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A Study on Wastes in Shallow Aquifers in Kpagungu Community, Minna, Niger State (pp. 195-202.)

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Abstract: An assessment of the physio-chemical and bacteriological properties of domesticated open shallow wells was carried out in order to ascertain the effect of dump sites on water quality in Kpakungu area of Minna, Nigeria. Three different water samples were collected from three different shallow open wells, 120m to 150m apart. Laboratory analyses were carried out on the samples using the suitable reagents for each case. The results obtained from all the samples show that the chemical contaminants Mn (0.022, 0.07, 0.106), Zn (0.04, 0.07, 0.11), Cr (0.00043, 0.00043, 0.00014) were within the limits of both World Health Organization and Nigerian Industrial Standards. The bacteriological contaminant was found to be more in all the samples for total coli-form (204, 160, 75) and E-coli (4, 3, 15), indicating that the water is not suitable for drinking. These results show that there is a strong correlation between the refuse dump sites and ground water pollution. Therefore, Sanitary Regulatory Agencies and Households need to take adequate measures to guide against this crude way of waste disposal so as to forestall the outbreak of epidemics.

Keywords: bacteriological contaminant, shallow aquifers, groundwater, pollution

1 INTRODUCTION

Groundwater makes up about twenty percent (20%) of the worlds fresh water supply, which is about 0.61% of the entire worlds water, including oceans and permanent ice (MacDonnell, 1996). Ground water is naturally replenished by surface water from precipitation, streams and rivers when this recharge reaches the water table. It is estimated that the volume of ground water comprises 30.1% of all fresh water resource on earth compared to 0.3% of surface fresh water. Ground water can be a long term reservoir of the natural water cycle. It comes from rain, snow, sleet, and hail that soaks into the ground. The water moves down into the ground due to gravity, passing through different soil strata till it reaches a point of saturation. Groundwater is particularly subjected to chemical alteration, because as it moves downward from the surface it slowly dissolves some materials contained in rocks and soils. Chemicals are major source of water contaminants (Richman, 1997).

The simplest and oldest way of collecting ground water is by digging into ground, hence penetrating the water table. If the quantity of water that can be taken from the hole is not adequate, then the hole must be extended either horizontally or vertically. The method chosen depends on the local hydro-geological formation. If the hole is extended horizontally it becomes an open collecting ditch. On the other hand, vertical extension of the whole makes it a dug or drilled well, or a bore hole. This method can be used when the aquifer is of sufficient thickness and in any case when the aquifer is more than about 6m below ground level. Dug wells are usually 1m or more in diameter (Wilson, 1990). Ground water as a valuable resource is often used for industry, commerce, agriculture and most importantly for drinking. It is an important source of potable water for rural and medium sized communities in Nigeria. The raw water used for domestic purpose is vulnerable to contamination due to the influence of domestic wastes and other contaminants. Groundwater pollution is mainly due to the process of industrialization and urbanization that has progressively developed overtime, without any regard for environmental consequences.

Protection of ground water is one of the major environmental issues, though water from such sources are suitable for drinking since it is less exposed to pollutants, which may be present in surface water. Often, surface water needs very expensive chemical treatments before it could be used for drinking. However, ground water could be exploited and used without any chemical treatment. Water is polluted when it is altered in composition, directly or indirectly as a result of the activities of man. The polluted water becomes less suitable for any meaningful domestic use. The environmental unfriendly act of dumping waste culminates in the concentration of impurities and other forms of water contaminants flowing as aquifers of most shallow wells within a given locality. This scenario has altered the physio-chemical properties of most open wells, thereby making it unhygienic for direct drinking. Water must be free from organisms that are capable of causing diseases and from minerals and organic substances that could produce adverse physiological effect. Domestic/drinking water should be aesthetically acceptable. It should be free from turbidity, colour, odour and from taste. Drinking water should also have reasonable temperature. Water that meets these conditions is termed potable. This category of water can be consumed in any desired amount without concern for adverse effects to health. Domestic water is that water which can be used in private residences, apartment, establishment, houses etc for drinking, bathing, lawn, sprinkling, sanitary and other purposes (Duncan et al., 1986).

Pollution has always been caused by man and animal and natural phenomenon. In developed world, domestic sewage, industrial sewage, etc are treated as sewage works to reduce its toxicity and then discharged into rivers and streams having met the set standards, e.g., 20/30 standard; i.e., 20mg/l BOD and 30mg/l suspended solid. Water pollution may originate either from a point source or from dispersed source. A point source pollutant is one that reaches water from a single pipeline or channel or when harmful substances are emitted directly into a body of water (Terry, 1996), such as sewage discharge or out fall pipe.

In view of the potential hazards associated with water pollution, this study is aimed at assessing the physical, chemical and bacteriological properties of groundwater samples from the shallow wells in Kpakungu and comparing the results with the recommended Standards by World Health Organization (WHO) and Nigerian Industrial Standard (NIS 554) for domestic/drinking water.

2 MATERIALS AND METHOD

The study area Kpakungu selected is situated in South-West geographical zone of Minna, Niger state. It lies between longitude 6^0 31' E and latitude 9^0 35'N. Kpankungu falls within the Middle Belt of Nigeria (Southern Guinea Savanna). It has an average annual rainfall ranging between 1200mm and 1300mm. In August rainfall is at its peak. The range of temperature varies from 19.73^0C-37.32^0C and the climate has excess humidity during greater part of the year. The months of February, March and April of every year, the area is at its peak of hotness, during this period the people of that area depends on underground water supplies to sustain their life.

The dump sites are located close to the residential structures in Kpakungu, while pit latrines are inside the compounds which could be less than 2m away from the water source. Also, gutters are close to these wells. The wells studied are within this radius, these wells are very close to either the dump or latrine or gutters that the leach ate definitely impacts on the ground water overtime.

Accessing the physio-chemical, and bacteriological analysis of domesticated open shallow wells within the study site and comparing measured values to WHO, 2007 and NIS 554, 2007 standards and to determine whether or not the affected shallow well aquifers in Kpakungu satisfies the WHO, 2007 and NIS 554, 2007 water quality standards for the stated parameters.

3 RESULTS AND DISCUSSION

The results shown in the Table 1 were obtained from the physical chemical and biological analysis of water sample. Table 1, shows the parameters of the sample one (1), two (2) and three (3) tested. Most of the physical parameters were found not to be within acceptable limits (except odour) as recommended by WHO Standard. Most of the chemical parameters were found to be within the acceptable limits except for Iron (Fe) in sample 1 which is relatively too high compared to the recommended values by WHO and NIS 554.

The total coli form count (indication of faecal contamination) and E.coli are high for all the samples from the wells. The wells are 2m, 120m, 150m away from the dump site i.e. the biological characteristic was much more than the WHO and NIS. Therefore, based on these results the groundwater from such shallow well aquifers shows a significant level of contamination and therefore not safe for human consumption, because of its implication on health. However, it can only be used for domestic purposes such bathing, washing and raising of plants in the garden. The nature of the sites and well studied are shown in figures 1-3.

Table 1: Results of Physio-chemical and Bacteriological Analysis (Regional water Laboratory Minna, 2009)

Parameter	**Unit**	**Measured Values**			**WHO Guide 2007**	**NIS 554:2007 Permitted Maximum Level**
		1	**2**	**3**		
Temperature	^0C	28.8	28.7	28.6	25	Ambient
Ph	-	6.81	6.96	6.45	6.5-8.5	6.5-8.5
Conductivity	µs/cm	1039	1362	1075	10-1000	10-1000
Colour	TCU	337	371	324	15	15
TDS	Mg/L	696.13	912.54	720.25	1000	500
Turbidity	NTU	16.13	2.24	5.44	5	5
Disolved Oxygen	Mg/L	4.68	5.55	4.77	7.5	-
Suspended	Mg/L	14	0	0	-	-

solid						
Fluoride	Mg/L	0.01	0.49	0.22	1.5	1
Chloride	Mg/L	150.95	143.45	145.95	250	250
Total hardness	Mg/L	150	193	153	100	150
Cal Hardness	Mg/L	125	121	122	-	150
Mg Hardness	Mg/L	25	72	31	-	-
Ca^{2+}	Mg/L	50.1	48.49	48.89	-	-
Chromium	Mg/L	0.00043	0.00043	0.00014	0.05	0.05
Magnesium	Mg/L	6.1	17.56	7.56	-	-
Alkalinity	Mg/L	121	293	104	200	-
CO_3^-	Mg/L	0	0	0	-	-
Sodium	Mg/L	75.04	61.5	59	200	200
Potassium	Mg/L	23.45	65.66	22.78	-	-
Ammonia	Mg/L	1.8	1.3	2.6	-	-
$HCO3^-$)	Mg/L	121	293	104	-	-
Manganese	Mg/L	0.022	0.07	0.106	0.2	0.05
Iron	Mg/L	0.85	0.08	0.13	0.3	0.3
Zinc	Mg/L	0.04	0.07	0.11	3	5
Nitrate	Mg/L	7.97	5.75	11.51	50	10
Hydroxide	Mg/L	0	0	0	-	-
Total coli-form	Cfu/ML	204	160	75	0	10
E-coli	Cfu/100 ML	4	3	15	0	0

Figure 1: Refuse Dump Site Close to an Open Well

Figure 2: Affected Well Close to a Residential Toilet

Figure 3: Affected Well Close to a Household Canal

5 CONCLUSIONS

The study of this area has revealed that the concentration of waste materials from pit latrines, wastewater canals very close or within the residential households often influence groundwater pollution and subsequent contamination over a given period. Obviously, the problems associated with environmental pollution have negative tendencies on the quality of life of the people within the radius of the affected community

It is found that the water is polluted both physically and biologically. Pollution of the wells depends on the nature of the well i.e. its nearness to domestic wastes, depth of the well, fetching technique, well-cover and droppings (organic and inorganic wastes) into the well.

The following recommendations are therefore made:

a. Landfill disposal is the most common management strategy for municipal solid waste.

b. Refuse can be safely deposited in a sanitary landfill, a disposal site that is carefully selected, designed, constructed and operated to protect the environment and public health.

c. Governments at all levels should enforce the monthly environmental sanitation.

d. Strict measures should be taken against environmental ethics violation.

e. The society should be adequately enlightened about ecological apathy.

f. The sides of the well should be lined with impervious material to a depth of about three meters to prevent easy influx of waste water through the porous media into the well.

g. An area within 15 meters of the well should be kept free from pollution. In this area, there should be no any pit latrines, soak-away should be relocated and refuse dump should be minimum of 200 meters away.

h. Local government should designate area where all forms of waste are to be dumped. License should be issued and renewed for permission to dump waste in the specified area.

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