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Full Length Research Paper

Sustainability problems and bacteriological quality of rural water supply in Alabata community, South-western Nigeria

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Alabata is a community with no electricity and comprehensive topographic or administrative map. They also depend on a fuelled generating set to power the pumping machine for the UNICEF assisted borehole. The citizens often had to resort to an unsafe alternative water source for domestic purposes. In March 2006 an observational study trip through which data on sanitation, health and water sources were acquired was made to Alabata community. Coordinates of relevant facilities and water sampling points were taken and plotted in a Geographic Information System (using ArcView 3.2a GIS software). A base map for the study area was generated from satellite imagery (IKONOS). Sample points of water were overlaid on the base map that was produced from the satellite image. Water was collected from alternative water sources and analysed for bacteriological quality in the Microbiology laboratory. The bacteriological analysis of the different water sources with the exception of deep protected well with no recorded growth, showed that coliform count (> 1100 MPN/1000 ml), total *Escherichia coli* count (3-6 log cfu/ml), and total heterotrophic count (3-5 log cfu/ml). In all, the water samples generally exceeded the WHO and EPA standards of acceptable limit for drinking and domestic use.

Key words: Geographical information system (GIS), rural water, sustainability problem, South-western Nigeria.

INTRODUCTION

UNICEF/WHO (2004) reported that more than 2.6 billion people, over forty percent of the world population do not have access to basic sanitation. Around 2.2 million children die of basic hygiene related diseases like diarrhoea every year, the great majority of which are in the developing countries. A large fraction of the World's population-around 1.1 billion people do not have access to clean sources of water for drinking and essential purposes while for many others, contamination during transport and in the household presents a significant health risk (WHO, 2004). Through the adoption of resolution A(RES/47/193) of 22nd February 1993, United Nations declared the 22nd of March of each year as World Water Day, to be observed beginning in 1993.

The aim is to create public awareness on the benefit of clean water, and the problems of water supplies. In September, 2000, 189 countries adopted the Millennium Development Goals one of which was to reduce the proportion of people without access to safe water and basic hygiene by 2015. A midterm assessment of progress on the Millennium Development Goals (MDGs) on drinking water and sanitation target between the MDGs baseline year of 1990 and halfway mark of 2002 made two significant predictions on reaching 2015 goals (UNICEF/WHO, 2004) first, that the world is on track to meet the drinking water target and second that the global sanitation target will be missed by half a billion people mostly in rural area of Africa and Asia. This allows waste and diseases to spread, potentially killing millions of children and leaving millions more on the brink of survival. Specifically, the Sub-Saharan Africa had shown patchy progress towards

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the provision of drinking water goal and still has the lowest proportion of people with access to basic sanitation facilities 36% with only a 9% increase since 1990.

The provision of safe drinking water in adequate quantities still poses a serious health problem in Nigeria. Rainwater, surface and well water are the major sources of our rural supplies of drinking water in Nigeria. Despite the provisions of safe water supplies, there is no significant reduction in the use of unsafe water sources for domestic purposes as indicated in various reports on bacteriological quality (Edema et al., 2001; Okonko et al., 2008; Shittu et al., 2008). A case study of Alabata community is used to address the sustainability problems and bacteriological quality of rural water supply.

MATERIALS AND METHODS

The study area

Alabata community is situated within Odeda Local Government Area of Ogun State, Nigeria. It is approximately 60 km off Abeokuta-Ibadan Road, Abeokuta, Ogun State. The area lies within longitude 3º15'E and 3º25'E and between latitude 7º15'N and 7º20'N. The community area falls within the humid tropical lowland region which is characterized by alternating well-marked wet and dry seasons. The wet season occurs from March to November with intermittent dry spells. This is the period when the south-easterly winds prevail. The dry season usually occurs from December to March when the area is under the influence of the north-easterly winds. The annual rainfall is estimated at about 1600 mm. The mean monthly temperature ranges between 25.7°C in July and 30.2°C in February. The lowest temperature is recorded in June and September. The relative humidity of the study area is high all the year round. The most humid months coincide with the rainy seasons spanning between March and October. The relative humidity figures for these months range between 80 and 90%. During the dry season, between December and February, the humidity figures range between 60 and 80%. The study area lies within the transitional zone between the derived savannah and dry lowland forest featuring a mainly mixed association of secondary bush re-growth. The majority of the population is concentrated around the Alabata market with many other sub-villages, approximately fifty nine villages in all. The total population of the area is approximately seven thousand five hundred and the major occupations are farming and trading. The community has a combination of different cultures but majority are basically Yoruba's.

Data collection

A visit was made to the village on the 3rd of February, 2006 after an official permission was obtained from the Chairman of the Local Govt. Area and the overall Village head and leaders of the community. Some members of the community were addressed in the mosque during Friday Jumat prayer. Qualitative case-history/narrative research was used in investigating the water, sanitation and sustainability problems associated with the UNICEF assisted borehole. In depth interview was conducted on the 27th of the same month with the village head, the coordinator of borehole and some village women. Questions were based on drinking and domestic water sources, problems encountered with the available borehole and reasons for resolving to unsafe water sources. The community health centre was also visited to investigate recorded cases of diarrhoea in the community. Pictures were captured with camcorder.

GIS mapping

A hand-held Global Positioning System (GPS) receiver (Gamin GP 12 Personal Navigator) was used to obtain co-ordinates of relevant facilities such as the market place, Health Clinics, schools, refuse dumps, and the different water sources within the study area. The geo-ecological characterization of the study area was obtained by incorporating the existing spatial and in-situ data into Remote Sensing (RS) data of specified satellite imagery (IKONOS) captured in Dec. 2007 and Geographical information System (GIS). ArcView 3.2a Program (Environmental System Research Institute [ESRI], Inc., Redland) was used as basic GIS Software (Dangendorf et al., 2002). The development of a geographical information system-remote sensing system (GIS-RS) allowed an overlapping of spatial location of water sources and the bacteriological quality as well as generation of map for the study area (Figure 1).

Bacteriological examination of water quality

Water samples were collected from the various sources and transported to the Microbiology laboratory of the University of Agriculture, Abeokuta, Nigeria in ice packs. Bacteriological characteristics were determined as described by Bezuidenhout et al. (2002). The Most Probable Number- multiple tube technique was used for presumptive coliform enumeration. Plate count agar (PCA) and Eosin methylene blue (EMB) agar were used to determine heterotrophic bacteria, and Escherichia coli counts respectively. All plates were incubated at 35°C for 24 h. Colonies from agar plates were confirmed by gram staining and biochemical reactions.

RESULTS

Observational study

Alabata community depended majorly on water from shallow wells for domestic use and had a multiple problem- borehole source for drinking water only. Figure 1 to 9 showed observations made during the visit to the community. There had never been any outbreak of cholera or other water borne infections in the village up until the time of this research. The community health centre was visited for recorded cases of diarrhoea but did not yield any positive result as cases were separated from the community. The community depends on rainwater during the wet season because the shallow well became filled with run-off water. Bush defecation is widely practiced, as there is not a single house with a pit latrine or pour flush toilet.

Sustainability problems of the UNICEF assisted bore-hole

The community did not have electricity but used an electrical pumping machine for their borehole and thus used a fuel-generating set to operate the machine. Every member of the community contributed money to the

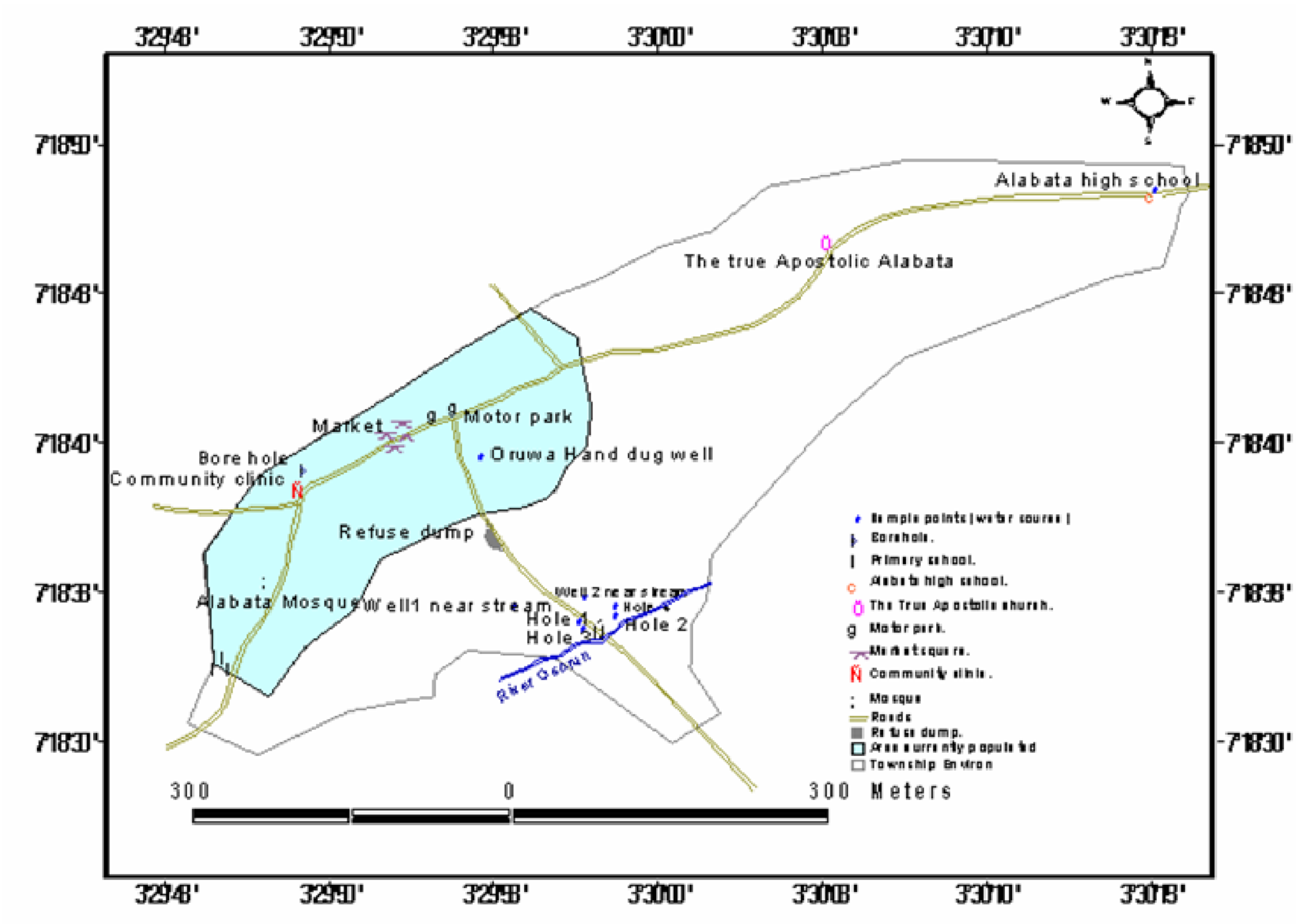

Figure1. Map of Alabata community showing relevant facilities.

Figure 2. Water fetched and left for plain sedimentation from shallow well A.

Figure 3. Full view of shallow well B.

Figure 4. A woman scooping water from shallow well B.

Figure 5. A boy fetching water from a protected hand-dug well C located beside a dried-up stream.

Figure 6. Water fetched from shallow well D1.

Figure 7. Dirty water fetched as water ooze out of shallow well D1.

project- which constitutes social economic stress on members. Sometimes, the generator would have faults, which cannot be rectified within a short period. This means they must resort to other sources of drinking water. About 10 neighbouring villages, which were up to 30 min of trekking, depend upon the borehole as drinking water source. These villages were divided into three divisions. Each division can only fetch water between 2.00 -7.00 pm when the borehole is opened for them at a specified day of the week. Only drinking water is fetched from the borehole, while water from the shallow well is used for other domestic uses after being treated with alum. There are other two non-functioning wells dug by the LGA. The community said that the wells are about five and ten rings and that water level was not reached during digging, even though they were covered up as completed and functioning. During the dry season, the community uses the shallow well water but some of the women had to stay up all night for water to ooze out before they could scoop.

GIS mapping and bacteriological examination of water quality

Presented in Figure 10 is the GIS-RS generated bacteriological quality of water in relation to sampling points. The bacteriological quality testing (coliform counts) of the borehole and the shallow wells did not meet the standard

Figure 8. A woman fetching water from shallow well D2.

Figure 9. A woman who had just finished bathing her little boy with water from one of the shallow wells.

of WHO recommendation for drinking water. Levels generally exceeded MPN/ml (Table 1).

DISCUSSION

The application of GIS to a rural community water supply had been shown in this study. A GIS is an organized collection of computer hardware, software, geographical data and personnel designed to efficiently capture, store, update, manipulate, analyze and display all forms of geographically referenced information (WHO, 1999). It is an information system with a geographical variable which enables users to easily process, visualize and analyze their data or information spatially. Each piece of information is related in the system through specific geographical coordinates to a geographical context (Kistemann et al., 2000).

GIS offers the possibilities of automated generation of maps (O'Dwyer, 1998). And it is the most widespread GIS application in the health care research sector (Scholten and Lepper, 1991). Due to the technology of satellite-supported remote sensing, ecological research is provided with a huge quantity of data. User-friendly soft ware for remote sensing and GIS are the ideal tools to collect, to organize and to use this large quantity of space -related information (Kistemann et al., 2002). The potential of GIS-RS technology is useful and promising for many areas (Hay, 2000; Brooker et al., 2000). Remote sensing data are increasingly used for investigations in the field of environmental health sciences for risk mapping, surveillance or monitoring, particularly of vector-borne diseases (Beck et al., 2000). Through the efficiency of the task specific GIS-RS, we have been able to generate a map for a community that is not existent in the state topographic or administrative map which could serve as a baseline studies for further investigation on public health significant problems such as impact of water and sanitation on antimicrobial resistance.

The water and sanitation case study of Alabata community exemplifies what happens in our rural communities. It shows that even in the pursuit of Millennium Development Goals, rural areas in Nigeria have sustainability problems with provision of portable water supply. The villagers still resort to surface water because of the hardship encountered with the borehole which is under strict regulation and only drinking water is allowed. As at the time of this investigation the borehole was functioning. Surface water is highly polluted as a result of the disposal of refuse and sewage. The community practice bush, stream, backyard and open field defecation take place as there is not a single household with toilet facility. The only one is still under construction as at the time of this investigation. The sanitary practices are all contributing factors to water contamination. Water contamination may be due to: improper disposal of refuse which may contain contaminated waste such as rotten vegetable, stale food, improper drainage and open field defecation.

Open field defecation contaminates water bodies and stored water through various routes such as soil, insects, nails etc. It was gathered that children on their return from school do consume the water fetched and left for sedimentation by just dipping their cup in it before their mothers could intervene. Children even also bath with the untreated water as can be seen from the figures with likelihood of ingestion. The alternative surface water source of the community is not safe for consumption especially, the children. Reasons for resort to surface water sources were enquired from people in schist-osomiasis - endemic communities (Akinwale et al., 2005). When asked why they still go to the river since there are

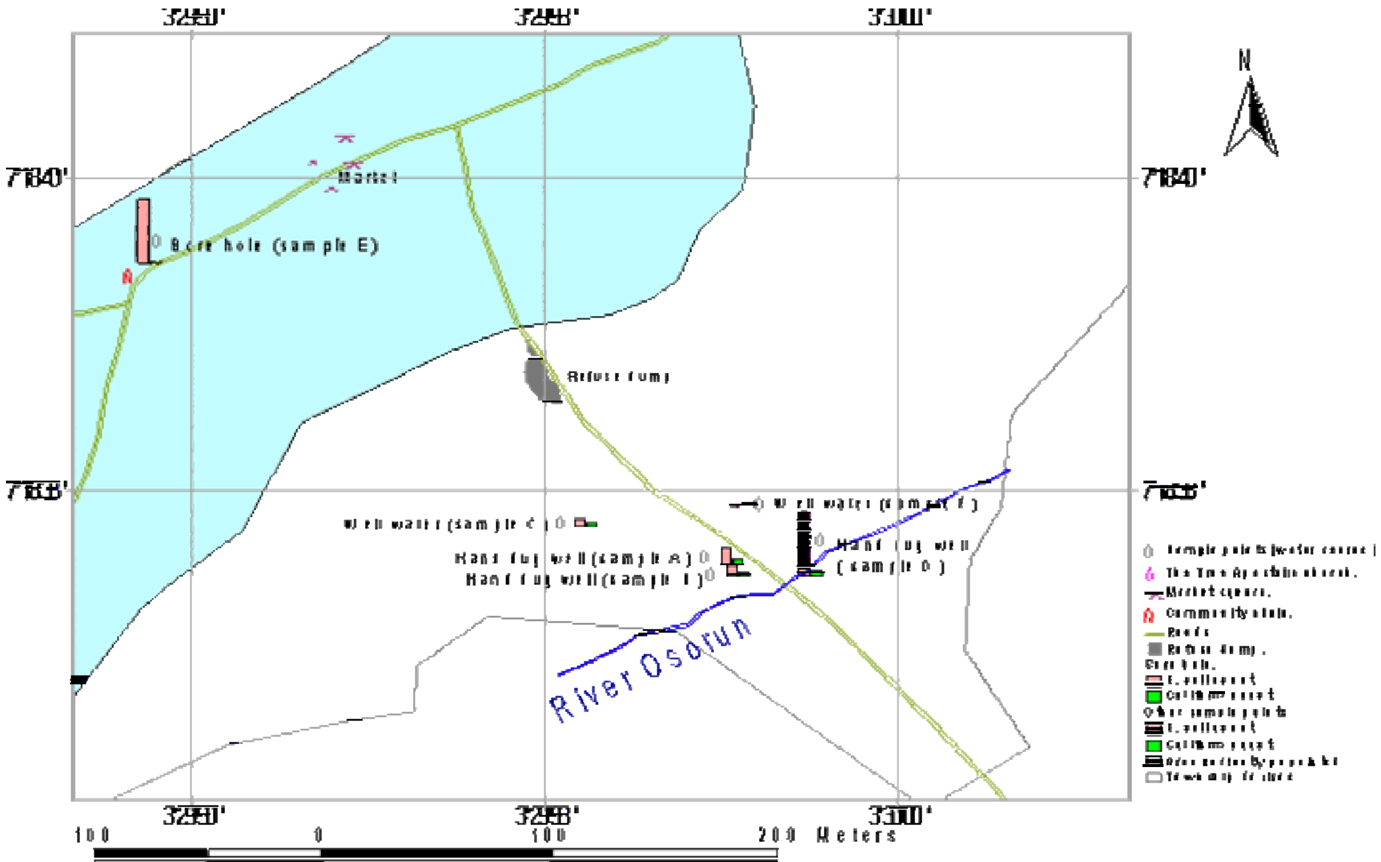

Figure 10. GIS-RS generated map of Alabata community showing the quality of water.

Table 1. Bacteriological water quality of water sources.

Water samples	Total coliform count (MPN/1000 ml)	Total *E. coli* count (log cfu/ml)	Total heterotrophic count (log cfu/ml)
A	1100+	3.0	3.0
B	1100+	3.0	4.0
C	1100+	4.0	4.0
D	1100+	6.0	5.0
E	1100+	3.0	3.0
F	1100+	(NG)	3.0
WHO Standard	Nil	0	2.0
EPA Standard	Nil	0	2.0

A = hand dug shallow well close to refuse dump; B= hand dug shallow well close to refuse dump; C = well water close to refuse dump; D = hand dug shallow well far from refuse dump; E = Borehole; F = protected well water sample; NG = No Growth.

water boreholes in some of these communities, the women complained of the difficulty they encountered while fetching water from the few boreholes that are functioning. They explained that they need to exert a lot of energy before the water can be drawn from some of these boreholes while some are not functioning at all. Hence they resolve to fetch water from the river. Safe drinking water and sanitation are essential for health.

Health status determines the social and economic development of families, communities and nations. The concept of faecal oral cycle and socio-environmental risk factors of water borne diseases is not vivid to the rural people. Environmental risk factors include improper disposal of human excretes, sewage, and garbage while the social risk factors includes improper handling and usage of water. These can be demystified through public education.

The bacteriological analysis of the different water sources showed that coliform count (> 1100 MPN/1000 ml), total Escherichia coli count (3-6 log cfu/ml) with the exception of deep protected well with no recorded growth, and total heterotrophic count (3 to 5 log cfu/ml), in all the water samples generally exceeded the WHO and EPA standards of acceptable limit for drinking and domestic use. The deep protected well recorded no growth in Escherichia coli count. The high heterotrophic count is indicative of presence of high organic matter and dissolved salts in the water which are common feature of natural and untreated water sources (Osuinde and Enuezue, 1999). High coliform count on the other hand increases the probability of other pathogenic organisms such as Cryptosporidium (EPA, 2003). Notable is the high heterotrophic count, E. coli count and coliform count of the borehole which is suggestive of improper construction, that is, the borehole is having inadequate (overburden) well depth. Since the construction of the borehole is under the supervision of the individual LGA's management, leadership personal and monetary gratification is usually set above the need of the masses. This study has been able to apply Geographical Information System-Remote Sensing (GIS- RS) into water health and sanitation problems in a rural community in Nigeria. The sustainability problems of the UNICEF assisted borehole has also been highlighted which is informative for Non-Governmental Organisations and policy makers on next line of thought and intervention programs.

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