized by less populated and more economically comfortable urban dwellers that rely on boreholes as means of water supply. Dwellers in the transition zone are generally in between the core and outskirts dwellers and their main water resources are the hand-dug wells and machine-drilled boreholes (Onibokun and Faniran, 1986; Eludoyin *et al., 2004;* Olajuyigbe and Fasakin, 2010; Olajuyigbe *et al*., 2012; Onokerhoraye and Omuta, 1994; Adekola, 2018). In Oyo town, Adekola (2018) reported that about 75% of residents in the core people depend on water from hand dug wells and harvested rainwater (in the wet season) while majority of residents in the transition and outskirts clusters depend

on streams or hand dug wells, and borehole wells, respectively. In general, the available water infrastructure was mostly provided by individuals, and thus accessibility to safe water depends on the capacity of house owners to provide them.

Access to the safe water is a serious challenge in Nigeria, and some progress were made with the organization of river basin development authorities, until 2005, when probably the last noticeable effort was made at national level (Nwankwoala, 2011). Indeed, Emenike *et al*. (2017) reported that about 80% of all government-owned water systems in small towns were non-operational. Problems associated with failure of water schemes in the country include seasonal change in climate, increased demand occasioned by population increase and urban growth, as well as shortage of skilled manpower, poor funding, poor management and decline in government efforts (World Bank, 2010). Despite the importance of safe water, it is generally perceived that the privately (individual owned) supplied water is sufficient for residents of many urban areas in the region. This is probably a main reason why concerns over water supply have been significant. Consequently, this study focused on the evaluating the supply and quality of drinking water at household level in the region.

MATERIALS AND METHODS

The condition of water supply in selected studies in Nigeria is reported in this study. Case study settlements are in the southwestern part of Nigeria (Ile-Ife in Osun State, Oyo town in Oyo State, Ado-Ekiti in Ekiti State as well as Akungba-Akoko and Akure in Ondo State; Fig. 1). The settlements are urban with significant level of residential, commercial, religious and educational functions. There are primary and tertiary industrial activities, including essentially artisanal mining, wood extraction, food processing and commercial activities.

Fig. 1. Map showing Nigeria, and locations from which water samples were obtained.

The data used were the perception of key informants (238 key informants in Oyo and Ile-Ife) as well as the water samples from the existing water resources that were identified for domestic uses, including drinking. The targeted key informants were the women and heads of communities, as well as the water corporations in the area. The key informants were probed for responses on personal information, including living condition, income level, water resources for drinking and other domestic uses, health status/vulnerability to water-borne diseases, and access to portable water, water management approaches, environmental conditions and socio-economic conditions of the people. Groundwater and rainwater resources were examined in Ado-Ekiti, and the investigation in Akure and Akungba-Akoko in Ondo State was entirely focused on rainwater. Each water sample was collected in 2-litre polyethylene bottle, and pH, conductivity and total dissolved solids was determined from the samples, on site while the water samples were taken to laboratory for determination of some other important water quality variables. The settlements were investigated at different time between 2016 and 2018.

RESULTS AND DISCUSSION

Water sources

The result of the evaluation of the responses in the study area reveals a spatial variability in the sources of water consumed in the study area. Fig. 2, for instance shows the situation in Oyo town where the water sources appear to vary with the age of communities or neighbourhood. The relatively higher number of users of treated piped water is aged neighbourhood that benefited from the first major intervention from the Western Nigeria regional government's creation of Water Corporation in 1966; a period within the 1962-1968 National Development Plan that also saw to the establishment of River Niger and Lake Chad Basin Commissions in Nigeria. In 1976, River Basin Development Authorities (RBDAs) were created across the country, totaling 11 (Akindele and Adebo, 2004; Eludoyin *et al*., 2007).

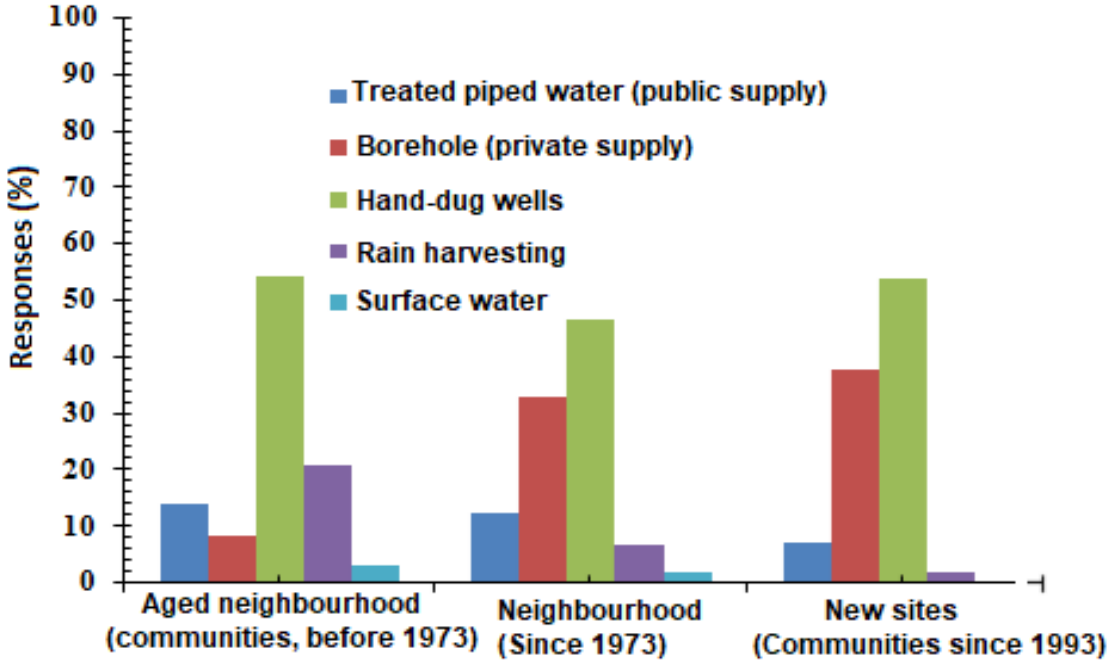

Fig. 2. Water resources available to different socio-economic residents

Fig. 2 also indicates that the capacity of the treated piped water diminished over the year. The diminished capacity is a likely reflection of the decayed infrastructure in the communities, probably due to population increase, abandonment or lack of maintenance. According to Akindele and Adebo (2004), the RBDAs did not make 'any impressive performance due to proliferation of unhealthy political rivalry, inconsistent government policies, and the organizational structure of some of the RBDAs'. Eludoyin *et al.* (2007) noted that government agencies, at different level of government often duplicate, rather than complement, activities, and that this has in the most cases caused waste of resources and occupational redundancy. Consequently, the majority of urban residents in the study area (and quite representative of the entire country) rely on groundwater resources; machine-drilled borehole wells and hand-dug wells. Since machine-drilled boreholes are typically expensive (costing at least NGN 400, 000 or US$ 1022 as at 2016), they appear more in newer neighbourhoods but more people across the study area still depend on hand-dug wells. Rainwater harvesting tends to be more practiced among residents of aged neighbourhood. The aged neighbourhood is generally characterized by aged, traditional people as well as socio-economically poor young adults with large families. The housing condition is such with poor sanitation.

Water accessibility

More proportion (62.5%) of residents in the new neighbourhood have at least one resource of water within their household than either the neighbourhood that commenced in 1973 or the aged neighbourhood; that latter has the least proportion of residents with water resource in their household compound (Fig. 3a). Fig. 3a also indicates that more residents in the neighbourhood since 1973 and the new neighbourhood travel at least 1 km to the nearest water resource (15.3%, 29.3%; 19.6%, respectively). In terms of time, except at the aged neighbourhoods, at least 20.3% of the population spend 30 minutes on water search, daily (Fig. 3b). On-the-site investigation about the low proportion of residents who spend more than 30 minutes in search of water in the aged neighbourhood suggests that most of the residents in the neighbourhood are only satisfied with the low quality of water that hand-dug wells provide, without minding the consequences on their health. However, in some of new neighbourhood, efforts are made by the state government to provide solar powered water (Plate 1) but this was found in only one (Ondo) of the states in the southwestern region, and even there, only few communities were fortunate to have them.

Plate 1. One of the solar-powered water supply outlets in Ondo State, Nigeria

In general, accessibility to the potable water has apparently become more physically difficult with settlement growth. The physical difficulty in some cases was overcome by an improved road transportation, such that water is transported from the long distance using different type of storage facilities. Existing studies confirm that water supply is rapidly declining in urban neighbourhoods in the sub-Saharan Africa, due to population increase, inadequate control facilities for water in-use (Nwankwoala, 2011; Adefemi, 2012). In terms of the volume of water use, less than 50% of each of the community stratum meets the sustainable development goal six requirement of 50 liter per person per day (Fig. 4).

Water quality assessment

Analysis of water samples collected from drinking water sources in Ile-Ife, Osun State, showed a level of alkalinity that is beyond the World Health Organization (2017)'s recommended limit (Table 1). Concentrations of manganese ion and abundance of *E.coli* were also more than the recommended limits for drinking water. Similarly, the samples from Ado-Ekiti (Ekiti State), Akure and Akungba-Akoko (Ondo State) reveal that those who drink water directly from hand-

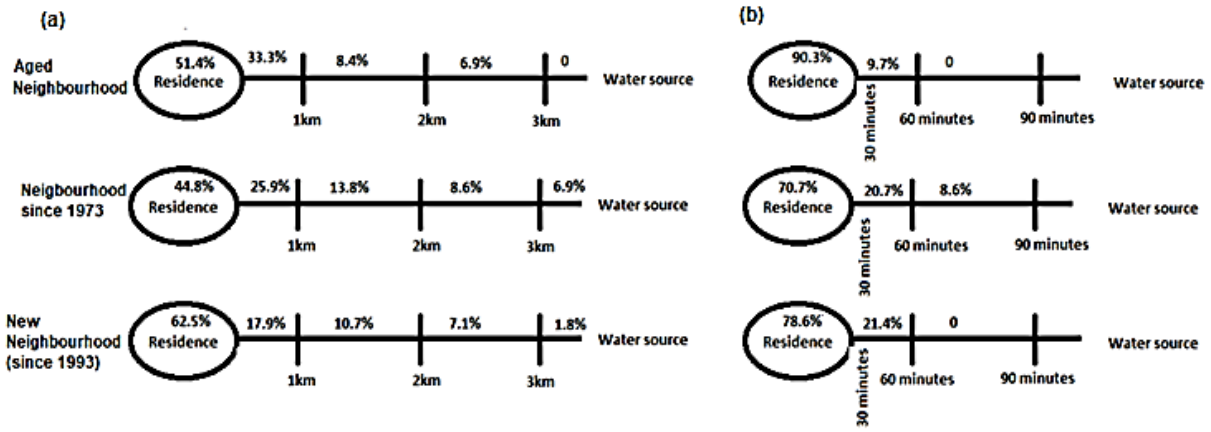

Fig. 3. Distance travel (a) and time taken (b) to the nearest source of potable water

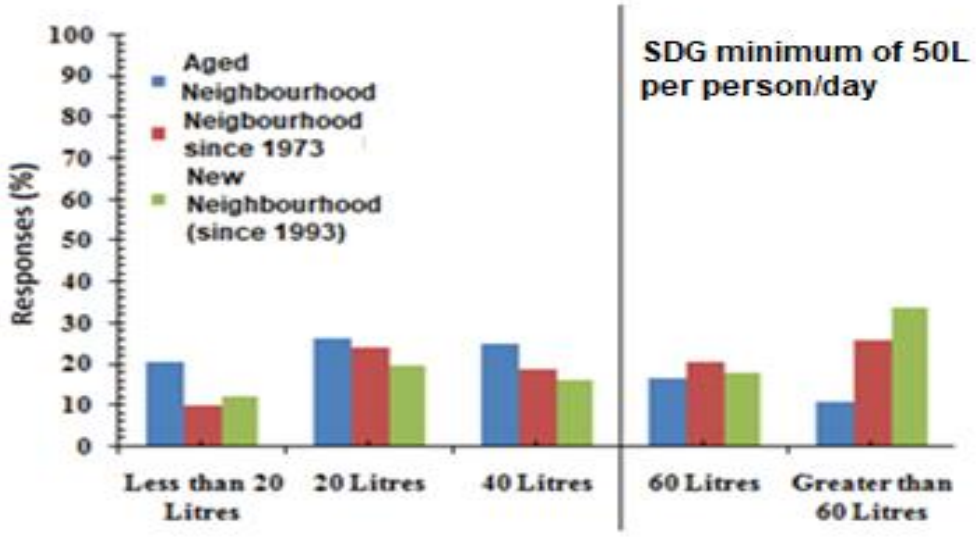

Fig. 4. Daily water consumption in a typical settlement in southwestern Nigeria

dug wells and rainwater are prone to ingesting excess chloride and manganese, respectively (Table 2). The studies have shown that whereas slightly high pH may not possess significant effect, excess manganese may cause cerebral relapse in children and fetal-umbilical dysfunction (Joode *et al*., 2016; Eludoyin *et al*., 2018). Abnormally high concentrations of E-coli in drinking water are also associated with chorea and typhoid.

CONCLUSION

The results indicate that the water supply in southwestern Nigeria is negatively influenced by urban growth and associated population increase. The results

Table 1. Assessment of water quality (mean ±standard deviation) in Ile-Ife, Osun State, Nigeria

Variables	WHO Standard	Recent neighbourhood	New neighbourhood	Aged neighbourhood	Remark
pH (no unit)	6 - 8	8.5±0.8	8.5±0.9	8.2±0.8	Polluted
Total Dissolved Solids (mg/l)	<600	512.5±520.0	420.7±397	537.6±767.2	Acceptable
Conductivity (uS/cm)	Not stated	26.9±1.3	36.8±51.9	26.6±0.9	Unknown
Lead (µg/l)	10	0.01±0.004	0.01±0.002	0.01±0.003	Acceptable
Arsenic (ppm)	0.01	0.01±0.01	0.01±0.003	0.01±0.003	Acceptable
Cadmium (ppm)	0.003	0.01±0.01	0.01±0.01	0.01±0.01	Acceptable
Manganese (ppm)	0.4	0.03±0.01	0.03±0.01	0.02±0.01	Polluted
E.Coli (/100 ml)	0.00	13703±2618	440271±208	3993±9054	Polluted

Table 2. Water quality assessment from selected groundwater and rainwater resources in Ondo and Ekiti States, Nigeria

Variables	WHO Standards (2017)	Hand dug well at Ado-Ekiti	Boreholes Ado-Ekiti	Rainwater Ado-Ekiti	Rainwater at Akure	Rainwater at Akungba
pH (no unit)	6.5-9.5	6.6	6.9	7.1	5.5-7.9	5.1-8.0
Temperature (^{o}C)	30-32	27.6	28.0	24.0	24.5-27.5	24.0-27.0
Conductivity(µS/cm)	750-1500	362.62	375.2	7.6	20.0-380.0	20.0-480.0
Na^{+} (mgl^{-})	200	3.19	2.94	0.13	7.8-28.5	8.10-31.90
Mg^{2+} (mgl^{-})	50	3.22	4.19	0.30	1.6-12.1	1.9-12.1
Ca^{2+} (mgl^{-})	75	22.29	3.01	0.54	*	*
K^{+} (mgl-)	20	0.17	0.19	0.11	***19.9-79.9***	***20.9-82.5***
CO_3^{-}(mgl^{-})	150	17.79	19.28	2.1	20.0-63.0	26.0-74.0
NO_3^{-} (mgl-)	50	3.07	2.14	0.10	0.03-1.6	0.05-2.0
Cl^{-} (mgl^{-})	200	***371.5***	235.3	7.03	6.0-24.1	7.1-25.9
SO_4^{2-} (mgl-)	200	0.54	0.56	0.44	11.0-50.0	10.1-54.0
PO_4^{3-} (mgl^{-})	5	0.05	0.07	0.01	0.01-0.02	0.01-0.02
As (mgl^{-})	0.01	0.001	-	-	*	*
Mn (mgl^{-})	0.04	0.04	0.03	***0.08***	*	*
Pb (mgl^{-})	0.05	-	-	-	***0.0-0.08***	0.01-0.04
Zn (mgl^{-})	3	*	*	*	0.03-2.0	0.06-1.0

' – ' = undetected '*' = undetermined
Values that exceed World Health Organization (2016)' s recommended level for corresponding variables are underlined and in bold

of the water quality assessment indicate that many people are vulnerable to the health implications of drinking untreated water.Water supply may be adversely affected by socio-economic strength of the people, such that the poor people are able to afford water from hand-dug wells that are usually in poor conditions (Plate 2). The level of vulnerability becomes higher in rural areas where over 40% of the entire population of the country is. These rural populations are largely made up of the farmers and mine workers who mostly ensure food security for the nation. The aged neighbourhood in this study is usually involved in primary industry, involving extraction and cottage activities. The study indicates that although these people spend less than 30 minutes to walk to a water resource for drinking, the resources are not good enough. The new neighbourhood that is often low to medium density settlements with more educated and more affluent people. Here, water supply is inadequate as the length and time of travel are beyond standard limits, and the quality of water is below normal, too. It is obvious that the regional or country's policy on water supply is dysfunctional. The condition presented in this study is typical of the water supply problem in the sub-Saharan Africa, and this is probably a major factor of high level of water related diseases in the area. The study recommends the improved and sustainable household water schemes across the regions to meet a higher water productivity in Nigeria.

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Plate 2. The poor condition of some resources of drinking water in the study area

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