Water Quality Assessment in Nigeria: Statistical Perspective

Introduction:

Water is a vital source of human existence since body of man is made up of 70% water and gets thirsty when 1% loss of the fluid even risks death when up to 10% loss of the fluid (Park,2002). Water must not only be adequate in quantity but also in quality. The basic physiological requirement for drinking water has been estimated at about 2litres per person per day. Also a supply of 140-160 litres per capita per day is considered adequate to meet most of the domestic needs (Gleick, 1996). Man needs water for drinking, cooking, bathing, sewage disposal, irrigation for agriculture, industrial uses and for recreational purposes, transportation, life stock production, hydro electric power generation, building construction, fishing and agriculture. Its deficiency causes most of the ill- health which affects humanity especially in developing countries where there are not much availability and accessibility in quantity and quality of water for human consumption and other activities which needs water for its efficiency. Death due to water related diseases sums up to more than 3 million people per year (WHO 2003a), 50,000 people per day (Herschy 1999), and mortality in children under 5 years due to water borne diseases annually estimated at 4 million yearly in developing countries (USAID, 1990, Warner, 1998).

Nigeria: Historic Overview

Nigeria, a country in West Africa is bordered in the north by the republic of Niger and Chad; to the West, the Republic of Benin; to the South, the Atlantic Ocean; to the east by the Republic of Cameroun with the population estimated at 132 million spread unevenly over a national territory of 923,770km (Anukam, 1997). The climate which affects the quantity and quality of the country's water resources ranges from equatorial in the south to tropical in the centre and arid in the north. Nigeria has abundant water resources although they are unevenly distributed over the country. The highest annual precipitation of about 30,000mm occurs in the Niger Delta and Mangrove swamp areas of the south east where rain fall for more than 8 months a year. There is progressive reduction in precipitation northwards with the most arid north eastern Sahelian region receiving as little as 500mm, a precipitation from about 3 to 4 months of rainfall.

Several agencies in charge of water resource and supply has been established by Nigerian government over the decades such as River Basin Development Authorities which were charged with the responsibility of a comprehensive water resources (surface and groundwater) development in Nigeria for multipurpose uses (Handidu, 1990), Nigeria Dam Authority which was created for hydroelectric power generation; the Water Boards Corporations/ Utilities to take care of water supply to the people particularly in the urban and semi- urban areas; Directorate of food, Roads and Rural Infrastructure (DFFRI) , Agricultural Development Projects (ADP's) with water supply components in their functions; FAO,UNICEF, UNDP, etc. All these aimed at developing the water resources potentials in order to ensure the availability, equitable distribution and conservation of water for domestic and industrial uses, food production, navigation, hydro power, recreational activities etc, but still, its impacts has yet not been felt due to non- functionality of these policies and programmes which is attributed to several factors like poor management, non- functionality of equipment. This has forced most urban and rural areas to resort to boreholes or head dug wells, streams, rivers and creeks for their water sources. These sources are under threat from pollution either from human life style manifested by the low level of hygiene practiced in the developing countries which are not devoid of contaminants in terms of chemical (both organic and inorganic), biological, physical and radiological which are not healthy for human health(Punmia 1998,Ikem 2002, Akujieze et al 2003). In this study, quality of some country's source of water is assessed based on some physical, chemical, biochemical and microbial parameters. This is to check if they meet the WHO standard on drinking and potable water and which of the parameters contributed to the deficiency in the standard. Also, to discuss the possible impact environmental abuse could have on the health status of the country.

Materials and Methods:

Three different water samples: well water, boreholes and river were assessed on some regions of the country such as: South East , South South and South West Nigeria where the water samples analysed were collected and diagnosed for bacteriological analysis. Some water sample parameters analysed according to standard methods were PH level, temperature, conductivity, total solid, total suspended solids, total dissolved solids, turbidity, nitrates, sulphate, phosphate, copper, lead, cadmium, dissolved oxygen, chemical oxygen demand, biochemical oxygen demand, fecal coliform, total fecal coliform, iron, chlorides etc of which some were not available in some regions discussed.

Mean values of heavy metals, BOD, COD, TDS and the Ph levels were compared using student's t test with the aid of Excel package at 955 confidence interval.

From the South East zone where boreholes were assessed, the concentration (mean $\pm$ SEM) of sulphate, nitrate, calcium, magnesium, potassium, sodium, reactive silica and phosphate are 1.923 $\pm$ 0.727, 0.84 $\pm$ 0.044, 1.847 $\pm$ 0.613, 0.143 $\pm$ 0.047, 0.173 $\pm$ 0.105, 0.403 $\pm$ 0.257, 2.307 $\pm$ 0.11 and 1.24 $\pm$ 0.07.respectively. Arsenic, mercury, selemium,lead, zinc, total iron, copper, manganese, cadmium, hexachromium, chloride, aluminium, ammonia and cynide has zero standard error. Ph level, conductivity, total hardness, TDS, and total alkalinity are 6.757 $\pm$ 0.726, 38 $\pm$ 3.464, 6.867 $\pm$ 1.433, 22.8 $\pm$ 2.078 and 2.62 $\pm$ 1.074respectively.There was no difference in concentration of ammonia and cadmium, zinc and iron, lead, hexachromium and cynide, manganese and aluminium

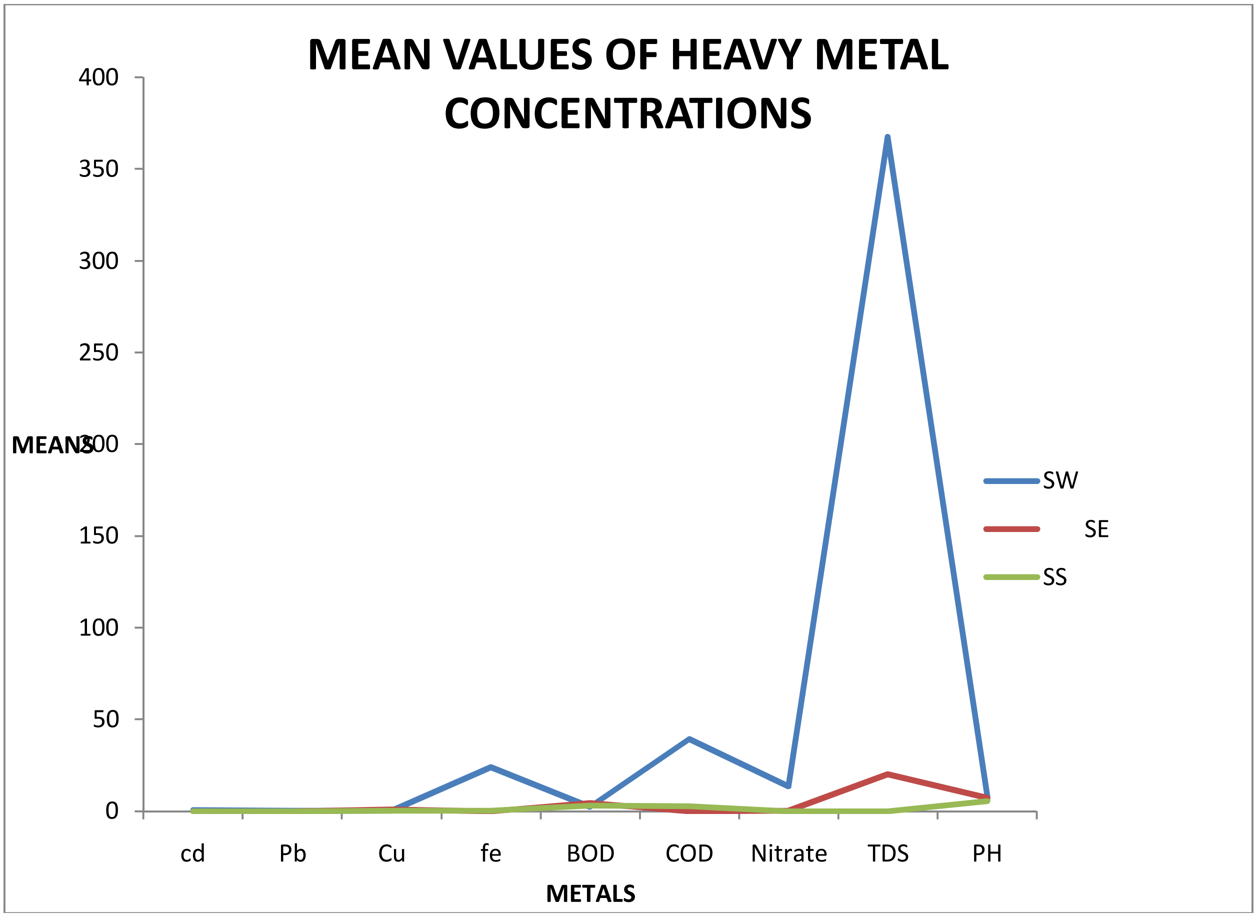
From the south west zone where the hand dug wells were assessed, the concentration (mean $\pm$SEM) of phosphate, sulphate, nitrate, copper, lead, cadmium and iron are 1.65$\pm$0.083, 15.633$\pm$0.465, 13.298$\pm$0.2, 0.093$\pm$0.018, 0.205$\pm$0.07, 0.425$\pm$.043 and 24.085$\pm$3.873 respectively. Ph level, turbidity, conductivity, temperature, TDS, TS, TSS, BOD, COD, DO and TC are 7.585$\pm$.59, 16.058$\pm$1.693, 493.75$\pm$42.143, 30.165$\pm$0.455, 367.488$\pm$31.473, 422.093$\pm$47.108, 21.58$\pm$0.605, 2.37$\pm$0.943, 39.283$\pm$16.138, 3.908$\pm$0.543 and 43.8$\pm$10.593 respectively. Some parameters like, TS, TDS, Conductivity, Nitrates, COD, BOD Iron and TC having high standard errors. These were attributed to the fact that the wells were unprotected and the wells are public utilities. Cu, Pb, faecal Coliform, total coliform, BOD, COD, electric conductivity, total dissolved solids increases with the season especially during the raining season

From the south south where a river is assessed, the concentration (mean±SEM) of iron, zinc, nickel, copper and chromium are 0.07± 0.027, 0.194± 0.043, 0.01± 0.00, 0.238±0.038, 0.01± 0.00 mg/l respectively. Cadmium, silver, asbestos, lead, manganese and vanadium are not detected. COD and BOD_5 and faecal Coliform are 2.52± 1.872, 3.05± 8.29 and 63± 6.342 respectively.
There was no difference in concentration of Nickel and Chromium between the samples.
The tables are not shown due to space.

From the table below, students **t** test was conducted to check if the results obtained is significant based on the standard water quality from the WHO. Null hypothesis was accepted for Cadmium, lead, iron, COD, nitrate, TDS and PH value since the calculated t is greater than the tabulated t. Copper and BOD has its null hypothesis rejected based on the result obtained.

Table4: Analysis of some heavy metals Concentrates

Metals	SW	SE	SS	Mean	SD	μ	N	tcal	ttab
cd	0.425	0.004	0	0.421	0.421	0.003	3	1.719708	2.353
Pb	0.205	0.012	0	0.193	0.193	0.05	3	1.283333	2.353
Cu	0.093	0.896	0.238	-0.803	-0.803	1	3	3.889026	2.353
fe	24.09	0	0.07	-0.07	24.085	0.3	3	-0.02661	2.353
BOD	2.37	4.43	3.05	-2.06	-2.06	20	3	18.54808	2.353
COD	39.28	0	2.52	-2.52	39.283	0	3	-0.11111	2.353
Nitrate	13.3	0.22	0	13.078	13.078	10	3	0.40765	2.353
TDS	367.5	20	0	347.488	347.488	750	3	-2.00632	2.353
PH	7.585	7.09	5.5	0.495	0.495	7.5	3	-24.5111	2.353



Discussions:

Surface water can pick up solid, liquid and gas either as rain water, or as it percolate through the soil layers. These added substances are classified as biological, chemical (both organic and inorganic), physical and radiological impurities. Others include industrial and commercial solvents, metals and acid salts, sediments, pesticides, herbicides, plant nutrients, radioactive materials, decaying animals and vegetable materials, living organisms such as algae, bacteria, fungi and viruses(Erah et al 2002,Nwidu et al 2008). The eventual emergency of this groundwater from aquifer as spring water, rivers, estuaries, quarries or pumping of this water as borehole water may have grave consequences on water quality since it will all pollute the water thereby making the water uncomfortable for consumption. This we know can cause health hazards in form of skin irritation, skin rash nausea, vomiting, dizziness even death if the intake is large.

From the south east, the metals considered were of the World Health Organisation permissible standard for potable water. The low conductivity level in the sample indicates absence of electrolytes. From the south west, study revealed that lead, cadmium, iron and TC exceeded the World Health Organisation standard for potable water. Nitrate, sulphates, turbidity, phosphates, solids, copper and DO were within the acceptable range. The result of the PH value is useful for drinking, domestics and agricultural purposes. Turbidity which is caused by reduction in transparency due to presence of some particles can provide adoption sites for chemicals that can be harmful to health and even cause undesirable tastes and odours. High turbidity levels are therefore associated with poor water quality. Conductivity indicates the presence of dissolved solid and contaminants. The low conductivity level in the sample indicates absence of electrolytes. Nitrate concentration above the recommended value of 10mg/l is dangerous to pregnant women and poses a serious health threat to infants less than 3to 6 months of age because of its ability to cause methaemoglobinaemia or blue baby syndrome in which blood loses its ability to carry sufficient oxygen. Malomo et al reported nitrate concentrations up to 124mg/l and nitrite up to 1.2mg/l in shallow groundwater near pollution source in South west Nigeria, these concentrations were unusually high. Traces of phosphates increase the tendency of troublesome algae to grow in the water. Threshold for dissolved oxygen is 5.0mg/l for drinking water and should be more than 5mg/l for agricultural purposes. Thus with very low DO, anaerobic conditions may result which can cause bad odours. COD and BOD are indices of organic pollution. Drinking water supply should not exceed COD of 2.5mg/l and potable water of COD content greater than 7.5mg/l is regarded as poor as high COD interferes with oxygen transfer to the soil, thus affecting plant growth. For environmental conservation, BOD is set at less than 10mg/l to prevent odour caused by the anaerobic decomposition of organic matter and water with BOD less than 4mg/l I is of good quality and levels greater than 10mg/l are polluted as reported by Environment Canada (1979). Coliform populations are indicators of pathogenic organisms. They should not be found in drinking water but are usually present in surface water, soil and feaces of humans and animals thus our water with very high coliform indicates poor quality due to poor sanitary condition in the society. High coliform counts appear to be characteristics of rural ground water quality in Nigeria (Asubiojo et al, 1997, Aremu et al, 2002). Human waste contaminants in water causes water borne diseases such as diarrhea, typhoid and hepatitis (Root et al 1982, Esry et al 1986).

From the south south, the concentration of the heavy metals in water sample was either within the permissible level of World Health Organisation or not detected which confirms some other studies conducted in the region (Nwidu et al 2008). Inorganic chemical constituents obtained in this study are in normal range permissible by World Health Organisation standard. The Biological Oxygen Demand (BOD)5 is considered fairly clean due to the peoples activities near the river which involves building latrine at the banks of the river, deposit refuse and washing clothes. These are detrimental to health thereby causing pollution and water related diseases. The chemical oxygen demand (COD) is slightly above permissible level. Large value of COD shows that the water body is in oxidative stress which can cause death of flora and fauna thereby lead to reduction in protein supply thus results to malnutrition. Thus our mean faecal coliforms are above the permissible level (WHO 1997, Adekunle et al 2007).

Conclusion:

From the result of the analysis, it was observed that in some region of the country, iron, cadmium and lead were above the permissible standard thereby producing poor water quality. The BOD, COD and faecal coliform count is beyond the legal permissible limit of drinking water and this has resulted to most of the water borne diseases prevalence in Nigeria which has great impact in the developmental and health status of the citizenry. Also the south western Nigeria has the poorest water quality due to their mode of waste disposal which must be checked if their source of water must be of international standard. Based on this result, the water sources of the country without standard treatment is unfit for drinking and domestic use.

It is recommended that proper environmental awareness and sensitization on solid waste disposal be made with governmental intervention on the modern waste disposal system. Wells if should be dug must be devoid of pollution source.

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