GEO-SPATIAL ANALYSIS OF THE OCCURRENCE OF WATER BORNE DISEASES ACROSS YAKURR LOCAL GOVERNMENT AREA, CROSS RIVER STATE, NIGERIA.

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ABSTRACT

In Nigeria, about 80 percent of the rural inhabitants lack access to potable water supply. This study aimed at examining the geo-spatial analysis of water borne diseases in yakurr Local Government Area of Cross River State Nigeria. The ANOVA was used to test the hypothesis. The result further revealed that there was a significant varieties in the occurrence of water borne diseases across the political wards. $F(12,286)=8.864$, $p<0.05$. There was a positive correlation between percentage occurrence of water borne diseases and average faecal coliform as 0.717 with a probability value of 0.006. The pollution index (P.I) of 7.63 implies that the water sources were seriously polluted with bacteriological contamination specifically faecal coliform. This could have resulted from surface and ground water contact with human and animal faeces and other means such as the poor sanitary habit displayed by the host communities. The study concluded that there is need to create awareness of the hazards associated with the consumption of contaminated water sources and ways of ameliorating these challenges through boiling and purification measures towards potable water in the area.

Keywords: Surface Water Quality, Water Borne Diseases, Ground Water Quality, Yakurr Local Government Area, Cross River State

INTRODUCTION

In recent times, due to the increasing demand for potable water, there is the upsurge in the construction of boreholes by individuals. This situation was caused by government's inability to supply of potable water to the people. The poor supply of potable water in Yakurr L.G.A has led to the indiscriminate sinking of boreholes by private individuals in the area as a way to meet the increasing water needs of the people. Unfortunately, water from these boreholes is pumped and sold to the inhabitants of the area for drinking and household uses without any form of treatment. The boreholes of some of these water merchants are often unhygienic because some of them are located in unsanitary areas, and most causes the containers used for storage are not properly cleaned and treated. Contamination as a result of anthropogenic activities(Improve and inefficient disposal of household effluents and wastes) effectively limits the quality of water available for most users, which makes it harmful to man who depends on it for survival, contaminated water serves as sanctuaries for disease such as typhoid, cholera, hepatitis, filariasis and schistosomiasis among others, which may be caused by different disease organisms such as parasites, bacteria, viruses and other pathogens. Thus, the rapid expansion in population and the rapid growth in commercial and construction activities in Yakurr Local Government Area made it expedient to investigate the various sources of water supply and ascertain their quality in relation to human health (Ellen and Kellong 2005, Adelekan and Alawode 2011 & Ebin 2016).

Yakurr L.G.A, majority of the people depends on streams, springs and ground water for their daily water needs, due to inadequate supply of pipe-borne water by the government as well as their inability to meet the daily cost of buying boreholes. Streams and boreholes remains the main source of domestic water supply, sewage and sanitary systems are poor and where they are located they are not managed properly, Thereby contaminating the water supply sources, absolutely, the quality of the water sources in the study area needs attention as the water from these sources are used for daily domestic uses without treatment (Ebin, 2019).

Eight hundred and ten thousand (810,000) death has occurred attributed to water borne diseases particularly diarrheal diseases. Globally that led to the death of children under age give 5 and about 90 percent of this death occurring in sub-sahara Africa and south Asia (Johanssan 2012). And it is very true that about 88 percent of water borne diseases are preventable through potable water, good sanitation and proper hygiene meanwhile the millennium development goal

is targeting to have 88 percent of the world population to have access to improved quality drinking water in 2010 (world health organization, 2015).

Drinking water sources containing pathogenic microorganisms can cause water-borne diseases among the consumers and the riok of drinking contaminated microbial water is related to feacal coliform contamination as a result of discharging of human and animal waste into water sources. World Health Organization 2001.

Materials and methods

Yakurr Local Government Area is a located approximately between longitudes 8^0 11^1 and 8^0 20^1 and latitudes 5^0 45^1 and 5^0 $55^{1.}$ North of the equator in Cross River State Nigeria. Water samples were collected in both streams and ground waters (boreholes) in all the 13 political wards in six months, three months dry season and three months rainy season and the samples were analyzed for total and feacal coliform bacterials using recommended standard of Nigerian standard for drinking water quality (NSDWQ 2007). Primary data were obtained from residents in the study area through probability sampling. Communities within each political ward were then purposively selected while the simple random sampling was adopted in the actual administration of questionnaire data from the pool of the households within the community based on the proportionate sample (Table 1). To allow for this, the study population was determined. This was obtained by projecting the national population size (target population) using 2.8 percent growth rate for the villages within each of the 13 political wards in the study area to 2014 and then aggregating them to have the total for the period under review in the study area. Four hundred copies of questionnaire were administered proportionately across the 13 political wards in study area. The random sampling techniques was used to administer the questionnaire across the political wards as indicated in Table 2. The researcher personally administered the 400 copies of questionnaire and were all retrieved. Also the health centres in Idomi, Niko, Nkpani/Agoi, Ekori, Assiga, Inyima and General hospital ugep were visited and data on water borne, diseases recorded were collected for fifteen (15) years to support the study on the spatial occurrence of the various water borne diseases like (typhoid, hepatitis, cholera, diarrhea and dysentery). Table 3 indicate the test of between subjects effect for feacal coliform in the study area table 4 shows the post hoc test result for feacal coliform

TABLE 1

Proportionate sample size for questionnaire administration in Yakurr Local Government Area

Political ward	2014 estimated population	Proportionate sample size	Communities in each ward
Idomi	20225/6	33	Kekowa, Okom, Otalosi, Nfut, Egbizum, Lebokam, Lekpankam, Kekamkuly
Inyima	15224/6	25	Ekere, Ekolo, Levate, Egbara, Egbago, Esogo, Elogbo, Ekpoto, Alego and Efijikgbo
Abanakpai	18214/6	30	Kagana, Nbono, Epono, Okomasi, Obuzuquwa, Lekomkapai, Okponwen, Okokowen
Assiga	18012/6	29	Lesali, Okwalike, Lavate, Ogala, Obovoh, Lekpanti, Patata, Osaja and Isongbe
Ajere	20221/6	33	Okobono, Eden, Ogbekuma, Akugom, Ajere beach, Usaja, Ejiman, Lebantanankem and Ketoty
Ntan	17118/6	28	Atakpa, Akogum 1&2, Ngam, Afufua, Ntakpan and Kokomkolo
Ikpakapit	17821/6	29	Lekankom, Ndayi, Usaja, Letekom, Egbizum, Ntankpo, Keyen, Yenon
Mkpani/Agoi	22418/6	36	Ekeden, Akanekpal, Reborakam, Ronowo, Rekam Tegomi, Iyorodo, Lebokom, Obioko, Akata, Atakpa, Agedon, Ibenda, Edan Ijiman
Ijom	21632/6	35	Loseni, Akugum, Lebubulikom, Aneja, Unebu, Usene, Lewankom
Ijiman	20123/6	33	Lekpankom, Lebulebukom, Keyeli, Keyeli
Nkpolo/Ukpawen	17278/6	28	Nkpolo, Lesekom, Elige, Osawen, Etombe, Lekpan kom, Egbizum
Afrekpe/Epenti	17162/6	28	Akojum, Lekpankom, Kotani, Beneni, Ibem
Biko Biko	20112/6	33	Lebukom, Nkpani, Ibenda, Emenko, Njelekoko, Lepankom, Ibenda II
Total	246560/6	400	

Source: Fieldwork, 2014

TABLE 2

Geographical positioning system of water sampling locations in both surface water and boreholes

S/No	Streams/Boreholes locations	Northings	Eastings
1.	Lokpoi stream	05^0 55′ 46.036″	$008^0$11′ 47.279″
	Lokpoi stream	05^0 56′ 16.310″	008^0 10′ 48.338″
	Lokpoi stream	05^0 56′ 55.210″	008^0 10′ 26.348″
2.	Kiwel stream	05^0 47′ 40.848″	008^0 05′ 09.670″
	Kiwel stream	05^0 45′ 58.595″	008^0 05′ 21.141″
	Kiwel stream	05^0 45′ 22.862″	008^0 05′ 08.438″
3.	Edem kokol stream	05^0 50′ 05.566″	008^0 05′ 35.131″
	Edem kokol stream	05^0 51′ 47.758″	008^0 08′ 29.673″
	Edem kokol stream	05^0 52′ 43.596″	008^0 07′ 35.098″
4.	Lebisong stream	05^0 52′ 38.688″	008^0 07′ 12.174″
	Lebisong stream	05^0 49′ 01.548″	008^0 04′ 44.391″
	Lebisong stream	05^0 47′ 46.627″	008^0 04′ 24.489″
5.	Idom ward borehole	05^0 52′ 55.931″	008^0 07′ 30.070″
6.	Ntan ward borehole	05^0 54′ 48.054″	008^0 06′ 49.471″
7.	Epanty/Afrikpa ward borehole	05^0 56′ 20.462″	008^0 09′ 55.555″
8.	Ajira ward borehole	05^0 52′ 45.501″	008^0 07′ 17.057″
9.	Assiga ward borehole	05^0 45′ 24.990″	008^0 05′ 11.953″
10.	Inyima ward borehole	05^0 55′ 06.435″	008^0 12′ 42.661″
11.	Nkpolo/Ukpawen ward borehole	05^0 52′ 37.278″	008^0 11′ 20.909″
12.	Abanapai ward borehole	05^0 52′ 11.049″	$008^0$11′ 11.567″
13.	Nkpani/Agoi ward borehole	05^0 50′ 27.013″	008^0 09′ 20.251″
14.	Ikpakapait ward borehole	05^0 48′ 38.712″	008^0 04′ 39.424″
15.	Ijom ward borehole	05^0 48′ 26.129″	008^0 04′ 22.340″
16.	Biko biko ward borehole	05^0 48′ 40.853″	008^0 05′ 00.847″
17.	Ijiman ward borehole	05^0 48′ 33.851″	008^0 05′ 09.608″

Source: Fieldwork, 2014

TABLE 3

Tests of between subject effect for faecal coliform

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	444747.755[a]	7	63535.394	68.196	.000
Intercept	4699682.343	1	4699682.343	5.044E3	.000
Streams	285642.436	3	95214.145	102.199	.000
Season	91522.820	1	91522.820	98.237	.000
Streams * Season	67582.499	3	22527.500	24.180	.000
Error	260862.650	280	931.652		
Total	5405292.748	288			
Corrected Total	705610.405	287			

Source: Statistical analysis by the author

TABLE 4
Post hoc test results for faecal coliform

(I) Streams	(J) Streams	Mean Difference (I-J)	Std. Error	Sig.
Kiwel stream	Lebisong stream	-27.5007*	5.08716	.000
	Lokpoi stream	-42.4725*	5.08716	.000
	Edem Kokol stream	40.3324*	5.08716	.000
Lebisong stream	Kiwel stream	27.5007*	5.08716	.000
	Lokpoi stream	-14.9718*	5.08716	.036
	Edem Kokol stream	67.8331*	5.08716	.000
Lokpoi stream	Kiwel stream	42.4725*	5.08716	.000
	Lebisong stream	14.9718*	5.08716	.036
	Edem Kokol stream	82.8049*	5.08716	.000
Edem Kokol stream	Kiwel stream	-40.3324*	5.08716	.000
	Lebisong stream	-67.8331*	5.08716	.000
	Lokpoi stream	-82.8049*	5.08716	.000

Source: Statistical analysis by the author

The one-sample t-test was used in testing the hypothesis. The one-sample t-test allows comparison to be made between the mean of data set and a specified test value. In this case the test values are the WHO recommended permissible limits of concentration of parameters in water for domestic purposes. Table 5 presents the mean values of the measured water quality parameter against the stated standards. The Table also shows results of significance test based on the *p*-value at the 0.05 level.

The results indicate that for all tested parameters, $p < 0.001$ for both surface and groundwater. Hence, the null hypothesis was rejected. However, some parameters (those with negative signs on the t-values) have concentrations below or within the WHO permissible limits while others (with positive t-values) have concentrations above the permissible limits.

TABLE 5

Comparison of measured water quality status with recommended standards

Water quality parameter	WHO permissible limits	FMEnv permissible limits	Surface water				Groundwater			
			Mean conc.	t-value*	df*	Sig.*	Mean conc.	t-value*	df*	Sig.*
BOD_5(mgl^{-1})	0	0	1.2785	52.737	287	< 0.001	.0737	8.129	311	< 0.001
Ca (ppm)	75	-	.0501	55850.00	287	< 0.001	.0455	-1247.00	311	< 0.001
Cl (mgl^{-1})	-	-	35.8781	-	-	-	72.1540	-	-	-
Conductivity (µS/cm)	-	-	1.0030E2	-	-	-	2.1390E2	-	-	-
DO (mgl^{-1})	8.0	7.5	4.9744	-81.041	287	< 0.001	4.6202	-122.909	311	< 0.001
Fe (ppm)	0.3	1.0	.0876	-77.129	287	< 0.001	.0575	-215.683	311	< 0.001
Faecal coliform (cfu/100ml)	0	0	1.2774E2	43.721	287	< 0.001	.5141	9.407	311	< 0.001
HCO_3 (mgl^{-1})	-	-	2.6047	-	-	-	5.5440	-	-	-
K (ppm)	50	-	.7458	1558.00	287	< 0.001	1.5883	-5262.00	311	< 0.001
Mn (ppm)	-	-	.0417	-	-	-	.0321	-	-	-
Na (ppm)	200	-	1.9093	-2453.0	287	< 0.001	4.2476	-12180.00	311	< 0.001
NO_3 (mgl^{-1})	1.0	1.0	5.4470	59.659	287	< 0.001	6.4440	104.438	311	< 0.001
pH (ppm)	6.5-8.5	6.5-8.5	6.0814	-11.226	287	< 0.001	5.4721	-30.932	311	< 0.001
PO_4 (mgl^{-1})	0	5	.0602	8.998	287	< 0.001	.1388	14.048	311	< 0.001
SO_4 (mgl^{-1})	400	500	5.0426	-1832.0	287	< 0.001	10.9296	-7046.00	311	< 0.001
TDS (mgl^{-1})	500	500	62.7614	-161.129	287	< 0.001	1.3503E2	-1191.00	311	< 0.001
Temperature (°C)	-	25-30	26.3969	-	-	-	25.7075	-	-	-
Total hardness (mgl^{-1})	500	200	31.2181	-374.11	287	< 0.001	18.4076	-1748.00	311	< 0.001
Turbidity(NTU)	500	1.0	8.5864	-1049.0	287	< 0.001	.1554	-1775.00	311	< 0.001

* Test based on WHO permissible limits

Source: Fieldwork, 2015

4.1.5 The occurrence of water-borne diseases across Yakurr Local Government Area

Table 6a shows the summary of reported cases of water-related diseases for 15 years across 7 health facilities in Yakurr Local Government Area of Cross River State. It reveals a total of 4832 cases of diarrhea, 6271 cases of cholera, 2212 cases of hepatitis, 2796 cases of typhoid and 4527 cases of dysentery (State Ministry of Health, Ugep, 2014). Also, the table reveals total cases of water-related diseases across the health facilities. Similarly, Table 6b shows the number of deaths cases due to water-related diseases as reported across the health facilities in Yakurr Local Government Area.

TABLE 6
Summary results of major water related disease cases reported in 15 years

Major water related diseases	Nko health centre	Nkpani/Agoi Health centre	Ekori health centre	Idomi health centre	Assiga health centre	Inyima health centre	General hospital Ugep	Total number of cases reported
Diarrhea	628	768	858	581	629	472	896	4832
Cholera	759	785	1099	619	875	923	1,211	6271
Hepatitis	356	57	253	35	332	413	766	2212
Typhoid	352	60	312	84	570	526	892	2796
Dysentery	629	622	844	509	623	388	879	4527

Source: State Ministry of Health, Ugep (2014)

TABLE 6b
Summary results of major water related diseaseand the total number of death cases in 15 years

Major water related diseases	Nko health centre	Nkpani/Agoi Health centre	Ekori health centre	Idomi health centre	Assiga health centre	Inyima health centre	General hospital Ugep	Total number of cases reported
Diarrhea	3	73	15	6	37	41	20	195
Cholera	30	75	33	30	37	58	30	293
Hepatitis	6	5	12	10	14	4	21	72
Typhoid	27	5	1	10	55	30	20	148
Dysentery	17	67	20	21	29	8	20	182

Source: State Ministry of Health, Ugep (2014)

Table 7 is the data matrix of percentage dominant occurrence of water-borne diseases and average feacal coliform for each political wards. This data was used to classify the study area based on percentage occurrence of water-borne diseases and to establish the relation between water quality and water borne diseases in the study area.

Table 8 shows clusters characteristics and their mean percentages.Cluster 1 (Idomi, Abanakpai and Nkpolo/Ukpawen) was characterized by 7.86 percent occurrence of water borne diseases. Cluster 2 (Iyima) was characterized by 14.94 percent occurrence of water-borne diseases while cluster 3 (Assiga) was characterized by 19.90 percent of water-borne diseases. Cluster 4 (Ajere, Ntan, Ikpakapit, Ijom, Ijiman, Afrekpe/Epenti and Biko Biko) was characterized by 6.07 percent occurrence of water-borne diseases while in cluster 5 (Mkpani/Agoi) it was 10.22 percent. In terms of ranking of average percentage occurrence of water-borne diseases, cluster 3 was ranked first, followed by cluster 2, then 5, 1 and the least was cluster 4.

TABLE 7
Data matrix of occurrence of water-borne diseases and feacal coliform for each political wards

Political ward	Percentage dominant occurrence of water borne diseases	Average Feacal coliform in ground water
Idomi	8.45	1.00
Inyima	14.94	1.00
Abanakpa	7.58	0.92
Assiga	19.90	1.00
Ajere	6.37	0.92
Ntan	6.37	0.00
Ikpakapit	5.86	0.00
Mkpani/Agoi	10.22	1.00
Ijom	5.85	0.92
Ijiman	5.86	0.00
Nkpolo/Ukpawen	7.58	0.00
Afrekpe/Epenti	6.37	0.92
Biko Biko	5.86	0.00

Source: Fieldwork, 2015

TABLE 8
Clusters characteristics and their mean percentages of occurrence of water-borne diseases

Cluster	Political wards	Case	Percentage	Mean percentage
Cluster 1	Idomi, Abanakpai and Nkpolo/Ukpawen	1	8.43	
		3	7.58	7.86
		11	7.58	
Cluster 2	Inyima	2	14.94	14.94
Cluster 3	Assiga	4	19.90	19.90
Cluster 4	Ajere, Ntan, Ikpakapit, Ijom, Ijiman, Afrekpe/Epenti and Biko Biko	5	6.34	
		6	6.34	
		7	5.86	
		9	5.85	6.07
		10	5.86	
		12	5.87	
		13	5.83	
Cluster 5	Mkpani/Agoi	8	10.22	10.22

Source: Fieldwork, 2015

4.1.6 Variation in water-borne diseases across Yakurr Local Government Area

Data for this analysis is found in Table 9. The table shows mean occurrence of water-related diseases (cholera, typhoid, hepatitis, diarrhea and dysentery) across Yakurr Local Government Area. This data were obtained as mean scores from the copies of the questionnaire that were administered and retrieved.

It was hypothesized that:

H_0: There is no significant variation in the occurrence of water-borne diseases across the political wards in Yakurr Local Government Area.

H_1: There is a significant variation in the occurrence of water-borne diseases across the political wards inYakurr Local Government Area.

The results of the analysis are presented in Tables 10. Table 11 shows the descriptive statistics of the data used. Table 12 is the ANOVA table which show that $F(12, 286) = 8.864$, $p < 0.05$. Since $p < 0.05$, the null hypothesis was rejected. This means that there was a significant variation in the occurrence of water-borne diseases across the political wards in Yakurr Local Government Area. Hence, the variation did not occur by chance. Table 13 (Multiple comparisons) reveals that most of the variations lies with the occurrence of water-borne diseases in Abanakpai. Finally, table 14 shows the water classification in the study area based on pollution index (Ebin 2019).

TABLE 9

Mean occurrence of water-related diseases (Cholera, Typhoid, Hepatitis, Diarrhea and Dysentery) across Yakurr Local Government Area.

Ijom	Ijiman	Assiga	Abanapai	Ajere	Idomi	Inyima	Ikpakapit	Afrekpe/ Epenti	Biko Biko	Ntan	Mkpani/ Agoi	Nkpolo /Ukpawen
2.6	2.8	3	2.4	2.8	2.2	2.2	2.8	2.8	3.6	2.8	3	2.6
2.8	2.8	3.2	1.8	3	2.8	2	2.6	2.8	3	2.6	3	3
2.6	2.8	2.2	2.8	2.6	2.8	2	3.4	2.4	2.2	3.2	3.2	2
2.4	3.2	2.6	2.2	3.2	2	2.6	3.6	2.6	2.6	2.8	3	1.8
2.2	3	3.2	2	3	2.2	2.2	3.8	2.8	2.2	2.4	3	1.8
2.4	3	2.4	2	2.8	2.2	3	2.8	2.6	1.8	2.4	2.4	2.2
3	2.8	3	2.6	3	2.6	2.8	2.6	2.8	1.6	2.2	2.4	1.2
2.6	3.4	2.8	2	2.8	2.4	2.4	2.4	2.8	2	3.4	3.2	2.2
2.6	2.6	2.8	1.6	2.6	2.2	2.2	3	2.8	3.4	3	2.4	1.2
2.6	3	2.8	1.4	2.6	2.2	2	3.2	3	1.8	2.4	2.8	2.2
2.8	2.8	3.2	1.6	3.2	2.2	3.4	3	2.8	1.4	3.2	2.4	2
2.4	3.4	3.2	2	3	2.2	3.6	2.8	2.8	2.2	3	2.8	2.6
2.8	3	3.2	2.4	3	2	2.6	2.2	2.4	2.2	3	3	1.4
2.6	3	3.4	3.2	3	2.2	3.2	2.2	3	2.4	3.2	3	2.6
3	2.8	2.6	3	4	2.8	2.8	1.8	2.4	2.6	3.4	3.6	3
2.8	3	2.8	3.2	2.6	2.2	2.6	3.2	3	2.2	3	3.2	2.6
2.8	3	3	2.8	3	2.6	2.4	2.2	2.2	2.8	3.4	2.6	2.4
2.8	3.2	3	2.4	3	2.2	2.8	2	2.6	3	3.2	2.8	3
3	3.6	3	2.6	3	3.8	3	2	3	3.2	2.8	2.8	3.2
2.4	2.6	3	2.6	3	3	3.4	2.4	2.4	3	2.8	2.8	3.2
2.6	3.8	3.2	2.6	3	3.4	3	3	3	3	2.6	2.8	3.2
2.4	2.2	2.8	1.6	3	3.4	2.6	2.6	3.2	3.2	3.6	2.6	3
2.6	2.6	2.4	2	3	2.6	2.8	3.2	2.4	3.2	3.6	3	2.8
3	2.6	2.6	1.8	3.6	3.2	2.6	3.2	2.6	3.6	2.8	2.8	3.2
2.8	3	2.8	2	3	2.8	3.2	3.4	3.6	3.6	3	3	2.4
2.8	2.8	3	2	3	2.6		3.2	2.6	3.6	2.8	2.4	3.8
3.2	3	3.4	2	3	2.8		2.8	3	3.2	3	3.2	2.4
3.2	3	3	1.8	3.4	2.8		3.4	3	2.8	2.4	3.4	2.6
2.8	3.2	3.2	2.2	3	3.4		2.8	2.8	3	2.6	2.8	
3	2.8		1.2	2.8	1.6				3		3.4	
3.2	3.2		1.6	3.6					3.4		3	
3	3			2.8					3		3.6	
3	3.2			2.6					3.6		2.8	
3.2											3.2	
3.2											3.6	
											3.6	

Source: Fieldwork, 2015

ABLE 10

Descriptive statistics of occurrence of water-borne diseases across the political wards in Yakurr Local Government Area

	N	Mean	Std. Deviation	Std. Error	95percent Confidence Interval for Mean Lower Bound	Upper Bound	Minimum	Maximum
Idomi	30	2.5800	.50746	.09265	2.3905	2.7695	1.60	3.80
Inyima	25	2.6960	.45869	.09174	2.5067	2.8853	2.00	3.60
Abanakpai	31	2.1742	.51573	.09263	1.9850	2.3634	1.20	3.20
Assiga	29	2.9241	.29959	.05563	2.8102	3.0381	2.20	3.40
Ajere	33	3.0000	.30414	.05294	2.8922	3.1078	2.60	4.00
Ntan	29	2.9172	.37614	.06985	2.7742	3.0603	2.20	3.60
Ikpakapit	29	2.8138	.51528	.09569	2.6178	3.0098	1.80	3.80
Mkpani/Agoi	36	2.9611	.35398	.05900	2.8413	3.0809	2.40	3.60
Ijom	35	2.7771	.27342	.04622	2.6832	2.8711	2.20	3.20
Ijiman	33	2.9758	.31128	.05419	2.8654	3.0861	2.20	3.80
Nkpolo/Ukpawen	28	2.4857	.64275	.12147	2.2365	2.7349	1.20	3.80
Afrekpe/Epenti	29	2.7655	.29311	.05443	2.6540	2.8770	2.20	3.60
Biko Biko	33	2.7697	.63467	.11048	2.5447	2.9947	1.40	3.60
Total	400	2.7635	.48575	.02429	2.7158	2.8112	1.20	4.00

Source: Statistical analysis by the author

TABLE 11

ANOVA Table of occurrence of water-borne diseases in Yakurr Local Government Area

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	20.304	12	1.692	8.867	.000
Within Groups	73.843	387	.191		
Total	94.147	399			

Source: Statistical analysis by the author

TABLE 12

Scheffe's multiple comparisons of occurrence of water-borne diseases in Idomi and Inyima political wards

(I) Political_wards	(J) Political_wards	Mean Difference (I-J)	Std. Error	Sig.	95percent Confidence Interval Lower Bound	Upper Bound
Idomi	Inyima	-.11600	.11829	1.000	-.6623	.4303
	Abanakpai	.40581	.11187	.361	-.1108	.9224
	Assiga	-.34414	.11375	.689	-.8695	.1812
	Ajere	-.42000	.11019	.273	-.9289	.0889
	Ntan	-.33724	.11375	.720	-.8626	.1881
	Ikpakapit	-.23379	.11375	.978	-.7591	.2915
	Mkpani/Agoi	-.38111	.10798	.413	-.8798	.1176
	Ijom	-.19714	.10868	.993	-.6991	.3048
	Ijiman	-.39576	.11019	.380	-.9046	.1131
	Nkpolo/Ukpawen	.09429	.11478	1.000	-.4358	.6244
	Afrekpe/Epenti	-.18552	.11375	.997	-.7108	.3398
	Biko Biko	-.18970	.11019	.996	-.6986	.3192
Inyima	Idomi	.11600	.11829	1.000	-.4303	.6623
	Abanakpai	.52181	.11742	.077	-.0205	1.0641
	Assiga	-.22814	.11921	.988	-.7787	.3224
	Ajere	-.30400	.11582	.863	-.8389	.2309
	Ntan	-.22124	.11921	.991	-.7718	.3293
	Ikpakapit	-.11779	.11921	1.000	-.6683	.4327
	Mkpani/Agoi	-.26511	.11372	.941	-.7903	.2601
	Ijom	-.08114	.11439	1.000	-.6094	.4471
	Ijiman	-.27976	.11582	.923	-.8146	.2551
	Nkpolo/Ukpawen	.21029	.12020	.995	-.3448	.7654
	Afrekpe/Epenti	-.06952	.11921	1.000	-.6201	.4810
	Biko Biko	-.07370	.11582	1.000	-.6086	.4612

*. The mean difference is significant at the 0.05 level.

Source: Statistical analysis by the author

TABLE 13

Scheffe's multiple comparisons of occurrence of water-borne diseases in Abanakpai and Assiga political wards

(I) Political_wards	(J) Political_wards	Mean Difference (I-J)	Std. Error	Sig.	95percent Confidence Interval	
					Lower Bound	Upper Bound
Abanakpai	Idomi	-.40581	.11187	.361	-.9224	.1108
	Inyima	-.52181	.11742	.077	-1.0641	.0205
	Assiga	-.74994*	.11285	.000	-1.2711	-.2288
	Ajere	-.82581*	.10926	.000	-1.3304	-.3212
	Ntan	-.74305*	.11285	.000	-1.2642	-.2219
	Ikpakapit	-.63960*	.11285	.002	-1.1607	-.1185
	Mkpani/Agoi	-.78692*	.10703	.000	-1.2812	-.2926
	Ijom	-.60295*	.10774	.002	-1.1005	-.1054
	Ijiman	-.80156*	.10926	.000	-1.3061	-.2970
	Nkpolo/Ukpawen	-.31152	.11388	.822	-.8375	.2144
	Afrekpe/Epenti	-.59132*	.11285	.008	-1.1125	-.0702
	Biko Biko	-.59550*	.10926	.004	-1.1001	-.0909
Assiga	Idomi	.34414	.11375	.689	-.1812	.8695
	Inyima	.22814	.11921	.988	-.3224	.7787
	Abanakpai	.74994*	.11285	.000	.2288	1.2711
	Ajere	-.07586	.11118	1.000	-.5893	.4376
	Ntan	.00690	.11471	1.000	-.5229	.5367
	Ikpakapit	.11034	.11471	1.000	-.4194	.6401
	Mkpani/Agoi	-.03697	.10899	1.000	-.5403	.4664
	Ijom	.14700	.10969	1.000	-.3596	.6535
	Ijiman	-.05162	.11118	1.000	-.5651	.4618
	Nkpolo/Ukpawen	.43842	.11573	.284	-.0960	.9729
	Afrekpe/Epenti	.15862	.11471	1.000	-.3711	.6884
	Biko Biko	.15444	.11118	.999	-.3590	.6679

*. The mean difference is significant at the 0.05 level.

Source: Statistical analysis by the author

TABLE 13 (cont'd)

Scheffe's multiple comparisons of occurrence of water-borne diseases in Ajere and Ntan political wards

(I) Political_wards	(J) Political_wards	Mean Difference (I-J)	Std. Error	Sig.	95percent Confidence Interval	
					Lower Bound	Upper Bound
Ajere	Idomi	.42000	.11019	.273	-.0889	.9289
	Inyima	.30400	.11582	.863	-.2309	.8389
	Abanakpai	.82581*	.10926	.000	.3212	1.3304
	Assiga	.07586	.11118	1.000	-.4376	.5893
	Ntan	.08276	.11118	1.000	-.4307	.5962
	Ikpakapit	.18621	.11118	.997	-.3272	.6997
	Mkpani/Agoi	.03889	.10527	1.000	-.4473	.5250
	Ijom	.22286	.10599	.974	-.2666	.7123
	Ijiman	.02424	.10754	1.000	-.4724	.5209
	Nkpolo/Ukpawen	.51429	.11224	.055	-.0040	1.0326
	Afrekpe/Epenti	.23448	.11118	.973	-.2790	.7479
	Biko Biko	.23030	.10754	.970	-.2663	.7269
Ntan	Idomi	.33724	.11375	.720	-.1881	.8626
	Inyima	.22124	.11921	.991	-.3293	.7718
	Abanakpai	.74305*	.11285	.000	.2219	1.2642
	Assiga	-.00690	.11471	1.000	-.5367	.5229
	Ajere	-.08276	.11118	1.000	-.5962	.4307
	Ikpakapit	.10345	.11471	1.000	-.4263	.6332
	Mkpani/Agoi	-.04387	.10899	1.000	-.5472	.4595
	Ijom	.14010	.10969	1.000	-.3664	.6466
	Ijiman	-.05852	.11118	1.000	-.5720	.4549
	Nkpolo/Ukpawen	.43153	.11573	.311	-.1029	.9660
	Afrekpe/Epenti	.15172	.11471	1.000	-.3780	.6815
	Biko Biko	.14754	.11118	1.000	-.3659	.6610

*. The mean difference is significant at the 0.05 level.

Source: Statistical analysis by the author

TABLE 14

Water quality classification based on pollution index

Class	Pollution index	Status
CLASS 1 - BOD_5, Ca, Conductivity, Cl, DO, Fe, HCO_3, K, Na, NO_3, pH, PO_4, SO4. TDS, Total hardness	PI < 1	No pollution
CLASS 2 - Mn, Temperature, turbidity	PI: 1-2	Slightly polluted
Class 3	PI: 2-3	Moderately polluted
Class 4	PI: 3-5	Strongly polluted
Class 5 - Feacal Coliform	PI: > 5	Seriously polluted

Source: Fieldwork, 2015

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