Assessment of the Impact of Anthropogenic Activities on the Drinking Water Qualities of Boreholes/Shallows Well Water in Huruma Estate -Eldoret, Kenya

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Abstract
The objective of this research was to investigate the drinking water qualities of boreholes/shallows well water used by inhabitants of Huruma –Eldoret , by comparing the chemical, physical and bacteriological qualities with WHO standards. Samples were collected in the dry season in the months of January and February, 2014 and analysed for pH, Turbidity, TDS, Conductivity, Total Hardness, Chloride, Nitrate, Phosphate, Calcium, Magnesium, Lead, Zinc, Total Iron, Copper, Manganese, Cadmium, Total Chromium, Total Coliform, Feacal Coliform and E-coli. Standard methods were adopted for field and laboratory studies. Results of the comparisons from the four sampled stations showed that the water was not acidic as the pH was within acceptable limits. The turbidity level was high in three of the sampled stations with the highest in Lutheran church (55.0 NTU). The metals were within the safe limits. The heavy metals investigated were within tolerable limits of WHO standards with the exception of lead and total iron. Lead and total iron were detected in all the sampled stations but exceeded tolerable limits in Bondeni and Lutheran church. The Total coliform exceeded the tolerable limits for drinking water. However the hardness levels were within tolerable limits. These results showed that the borehole/well water from Huruma estate is contaminated with some pollutants entering the water table. The borehole water should therefore be protected and treated before consumption. There is need for periodic monitoring of water samples from boreholes/wells sources to ascertain their qualities.
Keywords: Huruma, Borehole, Shallow well, Physicochemical, Bacteriological

1. Introduction

Drinking water supplies must obviously be fit for human consumption (of potable quality), and they should also be palatable -aesthetically attractive (Tebbutt, 1998). This also means that public water supplies should be suitable for other domestic uses such as clothes washing and others. The presence of a safe and reliable source of water is an important pre-requisite for the establishment of a stable Community since the absence of water for only a few days has fatal consequences. The quality of water is of vital importance whether for industrial or domestic purposes. For water to be of consumable quality, it must attain a certain degree of purity. Often, the raw water used for domestic purposes is vulnerable to contamination due to the human influence resulting in pollution (Adekunle, et al., 2013). Water is typically referred to as polluted when it is impaired by anthropogenic contaminants and either does not support human use or undergoes a marked shift in its ability to support its constituent biotic communities, such as fish (Nzubechukwu, et al., 2015). The supply of water of wholesome quality helps to reduce the incidence of water related diseases. Doornkamp (1982) and WHO (1984) remarked that virtually all economic, social and health sectors cannot operate without water. Water supply to communities may be public or private. Private supplies like borehole and dug wells can pose a threat to health unless they are properly protected and treated. In Huruma area the public water supply is not adequate and most people rely on dug wells.

Quality and quantitative measurement are needed from time to time to constantly monitor the quality of water from boreholes/wells (WHO, 1984; DWI, 2002). The rate of water pollution of all types has increased much more as compared to other fields of pollution due to discharge of all sorts of obnoxious matter into it (Akhtar, et al., 2005). Lawal and Singh (1981) reported a high degree of environmental pollution that was caused through discharge of effluents into streams, sewage and on the land. Most wells may become contaminated with bacteria, Protozoa, Viruses or other substances that may dissolve lead if the water supply passes through a lead tank or pipe since they are naturally acidic. Contamination of boreholes/wells may arise from pollutants entering the water table some distance from the industries or from sewage entering the borehole itself through cracked or corroded cases. To determine drinking water quality it is often necessary to measure several different properties by carrying out physical, chemical and biological analysis (Ubong and Gobo, 2001). Physical test indicate properties detectable by senses. Chemical test determine the amount of minerals and organic substances that affect water quality; while bacteriological test show the presence of bacteria, characteristic of feacal pollution. For the chemist therefore the quality of water is very important to ensure that it is potable for drinking (Agbazue, 2008). Metal contaminants pose serious threat to humans through ingestion of metal enriched aquatic Organisms (Butu, 2013). Huruma, a heavily populated community is one of the low income areas in Eldoret. It lies besides, and along Sosiani River. The community or estate is next to Rai Plywood industries, a pulp and paper industry. The indiscriminate waste effluents dumped into the water bodies and poor domestic waste management pollutes the area.

2. Study area

Eldoret town is in the Western part of Kenya, in the Great Rift Valley. It is located 263 km from Nairobi, the capital of Kenya. Eldoret is situated at a latitude of 031’0.001’ N and longitude of 3516’59.880 E. The town is 2103 m above sea level. The current population of Eldoret according to the official records of the 2009 census final results is 289,380 (Govt Kenya, 2009). The rapid growth of the town and its region has spatial and socio economic implications. Huruma area of Eldoret experiences the injection of large quantities of effluents due to improper domestic waste management that creates poor sanitary conditions. Water related diseases are the most critical health problems in the estate. The major sources of water in the town are rain water, piped water, hand dug wells and bore holes.

3. Materials and Methods

3.1 Sampling

Four sample stations were established. The criteria for the choice of the sampling stations were to assess the impact of activities taking place on the physicochemical and bacteriogical parameters of the borehole/well water. Station one is **Mwenderi**; Station two is **Kambi Teso**; Station three is **Lutheran Church**; and Station four is **Bondeni**. All water samples were collected in a container of 1 liter volume. A space of at least 2.5cm was left in the container to facilitate mixing by shaking. The containers used were according to the 18th edition of standard methods for the examination of water and wastewater (APHA, 1998). Samples were collected in non-reactive glass or plastic bottles that had been cleansed and rinsed carefully. Containers were lowered into the well by a string and allowed to fill. Sample collection spanned the dry months of January and February, 2014 and samples were transported to the laboratory in iced coolers after labeling. Metals samples were collected in 2 litre plastic bottles. Samples for microbiological examination were collected with sterile polyvinyl chloride plastic vial water bottles.

3.2 Experimental

Measurements of pH, TDS and conductivity were done within one hour of arrival of the water samples in the laboratory using the CORNING pH meter-MODEL 7 and the lovibond conductivity /TDS meter type CM-21 respectively. Hardness concentration was determined by EDTA method by titrating the sample against EDTA solution to give a colour change from pink to blue colour. For chloride concentration the test method was based upon the mohr procedure for determining chloride ion by titrating with silver Nitrate until there was colour change to orange at end point. Phosphate was determined by stannous chloride reduction method using UV spectrophotometer. Turbidimetric method was used to determine sulphate using UV spectrophotometer. Nitrate was measured by the brucine method at 410nm photometrically with spectronic 2ID photometer, and the concentration of nitrate obtained from calculation. Analysis of metals, and bacteriological parameters were based on the principles and procedures outlined in the standard methods for the examination of water and wastewater (APHA, 1998).

4. Results and Discussion

TABLE 1: Water test results

PARAMETER	STATION ONE: MENDERI	STATION TWO: KAMBI TESO	STATION THREE: LUTHERAN CHURCH	STATION FOUR: BONDENI	WHO LIMIT
pH	7.3	6.7	7.2	7.1	6.5-8.5
Turbidity	6.0	2.0	55.0	28.0	5.0
TDS	21.3	21.0	23.2	25.2	500
Conductivity	32.4	32.0	32.3	33.8	1000
Hardness	7.0	15.0	12.0	18.0	150
Chloride	4.0	7.0	6.2	6.8	250
Nitrate	0.1	3.2	1.6	2.3	10.0
Phosphate	0.2	0.3	0.32	0.4	
Calcium	1.3	1.5	1.54	3.6	70
Lead	ND	0.01	0.01	0.06	0.01
Zinc	0.05	0.05	0.06	0.06	3.0
Iron	0.08	0.10	0.40	0.51	0.3
Copper	ND	0.05	0.06	0.05	1.0
Manganese	0.19	0.10	0.010	0.20	0.50
Cadmium	0.002	0.002	ND	0.001	0.003
Chromium	ND	0.01	0.01	0.01	0.05
Total Coliform	200	15	20	30	10
Faecal coliform	15	0	0	0	0
E. coli	0	0	0	0	0

Table 1 shows the concentration of the parameter in the water samples from the four different sampled stations. pH ranged between 6.7 and 7.3; while the range of turbidity was from 2 NTU to 55 NTU. The TDS and Conductivity had a narrow range between 21.0mg/l and 25.2mg/l; and 32.0µS/cm and 33.8µS/cm respectively. Total hardness ranged between 7.0mg/l and 18.0mg/l. Chloride concentration ranged between 4.0mg/l and 7.0mg/l. Nitrate was from 0.lmg/l to 3.2mg/l. Phosphate and Sulphate ranged from 0.2mg/l to 0.4mg/l; and 0.1mg/l to 0.8mg/l respectively. Calcium ranged between 1.3mg/l and 3.6mg/l. For the heavy metals, Zinc ranged between 0.05 and 0.06; Copper between 0.0 and 0.06; Total Chromium between 0.0 and 0.01; and Cadmium between 0.0 and 0.002 mg/l in all stations. Lead ranged between 0.0mg/l and 0.06mg/l; while Total Iron range was from 0.08mg/l to 0.51mg/l. For bacteriological results, total coliform ranged between 10 and 200cfu/ml; while faecal coliform was found in one station, 10cfu/ml.

All of the pH levels at the sampled stations for the borehole water samples were found to be within normal range of WHO standard which is usually between 6.5-8.5. The turbidity of three of the sampled stations exceeded the requirements of WHO. Turbidity in water occurs as a result of suspended solids and colloidal matter. It may be due to eroded soil caused by dredging or due to the growth of micro-organisms. High turbidity makes filtration expensive. If sewage solids are present, pathogens may be encased in the particles and escape the action of chlorine during disinfection. The conductivity levels were parallel to the TDS results in that both data were lowest at Station 2, Kambi Teso and highest at Station 4, Bondeni. The total hardness values in the four sampled stations were within allowable limits and as a result the borehole/well water can leather effectively which makes it suitable for washing in the homes. The metals investigated in the study, Calcium, Magnesium, were all within allowable limits of the WHO standards. The heavy metals analyzed were within permissible range except lead and total Iron. Lead exceeded the limit at Bondeni. A likely source of lead in the drinking water from the borehole might be plumbing with lead or lead soldered pipes. Total Iron was detected in all the sampled stations but the level in Lutheran church and Bondeni exceeded the allowable limits. Water that is high in iron appears brownish (Ubong and Gobo, 2001). This may account for the brownish colour in the sampled stations. Iron in drinking water is safe to ingest, but the Iron sediments may contain trace impurities or harbor bacteria that can be harmful (EPA, 1998). The total coliform exceeded the limits in all the stations. This is an indication of bacteriological contamination.

5. Conclusion and Recommendation

This research has proven that borehole/shallow well water sources in close proximity to effluents from industries and sewage will experience some negative effects on water quality overtime. Contamination of borehole/well may arise from pollutants entering the water table some distance from the industries or from sewage entering the bore hole itself through cracked or corroded cases. The presence of bacteria was an indication of feacal pollution. The elevated level of turbidity makes filtration expensive; pathogens may be enclosed in the particles and escape the action of Chlorine during disinfection. Although the values in some cases were lower than the allowable limits, the continued discharge of the effluents may result in severe accumulation and unless the authorities implement laws governing the management of effluents and domestic waste, this may in turn affect the lives of the inhabitants. Lead and total iron were detected in all the sampled point but exceeded the limits in some stations. Total iron makes the water appear brownish and iron sediments may contain trace impurities or harbor bacteria that can be harmful. Lead affects the development in infants, toxic to the central and peripheral nervous systems. The Total coliform count exceeded the limits and this is an index of intermittent feacal contamination. It is therefore recommended that the careless disposal of effluents by industries and poor sanitary conditions should be discouraged and industries should treat their wastes before disposal.

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