Quality Assessment of Hand-Dug Wells in Numan Environs

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Abstract

The quality of water from five hand-dug wells in Numan environs was studied using monthly physical and chemical analysis on the well water samples. The results revealed that the environment and type of contaminants have direct impact on the quality of the well water. Water samples from the wells have higher levels of Heavy Metals. The levels of Zn, Fe, Cu and Pb ranges from 13 – 35mg/l, 1.4 – 2.8mg/l, 0.01 – 0.04mg/l and 0.1 – 0.04mg/l respectively, above the WHO specifications permissible limit. The pH ranges from 6.5 to 8.5 which is as recommended by WHO. The mean Temperature ranges from 29 – 30°C. The Total Dissolved Solids was in the range of 1242mg/l – 3642mg/l above the maximum acceptable limit of 500 mg/l of WHO. The Salinity level ranges from 1.3 – 3.8mg/l below the 200mg/l maximum acceptable limit of WHO. The Conductivity ranges from 2000us/cm – 6300us/cm while the Turbidity values during the study period was in the range of 0.20 NTU – 0.35 NTU which is generally lower than WHO permissible limit standard of 5.0 NTU. Wells close to pit latrine, domestic refuse dumps, drainages and stagnant water showed higher amounts of coliform bacteria from 120 – 192cfu/100ml.

1. Introduction.

Numan is located on the bank of the River Benue about 55km from Yola town, the state capital of Adamawa State. It lie between latitude 9°28'Nlongitude 12°2'E.The Local Government Area covers a land area of about 480.65sq.km with population of about 1 million people (National Population Commission Abuja 2006).

The climate is characterized by the distinct seasons (wet and dry). The wet season picks up from April to October while the dry season pick up from November with mean annual rainfall of about 950mm, the wettest month being August and September. Temperatures are generally high throughout the year except between November and February when harmattan winds tends to reduce temperature to 26.9°C. However, minimum temperature can be as low as 18°C during the harmattan.

Relative humidity also varies seasonally in the study area, with low value of about 20-30% between January and March. Increasing in peak of 80% between April to August and September, and declining again in October.

Numan is a town with characteristically rapidly growing populations with unplanned settlements that leads to the rise in refuse (waste) dumps, which invariably pose disposal

problems. This is usually a common problem with many rapidly developing towns in Nigeria.

Population growth, poor development plan, chronic unhygienic habits and poor enforcement of regulations have served collectively as factors for environmental pollution. The problem of acute water supply in Numanhas resulted in wide spread use of hand-dug wells among which are located in unhygienic areas. Previous studies in Yola [1] have shown that bacteria contaminate well water, depending on location. Thus, it is suspected that water from wells in these areas could be contaminated according to their proximity to sources of pollutions.

This study focused upon thedetermination of physiochemical, metals and microbial properties of well water samples from hand-dug wells in Numan environs, and the relationship between the nature of wells and pollutants found in the well water.

2. Procedures.

Well water samples collected from five wells were the major experimental materials and were chosen based on their proximity to obvious sources of pollution such as dumpsites, latrines, drainages, areas of high human activities like laundry and waste effluents. Description of some of the hand-dug wells are summarized in Table 1.

Table 1: Wells Descriptions.

Name of Sample Area	Nature and Dimension of Source
Jalingo Road (Dong Park)	Well at 3m from main road and 2m from mechanic workshop
GombeRoad (Numan)	Well at 3m from dumpsite
NasarawaDemsa	Well at 3m from irrigated farm and pool of stagnant water, 3m from Drainage
Numan town 1	Well at 3m from domestic waste effluent and 3m from high domestic activities (laundry etc)
Numan town 2	Well in a residence house at 3m from pit latrine and drainage effluent, 3m from dumpsite and high domestic activities (laundry etc)

Samples of the well water were collected using hard plastic and screw-capped bottles that have been sterilized. The collected well water samples were aseptically transferred into sterile, 2-liters plastic containers. Samples for

bacteriological analyses were kept in screw-capped bottles that have been sterilized in an autoclave for 20 minutes at 120^0C. Samples were then transferred to the laboratory where they are stored in the refrigerator for microbial analysis. Microbial analysis were conducted within the first 7 hours after sample collection.

3. ANALYSIS OF WELL WATER SAMPLES.

Immediately after sample collection, aHachSension 5 Portable Temperature meter was used for pH and Temperature measurements respectively. A HachSension 5 Portable Conductivity meter was also used to measure the Conductivities,Total Dissolved Solids and Salinity of the well water samples. The Trace and Heavy Metals in the well water samples were determined by Hach DR/2010, DR/2000 Spectrophotometer and Atomic Absorption Spectrophotometer, pyeUnicorn SP 9 (AAS) using appropriate wavelength for each metal (Fe, Zn, Pb and Cu). The Turbidity of the samples was also determined using a Turbidity meter.

The bacteriological analysis for the presence of microbial and faecal contamination was carried out. The organisms were cultured for 24 hours using nutrient agar, a general – purpose agar for the culture of non-fastidious organisms and Mac Conkey agar, which is a selective medium for the isolation and differentiation of enteric organisms. The colonies were counted using Leica Quebec dark field colony counter.

4. RESULTS AND DISCUSSIONS.

The results of the analysis of the water samples from the five hand-dug wells in Numan environs conducted from May to August 2011 are summaries in Tables 2-4.

The pH of the well water samples was in the range of 6.5 to 8.5 as recommend by WHO (1991). The non-significant variations are consistent with the very little cleaning that takes place once the water has reached saturation[2]. The mean temperature of the well water samples ranged from 29 to 31.2^0C which is about 2 to 3^0C cooler than that of the atmospheric temperature. The insulating property of the Earth dampens any extreme atmospheric condition on the well water samples [1].

Table 2: Variation of the Temperature and pH of the different Well Water samples:

Well Name	Temperature (^{o}C)				pH			
	May	June	July	August	May	June	July	August
Jalingo Road(Dong Park)	30.0	29.0	28.0	28.0	6.8	6.8	6.8	6.7
Gombe Road (Numan)	29.0	31.0	30.0	31.0	7.2	6.8	7.2	7.1
NasarawaDemsa	31.0	30.0	31.0	30.0	7.1	7.2	7.1	7.2
Numan town 1	31.2	29.2	29.2	29.5	6.7	7.1	6.7	6.8
Numan town 2	30.0	29.1	29.1	29.2	6.9	6.9	6.9	6.8

Table 3: Variation of the Total Dissolved Solids and Salinity of the Different Well Water samples:

Well Name	Total Dissolved Solids (mg/l)				Salinity (mg/l)			
	May	June	July	August	May	June	July	August
JalingoRoad(Dong Park)	2840	2842	2840	2845	2.8	2.9	2.9	2.8
Gombe Road (Numan)	1292	1290	1294	1297	1.3	1.2	1.3	1.4
NasarawaDemsa	1242	1242	1242	1245	1.3	1.2	1.3	1.4
Numan town 1	1580	1681	1681	1683	1.5	1.5	1.7	1.6
Numan town 2	3642	3642	3646	2643	3.8	3.6	3.8	3.6

The Total Dissolved Solids of the well water samples were in general above the maximum acceptable limit of WHO (500mg/l) specified for drinking water. Although the Salinity level of the well water samples was generally low (below the 200mg/l maximum acceptable limit of WHO, well at Numan town 2 had the highest value which is due to the nature of its environment of high human activities and dumpsite. Leachates such as Chlorine from pit latrines could increase the Salinity of the well water[3]. It is therefore the reason for the high Salinity level for thewell water sample with the highest Salinity (3.8mg/l) was found in the well at Numan town 2, which is very close to pit latrine.

The conductivity of the well water samples ranges from 2000us/cm to 6300us/cm and the highest value of 4870 to 63000us/cm were in wells located in Jalingo road and Numan town as shown in Table 4. The turbidity values of the well water samples during the study period was generally lower than WHO permissible limit standard of 5.0 NTU as shown in Table 4.

Table 4: Variation of the Conductivity and Turbidity of the different well water sample:

Well Name	Conductivity (us/cm)				Turbidity (NTU)			
	May	June	July	August	May	June	July	August
Jalingo Road(DongPark)	4870	4860	4870	4870	0.20	0.20	0.20	0.21
Gombe Road (Numan)	2280	2290	2290	2290	0.18	0.18	6.19	0.19
NasarawaDemsa	2210	2210	2210	2210	0.21	0.22	0.21	0.21
Numan town 1	2920	2930	2930	2930	0.33	0.35	0.36	0.35
Numan town 2	6300	6100	6200	6300	0.27	0.27	0.28	0.28

The levels of Heavy Metals in well water samples are generally higher than the maximum acceptable limits of WHO as shown in Figures 1 to 4. Fe level in all the wells was above the WHO maximum acceptable limit of 1.0mg/l. Higher level of 2.46 and 2.80mg/l is from wells at Gombe Road (Numan)and NasarawaDemsa respectively, situated near dumpsite, sewage water and irrigated farms. The amount of Zn detected in the well water samples from wells at Gombe Road (Numan),NasarawaDemsa, Numan Town 1 and Numan Town 2 were quite high. The levels were as high as 29.50 mg/l detected for Zn in well at Numan town 2 which is by far higher than the WHO maximum allowable limit of 5mg/l for Zn. These wells are located close to dumpsites, domestic wastes, drainages, pit latrines and stagnant waters where all sorts of metal waste are found. Rainfall is the probable cause of the leaching of these high levels of pollutants (metals.) The level of Cu in all the water samples was below the WHO maximum limit of 0.5mg/l. This is in agreement that copper is rarely found in natural water (UNESCO and WHO, 1984). The Pb level ranged from 0.2 mg/l to 0.4 mg/l which is higher than the maximum allowable limit of 0.05mg/l specified by WHO. The highest value of lead was found in the well at Gombe Road (Numan) which is located closer to the main road and mechanic workshop. This explains the fact that automobile emissions is one of the sources of pollution of the environment[4]. Pb is a well-known poison and its consistently high level in the well water samples would endanger the communities since the well water is a source of portable water for of the communities in the area.

The variation of the concentration of the metals zinc Zn, iron Fe, copper Cu and lead Pb in the different wells under study are shown in Figures 1 to 4.

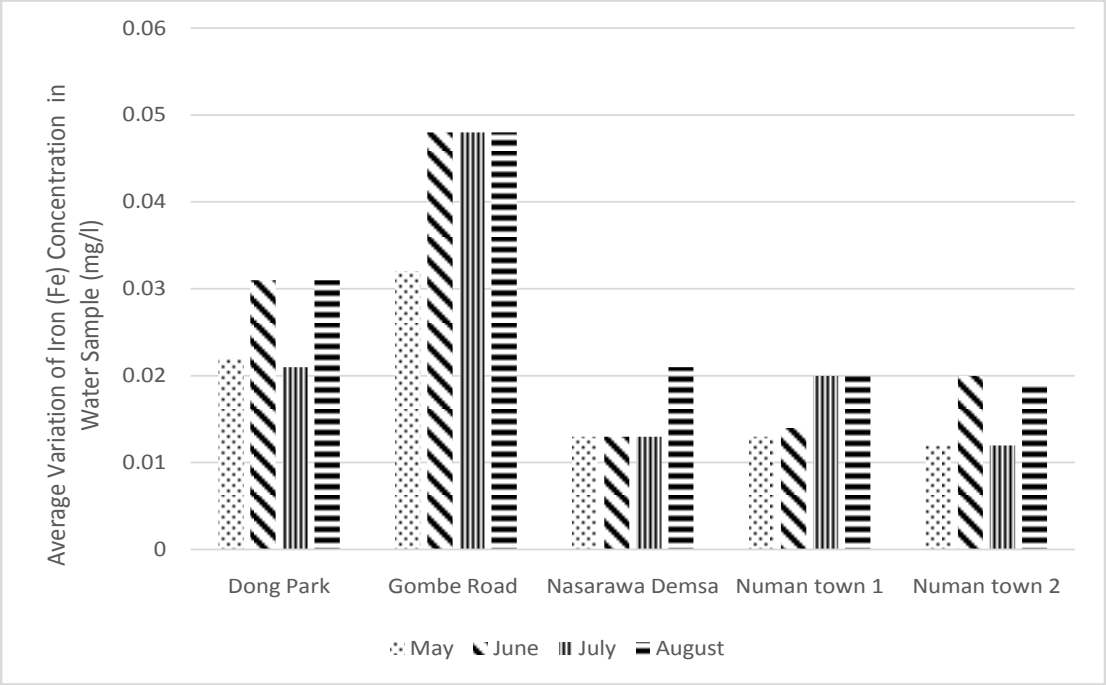

Figure 1. Iron (Fe) levels in well water samples.

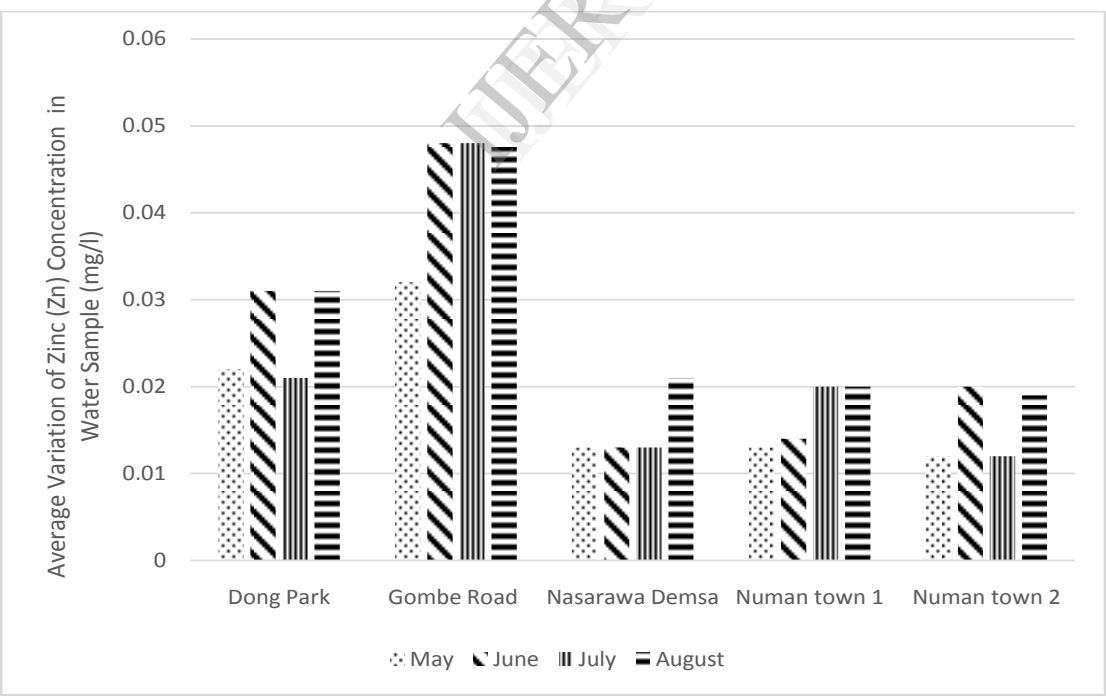

Figure 2: Zinc (Zn) levels in well water samples.

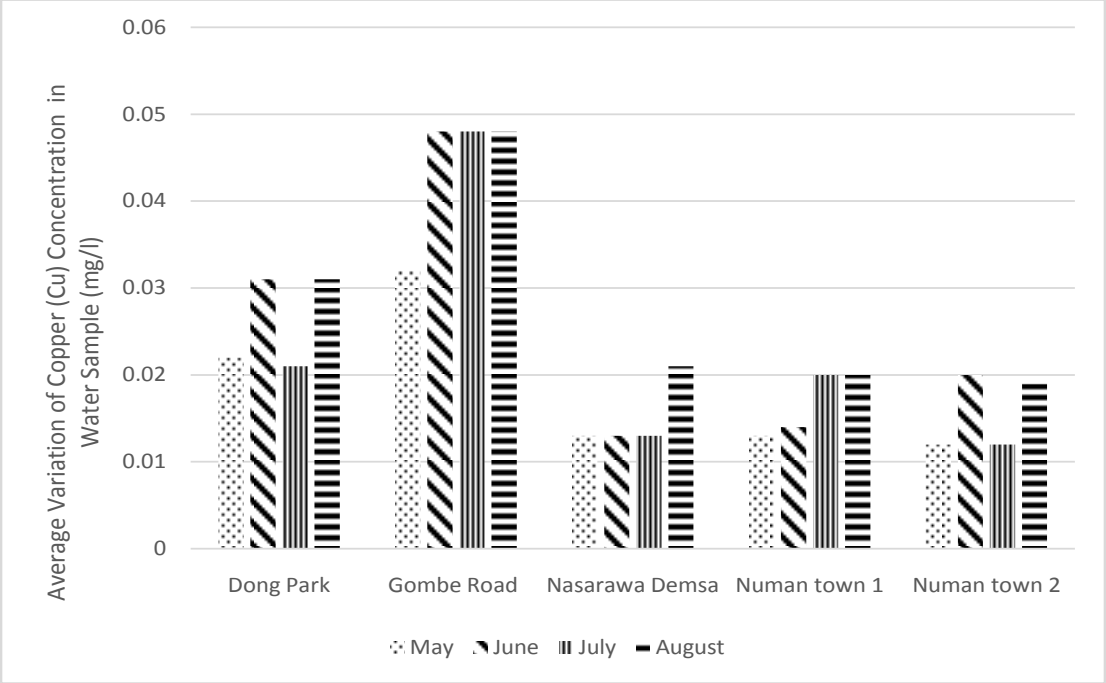

Figure 3:Copper (Cu) levels in well water samples

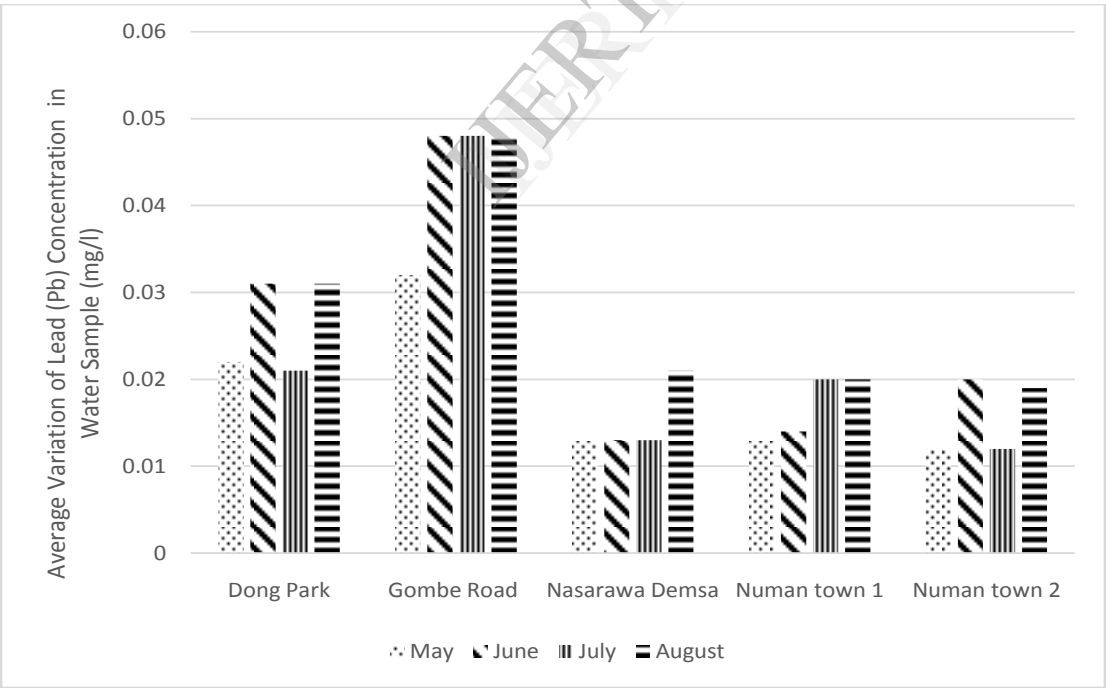

Figure 4:Lead (Pb) levels in well water samples.

Table 5: Variation of Bacterial Levels of the Different Well Water Samples:

Coliform Plate count								
Well No	Nutrient Agar (cfu/100ml)				Mac Conkey agar (cfu/100ml)			
	May	**June**	**July**	**August**	**May**	**June**	**July**	**August**
1	120	130	154	140	185	186	187	192
2	120	120	130	125	165	140	145	152
3	175	185	179	177	165	165	167	192
4	145	155	159	148	140	154	165	172
5	175	165	175	172	135	137	160	179

Bacteriological analysis of all the water samples shows a higher number of coliform bacteria except well 2 (located 3m from dumpsite). These wells are located either too close to domestic refuse waste and drainages. It is a source of concern because many diseases can be transmitted to unsuspecting people in the communities. Poor development plans, lack of enforcement of regulations and the development of unplanned houses to accommodate this rapid growth in population or changing conditions cause two general problems of water supply and waste disposal in developing countries like Nigeria. [1].

These results are consistent with the findings of Shimizu et. al.,[5] whose studies of over 318 wells in Japan showed more microbial activities were found in wells close to organic waste sites.

5. Conclusion.

The results revealed that the conditions of the immediate environment affect the qualities of the water samples. Wells located close to where there is high human activities, domestic refuse dumps, pit latrines, drainages or waste effluent and stagnant water showed high value of coliform bacteria.

All the wells located close to sources of heavy metal pollutants generally have the value of Fe, Zn and Pb above the WHO maximum permissible value except the values of Cu which are generally below the WHO maximum permissible limits.

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