EFFECTS OF DISTANCE FROM TREATMENT PLANTS ON QUALITY OF PIPE-BORNE WATER SUPPLY IN ILORIN

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Abstract

The study correlates distance from treatment plants with quality of piped water in Ilorin. Twenty four water samples taken with sterilized 50cl capacity bottles from running pipes at 500m equidistance points away from three treatment plants in the city were analyzed at chemistry laboratory according to the standard methods of water examination taken into consideration the W.H.O (2006) guidelines for drinking water. Results obtained indicate that quality standard of piped water in the city decreases with increasing distance from treatment plants. Values of five out of the six parameter investigated increases with increasing distance from treatment plants. The reduction in piped water quality in the city can be linked to aging infrastructure such rusted and busted pipes, unwholesome workmanship by plumbers and poor maintenance culture and negligence on the part of the authority concerned. The study thus put forward a number of recommendations towards meeting up with quality standard of piped water in the city.

Keywords: Treatment plants, Piped water, City, Water examination and Aging infrastructure.

Introduction

There are two systems of water supply and management in Nigeria. These according to Faniran (1991) can be described as traditional and modern or imported system. The traditional system which is the oldest is used by vast majorly of the people. This involves direct collection of rain water in containers and extraction from springs, streams, ponds and hand dug wells. These water sources are used depending upon people's perception of quality.

By contract, the modern system which started with the colonial administration is a public sector affair. It involves supply of water through pipe lines. This water system is undertaken and maintained by government at public expense. Though, considered as one of the best method of water supply to the people, the system is not sufficient and highly unreliable; according to Oyegun (1993), more than two third of the world's populations lack pipe water. To have a piped supply of first class water continuously is unusual for most of the world; it is not the norm. In developing countries, the emergent nations and in parts of many advanced nations, piped water supply is inadequate or wholly lacking (Mills, 1975).

Coupled with the above problem, pipe borne water supply which came as breakthrough in providing basic amenities for sustainable healthy living of the population is everywhere in Nigeria being confronted with problem of quality. This is because, most of the water pipes used in distributing water within the country are either busted or rusted due to age, poor maintenance and negligence on the part of both the residents and the authority concerned. Not only that, many water pipes can be seen laid in gutters and drainages which make it easy for already polluted water to drain into them.

The above described scenario thus accounts, amongst others, for high incidences of water related illness in Nigeria. Each year in the country, number of people visiting medical centers with complaints of diseases such as cholera, typhoid, and dysentery keep increasing, even when the water being used by these people, both for drinking and cooking activities is piped.

Lack of potable water supply constitutes a major constraint on development of many geographical regions. Population in such areas are affected not only by common effects of water related disease, but also by long period of time wasted in searching for potable water (Ubogu and Rimomson, 2008, Ijaiya, 2000; Iroye, 1993); Adeyemi, 1988; Faniran et. al, 1981. According to W.H.O. (2004), more than one billion people in low income countries such as Nigeria lack access to safe water. Though, the National Bureau of Statistics (2005) estimated that around 60 percent of household in Nigeria have access to safe water; this is far below the National Water Policy which prescribe water for all by 2020. The present pathetic water supply situation in Nigeria and the recent events in development issues which have stressed the importance of portable water supply in meeting the health and sanitation concerns of developing countries in order to achieve the Millennium Development Goals has inspired this particular work.

Study Area

Ilorin, the capital city of Kwara State, Nigeria is the study area for this investigation. The city lies between latitude $8^0 24'$ and $8^0 36'$ north of the equator and the between longitude $4^0 10'$ and $4^0 36'$ east of the Greenwich meridian (Fig. 1) Ilorin has humid tropical climate and it is characterized by wet and dry seasons Geography Dept., 1981.

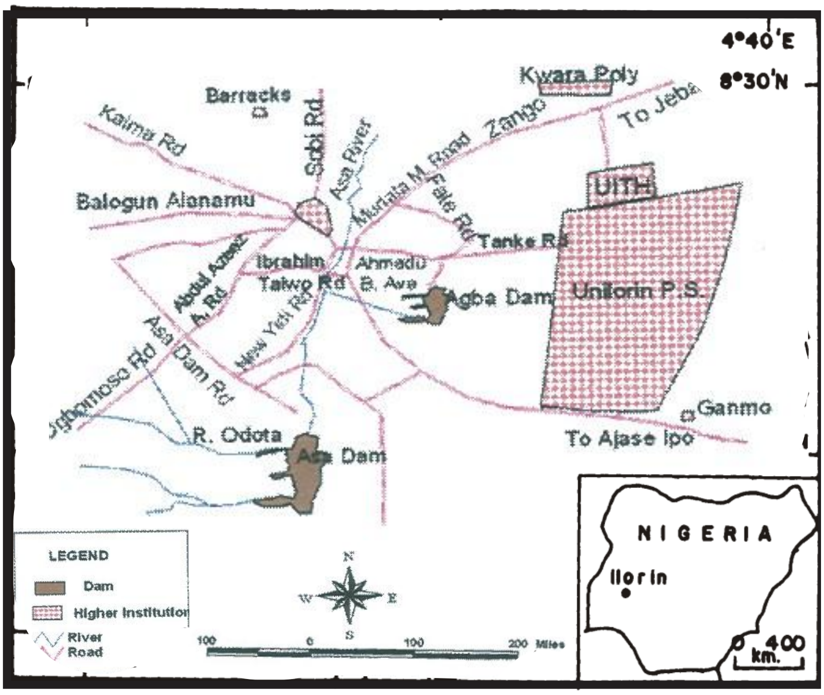

Fig. 1 Map of Ilorin, showing the study area

Wet season in Ilorin begins towards the end of March when Tropical maritime air mass is prevalent and ends in October, often abruptly. Dry season in the town begins with the onset of Tropical continental air mass which is predominant between the months of November and February. The mean annual total rainfall for Ilorin is 1200mm (Olaniran, 2002). Analysis of rainfall values for the city shows that rainfall scarcely occurs in the months of January, February, November and December (Oyegun, 1983). Rainfall concentration is usually between the months of March and October, exhibiting double maxima rainfall pattern with peak periods in the months of June and September and a period of dry spell in July. Temperature in the town is uniformly high (25^0c – 28^0c) and open-air insolation can be very uncomfortable during the dry season (Oyegun, 1983). Evaporation values in Ilorin range between 3.1mm and 7.8mm while potential evapotranspiration is usually highest in January. Ilorin is covered mainly by ferruginous tropical soil on crystalline acidic rock (Areola, 1978). The soil type has both sandy and clayey deposits lying on each other. The city is drained mainly by River Asa and its tributaries.

Modern public water supply in Ilorin began in 1952 with the completion of Agba Dam water project. The dam with an initial capacity of 658,000 gallons per day was raised to 1.2million gallons per day in 1974 shortly before the commissioning of Asa Dam built on the main river in the city in 1978. Asa- Dam with initial output capacity of 7.2 million gallon per day was recently raised to 25million gallon per day in 2009. Both Asa and Agba dams now utilize the six major reserviours in the town to service the explosive population of the city through 150km length of water pipelines.

Materials and methods

This work was based on data collected directly from field. Pipe borne water samples were systematically collected from 24 sampling points (Fig. 2) with the aid of sterilized 50cl capacity bottle. The collected samples were subsequently analysed at chemistry laboratory in University of Ilorin according to the standard methods of water examination taking into consideration, the WHO (2006) guidelines for drinking water. In all, six tests were conducted on each water sample taken. These were on nitrate and chloride concentrations, PH level, water hardness, total dissolve solids and total suspended solid. Procedures involved in carrying out these tests are presented in Table 1

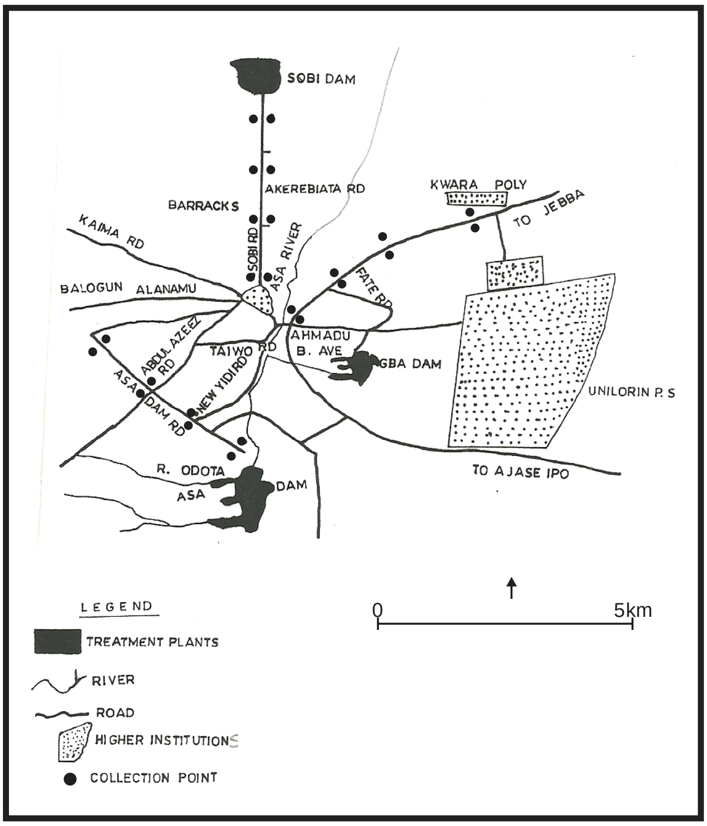

Fig. 2: Map of Ilorin showing data collection points
Source: Author's fieldwork (2010)

Table 1: Mode of determination of tested parameters

	Tested parameters	Test method	Test procedure
1	Nitrate		100 moles of the water sample was pipetted into a 250g beaker and 0.1g of Mercury (II) chloride was added and mixed thoroughly. The solution was then left for 5 minutes so that the flocculated particles can settle and then filtered. Thereafter, 2 moles of filtrate was pipette into an evaporating dish and then 1 mole of sodium silicate solution was added to evaporate to dryness. The residue was dried in an oven set at 105^0c for 30 minutes. The sample residue was removed from the oven, cooled and then 20 moles of concentrated tetraoxosulphate (IV) acid (H_2S0_4) was added quickly and mixed well by swirling. The solution was allowed to stand for 10 to 15 minutes but swirled occasionally to ensure dissolution of all soilds. When cool, 15 moles of nitrate-free distilled water was added, holding the pipette up against the dish to avoid spattering that can lead to loss of part of the residue. 15 moles of sodium hydroxide (NaOH and potassium heptaoxodichromate (VII) $K_2Cr_2O_7$ was added to the solution and then swirled. Yellow colour which developed immediately indicates nitrate level in the water.
2	Chloride	Mohr method	100 moles of water sample was measured into a clean conical flask and placed on a white surface. 1 mole of potassium chromate solution was then added to reveal a yellow solution. This solution was then titrated against silver nitrate solution with constant stirring until lightest precipitate or reddish colouration persists as the end point.
3	PH	PH meter	100 moles of water sample was put into measuring cylinder and the PH value determined using PH meter. The PH meter was first standardized using buffer solution of 4, 7, and 9. Thereafter electrode was dipped into the cylinder containing the water sample and the measured PH value recorded.
4	Water hardness	Ethylene Diamine Tetraethanoic Acid (EDTA) method	100 moles of water sample was buffered to PH_{10} (5 moles of amonical buffer) and the solution titrated against 0.01moles of ethylene diamine tetraethanoic (EDTA). Change in colour of the solution from purple to blue depicts presence of calcium and magnesium which indicates water hardness
5	Total dissolved solids	Evaporation	An empty 250g beaker was washed and dried in the oven for about 20 minutes. The beaker was then filled with 100 moles of water sample put back into the oven for 40 minutes for the water to dry. The beaker was subsequently reweighed and the difference in weight recorded as the total dissolved solids.
6	Total suspended solid	Filtration	100 moles of water sample was measured into four beakers. Filter papers to be used weighed and labeled. The filtering apparatus were connected by inserting the shaped filter paper into the funnel appropriately and filtered to a conical flask. The water samples were filtered differently through the filtering apparatus. The resulting residue were taken and the total suspended solid was then calculated

Source: Author's compilation (2010)

Observations and discussion

Table 2 below shows the variation in piped water quality with distance in Ilorin metropolis

Table 2: Variation in water quality with distance in Ilorin

Distance from treatment plant	Nitrate (mg/l)	Chloride (mg/l_)	PH	Water hardness (mg/l)	Total dissolved solids (mg/l)	Total suspended solid (mg/l)
500m	1.5633	22.2233	7.4100	0.6400	0.7900	0.1917
1km	1.5733	18.9000	7.3100	0.6800	0.7567	0.1833
1½km	1.5500	22.2000	7.3100	0.6933	0.7900	0.1767
2km	1.5600	19.9900	7.3033	0.7067	0.7900	0.1767
2 ½km	1.5700	24.4667	7.3500	0.7867	0.7967	0.1750
3km	1.5633	21.1233	7.3933	0.7333	0.7933	0.1733
3 ½ km	1.5700	23.3333	7.4133	0.8133	0.7900	0.1733
4km	1.5667	25.5667	7.4267	0.8933	0.7967	0.1833
Total	12.5300	177.8033	59.9166	5.9466	6.3034	1.4333
Mean	1.5700	22.2254	7.3645	0.7432	0.7879	0.1792
Standard deviation	0.0291	10.0243	0.1909	0.2081	0.0447	0.02165
Co-efficient of variation	0.0023	0.0564	0.0032	0.0035	0.0071	0.0150

Source: Author's fieldwork (2010)

Nitrate concentration fluctuates around 1.5mg/l with standard deviation of 0.029 and coefficient of variation of 0.002. Concentration of chloride range between 18.9mg/l observed at a kilometer distance from treatment plant to 25.6mg/l observed at 4km distance away from treatment plant. Water PH values in the city fluctuates around 7.36 while values of water hardness increase with distance from treatment plant. Values of total suspended solids however decreases with increasing distance from treatment plants. This parameter (total suspended solids) however exhibits the least variability among the studied variables followed by PH value. Chloride level exhibits the least variability.

Though, the above statistics fairly conformed with W.H.O, 2006 standard on drinking water, the increasing values of five out of the six parameter investigated with distance from treatment plants calls for concern. The deteriorating quality of pipe water supply with distance from treatment plant in the city may not be unconnected with aging infrastructure (particularly water pipe) and out-dated technology of water treatment and transfer. All around the city, pipes distributing water which are supposed to be buried feet into the ground can be seen exposed to the surface. In most cases, water pipes are either busted or rusted due to age and inefficient management by the authority concerned. It is also not uncommon to see water pipes laid along drainages and waste dump sites. These situations thus make it easy for polluted water to find its way into such pipes. Scale formations and deposit within the pipes (especially, the iron types) also affect water quality. Poor quality water increases the potential health risk of the people. According to Muller (2003), about 40% of the people of sub-saharan Africa lack access to safe water supply and almost half of the population suffer from water related diseases.

Results obtained from simple correlation and regression shows that five out of six parameters studied indicates positive relationship between distance from treatment plants and quality of pipe-borne water in Ilorin. The five parameters are nitrate concentration (r = 0.19), Chloride concentration (r = 0.38), PH (r = 0.26), water hardness (r = 0.87) and total dissolved solids (r = 0.27). Only total suspended solid exhibits inverse relationship with distance from treatment plant in the city. While the increase in values of five out of the six studied parameters with distance can be linked to nature, condition and system of piping in the city, the reduction in values of total suspended solids with distance can be linked to infiltration and settlement of sediments in pipes. However, despite the increase in values of water parameters investigated with distance, water quality parameters examined in this study in Ilorin generally conformed with the World Health Organisation Standard on drinking water. This to a large extent shows the level of purification exercise being carried out by water management board in the city.

Consumption of water with excess concentration of any of the studied parameter can be injurious to health. For example, while consumption of water with high concentration of chloride may cause hyperchlorinemia and acidiosis when in association with other water elements such as hydrogen and potassium; consumption of water with high nitrate concentration may result in digestive tract cancer and metamoglobenamia, a disease condition known as blue baby syndrome among others.

Conclusion and recommendations

The study has revealed that quality of piped water supply in Ilorin city is a function of distance from treatment plant. Adequate provision of portable water is of great importance in any human society. This is because of its role in healthy living, ecological integrity and sustainable economic growth. According to World Bank Statistics (2004), water borne disease is estimated to be responsible for about 3 million deaths annually and deterioration of the physical health of a billion people on global scale. Unfortunately, the modern water supply system through pipes which came as breakthrough in providing water is being confronted with problems nor only in the area of supply coverage, but also in its quality standard. Causes of this quality problem in this study has been traced to aging infrastructure such as rusted water pipes, unwholesome workmanship and poor maintenance culture and negligence on the part of authority concerned. Since based on these findings, the study thus put up the following recommendations towards improvement in standard of living of the people and achievement of Millennium Development Goals.

i. Regular monitoring of water quality within the town by the authority concerned,
ii. total replacement of iron pipes with rubber pipes,
iii. regular monitoring of distribution network to effect immediate repair when damage occur, and
iv. enactment and enforcement of necessary laws and regulations to dissuade people from carrying out illegal water connection.

Reference

Adeyemi, S.O. (1988), Nation's Quest for Water *Inaugural Lecture*, Dept. of Civil Engineering, University of Ilorin.

Areola, O.O. (1978), Soil and Vegetal Resources In: J.S. Oguntoyinbo, O.O. Areola and M. Filani (eds.) *A Geography of Nigeria Development.* Heinemann Educational Books (Nig.) Ltd; Ibadan

Faniran, A. Akintola, F. O. and Areola,O. (1981), The Elements of Water

Quality and Social Costs in Rural Water Supply and Utilization, *Water Supply and Management.* Vol. 4

Faniran, A. (1991), Water Resource Development in Nigeria, *University of Ibadan Lecture Series,* 95pp.

Geography Department (1981), *Ilorin Atlas* Geography Dept. University of Ilorin, University Press Ilorin, 39pp

Ijaya, G.I. (2000), Impact of Water Shortage and Depletion on the Productive Time of Women in Ilorin Metropolis: A Pilot Survey *Geo-Studies Forum*: An Int. Journal of Environmental and Policy Issues. Vol. 1 Nos 1 and 2 pp 38 – 45

Iroye, K.A. (1993), Underground Water Demand and Supply in Parts of Afon River Catchment Area of Kwara State. *Unpublished M.Sc. Dissertation* Geog. Dept. University of Ilorin 158pp

Mills, L.F. (1975), Water and Water Management: The Development Philosophy. *Engineering Hydrology Today* ICE London pp 3-9

Muller, M. (2003), South Africa: World in One Country Experience. *Insight.* Development Research www.1d21.org.

Olaniran, O.J. (2002), Rainfall Anomalies in Nigeria: The Contemporary Understanding. *55th Inaugural Lecture,* University of Ilorin, University Press Ilorin, 66pp

Oyegun, R.O. (1983), *Water Resources Development in Kwara State.* Matanmi Press, Ilorin, Nigeria 113pp.

Ubogu, A.E and Rimomson, A.M. (2009), An Overview of Access to Potable Water in Jema'a. *Proceedings of 50th Annual Conference, Association of Nigerian Geographers* pp. 218-223

World Health Organisation (2004), Water, Sanitation and Health *www.who.Int/Water*

World Health Organisation (2006), *International Standard for Drinking Water,* Geneva