BOTSWANA JOURNAL OF TECHNOLOGY

Vol. 14 Number 1 April 2005

Botswana Journal of Technology is indexed and abstracted in Chemical Abstracts and AJOL (http://www.ajol.info)

Botswana Journal of Technology

WATER QUALITY MONITORING: A CASE STUDY OF WATER POLLUTION IN MINNA, AND ITS ENVIRONS IN NIGERIA

O.D Adeniyi[1], J.O Odigure[2], A.S Abdulkareem and F.T Amao
Chemical Engineering Department
Federal University of Technology
PMB 65, Minna, Niger State, Nigeria
Email: [1] lekanadeniyi2002@yahoo.co.uk, [2]josephodigure@yahoo.com

This work investigates the level of purity in Minna water and its environs. Water samples were collected from four water sources; Federal University of Technology (FUT), Minna water tank (Treated water), Maikunkele (Borehole), Chanchaga (Water treatment plant) and Tagwai dam (Raw). The following analyses of pH, Total dissolved Solids (TDS), Conductivity, Chemical oxygen demand (COD), Total hardness, Concentration of carbonate, chloride, nitrate and Bacterial count were carried out on the samples collected. From the analyses, it could be seen that there were difference in the quality of water from the various locations investigated. Apart from the micro bacterial count, the various sources conformed to the standard set by the World Health Organization (WHO). The high nitrate content of 4.6 mg/l in the Maikunkele water shows the danger of inappropriate location of borehole in the community. However, it could be said that majority of the water sources are not fit for direct human consumption due to the high microbial population.

Keywords: water quality, pollution, borehole sites

1 INTRODUCTION

There is only one landmass, one atmosphere and a finite supply of water to share. The history of water problem dates back to 19th century when an outbreak of cholera epidemics and other water borne diseases occurred in Europe as a result of gross organic pollution, of river water with raw human waste (Federal Environmental Protection Agency, FEPA) [1]. The World War II and concurrent industrial growth, which enhanced the use of burgeoning trucks and automobile, coupled with population explosion contributed greatly to the degradation of water quality due to increased waste generation [2]. Polluted water It is known to contain heavy metals – Pb, Ni, Cd, Hg [3]; natural organics phenols and formaldehyde; synthetic organic – pesticides, herbicides and detergents; inorganic – ammonia, cyanide, fluoride, nitrates, magnesium, calcium and sulphite. Heavy metals cause a lot of malfunctions in human beings ranging from lungs to heart diseases. Organic matters give rise to bad taste/odour as they favour the development of algae, fungal and bacterial, and provide malodorous compounds with chlorine. Nitrate can contribute to eutrophication. Ammonia when combined with chlorine causes chloramines – poor disinfectant microorganisms are known to alter taste and release odorous substances and on decomposition can produce distasteful smell [4].

The Federal Environmental Protection Agency (FEPA) [1], reported that traditionally the location of human settlements as well as the siting of industries were influenced by proximity and access to lakes, rivers and coast for strategic reasons such as access to jetty, port or harbour facilities, water transportation, fishing and other socio economic benefits. However, the resultant high population pressure from uncoordinated urbanization has increased the disposal of domestic and raw sewage into nearby water. Sewage from cesspools and soak away pits is a major contributor to ground water pollution in heavily populated cities like Lagos, Port -Harcourt and Kaduna. Lack or inadequacy of sanitary facilities in most rural and urban area settlements have turned many surface waters into open sewers. It is estimated that the Lagos Lagoon at Iddo receives about 50 million liters of human wastes annually, resulting in declining fish catch in the Lagoon [1].

The continuous discharge of untreated industrial effluent, laden with lethally toxic chemicals such as lead, mercury, cadmium and persistent organics such as DDT, Dieldrin and Polynuclear Aromatic Hydrocarbons (PAH's) into drains and surface water exacerbated by improper sewage disposal have rendered most of the streams and rivers in the urban centers murky, coloured, odoriferous and unwholesome for use by man.

Weather plays a critical role on the level, strains and the effect of point source pollutant dispersion. It also increases the contribution of non-point sources pollutant through land run offs from agricultural fields and larch ate from refuse dumps [5]. In the dry seasons rivers have low flow and low water volume and some streams dry up completely, or contain virtually nothing but sewage or industrial effluent. The majorities of the local people are constrained in the dry season to use such polluted water for domestic purposes, thereby endangering their lives [6]. The aims and objectives of this write up are to determine the level of impurities in treated and portable water sources in Minna and the environs, and to determine the influence of water source on its quality.

2 METHODOLOGY

Samples of raw and treated water were collected from four areas within Minna and its environs (Fig. X): FUT Minna water tank (Treated water), Tagwai dam (Raw water), Maikunkele (Borehole) and Chanchanga (Water treatment plant). All the data used were obtained from the logbook of water board agent [7]. The available data are pH. conductivity, total dissolved solids (TDS), total hardness, carbonate, chloride, nitrate, organic substances and Bacteriology.

3 RESULTS AND DISCUSSION

Results of all analyses are presented in Tables 1 – 4.

Table 1: Physico-chemical analysis of water samples from various environs in Minna.

Parameters	Standard	FUT. Minna	Maikunkele	Chanchaga	Tagwai
pH	6 – 7	6.62	6.92	6.44	6.68
Total dissolved solids (TDS) mg/l	1500	10	20	10	10
Conductivity (μS/cm)	400	150	445	100	85
Chemical oxygen demand (mg/l)	10	0.03	0.04	0.04	0.02
Carbonate (mg/l)	10	1.5×10^{-3}	4.5×10^{-3}	0.6×10^{-3}	1.3×10^{-3}
Total hardness (mg/l)	100-500	0.9	2.1	0.7	0.8
Chloride (mg/l)	25	10.5	12.25	8.75	14.88
Nitrate (mg/l)	10	0	4.6	0	0
Bacterial (Viable count / ml)	1	0	18800	5600	2400

Table 2: Presumptive Test

Water Sample	Acid and Gas			Reading	*MPN	Range 95% Probability
	LBX2X–10	LBX – 1	LB X –0.1			
Tube	1 2 3	4 5 6	7 8 9			
FUT	+ - -	- - -	- - -	1- 0 - 0	4	<0.5 – 20
Maikunkele	+ + +	+ + +	- + +	3 – 3 - 2	1, 100	150 – 4800
Chanchaga	+ + -	- - +	- - -	2 – 1 - 0	15	3 – 44
Tagwai	+ + +	- + +	+ - -	3 2 - 1	150	30 – 440

*MPN-Most Probable Number

Table 3 Confirmed Test

Water Sample	Coliforms Endo agar late	Potable	Non Potable
FUT	Pale Colonies		Non – Tentative
Maikunkele	Pale / White Colonies		Non – Tentative
Chanchaga	Pale / Pink Colonies		Non – Tentative
Tagwai	Pink colonies		Non – Tentative

Table 4: Completed Test

Water Sample	Lactose (A/G) (+) or (-)	Gram Stain	Potability	
		Reaction Morphology	Potable	Non Potable
FUT	+	Gram positive. long bacilli with few short bacilli	Yes	
Maikunkele	+	Gram negative. short bacilli purple in colour		Yes
Chanchaga	+	Gram positive long bacilli with some short bacilli		Yes
Tagwai	+	Gram negative. short bacilli		Yes

It could be noticed from table 1 that the pH of water source from Maikunkele had the highest value of 6.92. Tagwai had 6.68, FUT - 6.62 and Chanchaga - 6.64. In the bacteriological tests carried out the results are presented in Table 2-4, the positive values (+) indicate the presence of bacterial while the negative (-) values indicate that no presence of bacterial was detected. Table 2 gives the results of the presumptive test obtained. Nine different test tubes were used and were treated with different concentration of acid (between 10 to 0.1 moles) these test tubes were labeled LBX2X -10, LBX-1 and LBX-0.1 with each group having three test tubes. All the values obtained from the experimental results fell within the standard of 6.00 – 7.00. FEPA [8] reported in their work that the pH of water in Warri ranged from 6.2 – 7.8 in the dry season. pH of 7.8 was measured in location near the steel and refinery effluent discharge point. The effluent had pH values ranging from 7.4 – 8.3, which is slightly alkaline and may be due to the alkaline treatment given to the effluent before discharging into the river [7]. The total dissolved solid (TDS) was found to be 20 mg/l for Maikunkele and the remaining sample had TDS of 10 mg/l, however all the water samples values were within the required standard of 1500 mg/l.

The conductivity of the four points ranged between 85 – 445 μS/cm at 24°C. Tagwai had the lowest of 85μS/cm. Maikunkele had the values of 445 μS/cm, FUT had 150 μS/cm and Chanchaga had 100 μS/cm. The acceptable standards being 1500 μS/cm at 24°C. High value of conductivity can be attributed to increased ionizable total dissolved solid. The chemical oxygen demand (COD) of the four water samples ranged between 0.02 – 0.04 mg/l. The values obtained for all the samples were within the acceptable standard of 10 mg/l. COD can be influenced by the presence of oxidizable substance in the run off during the rains. Such substances include fertilizers and other agrochemicals washed from farmlands into water sources. Also, the Total hardness, carbonate and chloride content of the samples water were within the recommended values by WHO. The nitrate value of Maikunkele water was higher than the others. The nitrate level in Maikunkele was 4.6 mg/l, while others had zero value; these are below the 10 mg/l of WHO standard. The presence of nitrate ion in Maikunkele bore hole water could be attributed to the contamination from adjoining septic tanks, soakage pits of the surrounding residential buildings. Tagwai, Chanchaga and FUT waters were subjected to treatment and their sources are not polluted by haulers. Frederick [9] reported in their work on the distribution of nitrate in 120 water points in Jos, Nigeria that 91% of the points have nitrate less or equal to 5 mg/l and only four water points have high nitrate in excess of 100 mg/l. Excessive concentration of nitrate in drinking water has been implicated in infantile methamoglobinaemia or the blue baby syndrome and is perhaps related to an increase risk in gastric cancer [6].

From the viable count analysis shown in Table 2, it was observed that there were negligible bacteria in sample collected from FUT, while that of Maikunkele had 188 per ml and 56, 24 per ml of bacterial for Chanchaga and Tagwai water samples respectively. It could be seen from Table 2 that the MPN in FUT was approximately 4 microorganisms per 100ml of water, with 95% probability that there were between 0.5 – 20 organisms present. In Maikunkele water sample, the count was approximately 1,100 microorganisms per 100 ml of water with a 95% probability that their population was between 150 – 4800 organisms. In Chanchaga, it is approximately 15 microorganisms per 100 ml of water, with a 95% population probability of between 3 and 44 organisms. In Tagwai, the bacteria count was approximately 150 microorganisms per 100ml of water, with 95% population probability of 30 and 440 organisms present. Thus by standard, most of water sample did not conform to the standard value of 1 coliform bacteria per 100 ml of water.

The confirmed test, showed the presence of colonies, which indicate that the various water samples were polluted. The presence of long, short bacilli is an indication of E.Coli in the water. It is a measure of continuous pollution of all the water sources, as E.Coli cannot survive long when removed from its natural habitat. A number of factors could be responsible for the bacteria contamination of the water samples. These include contamination from animal discharge, septic tank effluent, and contamination from natural source[3]. Another cause of the high contamination could be attributed to the piping network of water from the treatment point to the consumer. The water comes into contact with variety of materials such as metals, cement mortal or concrete linings of pipes and reservoirs and sealing materials [10]. FEPA [1] reported that the occurrence of bacterial colony increased in water from reservoirs, which had received new bitumen, based coating. Also Hawkes [11] describe a case in which colony count increased in the water with a corresponding rise in the number of the E.Coli, due to the leather sealing rings of a pump.

4 CONCLUSION

Based on the available data, it can be concluded that there were difference in the quality of waters from the various locations investigated. Apart from the micro bacterial count, the various sources conformed to the standard set by WHO. The nitrate content of 4.6 mg/l of the Maikunkele water shows the danger of inappropriate location of borehole in the community. However, it can be said that majority of the water sources are not fit for human consumption due to the high microbial population.

5 RECOMMENDATIONS

1. Care should be taken to prevent foreign materials from polluting treated water supplied to consumers especially to avoid bacterial attack.

2. With increase use of inorganic fertilizer and ever expanding settlement coupled with bush burning, the nitrate concentration in the water will continue to increase in future [10,12,13]. This therefore, calls for a rigorous policy to protect the aquifer systems by mapping or a protection zone around water source.

3. Boreholes should be sited, taking into consideration available septic tank and waste disposal points.

REFERENCES

1. FEPA "Quality Status in Nigeria" FEPA Monograph, 1994, pp. 1 – 100

2 Michael G. R. "Pollution Prevention Pays" Pergamon Press, New York, 1979, pp. 2 – 4

3. Adeniyi O.D., Odigure J.O. and Abdulkareem A.S. "Heavy metals concentrations in the soils of Minna and its environs" Proc. 4th Annual Eng. Conf., Federal University of Technology, Minna, Nigeria, 2002, pp. 6-10.

4. Ravera O. "Biological Aspects of fresh Water Pollution" Pergamon Press, New York, 19 9, pp. 9 - 167

5. Kepner D.E "Chloro – Phenol Tastes from Creoseted Wood stave Pipe" J. American Water Works Association, Volume 20, 1928, pp. 473 - 478

6. Walter L. "Handbook of water purification" Ellis Horwood Ltd., 2nd Edition, 1987, pp. 85 - 90

7. Amao F.T. "Genealogy and Economic Consideration of water pollution" B.Eng Thesis, Federal University of Technology, Minna, Nigeria, 1998, p. 1-18

8. FEPA "Quality Status in Nigeria" EPA Monograph, 1996, p.30

9. Fredrick W.P "Water Quality and treatment" R.R Donnelley and Sons Company, 1990,pp. 158 – 160

10 Odigure J.O. and Adeniyi O.D. "Analysis of water quality in Minna Metropolis" ETIA Journal, Crosxing Publishers, Kaduna, Nigeria, Vol. 1, No. 3, 2001, pp. 33-36.

11. Hawkes H.A "Biological aspects of River pollution, River pollution II. Causes and Effects" Buttersworth, London, 1962, pp. 311 - 314

12. Odigure J.O. and Adeniyi O.D. "Mathematical modeling of weathering process to soil water ions concentration". J. Ass. for the Adv. of Modelling & Sim. in Ent. (AMSE), Lyon, France, Vol. 64, 2003a,No. 1, pp. 9-20.

13. Odigure J.O. and Adeniyi O.D. "Mathematical modeling of cations from various sites" J. Ass. for the Adv. of Modelling & Sim. in Ent. (AMSE), Lyon, France, Vol. 64, 2003b, No. 6, pp. 59.

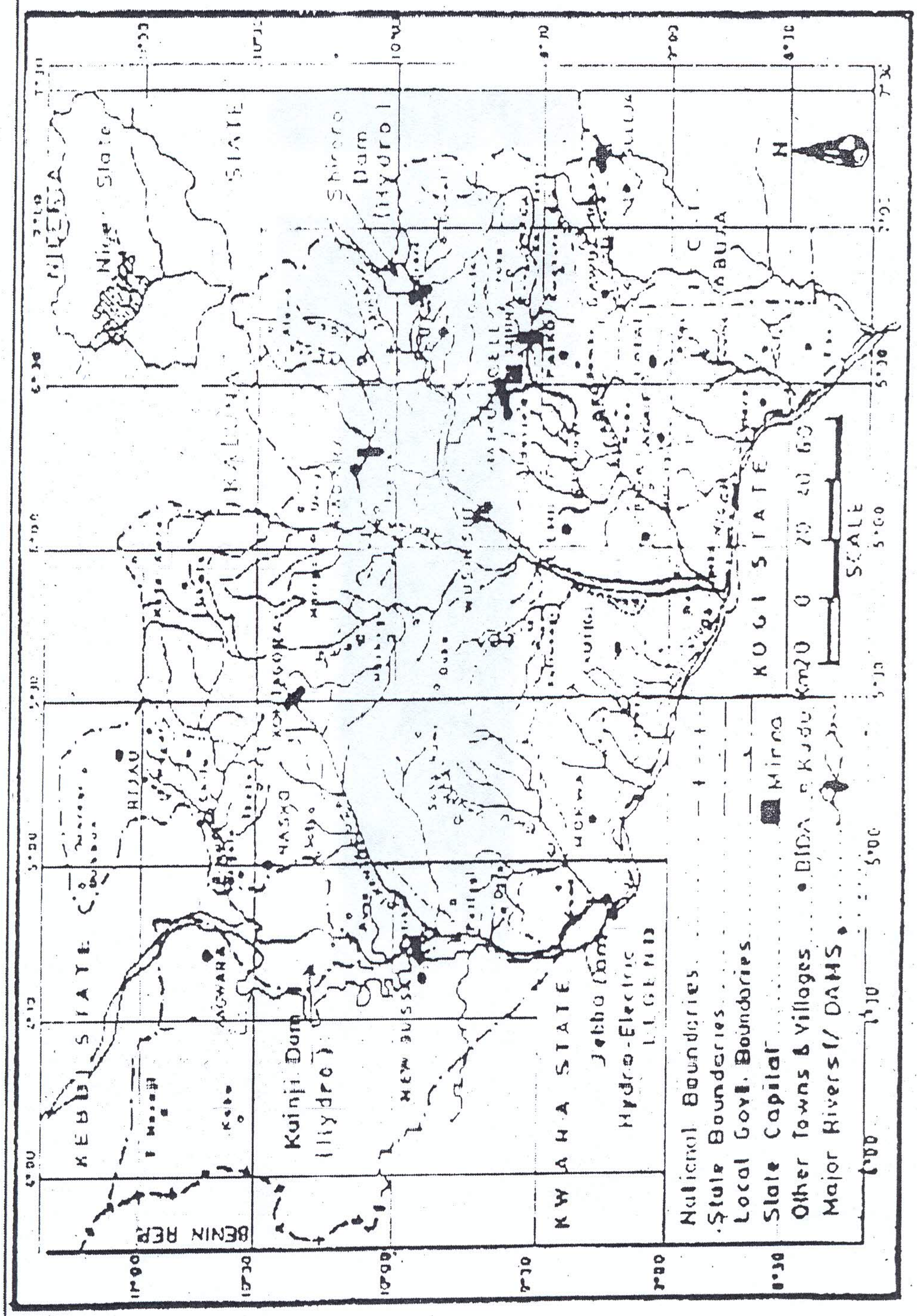

Fig. X: Map of Niger State of Nigeria