International Journal of Environmental Monitoring and Analysis
2014; 2(4): 185-190
Published online July 30, 2014 (http://www.sciencepublishinggroup.com/j/ijema)
doi: 10.11648/j.ijema.20140204.11
ISSN: 2328-7659 (Print); ISSN: 2328-7667 (Online)

Effects of domestic wastes on water from shallow - wells in Moduganari, Nigeria

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To cite this article:
Gwana, Adamu Mohammed, Mshelia, Ngita Hassan, Abdullahi, Mumin Mai, Auwal, Mohammed Shu'aibu, Bagudu, Buhari Yawuri, Mala, B. Mohammed, Abdullahi, Hala Mai, Sadiq, Aji Bukar. Effects of Domestic Wastes on Water from Shallow - Wells in Moduganari, Nigeria. *International Journal of Environmental Monitoring and Analysis*. Vol. 2, No. 4, 2014, pp. 185-190.
doi: 10.11648/j.ijema.20140204.11

Abstract: This study was conducted on the effects of domestic wastes on water from shallow - wells in Moduganari, Nigeria. Randomly designed into six water stations, samples collection was done as per the method of Gwana et al, (2014) applied. Physico-chemical and bacteriological examinations of water samples were applied as described by Association of Analytical Chemists, (1990), Tandon, (1999) and Cheesbrough, (2010). The results obtained reveal the type of water quality used in this area. The organoleptic characteristics of the water examined; four stations are colourless and the taste is agreeable, and five are odourless (not offensive). Five stations, falls within the standard value of pH (pH 6.5 to 8.5). Only one station met with the standard value for water turbidity (< 1TU) and the temperatures of the six samples were within normal range. Heavy metals concentration in the samples; cadmium, chromium, and copper, values obtained falls within the standard, and four samples falls within the standard values for lead (0.01mg/l), and two met with the standard values for manganese (0.05mg/l). The bacteriological examination of the water samples; only one met with the standard coliform count (1CFU / ml), two fit for table water, i.e. absence of E. coli. Aerobicmesophilic bacterial count falls within the recommended values (300 CFU / ml) for all of the samples. Most of the sources of water used by the communities in this area are unwholesome for consumption. There are high levels of contamination by the pollutants in this area; the populace are at risk with time unless these situations been addressed by the relevant authority concern. Proper planning, management, and development of this valuable resource in order to prevent pollution, to harmonize its availability with the need for different uses become necessary. Authority concern addressed this situation.

Keywords: Moduganari, Shallow-Wells, Wastes, Water, Quality

1. Introduction

Water is a universal solvent. Historically, the availability of water supplies has determined where villages, towns, and cities are sited. Water is used for various purposes. Water is the basis of life on which all the life depend for survival, very valuable but finite natural renewable resource, contains dissolved elements in various quantities such as heavy metals, e.t.c, [1, 4, 5, 10, 13]. Water of good drinking quality is of basic importance to human physiology and man's continued existence depends on its availability [12]. The provision of potable water to the rural and urban population is necessary to prevent health hazard [15]. It has been estimated that the total volume of water that falls to the Earth's surface each year is approaching 500×10^{12} metric tonne. About one quarter (1/4) of this precipitation occurs over land, the rest over the sea (water cycle), evaporation mainly takes place from the sea (about 425×10^{12} metric tonne each year). On land, much water evaporates from rivers and lakes, but a great deal returns to the atmosphere. Some precipitation escapes evaporation by finding its way through the surface layers of rock and settled to underground chambers (*aquifers*), where it may remain for years and they are useful source of water where wells can be sunk sufficiently, deeply to reach them, [6, 11]. Water exist in many places and forms which are categorised as surface (ocean, polar, ice caps, rivers, lakes, rain water, etc), atmospheric (water vapour) and ground water (in aquifers) which makes up about 41.3% of the world water and 20% of the fresh water supply, which is about 61% of the entire worlds domestic fresh water supply. Ground water is one of worlds 'hidden' resources. Many consider ground water a potential source of drinking water that cannot be polluted because it is naturally protected from pollution by layers of soils and rocks, yet pollution of ground water has always been with us, because of the close links to human activities, [1, 16]. Water-well is an excavation or structure created (a hole or shaft usually vertically) in the ground by digging, driving, boring or drilling to have access to ground water [1, 7]. Wells are of water table wells and artesian wells. The water table wells are those that penetrate into aquifer in which the water is not confined by an overlaying impermeable layer. In overall water budget, human consumption of water for domestic activities and commercial enterprise accounts for a small percentage of annual rainfall. However, human actions have a wide ranging effect both in terms of water quality and quantity [6]. Lack of good quality drinking water and sanitation bringdeadly illnesses such as water borne diseases. W.H.O. estimated that 2.6 billion people have no access to improve sanitation facilities [14, 16]. W.H.O, (2004) stated that many water sources in developing countries are unhealthy and contains harmful physical, chemical and biological agent To maintan good health, however, not only must a water supply be safe for drinking, it must also be; available in sufficient quantity for cooking, hand washing, personal bathing, cleaning and laundering clothes, easily and safely accessible by all the community without the need to carry heavy containers of water over long distances, available all of the time or when it is needed, available at affordable cost and should also meet local standards for taste, odour, and appearance [14, 21]. Safe drinking water should conform to the following water quality characteristic; it should be free from pathogenic organisms, low in concentration of compounds that are toxic to man, livestock, and plants, and finally free from compounds that causes offensive taste and odour. Guide lines for drinking water quality which are the informational reference point for standard setting and drinking – water safety. Water Pollution is the contamination of streams, lakes, underground water, bays, or oceans by substances harmful to living things. People who ingest polluted water can become ill [4, 14]. According to [6, 16]. The major water pollutants are biological, chemical, or phys-ical materials that degrade water quality. These pollutants, each presents its own set of hazards; human activities, infectious organisms, heavy metals, hazardous wastes, sediments and soil particles, oil and chemicals e.t.c. The table water quality standard describes the quality parameters set for drinking water. Some countries specify standards to be applied in their own country, but, for those without, the W.H.O, publish guideline on the standards that should be achieved [17, 22]. Therefore, the need for proper planning, management, and development of this valuable resource in order to prevent pollution as well as to harmonise its availability with the demand for different uses become necessary. The objective of this study is to determine the effects of domestic waste on water from shallow wells in the study area.

2. Methodology

2.1. Study Area and Location

The study was conducted in Moduganari area of Maisandari ward, Maiduguri, Borno State. The State is located in the North – Eastern region of Nigeria, and is among the six geo – political zones of the Federal Republic Nigeria and Maiduguri shares local boundaries with Konduga, Jere, and Mafa Local Government areas, with majority of the local people as small scale business men, farmers, fishermen and herdsmen, Islamic and Western scholars. The major languages are Kanuri, Shuwa-Arab, Hausa and English respectively. Maiduguri has an area land-mark of 300 square kilometres (300 km^2), which lies between latitude 12^0 North to 13^0 North and longitude 13^0 East to 15^0 East respectively. It has an estimated population of 629,486 people, out of which 340,809 are males and 288,977 are females. The climatic condition in this area is of a hot dry season (27^0C to 42^0C), and an annual rainfall of 500 to 600 mm has been recorded [9].

2.2. Materials

2.2.1. Reagents Used

Copper tablets (for copper analysis), sodium cyanide solution (for manganese and lead), 0.1g of chromium powder (for chromium), 1.0ml of ammonia and sodium citrate solutions (for cadmium), 0.5ml of sodium arsenate solution and acid zirconyl (for fluorine), deionized water, distilled water, tap water, nutrient agar (culture medium), Mac conkey broth (culture medium), brilliant green broth and 70% alcohol solution (as disinfectant).

2.3. Methods

The methods used in this research study were the Physical, chemical and bacteriological technique as described by [3, 14, 19]. The methods were divided in to six (6) experimental stages: Water samples collection from six stations within the study area, measurements of the pH and the temperature, turbidity, colour and organoleptic parameters of the water samples, determination of heavy metals estimation by using AAS and bacteriological techniques of water examination.

2.3.1. Experiment Stage 1

Water samples collection

The study area was designated into six stations namely; Moduganari north (A), sought (B), east (C), west (D), north-central (E) and sought central (F) randomly, i.e. six shallow wells (stations) were selected for the purpose of water sampling as per the method applied by [8]. At 6: 00AM, 200 mls of pooled (water collected from various portions of the well and mixed together) water samples were collected in sterile plastic bottles from each station, properly screw capped and labelled with the following information; date and time of collection, name of the station, and volume of water sample collected, aseptically. The water samples were packed in a cold - chain container and transported to the Laboratory.

2.3.2. Experiment Stage 2

Measurements of the pH and temperature of the water samples.

The pH of the water samples were measured and recorded by using pH digital meter at the point of sample collection. This was done by dipping the electrodes point of the pH meter in to the water sample for thirty seconds, then rinsed with distilled water and deionised water finally. Also measurement of the temperature were performed by dipping the bulb end for one minute and the readings were recorded, then rinsed with distilled water and deionised water after each reading were taken.

2.3.3. Experiment Stage 3

Measurements of turbidity of the water samples by using a calibrated 5 – 25 TU turbidity tube (PT 513).

The two tubes were joined together by pushing the upper tube into the lower one and the black cross at the bottom of the tube was seen and noted. The tube was held over a white surface (a white tile surface), viewed through the tube, the water sample was dispensed slowly into the tube until the black cross is no longer visible, and air bubbles were avoided. The turbidity unit, that is, the graduation which corresponds to the water meniscus (level) was taken and recorded.

2.3.4. Experiment Stage 4

Assessment of colour and organoleptic (aesthetic i.e. odour and taste).

1000 mls of the collected water samples from the six stations were subjected to an assessment each, as such; 18 volunteers (persons) were chosen to assess and observations on the colour, odour and taste. The volunteers are grouped into three (3). Each group had six (6) members, each group was issued with an information form (in form of simple structured and closed - ended questionnaire) for the purpose of data collection on the colour, odour and taste of the water sampled, whether it is normal or abnormal. The filled-in forms were retrieved from the volunteers. The results collected are in triplicate folds (i.e. 3 times).

2.3.5. Experiment Stage 5

Determinations of cadmium, chromium, copper, lead and manganese in the water sampled.

The screening and evaluations of cadmium, copper, lead and manganese in the water sampled A, B, C, D, E and F were prepared and the atomic absorption spectrophotometer (AAS) was used to determine and evaluate the heavy metals in the water sampled, as in the methods described by [3].

2.3.6. Experiment Stage 6

Bacteriological examinations of water were sampled by using the plate count, presumption coliform count (multiple tubes technique) and confirmatory coliform test techniques as described by [14].

2.3.6.1. Plate Count

0.1 ml of the water sample was inoculated on to a nutrient agar plate. The inoculated plate was incubated at 37OC for 24 hours. It was done on duplicate plates. After 24 hours, the numbers of the colonies yielded per plate were counted.

2.3.6.2. Presumption Coliform Count (Multiple Tubes Technique)

Fifteen (15) sterile tubes containing inverted Durham tubes were arranged and divided into 3 set of five. 10 mls of double strength Mac conkey broth medium was dispensed into each of the tube. The first five set were inoculated with 10 mls of the inoculum (water sample), then the second five set of the tubes were inoculated with 1 ml of the inoculum, while the third five set of the tubes were inoculated with 0.1 ml of the inoculum. The tubes were mixed thoroughly and incubated at $37^{O}C$ for twenty four hours (24 hours) and up to forty eight hours (48 hours) respectively. It were then observed for any production of gas or colour change of the broth from violet to yellow in the inverted Durham tubes within the said incubated period which indicate a positive presumption test.

2.3.6.3. Confirmatory Total Coliform Test Techniques

A loopful was taken from the positive culture tubes from the presumption test and inoculated in to Brilliant green broth medium which contains Durham tubes. It was incubated at $37 \pm 0.5^{O}C$ for 24 hours. It was then observed for the presence of gas production which confirms the presence of bacteria. The presence of colonies indicated probable identity for typical Coliform. Green stained portion, confirmed Coliform and those with a greenish stain confirms the presence of *E. coli*, those without any colouration means negative.

2.4. Data Analysis

The data obtained from this research study were subjected to statistical tool of analysis by using mean and standard deviation in order to the verify the dispersions and the central tendency of the variables being obtained as described by Stroud and Booth, (2001).

3. Results

The results obtained in this study are presented in tables and shown as follows: -

Table 1 showed the physical (aesthetic) parameters values of the ground shallow well water sampled from the six stations; in terms of colourless of water, samples A and E have abnormal, while samples B, C, D and F are colourless. With regard to odour, sample D has an offensive and the rest of the samples are normal in odour. The taste of the water sampled tested, only samples from station A and E taste abnormal, while the rest are normal in taste of water.

Table 2 showed the values of the physical condition (pH, temperature and turbidity) of the water sampled in the six stations; in terms of pH measured, samples A (7.2), B (8.02), C (7.16), D (6.6), E (8.7) and F (8.0). The turbidity measured in turbidity unit (TU) of the water samples are A (5 TU), B (3 TU), C (2 TU), D (1 TU), E (5 TU) and F (2 TU). The temperature measured in degree centigrade (^{O}C) of the water samples are A (30 ^{O}C), B (32 ^{O}C), C (30 ^{O}C), D (28 ^{O}C), E (32 ^{O}C) and F (29 ^{O}C).

Table 3 showed the concentration levels of heavy metals evaluated in ground shallow well water sampled from the six stations in milligram per mile (mg/ml); Cadmium concentration in sample A, B, C, D, E and F are 0.28, 0.05, 0.06, 0.17, 0.11 and 0.03 mg / ml. Chromium concentration in samples A, B, C, D, E and F are 0.05, 0.01, 0.02, 0.04, 0.01, and 0.05 mg / ml. Copper concentration in samples A, B, C, D, E and F are 0.48, 1.39, 0.10, 0.51, 0.29, and 1.40 mg / ml. Lead concentration in samples A, B, C, D, E and F are 0.0, 0.02, 0.01, 0.01, 0.03, and 0.01 mg / ml. Manganese concentration in the water sample A, B, C, D, E and F are 0.23, 0.07, 0.03, 0.01, 0.09 and 0.18 mg / ml.

Table 4 showed the results of the bacteriological examination of the ground shallow well water sampled from the six stations are counted in colony form unit per miles of water sampled (CFU); coliform colonies yield, counted in the water samples are A (95), B (13), C (0), D (100), E (20), and F (2) CFU / mls. *Escherichia coli* colonies yield, counted in sampled are A (70), B (11), C (0), D (21), E (8), and F (0) CFU / mls. Aerobicmesophilic bacteria yield, counted in samples are A (286), B (230), C (0), D (290), E (210), and F (5) CFU / mls.

Table 1. *Shows Colour, Odour and Taste of ground shallow-well water sampled.*

Physical Parameters. (aesthetic)	Stations of water sampled from shallow – well (200mls each).						Recommended Standard (Aesthetic)
	A.	B.	C.	D.	E.	F.	
Colour.	a	n	n	n	a	n	translucent
Odour.	n	n	n	a	n	n	odourless
Taste.	a	n	n	n	a	n	tasteless and agreeable

KEYS: a = abnormal. , n = normal

Table 2. *Shows pH, Temperature and Turbidity of ground shallow-well water sampled.*

Physical Parameters.	Stations of water sampled (200mls each) and parametric values						Standard values
	A.	B.	C.	D.	E.	F.	
pH	7.2	8.02	7.16	6.6	8.7	8.0	6.5 – 8.5
Turbidity (TU).	5	3	2	10	5	2	< 1TU
Temperature (^{o}C).	30	32	30	28	32	29	< -8

Table 3. *Shows Concentration levels of Heavy metals contained in ground shallow-well water sampled.*

Heavy metals screened and evaluated in Mg / L.	Stations sampled (200mls each) and Concentration						Standard values.
	A.	B.	C.	D.	E.	F.	
Cadmium.	0.28	0.05	0.06	0.17	0.11	0.03	0.33mg/l
Chromium.	0.05	0.01	0.02	0.04	0.01	0.05	0.05mg/l
Copper.	0.48	1.39	0.10	0.51	0.29	1.40	2.0mg/l
Lead.	0.0	0.02	0.01	0.01	0.03	0.01	0.01mg/l
Manganese.	0.23	0.07	0.03	0.01	0.09	0.18	0.05

Table 4. *Shows bacteriological examination of ground shallow-well water sampled.*

Types of Bacteria Isolated (CFU / mls).	Stations sampled (200mls each) and bacterial count (CFU / mls)						Standard values
	A.	B.	C.	D.	E.	F.	
Coliform.	95	13	0	100	20	2	1 CFU / ml
Escherichia coli.	70	11	0	21	8	0	0 CFU / ml
Aerobicmesophilic Bacteria.	286	230	0	290	210	5	300 CFU / ml

3. Discussion

The research study conducted on the effects of domestic wastes on water from shallow- wells in Moduganari area of Maisandari ward, Maiduguri, reveals the results on the type of water quality used by the communities of this area. Underground water well is an excavated, vertically structured, created in the ground by digging, driving or boring to have access to ground water from the aquifers when water are recharged by rain and this may be contaminated by human activities domestically and or industrially. The finding of this study supports the works of most authors, amongst others are Frazier and Westhoff, (1988) who stated that human actions have a very wide range effects both in terms of water quality and quantity, and that of W.H.O, (2004), stated that many water sources in developing countries is unhealthy and contains harmful physical, chemicals and biological agents.

The results revealed that the organoleptic (aesthetic) characteristics of the water sampled from the six stations (A, B, C, D, E and F) are, out of these, four stations are found to have normal characteristics of water in terms of translucent and taste. Only two stations (A and E) had an abnormal colour (translucent) and taste (tasteless) of water quality for table water. With regard to odour, all of the water samples are found to be normal (not offensive odour or odourless), except water sampled from station (D) which was found unhealthy for consumption.

In another observations made, the results revealed that the physical parametric values, i.e. pH of the water sampled from these stations, all met with the W.H.O. recommended standard value (pH 6.5 to 8.5) and this qualified it to be healthy for table water, except station E (8.7) which exceeded with 0.2 value and made the water from this station to be unwholesome for consumption. In terms of the turbidity of the water sampled from these stations, only station, D (1TU) met with the W.H.O standard turbidity unit (TU) of water (< 1TU) which qualify it to be table but all the rest had greater values than the recommended standard which are unfit for consumption. The temperature of the water samples from all of the stations were found to be within the normal range, and the highest among these are from stations B and E with 32 ^{O}C, while the least is from station D with 28 ^{O}C which falls within the normal range and fitful for consumption.

From the study, it revealed that the bacteriological examination of the water sampled from these stations, only station C was found to meet with the recommended standard coliform count (coliform = 1CFU / ml of water) and the remaining five stations exceeded with much higher count. Thus, only station C is fit for consumption, but the rest of the station are unfit for table water. In another observation made from the results obtained, two stations (C and E) were found not polluted with faecal pollutant, (i.e. there is no presence of *E. coli*) thus provides good quality water and met with the standard (E. coli count must be at 0 CFU/ ml), but the rest are found highly contaminated and unwholesome for consumption. In addition to this, Aerobicmesophilic bacterial count revealed that the count is within the limit of the W.H.O recommended values (300 CFU / ml), hence, this make the water from these stations wholesome for consumption.

The results of the heavy metals concentration levels determined on the ground shallow wells water that are sampled from the six stations, revealed that, cadmium, chromium, and copper parametric values obtained from the analysis falls within the range values of the W.H.O recommended standard for cadmium (0.33mg/l), chromium (0.05mg/l), and copper (2.0mg/l) in table water which qualify all the water stations fit for consumption as table water. The concentration of lead in station B and E were found unwholesome for consumption as table water, this is because, it does not met with the W.H.O standard (lead = 0.01mg/l), while the rest are found to meet with the recommended standard and fit able for table water. Manganese metal concentration levels in the analysed samples from these stations only two stations (C and D) were found fit and healthy for consumption, while the rest are found not met with the W.H.O. recommended standard values for manganese (0.05), thereby making the water from these sources not fit able for consumption. Data obtained from this study are subjected to statistical analysis and found significant, and the results obtained are accepted.

4. Conclusion

The study conducted on the effects of domestic wastes on ground water quality of shallow- wells in the studied area, where six sources of water (stations) were designed for the purpose of sample collection and were analysed by using the physical, chemical and bacteriological examination of water methods applied. The work revealed that most of the sources of the water used by the communities in this area are heavily contaminated with physical, chemical and biological agents of contaminant, probably, this is as a result of human activities made the water from these stations unfit and unhealthy for consumption as table water. This is because; most of the parametric values obtained did not meet with the W.H.O recommended standard values.

Recommendations

Based on the finding of this study, the need for proper planning, management, and development of this valuable resource (quality water) in order to prevent pollution as well as to harmonies its availability with the demand for different uses become necessary. We therefore recommend that, all tiers of Government, Non-Governmental Organisation, or any authority concern should come to their aid and provide health education, by enlighten the communities of the studied area on the proper sanitation and hygienic characters, and the provision of water quality and quantity for their domestic activities and wellbeing.

Acknowledgement

We acknowledge with most honoured, duly respected, and most grateful to all persons who have helped and aided us in the course of carrying out this research study successfully.

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