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Meeting the Millennium Development Goals' Target for Potable Water Supply through Borehole Construction in Nigeria- An Overview

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Authors' contributions

This work was carried out in collaboration amongst all authors. Author AJO designed the study, wrote the protocol and the first draft of the manuscript. Authors KOM and GGA managed the analyses of the study and literature searches. All authors read and approved the final manuscript.

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ABSTRACT

An overview of the success, challenges and prospects of the use of boreholes to meet the potable water supply target of the Millennium Development Goals (MDGs) in Nigeria was carried out. The study employed an extensive review of literature on the quantitative and qualitative assessments of boreholes including their spatial coverage, across the country. Similarly, reports of studies on the progress made to attain the MDGs target in Nigeria were also evaluated. From the review, it was observed that adequate access might not have been achieved owing to the high rate of failure of boreholes and the poor coverage of the system. The presence of harmful substances in water from boreholes in many instances as revealed by previous bacteriological and physico-chemical studies across the country also puts a doubt on the reliability of the system for potable water supply. Although there is no consensus as regards the water supply status of the country, more reports showed that there is great challenge to the attainment of the MDGs target. Thus, the paper recommended amongst other things, quantitative and qualitative assessment of all existing boreholes across the country to identify non-functioning ones for repair and as well determine their level of wholesomeness, and compliance with international best practices in borehole construction.

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In addition, reduction of groundwater pollution through the enforcement of all environmental laws will help to achieve the MDGs target of water supply in the country.

Keywords: MDGs; target; access; Nigeria; quantitative and qualitative assessment.

1. INTRODUCTION

Water is a vital resource for all living things. In fact, it is so important that when lacking or inadequate in quantity and quality, many activities of man are rendered almost impossible. For instance, water is used for such domestic activities like cooking, washing, drinking purposes and watering of lawns; it is required for all body metabolic processes [1,2,3]. Federal Republic of Nigeria (FRN) [4] noted that the increasing relevance of water in national development cannot be overemphasized given that agriculture and food security are also critically dependent on water availability. This is because, planting time and crop yield are both determined by the onset, duration and the amount of rain that is recorded in a rainy season. Consequent upon this, numerous scientific and economic facts have posited that inadequate water supply can cause severe decrease in productivity and deaths of living species [5,6]. In the same vein, health officials have also emphasised the importance of drinking at least eight glasses of clean water every day to maintain good health [7].

Healthy living which greatly depends on the maintenance of good sanitary measures is related to access to adequate potable water supply [8]. For example, waterborne diseases cause death and suffering of millions of people, especially children, worldwide [9,10,11]. In addition, waterborne and water-related diseases like diarrhea, cholera, typhoid, malaria, hepatitis and more have been linked to an estimated 80% of illnesses [12,13,14], in developing countries. This was why World Health Organization (WHO) [15] suggested that improving sanitation and hygiene could drastically reduce child mortality. Thus, inadequate potable water supply creates a serious threat to the attainment of health for all according to the Nigeria Vision 20:2020 and impedes efforts to reduce poverty since poor health on its own exacerbates poverty.

Despite the foregoing critical importance of water for human life, its supply is grossly inadequate at varied percentages in Nigeria, depending on the area. For instance, in 2009, Nigeria was ranked 130 out of 147 countries on the world Water Poverty Index (WPI) [4] while the country was placed at third position globally on the list of countries with inadequate water supply and sanitation coverage [14]. Recent assessments have also given damning verdicts on water supply situation in the country. Although Orebiyi et al. [16] stated that 52% of Nigerians did not have access to improved drinking water supply; a survey by Majuru et al. [17] estimated that 65 million Nigerians had no access to safe water. The situation was worse in the rural areas where only 24% of the population were said to have access to safe water. This is traceable to the country's inability to supply water through pipe-borne system as a result of the failure to complete some water supply schemes started some years back while those completed are not judiciously utilized. In addition, many policies formulated in the country and international treaties signed have not been properly implemented. Accordingly, for these obvious reasons, adequate supply of potable water in the country has been elusive.

However, in recognition of the problems of inadequate supply of potable water in many developing countries, the MDGs stipulates as one of its eight goals (Goal 7) that by 2015 the population of people without sustainable access to safe water will be reduced by half [18]. Nigeria as a member of the United Nations, quickly signed the deal and to achieve the targets, governments at all levels adopted the construction of boreholes as a quick solution to the perennial water supply problem, especially in the rural areas. Consequently, many boreholes have been sunk in most semi-urban and rural areas of the country to supply water to the citizens. Despite the efforts and given that the year 2015 is already at hand, there are doubts as to the attainment of the said goal in the country. This is in view of the high susceptibility of the system to failure as observed in Sub-Sahara Africa. In fact, a survey of water facilities in eleven countries in Sub-Saharan Africa had shown that only 35-80% was functioning [19,20]. Therefore, the aim of this paper was to conduct an overview of the success, challenges and prospects of the use of boreholes to meet the potable water supply target of the MDGs in Nigeria.

2. WATER SUPPLY THROUGH BOREHOLE CONSTRUCTION IN NIGERIA

Supply of potable water though the use of boreholes in Nigeria started in the early 1980s after the recorded success of the system in the rural areas of the former Eastern Nigeria. According to Bob-Duru [21], the first national borehole construction programme aimed at providing safe water supply to rural areas was initiated in 1981. Between 1980 and 1990, about 760 boreholes were said to have been constructed across the country with only 228 (30%) being productive [22,23]. At first, boreholes were limited to rural areas and specifically in public places such as markets, hospital and maternity homes, mosques and churches. This was done perhaps to feel the pulse of the people and as well give room for the proper assessment of the suitability of the system.

The emergence of such agencies as Directorate for Food, Roads and Rural Infrastructures (DIFFRI) and National Agricultural Land Development Authority (NALDA) around the mid-80s to late 80s also helped to extend boreholes provision to the rural farms and settlements. This was done by the federal government of Nigeria as a way of meeting the core mandate of the agencies. But, with the increasing inability of the various governments to provide pipe-borne water supply since early 1990s, the number of boreholes all over the country in both rural and urban areas may have increased. Indeed, individuals started to construct boreholes for both domestic and commercial purposes between late 80s and early 90s. Additionally, the need to meet one of the targets of the MDGs as earlier mentioned by 2015 in the country further increased the number of boreholes constructed by governments. With the effort fully supported by many international organizations such as the African Development Bank (ADB), The World Bank, United Nations Development Programme (UNDP), United Nations Children's Fund (UNICEF), United States Agency for International Development (USAID) and The Department for International Development (DFID), it was not long before boreholes spread to every nook and crannies of the country.

2.1 Quantitative Assessment of Boreholes in Nigeria

There is high rate of boreholes failure in both rural and urban communities in the country, as revealed by previous studies. This is not peculiar to only the handpump-fitted boreholes, but also affects the motorized ones which have become famous in the country recently. For example, a study on the rates of borehole failure has shown that less than 50% installed water points (including hand pumps and motorized) function in most cases in Nigeria [24]. Moreover, Oloruntade et al. [8] in a study of borehole sustainability reported that while 57% of the hand-pump fitted boreholes failed, 47% of the motorized ones had failed in Akoko Area of Ondo State, Nigeria. This shows that provision of potable water through the use of boreholes may not be completely reliable afterall.

Furthermore, an appraisal of water supply facilities carried out in the rural riverine coastal areas of Lagos State by Longe et al. [25], also showed that despite the high dependence of the inhabitants on hand-dug wells and boreholes, all the boreholes fitted with hand pumps had failed, while about 86% of those fitted with electrical pumps had failed. Nevertheless, it was further recommended that the use of hand-pump fitted boreholes would enhance potable water supply in the area owing to its low operational efficiency, effectiveness, affordability and availability of spare parts. Similarly, Yusuf et al. [26] reported that high percentage of the boreholes were non-functional in a study carried out on boreholes in some parts of Osun and Kwara States. Eduvie [27] opined that despite the huge investment on water supply in Nigeria, there was still severe scarcity of water in the country for domestic, agricultural and industrial purposes heaping the blame on the very alarming rate of borehole failure arising from technical, political and financial constraints. Isa et al. [28] also observed that due to increase in population, public water supply from boreholes has been very unstable and unpredictable as supplies are often irregular in Maiduguri metropolis. In Kaduna State, despite the huge investment on water supply by the government, only 20% of the boreholes in rural areas were active while service coverage was estimated at 11% and 32% of the rural and urban population, respectively [29].

Rural Water Supply Network (RWSN) [30] had estimated the functionality of hand pumps installed on boreholes in rural areas of Sub-Saharan at 66%. The report further adduced such reasons as poor community mobilization towards the execution of borehole provision in communities, poor community cohesion and lack of community participation or very low community involvement in borehole provision processes, for the very high failure rate. Several other studies have also given other factors for the failure of boreholes to ensure sustainable supply of water to its target users after its completion. Although the present study did not include the review of the reasons for the failures of boreholes in the country, factors such as insufficiency of the groundwater as stored in the aquifer serving a particular borehole to meet community population, poor siting owing to political manipulation, faulty pumps and inadequate policy framework for maintenance have been cited [8,27]. Similarly, causes of borehole failure in Nigeria have been stated to include lack of expertise or inexperience and poor performance of the driller, poor supervision, peculiar characteristics of the aquifer, poor technological and poor handling by well users [31]. In addition, Udon et al. [32] reported that inadequate groundwater studies and evaluation, poor planning and lack of foresight, poor technology and service delivery, lack of suitable expertise, poor financial resources and corruption, over exploitation of groundwater by over-pumping, absence of well data and mechanical obstructions of well caused failure of boreholes in Nigeria.

From the foregoing, it can be deduced that while the use of boreholes by governments at all levels in the country has been adopted for improved accessibility, sustainability of the system might not have been properly handled. There is also no satisfactory evidence to show that adequate coverage has been ensured, especially in the rural areas in line with scientific projections. For example, Eduvie [24] had opined that for Nigeria to meet the MDGs target for water supply in the rural area alone, one borehole will serve 230-500 people living within 500 m radius of the water point. Given that 50% of the population lives in rural areas, which are to be served with hand-pump boreholes, the country may need about 2,000 boreholes for every 1 million people [24]. Therefore, to provide potable water for 70 million people living in the rural areas require about 140,000 boreholes (assuming no increase in population). However, such a target is far from the present reality in the country. Thus high rate of borehole failure and poor coverage of the system may have negatively affected the country's drive to meet the safe water supply target of the MDGs.

2.2 Qualitative Assessment of Boreholes in Nigeria

Apart from wider coverage, the MDGs requirement for water supply target also include that the water must be potable. But for water to be potable, its supply must meet the quality requirements set by WHO and the various national water regulatory agencies to ensure that the consumption of such water is not injurious to human health. Potable water has been defined as that which does not contain chemical substances or microorganisms in amounts injurious to health [33]. However, scientific/ laboratory analyses of water from boreholes in various parts of the country have suggested that supply of water through the system may not be completely wholesome (Table 1). This, nonetheless, depends on the location of boreholes with respect to pollution sources, depth and the type of geological formation in the area. For instance, Essien and Bassey [34] in their assessment of the spatial variation of borehole water quality with depth in Uyo showed a strong positive correlation between water quality and depth of boreholes in the area. It was in their opinion that runoff from pollution sources must have found its way into many of the boreholes with depths less than 50 metres and therefore, suggested that a minimum depth of 100 metres should be observed in borehole construction to prevent seepage of polluted runoff.

Similarly, high coliform counts, greater than the WHO standards was observed in over 60% of the boreholes sampled in Akamkpa and Calabar Municipality [35]. A comparative analysis of water quality from hand-dug wells and boreholes in Calabar South Local Governemnt Area, Cross-River State found pH values in boreholes that indicated high level of acidity which required some treatments to make the water potable [36]. Another study [37] also showed that proximity of boreholes to landfill areas in Calabar caused high presence of heavy metals and coliform counts beyond acceptable limits which made water from boreholes in the area unsuitable for consumption. Maureen et al. [38] reported the presence of *E. coli* as a result of contamination in stored borehole water in Okutukutu, Bayelsa State. A comparative analysis of public and private borehole water supply sources conducted in Uruan Local Government Area of Akwa Ibom State, Nigeria also reported a high conformity to physiochemical standard, but high presence of different types of microorganisms [39]. This, according to the study, made the water to be unsafe for human consumption, thus suggesting the need for treatment before use. However, results of the study conducted in Awka, Anambra State, by Anyaeze et al. [40] indicated high conformity of the physical and chemical properties of the sampled boreholes to WHO standards.

In South Western Nigeria, an analytical study of groundwater in both sedimentary terrain and basement complex using Lagos and Oyo States, respectively reported that while all samples were almost suitable for human consumption, the presence of iron in some samples from sedimentary terrain called for concern [41]. In addition, Amori et al. [42] analysed groundwater using both hand dug wells and boreholes in Odeda area of Ogun State and reported the presence of heavy metals in most of the samples, with only those in hand-dug wells higher than the WHO permissible limits. Adekoyeni and Salako [43] in a study of the microbiological, physiochemical and mineral quality of borehole water in Ijebu Land, Ogun State observed high contaminations and therefore recommended the treatment of water from boreholes sources in the area for safe consumption. Oyedotun and Obatoyinbo [23] also revealed in their hydrogeological evaluation of groundwater quality in some parts of Akoko Area of Ondo State, a high contamination of water samples from boreholes as a result of the proximity of septic tanks with lead almost exceeding the permissible limits. However, in an assessment of heavy metals in boreholes and hand dug wells in Ife North Local Government Area of Osun State it was discovered that heavy metal contents were within the permissible limits in the sampled wells and boreholes indicating their suitability for human consumption [44].

Moving upward north in the country, Musa *et al.* [45] carried out an assessment of groundwater in Obajana and its environs, Kogi State, North Central Nigeria and concluded that heavy metals presence in the samples conformed to the required standards, but suggested the need for regular and systematic assessment of the situation in the area. Onojah et al. [46] also in a study of the physicochemical and bacteriological assay of sub-surface water in Idah Local Government Area of Kogi State, observed high level of heavy metals which seriously impaired the quality of ground water in the area. To this end, the study recommended treatment by boiling, addition of lime, sedimentation and filtration using appropriate medium to improve the water quality and make it safe for drinking and other uses. In a contaminant evaluation of major boreholes water in Lapai metropolis by Oladipo et al. [47], high acidity was recorded in many of the water samples as a result of dissolved minerals from the leaching or corrosion of sink pipes. This put a doubt on the suitability of water from the source for consumption. In Kaduna, Eduvie and Olaniyan [48] also observed heavy contamination of groundwater from wells and boreholes in their study and therefore recommended lining and siting of wells far away from any source of possible pollution like pit latrines and soak-away.

A study of wash boreholes in Maiduguri metropolis revealed a substantial non-compliance of the samples with the bacteriological standard, pH level and total dissolved solid set by WHO and Nigerian Standard for Drinking Water Quality (NSDWQ), as the total coliform count ranged between 6 x 10^3 and 145 x 10^3 MPN/ml [28]. Hence, the authors submitted that further treatment of water from the boreholes was necessary before they could be used for both drinking and domestic purposes. Oruonye and Medjor [49] in a study of the physicochemical analysis of borehole water in the three resettlement areas in the Lake Chad region of Nigeria showed that although some of the physical and chemical parameters were within the WHO permissible limits for drinking water, parameters such as Fe, NO_2^-, Mg and pH were above the permitted limits. The study, therefore, recommended provision of water treatment facilities at the resettlement sites to safeguard the people's health and wellbeing. An assessment of the level of pollution of water from boreholes in some selected motor parks in Maiduguri, Nigeria also showed high heavy metals contamination capable of causing health hazards to users [50]. Thus, it was suggested that treatment of borehole water in the area should be done before consumption. In addition, Garba et al. [6] reported a mean arsenic concentration of 0.34 mg/l in drinking water from hand dug wells, boreholes and taps of Karaye Local Government Area, Kano state.

In a study of the status of the quality of groundwater in urban areas of Nigeria [51], it was shown that Nigeria urban groundwater quality is influenced by the geology and geochemistry of the environment, rate of urbanization, industrialization, landfill/dumpsite leachates, heavy metals, bacteriological pollution, and effect of seasons. Drawing a conclusion from the study, they suggested protection of water sources, proper handling of wastes and construction of sanitary landfills, control of all land use polluting activities, and treatment of water before its use for consumption. Above all, continuous monitoring of groundwater quality was recommended to forestall any unpleasant consequences. Yet, in many instances where boreholes are constructed, there are ample reasons to suggest that standards are not usually followed. It had been mentioned that many boreholes were sited based on political influence, even against the result of geophysical survey [8]. Thus, non-compliance to standards may have been one of the causes of poor water quality from many of the boreholes assessed in the studies reviewed. Hence, it can be submitted that water supply through the use of boreholes might not be safe enough to meet the MDGs target. Unfortunately, many rural dwellers in the country have relied on this source for all their domestic supplies without any form of treatment.

2.3 Current Water Supply Status in Nigeria

As a result of the dearth of adequate data, accurate assessment of the current water supply status in Nigeria has been a difficult task. This is even as there are differences in the level of accessibility amongst the various states in the country. For instance, a release by the Federal Ministry of Water Resources (FMWR), Nigeria in 2011 [52] and adapted in this work (Fig. 1) showed that more than half of the states of the country had less than 60% access; while Taraba (20%) was the worst, Lagos provided the highest access of about 92%. The greatest accessibility was recorded amongst the South Western states (Ekiti, Lagos, Ogun, Ondo, Osun and Oyo) while the least was recorded amongst the North Eastern states (Adamawa, Bauchi, Borno, Gombe, Taraba, and Yobe). However, it is important to emphasise that the zone with the least access take about 15% of the population of the country [53].

Nevertheless, Longe et al. [54] found that about 47 million Nigerians still relied on surface water sources to meet their domestic needs, blaming the situation on existing weak water and environmental laws. John-Dewole [55] also observed that inadequate supply of potable water from boreholes contributed to the use of water from unwholesome sources which gave rise to various diseases outbreak and poor health in Kajola local government areas of Oyo State. Omole and Alakinde [56] noted that despite the fact that the Ilajes in Ondo State reside on water, they lacked access to good drinking water, therefore recommending the application of water poverty index (WPI) amongst others to salvage the situation in the area. Onuoha et al. [57] also found that the volumes of water supply for domestic purposes were below the minimum requirement in the entire areas sampled in Auchi metropolis, suggesting rainfall harvesting using reservoir as solution to the problem. It has also been observed that rural dwellers are usually neglected whenever water supply schemes are being planned in Nigeria, as over 90% of rural dwellers in some parts of Kwara State depended on unwholesome sources for domestic water supply [9].

A report had stated that Nigeria was not on track to reach the MDGs targets of 75 % water supply coverage by the year 2015 [58]. The report further stated that the urban proportion with access to improved sources of drinking water in Nigeria decreased by 15% from 80% in 1990 to 65% in 2006. The rural areas recorded a decrease of 4% from the 34% in 1990 to 30% in 2006; the decrease by 15% in 16 years was said to be very significant at a time that the proportion of the population living in urban areas increased from 30% in 1990 to 49% in 2006. The decreases are also significant because of the already huge pressures on existing services/facilities in both urban and rural areas. The report therefore concluded that should the negative trend of water coverage continue, only 44% of the people in Nigeria will have access to improved water sources, a percentage far from the MDGs target. In addition, Water and Sanitation Monitoring Project (WSMP) [59] in its Core Welfare Indicators Questionnaire Survey (CWIQS) carried out in 2006, revealed that only Lagos and Oyo States had met the 75% water coverage target, while most states especially those in northern and south-eastern Nigeria had less than 50% coverage. While it might be difficult to accurately assess the status of Nigeria's progress towards the MDGs targets due to inconsistent data, reaching the water supply targets of the MDGs poses a daunting challenge [58,59].

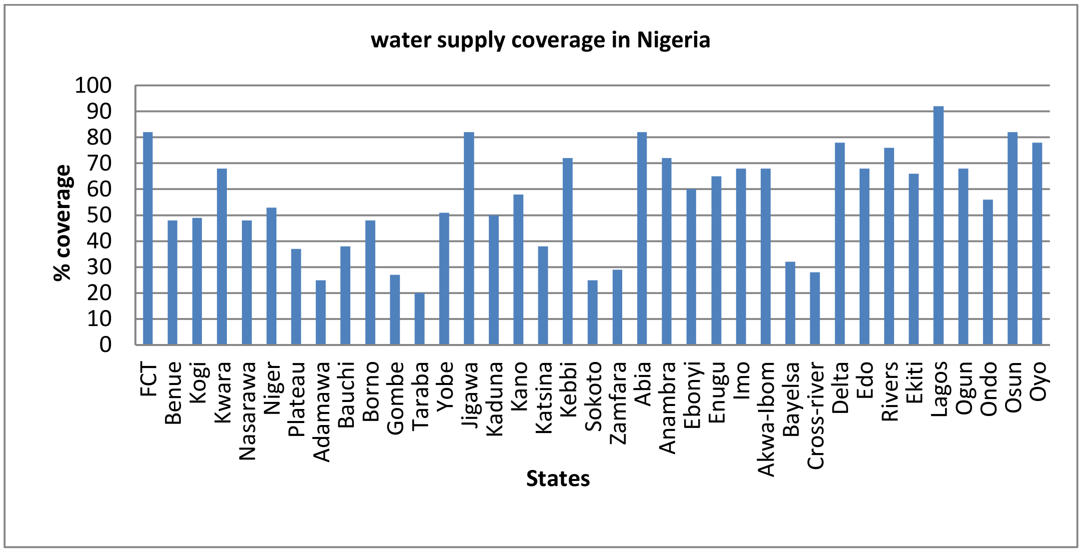

Fig. 1. Water supply coverage by states in Nigeria adapted from the Federal Ministry of Water Resources Executive Summary (2011)

Table 1. Major pollutants found in boreholes water in Nigeria

S/N	Location of study	Pollutants found	Authors	Recommendation
1	Uyo, Akwa-Ibom State	Calcium hardness	Essien and Bassey, 2012	Adequate construction depth
2	Akamkpa & Calabar	High coliform counts	Okorafor et al., 2012	Boiling of water
3	Calabar South	High acidity	Ukpong et al., 2013	Treatment
4	Calabar Landfill area	Heavy metals/*E. coli*	Ekpo et al., 2013	Not to be consumed
5	Okutukutu, Bayelsa	*E. coli*	Nkamare et al., 2012	Good hygiene measures
6	Uruan, Akwa-Ibom	Micro-organisms	Ukpong and Okon, 2013	Treatment
7	Akwa, Anambra State	None	Anyaeze et al., 2013	Suitable for consumption
8	Lagos State	Iron	Fasuwon et al., 2010	Treatment
9	Ogbomoso, Oyo State	Heavy metals	Amori et al., 2013	Treatment
10	Ijebu, Ogun State	Solute contaminants	Adekoyeni and Salako, 2012	Treatment
11	Akoko Area, Ondo State	High coliform counts	Oyedotun and Obatoyinbo, 2012	Treatment
12	Ife North, Osun State	Heavy metals	Jeje and Oladepo, 2014	Suitable for consumption
13	Obajana, Kogi State	Heavy metals	Musa et al., 2013	Regular assessment
14	Idah, Kogi State	Heavy metals	Onojah et al., 2014	Water treatment
15	Lapai, Niger State	High acidity	Oladipo et al., 2011	Treatment
16	Kaduna, Kaduna State	High contamination	Eduvie and Olaniyan, 2013	Good construction practice
17	Maiduguri, Borno State	High coliform	Isa et al., 2013	Treatment
18	Lake Chad, Maiduguri	Heavy metals	Oruonye and Medjor, 2009	Treatment
19	Motor Parks, Maiduguri	Heavy metals	Kolo and Waziri, 2012	Treatment
20	Karaye, Kano State	Arsenic	Garba et al., 2008	Not to be consumed

3. CONCLUSION AND THE WAY FORWARD

High dependence on boreholes is not peculiar to Nigeria. This is because, about 250,000 boreholes with hand pumps are serving several rural communities in Africa [60]. Under this situation, high rate of failure of boreholes can have direct impacts in many ways on the general wellbeing of the people. This can lead to a situation whereby people use water from unwholesome sources resulting in health problems. Given the current precarious economic situation of the country arising from the dwindling earnings from crude oil sales, there are reasons to believe that many ongoing water supply schemes involving dam construction/ rehabilitation and pipe laying / extension in both rural and urban areas may not be completed in due time. Consequent upon this, there is a likelihood that governments would continue to construct boreholes to meet the immediate need of the people especially in the rural areas. However, despite the fact that the target year 2015 is already at hand, there are enough reasons to conclude that the country may not have attained the set target. One, a review of literature has shown that provision of potable water supply through the use of borehole in Nigeria is not sustainable considering the high rate of system failure. Poor coverage of the system may have also reduced its accessibility. Similarly, lack of regulation and standardization in addition to poor implementation of environmental laws which predispose the system to pollution also reduce its reliability for potable water supply. Therefore, for Nigeria to meet the MDGs target of potable water supply in the country, a paradigm change of approach is imperative. Consequent upon this, the following recommendations are found useful:

1. Quantitative and qualitative assessments of all existing boreholes across the country should be carried out to identify non-functioning ones for repair and as well determine their level of wholesomeness.
2. Provision of potable water supply in the country through boreholes should be made to comply with international best practices and reduction of groundwater pollution through the enforcement of all environmental laws to ensure quality water supply through the system.
3. Water supply through the use of boreholes should be completely left to the states and local governments to ensure efficiency of the system and avoid duplication of efforts.
4. Sensitisation of all boreholes users on the need for treatment and the provision of simple water treatment facilities especially at the rural areas will help to improve the suitability of the water for consumption.
5. There is the need to rehabilitate, upgrade, complete and efficiently utilize all existing water supply schemes in the country to ensure provision of potable water through the pipe-borne system that could be more sustainable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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