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Research Article

Assessment of domestic water quality in coastal region of Ilaje Akoka, Lagos state

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ABSTRACT

Coastal regions are surrounded by water yet often have limited access to potable water. These regions are usually at the receiving end of indiscriminate dumping of industrial and domestic waste water. Using the co-production approach, some issues observed by residents with available water were noted. These were investigated by undertaking a laboratory analysis examining selected physico-chemical properties (colour, pH, Tds, Hardness, Iron and Manganese) of water from different sources. Results revealed that none of the sources produced water completely within acceptable limits. Sachet water which is widely taken as the safest source, had a pH value of 5.3 which makes it more acidic than is acceptable. Manganese which could lead to neurological disorder over a long period of exposure was found to be present at 0.7mg/l and 0.25mg/l in water from well and water trucks respectively. All other elements have relatively insignificant health implications yet are important for acceptability by consumers and system maintenance. Constant water system monitoring and treatment especially in such coastal area, provision of mini-water treatment plants and appropriate water storage practices were recommended accordingly.

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INTRODUCTION

Water is essential to life and human health, economic development, food, security, poverty reduction and sustainable ecological functions [1]. Continuous increase in the world's population is expected to consequentially intensify the demand for potable water for domestic use, food production and other competing uses. Poor sanitation systems amongst other factors, has aggravated the contamination of surface and groundwater resources in most developing countries ([2], [3], [4]).

Coastal regions are surrounded by water yet often have limited access to potable water. Most of them are usually at the receiving end of indiscriminate dumping of industrial and domestic waste water. In the coastal region of Southwestern Bangladesh, nearly one fourth of the population lack access

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to potable water in spite of their proximity to water bodies. [5] Indeed [6] examined water quality of this region and found levels of arsenic, salinity and a multitude of contaminants above Bangladesh's drinking water standard and WHO guideline values. This, they connected to the occurrence of various skin and intestinal diseases such as dysentery, fever and diarrhea in the region. [7] also investigated various water sources in six costal districts of Ghana where they found that residents rely considerably on surface water, pipe borne water, rainwater, bottled and sachet water for drinking. They further established the generally poor quality of water in the region and speculated that there may be substantial elevated risk of childhood diarrhea and other water borne infectious diseases.

The inability of the Nigerian government to provide adequate portable water for her citizen has left the public, drinking water from unreliable sources. Various households and communities have therefore taken several adaptive measures to alleviate this stress [8]. In the coastal area of Ilaje-Bariga, community, Lagos Nigeria, various water consumption practices have been adopted according to varying levels of water availability. Despite being surrounded by water, the inhabitants are compelled to obtain drinking water from various sources such as boreholes, sachet water, bottled water and the local water vendors (*Mairuwa)*. Indeed the provision of drinking water that is safe and aesthetically acceptable is a priority as anything less will undermine the confidence of consumers. This, [5] noted could lead to complaints and use of water from sources that are less safe.

Sachet and bottled water are subject to regulations under National Agency for Food and Drug Administration Control (NAFDAC), yet there are more concerns about the purity of sachet water. The ever-increasing demand for readily available water has led to the general perception that bottled water is safer for consumption than sachet water [9]. The integrity of some sachet water brands have been questioned as well as the hygienic level of the environment where some of the water is produced with reports of health problems resulting from their consumption ([8], [10]). [8] investigated some brands of sachet water in Lagos, and concluded that; while some brands are contaminated others are of good quality but assumptions of its purity should be avoided. On the other hand, bottled water includes natural mineral water, water from springs and wells, but could also include purified water which is mostly treated municipal water. Despite the packaging and attractive nature of bottled drinking water, [11] investigated and realized that the consumption of some bottled water has led to the outbreak of typhoid and cholera also [12] reported that some bottled water in Lagos market did not meet the recommended standard by regulatory bodies in Nigeria, and therefore unfit for human consumption.

Unlike sachet and bottled water, *Mairuwa* and borehole water are not subject to regulation, hence its quality may not be tested before consumption. *Mairuwa* water are supplied by the local water vendors in jerry cans from various sources and used for domestic purposes. However most vendors do not take cognizance of its hygiene, but are more concerned about making quick sales. While borehole water is sourced from the ground, during the construction process, drilling fluids, chemical castings and other materials may find their way into the borehole well thereby polluting the water. If the well is disinfected and piped within a short space of time contamination may be avoided [13]. Apparently not every individual has the financial strength and awareness to take such measures. The effect of not carrying out a detailed chemical test on the groundwater may lead to health issues.

The World Health Organization prescribed that water quality tests involve about fifteen parameters, both biologically and chemically derived [5]. These constituents were noted to have direct impacts on public health and include Iron bacteria, algae, fungi, chloride, colour, hardness, manganese, iron, pH, total dissolved solids, amongst others. The global response to the problem of sustainable access to safe drinking water and basic sanitation culminated in the inclusion of specific water-related targets in the Sustainable Development Goals (SDGs) number six (6). The goal is to ensure availability and sustainable management of water and sanitation for all by 2030. In view of these, the study assessed the quality of water used for domestic purposes in the coastal region of Ilaje, Bariga, Lagos state.

The Study Area

The study was conducted in Ilaje-Bariga Community of Shomolu LGA in Lagos Metropolis (South-Western, Nigeria). Lagos State is composed of 27 Local Government Area and Shomolu is one out of the lot. Ilaje is a ward and suburb of Bariga Local Council Development Area. It is 12km from Ikeja, the capital of Lagos, bounded in the north by Seriki-Okuta, to the south by Akoka to the west by Orile Bariga and to the east by the Lagos Lagoon (Fig. 1). Ilaje-Bariga lies between latitude 4°N, 14°N and Longitude 3°E, 15°E of the equator with about 22 hectares of land and a perimeter of about 3km. This community has an estimated population of 43,880 occupying an area of 16km^2 [14].

The area has a low-lying undulating flat landform, but with some very rugged areas having scarp slopes and gorges. The altitude varies from sea level to about 15m above sea level in some parts. The major water body in the area is the Lagos Lagoon in the south eastern part of the area.

Presently Ilaje is an unplanned area with an uncontrolled land use, overcrowded population, unpaved bad road, uncontrolled waste disposal, dirty environment, no sewer

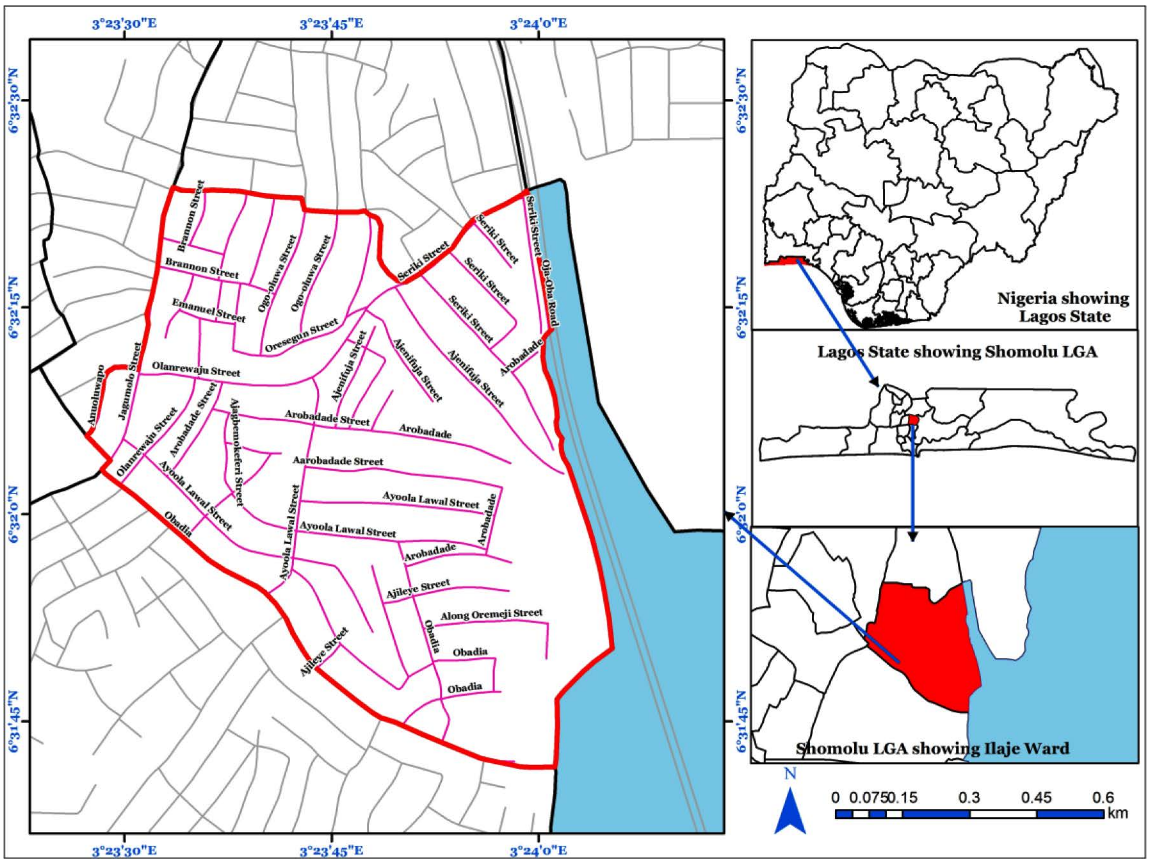

Figure 1. Ilaje coastal area, Lagos state.

or drainage system and mostly flooded during the rainy season. Some of the buildings are badly constructed with inferior building materials and lacks sufficient air space between them [15]. Generally, this area lacks potable water, sanitation and other social amenities.

MATERIALS AND METHODS

A reconnaissance survey was carried out in the study area to identify the various water sources and to identify water quality issues by interviewing residents about same. The interview was semi-structured, conducted with two (2) residents in five (5) streets close to the lagoon as it was aimed at finding out the quality issues they had encountered with available water sources. Samples of water (one each), were afterwards collected from different locations on the same day using sterilized bottles that were marked by each water source. These locations were chosen close to populated areas where residents frequently obtain water. For the water quality analysis, the focal point was mainly on pipe borne water as this is the most frequently used water in the community for domestic purposes. Residents noted the discolouration in the water few days after collection from this source unlike other water sources which appeared colourless. Water samples collected from the study area were analyzed in the laboratory to determine the physico-chemical characteristics of the water, seven parameters were analyzed. These include; appearance, colour, pH, total solids, hardness, iron, and manganese. The World Health Organization prescribed that water quality tests involve about fifteen parameters, both biologically and chemically derived [5]. The study was however was limited to the seven earlier identified because of our primary interest in addressing issues of discolouration in their water. The results of this analysis were compared with Nigeria and WHO recommended standard for drinking water in Nigeria to determine the potability of the water.

Appearance and Colour: Appearance was determined by organoleptic visual observation of the water samples for any suspended particles. The visual presence is indicated as clear or not clear respectively. Water samples were physically observed and the colour as either colourless, yellow, light yellow or rust brown.

pH: The pH of the water samples was determined potentiometrically using a potable hand held/Bench top pH meter (palintast water proof). The pH meter was first standardized/ Calibrated against buffer solutions of known pH values 4, 7 and 9.2

Total Dissolved Solids (Tds): The TDS was determined gravimetrically by taking a liquot of the water sample in a clean, dry beaker, evaporated on a plate and completely dried in an oven maintained at 105°C. TDS was the difference between the mass of the dried empty beaker and that of the beaker containing the residue with the results expressed in mg/l.

Total Hardness: 100cm^3 water sample was measured into a conical flask (250 cm^3) and 2.0ml buffer solution was added and mixed. Eight drops of Erichrome black T indicator was introduced followed by titration with 0.01M EDTA solution. At the end point, solution changed from wine red to pure blue.

Calculation of Total hardness as $CaCO_3$ (mg/l)
= titre value × 20

Iron and Manganese: Sample pre-treatment 100ml of thoroughly well mixed water sample was transferred into a beaker and 5ml concentrated nitric acid was added. The beaker was placed on a hot plate and evaporated to dryness. The beaker was then cooled and another 5ml concentrated nitric acid was added. Heating was continued until a light-coloured residue was observed. Then 1ml concentrated nitric acid was added and the beaker was warmed slightly to dissolve the residue. The walls of the beaker were then washed with distilled water. The volume was adjusted to 50ml. Iron and Manganese were determined in the digested samples using atomic absorption spectrophotometer (analyst 200 Perkin Elmer).

RESULTS AND DISCUSSION

Water from all the selected source were colourless and clear at the time of analysis. The results of other tests carried out indicated varied levels of contamination even though most were within acceptable limits. Results showed that the total dissolved solids (TDS) in water from borehole and wells in the area were at high levels of 1,600 and 826mg/l respectively (fig 2).

TDS is said to comprise inorganic salts and small amounts of organic matter that are dissolved in water (WHO, 2008). They usually originate from industrial wastewater, sewage, natural sources and piping used to convey water. Issues with piping were noted at borehole site hence the high value could be attributed to this. Wells are also rarely constructed with standard materials in the area hence the tendency for material deposition in such water. As expected, TDS values in sachet water were least and within the acceptable limits by both the WHO and the Standard Organization of Nigeria (SON).

At minimal values, TDS has not been associated with any health hazard. At levels greater than 1,200mg/l, it may be objectionable to consumers with such issues such as staining and unpleasant taste which were also alluded to by residents in the area. Very high levels of TDS may however result in gastro-intestinal irritation [16].

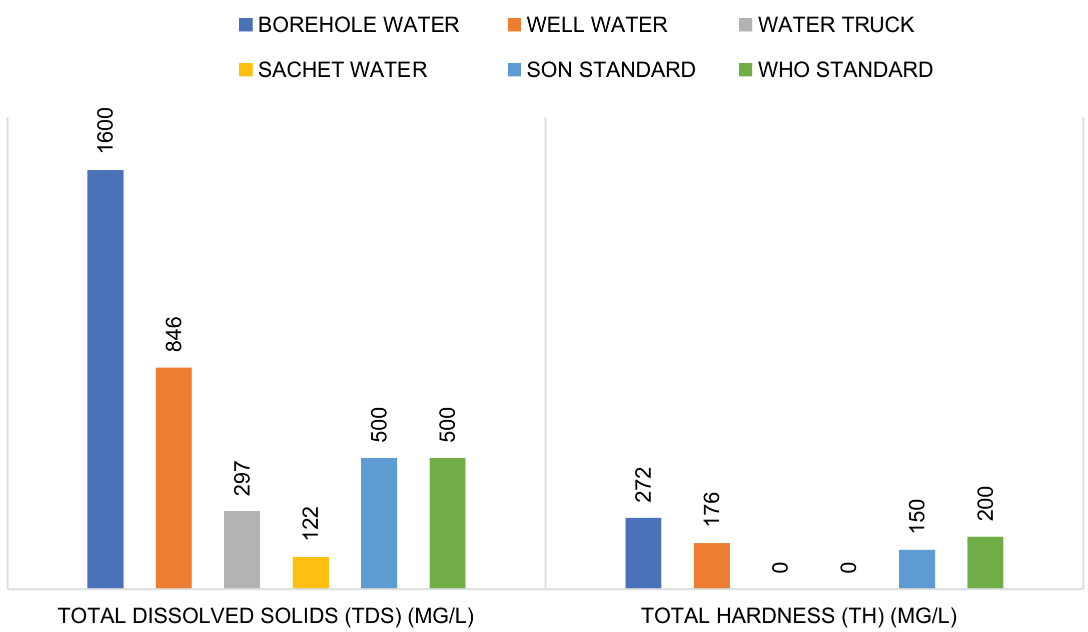

Figure 2. Results of Total Dissolved Solids and Total Hardness from selected water sources.

The acceptable limit for Total Hardness (TH) from the WHO and SON were varied, being 200 and 150mg/l respectively. Water from the borehole returned a value above both standards (272mg/l) while that of the selected well had a value slightly above the SON standard but within the WHO limit (176mg/l). Hardness in water is noted to be caused by dissolved calcium and magnesium with barely any reliable evidence of health implications. Yet hardwater has implications for domestic use as it consumes excess soap and subsequently soap curd deposition. Depending on pH and alkalinity, TH above 200mg/l can also result in scale deposition in heaters, pipework and tanks within buildings. [5]

The pH level across all water sources was less than both the WHO and SON standards with the best being from sachet water at 5.3 and the worst from borehole at 3.6 (Fig. 3). These reflect acidity beyond acceptable limits.

Similar pH values for sachet water was noted by[17]. On the other hand, pH values from the borehole is similar to that reported by [18] of the private borehole in Omoku, Rivers State, a coastal area having a pH value of 4.74 and well water having a mean pH of 6.06. Although pH has no real direct impact on consumers, it is one of the most significant operational water quality parameters. Low pH however is likely to be corrosive, leading to contamination of drinking water and adverse effect on its taste and appearance [5].

The standard values from WHO and SON were varied for Iron constituent in water put at 1 and 0.3mg/l respectively (Fig. 3). Hence while sachet and borehole water were within WHO acceptable limits, only the latter met SON standards. Water from both well and water truck had values above both standards. Iron in the study area occurs most likely through the corrosion of steel and cast-iron pipes during water distribution. Residents complained of water appearance being colourless initially but turned brownish over time when stored. There are no established health implications for iron contamination but water potability may be significantly impaired beyond 1.0mg/l.

Results of test for Manganese indicated levels within WHO standard for all sources except the well but only sachet and borehole were within SON limits (Fig. 3). High concentration of Manganese can result in adverse neurological effects following extended exposure [5] For domestic use, water contaminated by it, may have an unpleasant metallic flavor, form a brownish-black slime in toilet tanks and clog water systems.

CONCLUSION

The study set out to investigate the causes of issues identified in water from various sources by residents of Ilaje coastal area. Some of these issues include taste dissatisfaction, change on water colour over time, material deposits, and slimy texture. The study found various levels of contaminants in water from the selected sources, most of which were within either the WHO or SON acceptable limits. However significant levels of hardness, total dissolved solids, Iron and Manganese in water from some sources would explain the issues raised by residents.

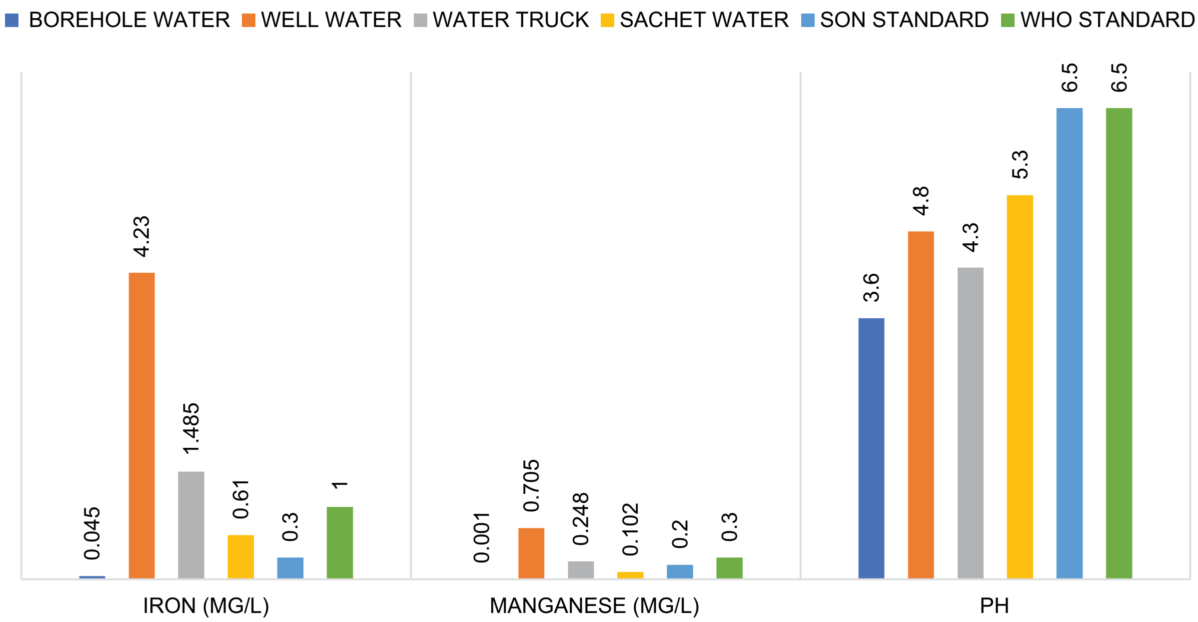

Figure 3. Results of pH, Iron and Manganese constituents from selected water sources.

In view of these, the following recommendations were made:

1. Application of Ion water softeners for hardness reduction and other element-specific softeners to regulate Iron and Manganese levels preferably at household level.
2. Regular replacement or chemical treatment of plumbing and water distribution systems to reduce the buildup of contaminants over time.
3. The use of metal water pipes should be reduced and replaced with standard plastic pipes to reduce deposition of corroded materials.
4. Adoption of more appropriate water storage practices at household level
5. Constant water system monitoring especially in such coastal area
6. Provision of mini-water treatment plants in the area.

DATA AVAILABILITY STATEMENT

The authors confirm that the data that supports the findings of this study are available within the article. Raw data that support the finding of this study are available from the corresponding author, upon reasonable request.

CONFLICT OF INTEREST

The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

ETHICS

There are no ethical issues with the publication of this manuscript.

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