

Pollution Studies on Ground Water Contamination: Water Quality of Abeokuta, Ogun State, South West Nigeria

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Abstract

Changes in water levels in wells reflect changes in recharge to, and discharge from an aquifer. Generally groundwater is rain water or water from surface water bodies, like rivers, lakes or streams that permeate into the soil and bedrock and is stored underground in the pores spaces between soil particles. Groundwater pollution occurs when hazardous substances come into contact and dissolve in the water in the soil or on the surface. Groundwater is generally less susceptible to contamination and pollution when compared to surface water, naturally impurities in rainwater or surface water which replenishes groundwater systems, get removed while infiltrating through soil strata.

In Nigeria, groundwater is used intensively for irrigation and domestic purposes, a variety of land and water-based human activities are causing pollution of this precious resource. Its over-exploitation is causing aquifer contamination in certain instances, while in certain others its unscientific development with insufficient knowledge of groundwater flow dynamic and geo-hydro-chemical processes has led to its mineralization. Adequate supply of safe and portable fresh water is an inevitable factor for socio economic development. Although the recent global attention focuses on how the current and foreseeable water crisis and associated consequences would be addressed, quite a lot of factors such as low level of education, insufficient budgetary funding, inefficient government policies, drought are increasingly contributing to the pollution of domestic water in Nigeria.

Keywords: Nigeria, Groundwater, Pollution, soil strata, Quality

1.0 Introduction

Groundwater is widely distributed under the ground and it is replenish able resource unlike other resources of the earth. Groundwater includes all water found beneath the earth's surface. It is part of the earth's natural hydrological cycle. It is the body of water derived primarily from percolation and contained in pore spaces of a permeable rock. Groundwater is an economic resource and more than 85% of the public water for consumption is obtained from groundwater. It is often used for industry, commerce, agriculture and most importantly for drinking.

Ayoade (2003) described hydrogeology as the scientific study of groundwater with emphasis on the geology and its occurrence, movement and chemical characteristics of groundwater. He reported that all groundwater can be said to originate as atmospheric or surface water and principal sources of natural recharge of groundwater are falling precipitation that eventually percolates, and seepage from the stream flow in channels, lakes and reservoirs.

The quality of water is of vital importance whether for industrial or domestic purposes. For water to be of consumable quality, it must attain a certain degree of purity. Often, the raw water used for domestic purposes is vulnerable to contamination due to the human influence resulting in pollution.

According to Davis and Royer, 1966, drinking water standard are based on two main criteria namely; the presence of objectionable taste, odour and colour; and the presence of substances with adverse physiological effects. However, mineral enrichment from underlying rocks can change the chemistry of water, making it unsuitable for consumption (Ako, 1990).

Water can also be a source of serious environmental and health problems if the design and development of such water supply system is not coupled and tied with appropriate sanitation measures. According to Oloke (1997), drinking water can act as a passive means of transporting nutrients into the body system. However, the objectives or primary concern in providing potable water are freedom from harmful micro-organisms and freedom from undesirable or harmful chemicals. Therefore, both the physiochemical and bacteriological assessment of potable water is of paramount importance and monitoring must be given the highest priority. Groundwater pollution is mainly due to the process of industrialisation and urbanisation that has progressively developed over time without any regard for environmental consequences (Longe & Balogun 2010)

Southwestern Nigeria is underlain primarily by the basement complex rocks of pre-Cambrian age comprising gneisses, migmatites and schists. When fresh, such rocks have practically no porosity or permeability due to the interlocking crystal structure. The groundwater potential in crystalline rock terrains depends, therefore, on post-emplacement processes such as tectonism and weathering which could lead to the development of secondary porosity and permeability.

Houston (1995) reported that the bedrock over much of Africa is of Precambrian formations, which are dominated by relatively impermeable crystalline rocks such as granites, schist, gneiss and quartzite. It was often necessary to drill 60 - 80 m deep, with wells often yielding less than 2 m^3/day (Dijon, 1981). Selby (1985) reported that rocks often break down quickly, producing a zone of weathered materials of saprolite or laterite and the surface soils are often underlain by red-brown silty clay, which does not function as a good aquifer.Development of the regolith components is by wells and shallow boreholes, which are liable to be drilled by lightweight percussion rigs. Viable aquifer wholly within the fractured bedrock are of occurrence because of the typically low strativity of fracture systems that is less than < 1%. In order to be effective, development of bedrock components requires interaction with storage available in overlying adjacent saturated regolith or other suitable formations such as alluvium.

A large number of people are dependent on the groundwater resource in the weathered regolith for basic water requirements and abstraction is largely through large diameter wells using a bucket tied to the end of a rope for withdrawing water. The rope-and-bucket arrangement is now being replaced in several households with centrifugal pumps resulting in larger quantities of groundwater withdrawal.

1.1 Hydrogeology of Abeokuta Ogun State

In Abeokuta, as in many areas underlain by the basement complex rocks, the populace depend largely on the surface water, which is supplied by the water corporations from the River Ogun. This source of water supply is not sufficient and therefore does not meet the demand of the populace. This surface water, which is the major source of water consumption in Abeokuta, has a very low output especially during the dry season when the evaporation rate is high (and precipitation is lower than annual average). Normally, most sachet water industries depend on the water from the state water corporations this has increased the problem of water scarcity because the demand for the water becomes greater than the supply especially during dry season. Again, people use hand dug wells, but this poses problem during dry season because the required depth would not be reached due to the terrain and the cost of drilling borehole is very high.

For these reasons, groundwater should have been an alternative source of water but there is a great problem about locating high productive aquifers in different parts of Abeokuta. Abeokuta lies within the Basement Complex rocks. These rocks are of Precambrian age to early Palaeozoic age and they extend from the north-eastern part of the Ogun state (which Abeokuta belongs) running southwest ward and dipping towards the coast (Ako, 1979). The basement complex metamorphic rocks are characterized by various folds, structures of various degree of complexity, faults, foliation and many more. These structural features have a predominant North-South or North-North-East-South-South-West orientation which is particularly strong within the low grade metamorphic. The common metamorphic rocks encountered are gneiss, schist, quartzite and amphiboles.

The individual rock has various hydro-geologic characteristics. Abeokuta belongs to the stable plate which was not subjected to intense tectonics in the past.Therefore, the underground faulting system is minimal and this has contributed to the problem of underground water occurrence in this area.

The northern side of Abeokuta like Lafenwa side is characterised by pegmatite underlain by granite and therefore has good hydro-geological history. The southern part (made up of granitic gneiss) enters into the transition zone with the sedimentary basin and is characterised by fairly satisfactory hydro-geological history. The western part is characterised by granitic gneiss which is less porous and various quartzite intrusions (Key, 1992).This area is highly problematic and it is prone to low yield groundwater supply.

The terrain of Abeokuta is characterized by two types of landforms; sparsely distributed low hills and knolls of granite, other rocks of the basement complex and nearly flat topography. The rugged rock-strewn relief is prominent towards the north, in the central and south-eastern parts of the city. The city is drained by two major rivers, Ogun and Oyan and many small streams. Some of these streams take their source from local rocky hills while some are distributaries to the two major rivers.

Two main climatic conditions exist, the rainy season lasting for between seven and eight months between April and October with an interruption in August, and the dry season; running through November till February. Annual rainfall of about 963mm and the temperature is usually between 26^0C and 28^0C. The town has become increasingly cosmopolitan as a result of its elevation in status to state capital in 1976 (Olabisi, Awonusi & Adebayo, 2007). This has continued to place increasing stress on the existing infrastructural facilities in the town.

1.2Water quality monitoring in Nigeria

The basis of water quality monitoring is to obtain information which will be useful in management of water resources in the country. It would prove useful in management, control and investigation of pollution cases, Classification of water resources, Collection of baseline data, Water quality surveillance and Forecasting water quality. In Nigeria most of the portable water used for both domestic and industrial purposes is channelled from rivers and groundwater. There is no integrated river/ground water quality monitoring scheme in Nigeria.

2.0 Result

Table 1 shows the result of the analysis of water quality parameters obtained from shallow wells within Abeokuta. The results show that they are colourless, odourless and tasteless which make the well water acceptable to the consumers. It also reveled that the temperature ranges between 30 ^{o}C and 41.3 ^{o}C.

The chemical parameters of the samples are also presented in Table 1. From the table, the conductivity values range from 657 to 812 us/cm. These values are below WHO highest desirable level of 900 us/cm, the chloride content in the water samples ranged from 61 – 79 mg/l. The result of chloride contents were below the WHO standard of 250 mg/l. The results of the chloride ranges from 120 - 171 mg/l and this are far above the maximum desirable level of 100 mg/l.

The range of values of the results of zinc (Zn), lead (Pb), iron (Fe), copper (Cu) and cadmium (Cd) are 0.63 to 0.70 mg/l, 0.05 to 0.24 mg/l, 0.02 to 0.03 mg/l, 53.10 to 94 mg/l, 7 to 74 mg/l, 0.0003 to 0.001 mg/l, and 0.001 to 0.003 mg/l respectively. The corresponding WHO standard values are 3.0 mg/l, 0.01 mg/l, 0.03 mg/l, 500 mg/l, 75 mg/l, 2 mg/l and 0.003 mg/l respectively. The results show that the lead (Pb), cadmium (Ca) and iron (Fe) contents of the samples are mostly above the required WHO standards. Moreover, the result indicate that samples from lined wells indicate lower values compared with those from unlined wells in some cases. In other cases, this was not the case. This suggests that the effects of lining of the wells could not be seriously ascertained.

The presence of lead (Pb), cadmium (Ca) and iron (Fe) in quantities more than the WHO standard was an indication of toxicity level in the groundwater and therefore poses serious health risk. The presence of total coliform bacteria indicates microbial pollution of the well water. Since it is unlikely that bacterial contamination come from the underground, it suggests that the contamination was due to human activities. In addition, the effect of lining the well was not felt in all case. Though the effect was significant in some cases, it was not in some other cases. This calls for further investigation along this line. On the long run, it can be concluded that the water from the well sources are quite unfit for consumption and using it may lead to health problems. Though, the health impact may not be suddenly felt, the gradual accumulation of the identified toxic materials problem may lead to undesirable health problems on the long run.

3.0 Conclusion

In the light of the outcomes of this work, it is recommended that there should be a monitoring and control on the location and functioning of dumpsites to avoid pollution of the groundwater. The health departments of Local Government Authorities needs to improve on their effectiveness in the monitoring and control efforts. Dumpsites should be located at remote areas far from residential locations. Besides, people need to be educated by the local health officials on the effects of dumpsites on their health and there should be a follow-up to ensure that the residents heed the advice.

Moreover, government policies on waste disposal and management should be enacted and strictly enforced. These policies should ensure that dumpsites are cited far away from residential areas and wastes are sorted and treated before disposal. The possibility of re-designing waste dumps to incorporate clay or plastic lining (to prevent percolation of leachates) can also be exploited. Alternatively, the use of these wastes as biomass for energy provision can also be considered.

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Table 1: Physical, Chemical and Microbiology Characteristics Results and WHO Standard.

S/No	Location	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Ibaja	30	8.6	Odour less	812	76	0.06	0.65	0.002	0.03	0.001	44	170	220	3.5
2	Sokori	32	8.5	Odour less	678	75	0.05	0.67	0.001	0,03	0.001	46	167	225	4.5
3	Omida 1	31	8.4	Odour less	667	78	0.07	0.68	0.001	0.03	0.001	45	176	230	4.5
4	Omida 2	31	8.6	Odour less	689	75	0.07	0.66	0.002	0.03	0.001	43	170	230	4.5
5	Obantoko	30	8.3	Odour less	789	77	0.07	0.68	0.001	0,03	0.001	44	169	225	5.0
6	Car Wash	30	8.5	Odour less	678	75	0.10	0.86	0.002	0.03	0.001	47	178	240	5.0
7	Eleta 1	35	8.6	Odour less	655	67	0.14	0.67	0.001	0.03	0.002	45	177	235	4.5
8	Eleta 2	35	8.6	Odour less	687	67	0.14	0.67	0.002	0,03	0.002	45	175	230	4.5
9	Camp 1	35	8.5	Odour less	690	68	0.11	0.65	0.001	0.03	0.003	42	178	230	5.0
10	Camp 2	31	8.6	Odour less	667	68	0.12	0.66	0.002	0.03	0.003	47	176	230	5.5
11	Sapon 1	31	8.5	Odour less	687	61	0.21	0.67	0.001	0,03	0.001	47	167	240	3.0
12	Sapon 2	30	8.4	Odour	688	61	0.21	0.67	0.002	0.03	0.002	47	168	245	3.0

				less											
13	Sapon 3	30	8.6	Odour less	680	62	0.24	0.67	0.001	0.03	0.003	46	167	245	3.5
14	Iom 1	33	8.5	Odour less	676	74	0.20	0.66	0.002	0,03	0.001	46	176	250	5.0
15	Iom 2	32	8.7	Odour less	687	75	0.22	0.66	0.001	0.03	0.001	46	175	250	5.0
16	Ake 1	32	8.6	Odour less	670	79	0.22	0.68	0.001	0.03	0.001	44	176	235	5.5
17	Ake 2	32	8.5	Odour less	676	78	0.21	0.68	0.002	0.03	0.001	43	177	235	5.5
18	Igeore 1	32	8.5	Odour less	668	70	0.24	0.68	0.001	0.02	0.002	47	178	240	6.5
19	Igeore 2	31	8.4	Odour less	676	71	0.24	0.67	0.002	0.02	0.001	46	176	240	6.5
20	Oke-Itouku	33	8.4	Odour less	657	78	0.21	0.66	0.001	0.03	0.002	48	179	230	5.0
21	Oke Ilewo 1	32	8.5	Odour less	665	75	0.21	0.67	0.002	0,03	0.001	49	175	230	7.0
22	Oke Ilewo 2	32	8.4	Odour less	687	74	0.21	0.67	0.002	0.03	0.002	49	174	230	7.5
23	Isale Ake 1	32	8.6	Odour less	689	73	0.20	0.67	0.001	0.03	0.003	47	175	245	6.5
24	Isale Ake 2	31	8.4	Odour less	675	73	0.20	0.67	0.002	0,03	0.003	48	176	245	7.0
35	Adatan 1	31	8.5	Odour less	768	73	0.18	0.63	0.001	0.03	0.001	47	170	240	8.0
26	Adatan 2	30	8.5	Odour less	776	76	0.17	0.63	0.002	0.03	0.001	46	172	245	8.0
27	Asero 1	30	8.7	Odour less	787	78	0.16	0.68	0.001	0,03	0.002	46	177	240	8.5
28	Asero 2	33	8.8	Odour less	776	78	0.17	0.70	0.002	0.03	0.001	45	175	240	8.5
29	Asero 3	33	8.6	Odour less	788	77	0.19	0.70	0.001	0.02	0.002	47	175	240	8.5
30	Agooko 1	37	8.4	Odour less	798	75	0.20	0.73	0.001	0.02	0.002	47	176	240	7.0

1=Temperature (^{0}c), 2= pH, 3= Odour, 4= Conductivity(us/cm). 5= Chloride (mg/L), 6= Lead (mg/L), 7= Zinc (mg/L), 8= Cadmium (mg/L), 9= Iron (mg/L), 10= Copper (mg/L), 11= Nitrate, 12= TDS, 13= Total coliform (MPN), 14= DO