Arid Zone Journal of Engineering, Technology and Environment. October, 2004; Vol.4, 45-50

Print ISSN: 1596-2490, Electronic ISSN: 2545-5818
www.azojete.com.ng

GROUNDWATER CONTAMINATION IN DAMATURU, NIGERIA

Umara, B.[1], M. Yaji[1] and A. Fannami[2]

Abstract

Groundwater quality was monitored in 10 wells in the proximity of solid and liquid waste disposal systems in Damaturu, Nigeria. In this study, nitrate, pH, electrical conductivity, turbidity, total dissolved solids, hardness, colour, iron, chloride, sulphate, fluoride and coliform count were examined in the laboratory using standard procedures. Closeness to pit latrines and septic tank resulted in significant concentrations of nitrate (28, 40 and 41 mgl^{-1} in wells 2, 8 and 9 respectively) which exceed the European Community Standards. Consumption of water with high nitrates above the permissible limit of 20 mgl^{-1} can cause methyglobenemia syndrome. Co-existence with waste disposal system resulted in high pH, iron and faecal contamination with average coliform density of 29 $(100ml)^{-1}$ of sample exceeding the maximum permissible limit. Total coliform indicate pathogens that cause cholera, typhoid, dysentery, gastro-enteritis, diarrhea and so on. Excessive iron can impart colour and stimulate bacterial growth. The pH values normally exert influence on biological activity and may result in undesirable taste. The paper tries to offer some suggestions to the identified problems.

1. Introduction

Groundwater is an economic resource and water is one of the most essential elements needed for all forms of biological activity. Human beings, animals as well as plants depend absolutely on water which is an indispensable resource (Adeniji, 1997). Groundwater may become contaminated due to improper disposal of liquid wastes, defective well construction, improper siting of wells and failure to seal abandoned wells. These provide possible openings for the downward movement of water into subsurface formations without the process of natural filtration. Contamination may also take place as a result of movement of wastewater through large openings such as animal burrows, fissures in rocks, coarse gravel formations or man-made excavations. Bacteria from liquid effluents, septic tanks, cesspools, pit latrines, etc, are likely to contaminate shallow groundwater.

The unsanitary mode of wastes disposal such as defecation in streams and dumping of refuse in pits, rivers and drainage channels, as is seen in most Nigerian settlements, could be expected to affect surface and groundwater quality (Sangodoyin, 1991). Bacterial and viral contaminations are among the most significant health hazards that must be considered in protecting groundwater. The imminent and enormous dangers inherent in improper waste disposal need not be over-emphasized.

In spite of the considerable investment of the Nigerian Government on water supply program, a large proportion of the population has no access to potable water. In 1978 for example, the proportion of houses or compound served with pipe bore water supply in Nigerian towns varied from as low as 5% in Bauchi, to as high as 73% in Port Harcourt and Jos (NEST, 1991). Presently, industries, housing estates and private individuals depend, to some extant, on water from wells.

---

[1] Department of Agricultural & Environmental Resources Engineering, University of Maiduguri. Nigeria
[2] Department of Natural Resources, Damaturu Local Government Council, Damaturu. Nigeria.

Damaturu, the Yobe State capital, lies in the semi arid-region of Nigeria and has a population of about 81, 364 (NPC, 1991). Wells in the area are generally poorly constructed and both man and animals are often seen using the same wells as their source of water. Waste systems interference with ground water was confirmed with elevated levels of chloride nitrate, coliform count and electrical conductivities (Sangodoyin 1993). Waste disposal systems such as pit latrines and septic tanks are located close to some wells in the study area and most of the wells are not covered, thus allowing contamination of the water. These problems suggest that effective control of groundwater contamination through regular and adequate quality monitoring should be carried out. The objectives of this study were therefore, to recommend ways of monitor groundwater quality and to identify possible causes of contamination.

2. Materials and methods

For the purpose of this study, 25 locations within Damaturu were selected for sample collection. Ten wells were investigated during the period (April – May 2002). The following parameters were analyzed in Soil Science Department laboratory of the University of Maiduguri: nitrate, pH , electrical conductivity, total dissolved solids, hardness, colour, iron, chloride, sulphate, fluoride and coliform count. The Analyses were carried out using spectro-photometer, pH meter, conductivity instrument with de-ionized distilled water, colorimeter, turbidimeter and serial dilution for bacteriological analysis. Data for well age, depth, lining materials, diameter and distance from pollution sources were collected.

3. Result and discussion

Table 1 shows the data obtained for well age, depth, living materials, well diameter and distance from pollution sources. Tables 2 and 3 show the physical and chemical characteristics of the samples respectively. Water in wells located close to waste disposal systems are slightly alkaline, (wells 2 and 8, these being close to contaminated water ponds and septic tank respectively). High pH values normally exert influence on biological activity and may result in undesirable taste. The information gathered from consumers show that taste and odour are affected in about 25% of the cases. Water with objectionable tastes were found from wells located close to waste disposal systems. Withdrawal of water from wells using ropes and buckets, animal rearing close to wells, washing within the well premises, improper apron and lining are factors that encourage waste percolation into the wells.

The iron content of all samples from the wells monitored does not fall within the permissible limit for health consideration. Excessive iron content may impart colour and stimulate bacterial growth.

Table 1: Characteristics of the surveyed wells in Damturu

Well Number	Age (Year)	Depth (m)	Diameter (m)	Distance to polluting source (m)	Lining	Cover type	Apron (m)	Wall-Thickness	Pollution source
1	1	4.2	0.9	-	-	Drum	0.1	0.04	-
2	1	4.5	0.9	3	-	Drum	0.1	0.14	Contaminated water ponds
3	3	5.7	1.2	32	Concrete	-	0.6	0.01	Grave yard
4	11	4.8	1.2	30	Concrete	-	0.5	0.1	Abattoir
5	2	14	1.3	-	Concrete	-	0.5	0.25	-
6	3	8	1.2	12	Concrete	-	0.9	0.23	Refuse dump
7	3	3	1.2	-	Concrete	-	0.8	0.02	-
8	3	5.9	1	1.5	-	-	-	-	Septic tank
9	17	6	1 .3	4	Cement	Wood	0.3	0.25	Pit latrine
10	2	6	1.2	23	Concrete	-	0.4	0.1 8	Soak-away

Table 2: Some physical characteristics of water samples monitored

S/No	Well location	EC Electrical conductivity	Turbidity (NTU)	Colour TCU
1.	Tsallake I	0.17	0.50	8.00
2.	Tsallake II	0.09	6	16.0
3.	Ajari AI	0.39	0.30	6.00
4.	Faawari IV	0.55	0.50	7.50
5.	Maisandari	0.08	9.20	23.00
6.	Fawari I	0.14	0.30	6.00
7.	Dikumari III	0.06	2.50	14.50
8.	Malllum-Matari	0.10	7.0	16.00
9.	Gwange V	0.61	0.30	6.00
10.	Daki-tara I	0.19	0.20	5.00

Table 3: Chemical properties of the water samples monitored

S/N	Well location	PH	Total Dissolved Solid (TDS)	Hardness Ng	Iron (Mg)	Chloride (Mg/1)	Nitrate (Mg/1)	Sulphate (Mg/1)	Fluoride (Mg/1)
1	TsaIlake I	6.9	9.72	33.96	0.18	0.43	1.40	0.131	0.038
2	Tsallake II	8.7	16.61	23.97	0.22	0.54	28.00	0.361	0.013
3	Ajari AI	7.3	20.54	45.95	0.20	0.67	1.68	0.093	0.024
4	Faawari IV	6.8	32	81.92	0.36	1.11	2.66	0.22	0.041
5	Maisandari	6.9	27.95	23.96	0.71	0.17	0.07	0.736	0.076
6	Fawari I	6.8	25.3	19.98	0.23	0.44	1.26	0.163	0.014
7	Dikumari III	6.2	28.65	39.96	0.65	0.27	1.54	0.481	0.02
8	Mallum-Matari	9.0	39.3	19.98	0.16	0.34	40.00	0.556	2.00
9	Gwange V	6.5	41.89	129.87	0.42	1.07	41.00	0.253	0.019
10	Daki-tara I	6.6	29.45	33.96	0.39	0.67	1.41	0.109	0.011

Septic tank leachates have long been suspect of nitrate and, to some extent, chloride in groundwater (Ahajjar *et al.,* 1990). Closeness to septic tanks and pit latrines resulted in significant concentrations of nitrate (28, 40 and 41 mgl^{-1} in wells 2, 8 and 9 respectively), which exceed the European Community standards. Table 4 shows international water quality standards (WHO, 1971). Consumption of water with nitrates above the permissible limit is a potential health risk as this can cause methyglobenemia syndrome. Hardness was high in wells 4 and 9 with values of about 82 and 130 mgl^{-1} respectively as shown in Table 3. Hardness indicates the presence of metallic ions such Ca^{++}, Mg^{++} and Fe^{++}. The metals are associated with HCO_3, SO_4, Cr and NO_3. There is no health hazard in it. In fact, from toxicity point of view, animals generally survive longer using hard water than soft water. However, there are economic disadvantages expressed in increased soap usage and fuel cost. Results obtained for colour were not acceptable in wells 2, 5 and 8, this may be a problem in some industries.

Co-existence of wells with waste disposal system resulted in faecal contamination with average coliform density of $28.4(100ml)^{-1}$ of samples as shown in Table 5, which is beyond the permissible limit of $1\ (100ml)^{-1}$.

Table 4: International standards for drinking water (WHO, 1971)

S/No	Substances/characteristics	Highest desirable level	Maximum Permissible Level
1.	Colour	5 units	50 units
2.	Odour	Unobjectionable	Unobjectionable
3.	Taste	Unobjectionable	Unobjectionable
4.	Turbidity	5 units	25 units
5.	Total solids	500mg/ l	1500mg/l
6.	pH	7.0-8.5	6.5-9.2
7.	Ammonic detergents	0.2-mg/ l	1.0mg/l
8.	Mineral Oil	0.0lmg/ l	0.30mg/l
9.	Total hardness (as CaCo3)	100mg/ l	500mg/l
10.	Calcium	75mg/ l	200mg/l
11.	Chloride	200mg/l	600mg/l
12.	Copper	0.05mg/l	1.5mg/l
13.	Iron	0.1mg/l	10.mg/l
14.	Magnesium	Based on 30-150 mg/l Sulphate	150mg/l
15.	Manganese	0.05mg/l	0.5mg/l
16.	Sulphate	700mg/l	400mg/l
17.	Zinc	5mg/l	15mg/l
18.	Fluoride	0.6mg/l	1.7mg/l
19.	Total alkalinity	10mg/l	2.5mg/l
20.	Carbon dioxide	10mg/l	100mg/l
21.	Acidity total		
22.	Nitrates	0.lmg/l	0.2mg/l
23.	Phosphorous	-	2mg/l
24.	Ammonia, (Nitrogen)	0.05mg/l	0.05mg/l
25.	Chromium (Hexivalent)	0.lmg/l	0.lmg/l
26.	Lead	0.00mg/l	0.00mg/l
27.	Mercury	0.00mg/l	0.05mg/l
28.	Selenium	0.0lmg/l	0.0lmg/l
29.	Cadmium		2mg/l
30.	Arsenic	0.05mg/l	0.2mg/l
31.	Cyanide	0.0lmg/l	0.05mg/l

Table 5: Bacteriological (Coliform) counts of water samples

S/No	Location	Coliform counts $(100ml)^{-1}$
1.	Tsalkake I	27
2.	Tsallake II	84
3.	Ajari AI	24
4.	Faawari IV	17
5.	Maisandari	12
6.	Fawari I	11
7.	Dikumari III	12
8.	Mallum-Matari	17
9.	Gwange V	57
10.	Dakitara I	23
Mean		**28.4**

All the wells examined were contaminated with faecal coliform. Total coliform are indicators of pathogens that cause diseases such as cholera, typhoid, dysentery gastro-enteritis and diarrhoea. It is apparent from the forgoing that some form of treatment is essential before usage.

4. Conclusion

Groundwater quality was monitored in 10 wells located near solid and liquid waste disposal systems in Damaturu, Nigeria. Closeness to pit latrines and septic tank resulted in significant concentrations of nitrates (28, 40 and 41 mg/l) in three wells which exceed European Community standards. Consumption of water with nitrates above the permissible limit is a potential health risk and can cause methyglobenemea syndrome (anaemia).

Co-existence of wells with waste disposal systems resulted in faecal contamination with average coliform density of 29 $(100ml)^{-1}$ exceeding the maximum permissible limit. The iron content of all the samples monitored does not fall within the permissible limit for health consideration.

It is recommended that when wells are constructed, proper sanitary protection should be provided against surface contamination. A well should be located at a safe distance from all possible sources of contamination. There is the need for understanding pollution as a first step for its evaluation and control. The well site should be prevented from being flooded and should be graded so as to facilitate the rapid drainage of surface water away from the well.

References

Adeniji, F. A (1997). Water Resources Management for Drought Desertification control in Yobe State. *An invited paper presented at the World Bank-State Environmental Action Plan* (SEAP) Project Workshop for Yobe State at Damaturu, 15th May.

Ahajjar B. J., G. Chester and J.M. Harkin (1990). Indicators of chemical pollution from septic systems. *Groundwater* 28, 559-568.

NEST (1991). Nigeria's Threatened Environment - A National profile. Environmental study/Action Team. NEST Publication.

NPC (1991). National Population Commission. Damaturu, Yobe State.

Sangodoyin, A. Y. (1991). Ground and surface water pollution by open refuse dump in Ibadan, Nigeria. *Discovery and innovation* 3, 37-41.

Sangodoyin, A.Y. (1993). Considerations on contamination of groundwater by waste disposal system in Nigeria. *Environmental Technology.* 14, 957-964.

WHO (1971). Guideline for drinking water quality, Vol.I Recommendations. World Health Organization, Geneva.