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Pesticide Residue Pollution in the Groundwater System of Ishiagu and Potential Health Impacts

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Abstract: This study was initiated to examine pesticide residue in groundwater system in Ishiagu. Some objectives were also put forth to aid the achievement of the study aim amongst which are to; examine the quality of groundwater in Ishiagu, determine the type of pesticide residue in the groundwater system, determine the level of concentration of different kinds of pesticides residue in groundwater system and also determine the potential health effects of the consumption of pesticide residue concentrated water. Two hypotheses were tested in the study. The study used water samples from 5 wells located in different sub-communities; hence water quality analysis was done for physicochemical parameters of the water samples from the wells and after that for pesticide residue in the wells. The interest Physico-chemical parameters are; pH, Temperature (^{0}C), Conductivity (µS/cm), Resistivity (mΩ), Salinity (mg/l), Total Dissolved Solid (mg/l) and Dissolved Oxygen (mg/l) while the pesticide residues are; DDT, Gammaline, Altrazine, Carbonfuran, Eltrazine, Paraquat, Aldrin and Chlordane. Descriptive statistics and ANOVA were used to test the study hypotheses. The study showed that Conductivity amongst the physicochemical parameters tested was the only parameter that the wells' value exceeded the WHO acceptable limits. The study also showed that the water quality of the wells in Ishiagu is polluted and that the presence of DDT, Gammaline, Chlordane, Aldrin, Carbonfuran, and Altrazine in concentration level above the WHO acceptable level shows the potential impact of the consumption of water from the area. The study recommended Government intervention in potable water provision, having found

that the water available to the people is polluted, and Agro education and enlightenment in the area to ensure that pesticides are applied rightly in quantity and in accordance to land size.

Keywords: Pesticides, Residue, Groundwater, Health, Impacts

Introduction

Man's endeavors to improve his life have been a long and momentous pursuit throughout. Ecosystems in which life thrived have been generous donors of numerous services that man has tamed, manipulated, and extracted copious dividends and values. Agricultural ecosystems have played a pivotal role in providing man with his basic needs for foods, feeds, fibers, and many other raw materials (Mahmoud and Naglaa, 2015). Each year, forty million people die of hunger and hunger-related diseases. Our world is growing at an enormous rate, and by the year 2050, its population could reach 10 billion. World population growth is projected to reach over 8 billion in 2030 and to level off at 9 billion by 2050.

Pesticides have emerged as one of the most powerful tools to secure the provision of food and protect it against the broad mosaic of pests that attack food crops. Due to their chemical nature, pesticides are biocides, which can potentially poison organisms other than the target insect, microorganism, or plant species that should be controlled, as has been mentioned in the Biocidal Products Directive 98/8/EC of the European Parliament and Council.

Pesticides are chemical and biological materials that are used for pest removal or control, and are categorized into three main groups; insecticides, fungicides, and herbicides (Waxman 1998). Some pesticides (organochlorine compounds) are classified as persistent organic pollutants (POPs). POPs can volatilize and travel great distances through the atmosphere to become deposited in remote regions. They can also bioaccumulate and biomagnify, and can bioconcentrate up to 70,000 times their original concentrations. The occurrence of persistent organochlorine compounds in the environment is changing relatively slowly over years; similar time trends are characteristic of contents in fish, meat,

eggs, and dairy products, which are the foods that make the most significant contribution to the intake of organochlorine compounds (Watterson 1991).

The use of POPs is being phased out, and some are already banned, while others continue to be used. Following the discovery of pesticides' negative effects on all compartments of life, usage patterns have changed dramatically, particularly in recent years, introducing some alternative approaches to control pests, such as biopesticides. It is clear that feeding the world without pesticide use remains elusive, "especially with some 800 million undernourished" people in the world today; however, intensification in agricultural production should be sustainable and should protect human health and the environment as well. Therefore, sustainable agriculture is one of the greatest challenges that the world faces now.

Pesticides used in agricultural production affect environmental quality and human health. These external costs can amplify due to climate change because pest pressure and optimal pesticide application rates vary with weather and climate conditions. Pesticides have tremendously benefited humanity but at the same time caused considerable negative effects on biodiversity, environment, food quality, and human health. This is because the structure of pesticides and their mode of action and also application, especially the way they are used by farmers, have rendered them serious pollutants of the environment in general. As early as 2007, heavy use of pesticides was observed in the Ishiagu area and researcher's recommended an investigation of pesticides in the area (Ezekwe, 2009)

Mining and Agriculture are predominant occupations in Ishiagu area of Ivo LGA, Ebonyi State. The use of pesticides for great yield of crop has increased over the years, and farmers in the locality enjoy dividends of their labour by the application of pesticides to crops, and because of the heavy use of pesticides, these chemicals find their way through runoff and leaching to the groundwater system especially in Ishiagu area that is underlain by a cracked and metamorphosed clayey formation which enhances both runoff and infiltration. The geology of Ishiagu is characterized by cracked, wrapped, porous, weathered clay and silt and also igneous intrusion, and because of the geologic condition which occur at

the water table, it is suspected that runoff from the farm, pesticides residue from the farm contaminates the groundwater system of Ishiagu.

The Ishiagu area is also a water-scarce region whose water resources are threatened by mining. The water supply in the area depends on a few available hand dug wells and the Ivo river system for domestic use (Ezekwe et al, 2012). Therefore, it will be tragic if these water sources, especially the few wells in Ishiagu central area that serves as the only domestic water sources to people, are polluted by pesticides. This study is essential to evaluate the extent of contamination and/or pollution of the groundwater in the study area by pesticides. Therefore, the study objectives include to; examine the quality of groundwater in Ishiagu, determine the type of pesticide residue in the groundwater system, determine the level of concentration of different types of pesticides residue in groundwater system, determine the potential health effects of the consumption of pesticide residue concentrated water. In order to fulfill the study objectives, the following hypothesis was put forth, and they are:

1. Groundwater in the study area differs significantly with W.H.O standards for drinking water.

2. Pesticides residues pollutants vary significantly between sources of groundwater in the study area.

Materials and Methods

Ishiagu is a town in the Ivo Local Government Area in Ebonyi State, Nigeria, located on the plains of South-Eastern Savanna belt (Enyinna and Onwuka, 2014). It lies between latitude 5°54' – 5°59' N and longitudes 7°30' – 7°35' E. The area (about 25 sq.km), is situated in the SW tip of the Abakaliki Basin on the Lower-Benue Trough geologic complex, SE Nigeria and is composed of a low-lying sedimentary terrain with some intrusions of different episodes.

The area experience dry season between October and April of every year. The settlers are predominantly peasant farmers and the major industrial activities sited in the area are Lead/Zinc mines and quarry sites. The rural people in the area depend on hand-dug wells

for the sources of water for drinking and domestic purposes during dry season. The Ishiagu area of southeastern Nigeria has played host to mining activities for more than four decades (Ezekwe *et al*., 2012). This is as shown in figure 1 below.

The Ishiagu area of the Abakaliki Basin is delineated by geology of the Abakaliki Basin. Evolution of this generally low-lying to gently undulating shaly terrain is correlated to basement fragmentation, block faulting, subsidence, and rifting of the Lower Benue Trough during the early Cretaceous separation of Africa and America. It is underlain by faulted and jointed shales, sandstones, siltstones, and igneous intrusives. Groundwater in the study area is very much vulnerable to contamination, especially heavy metal pollution and pesticide residue, as it is essentially unconfined and highly influenced by infiltration and percolation.

The water supply sources are limited to rainwater, Ivo River, contact springs, and a few shallow hand-dug wells. All these water sources are inadequate for the people who live in this area and are unreliable in quality and mostly seasonal.

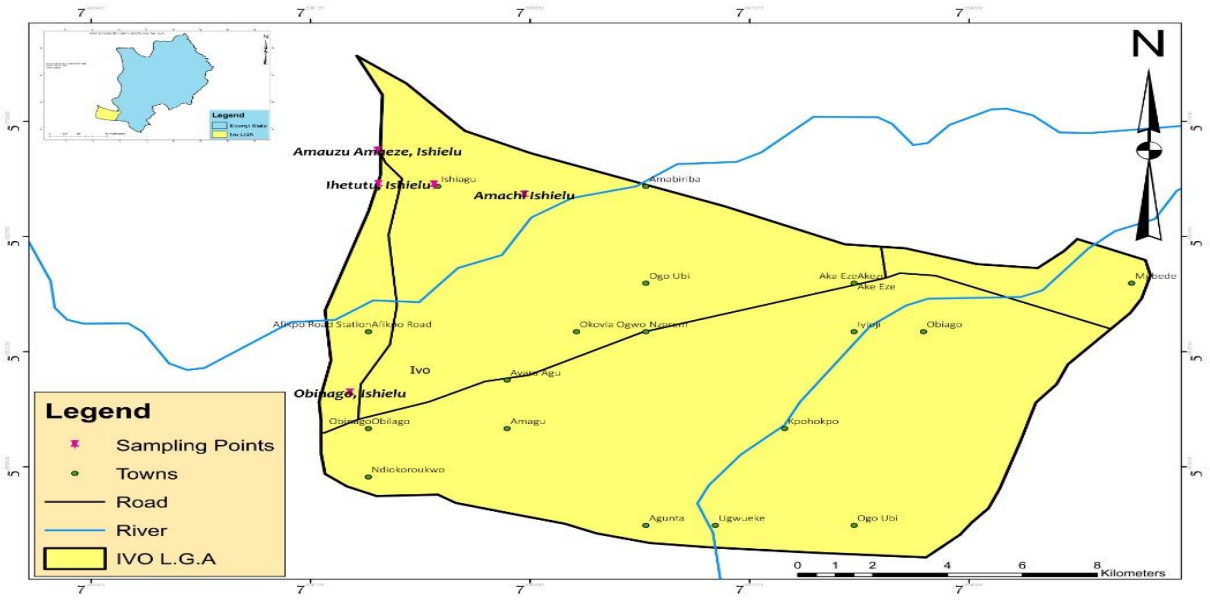

Figure 1: Ivo Local Government Area showing sample site in Ishiagu

It has a population of about 10,000. As a rural community, the primary occupation of the people is farming but a few people work with quarrying companies (Edeani, 2015). Mining is also an economic activity found in Ishiagu. Most mining companies such as the Crushed rock industry and Setraco Nig LTD are located there. The Ishiagu area of

southeastern Nigeria has played host to mining activities for more than four decades (Ezekwe et al, 2012). one of the major occupations of people living in Ishiagu is farming. Agriculture is the major occupation of the people of the state. The crops produced are rice, yam, maize, vegetables, okro, tomatoes, cassava, plantain, banana, maize, and cocoyam. Others are palm produce, cocoa and rubber

This study adopted the experimental research design. Data for this study was collected from two (2) sources. The first is the primary source which constitutes information obtained directly from field work. They include sampling and analysis of wells. About twelve (12) groundwater sources (wells) were identified during the reconnaissance survey and five (5) of the wells were selected to give adequate coverage of the study area.

The five (5) selected sampling sites for this study were determined with aid of a calibrated Global Positioning System (GPS Germin extra 10). Their locations are as follows; Onu-well at Akpunaoke Amagu Ishiagu G1 (N 05.95043, E 007.56580), G2 Well at Amachi Ishiagu (N 05.94695, E 007.58749), G3 well at Amauzu Amaeze, Ishielu (N05.962066667, E7.552233), G4 well at Ihetutu, ishielu (N5.950555556, E7.5524), G5 well at Obinago, Ishielu (N5.878833333, E7.545583). The sampling sites are already indicated in the study map (see fig 1).

Sample bottles and glassware were washed with detergent, rinsed with distilled water and 0.1m of HCl acid and then dried in an oven overnight at 100^0C. Glass containers were used in collecting water samples for pesticide determination while polythene bottles were used in sampling water for physicochemical analyses. Analar grade chemical reagents and materials were used in the study.

Groundwater was collected with the aid of a well-fetcher tied to a rope. The sample containers were rinsed three times with the site water prior to collection. Water samples were collected in 250ml pre-rinsed bottles and capped with aluminum foil before they are covered with bottle covers to avoid contamination. Samples were stored in ice boxes (coolers) and stored below 4 ^{0}C centigrade to ensure preservation of oxidation states of samples before sending them to the laboratory for analysis.

Samples for pesticides residue were extracted using MAE techniques and tested using GC-MS (El-Saeid et al., 2010) for different pesticides analyst (OCPs, OPPs, carbamites, etc) in water samples. Samples from biochemical oxygen demand (BOD) were collected using with 250ml brown reagent bottles and sealed to exclude air bubbles.

Results were compared with WHO and NESREA standard for pesticides residues and groundwater. Each sampling site was geo-located using Geographical Positioning System (Garmin extra 10). The American Public Health Association for water and waste water analysis field methods were strictly adhered to for sample collections. In-situ measurements of the following parameters viz: Temperature, pH, electrical Conductivity (EC), dissolved oxygen (DO), total dissolved substance (TDS), turbidy and total dissolved solids (TDS) were carried out in the field using HANNA water quality checker (APHA, 2005).

Results and Discussion

Table 1: Water Quality Physico-Chemical Parameters of sampled Wells in Ishiagu

Parameters	Well G1	Well G2	Well G3	Well G4	Well G5
pH	7.00	6.73	6.90	6.75	7.11
Temperature (^{0}C)	28.6	27.8	28.0	28.5	28.6
Conductivity (μS/cm)	550	516	419	693	443
Resistivity (mΩ)	1.80	1.94	2.39	1.45	2.27
Salinity (mg/l)	0.27	0.25	0.20	0.34	0.22
Total Dissolved Solid (mg/l)	368	349	283	474	300
Dissolved Oxygen (mg/l)	2.61	1.92	1.08	3.89	1.36

The water pH analysis is shown in table 4.1. The pH value of the water sample ranges from 6.73 to 7.11, with the Well G5 at Obinago-Isiagu accounting for the highest with a value of 7.11 and Well G2 at (Amachi-ishiagu) accounting for the lowest with a value of 6.73. The temperature on Well G4 Ihetutu, Ishiagu temperature was 28.5 and Well G3 Amauzu Amaeze, Ishiagu was 28.0 while Well G2 (Amachi-ishiagu) was 27.8. But Well G1 Onuwell (Akpuna-oke Amagu Ishiagu) and Well G5 Obinago-Isiagu both have same temperature as 28.6 respectively. Thus, the water temperatures at all the sampled wells are between 27.8 - 28.6 ^{o}C. The water Conductivity (μS/cm) ranges from 419 to 693, with the highest reading for

Conductivity at Well G4 (Ihetutu, Ishiagu) and the lowest at Well 3 (Amauzu-Amaeze Ishiagu), although the result shows that water conductivity differs from one source to another. The water resistivity (mΩ) analysis is shown in Table 4.1 with the highest reading at Well 3 (Amauzu-Amaeze Ishiagu) was 2.39, followed by Well G5 (Obinago-Isiagu) was 2.27. While Well G2 (Amachi-ishiagu) was 1.94 and Well G1 Onuwell (Akpuna-oke Amagu Ishiagu) was 1.80 with the least reading at Well G4 (Ihetutu, Ishiagu) was 1.45 respectively. The water Salinity (mg/l) analysis ranges from 0.20 to 0.37 with the highest reading at Well G4 (Ihetutu, Ishiagu) with 0.37 and the lowest reading at Well 3 (Amauzu-Amaeze Ishiagu) with 0.20. The Total Dissolved Solid present in water (mg/l) analysis ranges from 283 to 474, with the highest reading at Well G4 (Ihetutu, Ishiagu) and the lowest reading at Well 3 (Amauzu-Amaeze Ishiagu), although the result shows that TDS differs significantly from one well to another. The Dissolved Oxygen in water (mg/l) analysis is shown in Table 4.1 with the highest reading at Well G4 (Ihetutu, Ishiagu) was 0.34, followed by Well G1 Onuwell (Akpuna-oke Amagu Ishiagu) was 0.27, while Well G2 (Amachi-ishiagu) was 0.25 and Well G5 (Obinago-Isiagu) was 0.2 and the least reading at Well 3 (Amauzu-Amaeze Ishiagu) was 0.20 respectively.

Table 2: Types of Pesticide Residue in Groundwater System in Ishiagu

Parameters	Well G1	Well G2	Well G3	Well G4	Well G5
DDT (mg/l)	✓	✓	✓	✓	✓
GAMMALINE 20 (LINDANE) (mg/l)	✓	✓	✓	✓	✓
ATRAZINE (mg/l)	✓	✓	✓	✓	✓
CARBONFURAN (mg/l)	✓	✓	X	X	✓
ELTRAZINE (mg/l)	✓	X	✓	✓	✓
PARAQUAT (mg/l)	✓	✓	✓	✓	✓
ALDRIN (mg/l)	✓	✓	✓	✓	✓
CHLORDANE (mg/l)	✓	✓	✓	✓	✓

✓ **= Present, X= Not Present.**

Table 2 shows the types of pesticide residue in the groundwater system in Ishiagu, as shown in well G1 located in Akpauna-Oke Amagu Ishiagu community it was observed that DDT, Gammaline, Altrazine, Carbonfuran, Eltrazine, Paraquat, Aldrin and Chlordane were all present in the well. In well 2, located in Amachi Ishiagu, the table shows that DDT, Gammaline, Altrazine, Carbonfuran, Paraquat, Aldrin and Chlordane are the exception Eltrazine.

In well 3 as reported from the table, the following pesticide residue were present: DDT, Gammaline , Altrazine, Eltrazine, Paraquat, Aldrin and Chlordane except from Carbonfuran.

Well 4 located in Ihetutu Ishiagu shows that the following pesticide residue are present in the well which are DDT, Gammaline, Altrazine, Eltrazine, Paraquat, Aldrin and Chlordane except from Carbonfuran and lastly Well 5 located in Obinago Ishiagu showed that the following pesticide residue is present in the well amongst them are; DDT, Gammaline, Altrazine, Carbonfuran, Eltrazine, Paraquat, Aldrin and Chlordane were all present in the well.

The table in conclusion reports that all the selected parameters were presented mainly in well 1 and well 5 while the other wells had one in each case respectively.

Table 3: Concentration Levels of the different types of pesticide residue in the groundwater system.

Parameters	Well G1	Well G2	Well G3	Well G4	Well G5
DDT (mg/l)	34.56	13.41	8.20	30.69	42.33
GAMMALINE 20 (LINDANE) (mg/l)	4.33	6.00	1.55	3.23	1.96
ATRAZINE (mg/l)	2.0	0.98	0.24	1.8	2.00
CARBONFURAN (mg/l)	2.44	2.66	-	-	2.00
ELTRAZINE (mg/l)	14.00	-	9.20	11.29	12.00
PARAQUAT (mg/l)	3.80	2.00	1.8	2.24	4.20
ALDRIN (mg/l)	10.22	8.01	-	8.89	17.00
CHLORDANE (mg/l)	2.20	1.00	0.98	1.22	2.22

DDT = **(Dichlorodiphenyltrichloroethane)**

Table 3 shows the concentration levels of pesticide residue in the sampled wells, as observed, DDT which is dichlorodiphenyltrichloroethane in well 1, records 34.56 mg/l, in well 2 it recorded 13.41mg/l, well 3 recorded 8.20 mg/l, well 4 recorded 30.69 mg/l and well 5 recorded 42.33 mg/l. DDT was more in well 5, followed by well 1with well 3 having the least record of 8.20mg/l.

Gammaline as observed recorded in well 1 4.33mg/l, well 2 recorded 6.00mg/l, well 3 recorded 1.55 mg/l, well 4 recorded 3.23 mg/l and well 5 recorded 1.96 mg/l. Gammaline had it highest amount in well 2 with a value of 6.00mg/l and the least amount in well 1.55mg/l in well 4.

Atrazane as observed recorded in well 12.0 mg/l, well 2 recorded 0.98 mg/l, well 3 recorded 1.55 mg/l, well 4 recorded 1.8 mg/l and well 5 recorded 2.00 mg/l. Altrazane had its highest value in well 1 with a value of 12.00mg/l with the least value in well 3 with a record of 1.55mg/l.

Carbonfuran as observed in the table showed that in well 1 carbofuran recorded 2.44 mg/l, well 2 recorded 2.66 mg/l, there well no indication of carbofuran in well 3 and 4 while in well 5 it was observed that it recorded 2.00 mg/l. Carbonfuran had its highest value in well 2 and its least value in well 5 with no indications in well 3 and 4. Eltrazane was also observed in the table, well 1 recorded 14.00mg/l, there was no indication of eltrazane in well 2, well 3 recorded 9.20 mg/l, well 4 recorded 11.29 mg/l and well 5 recorded 12.00mg/l. Eltrazane had its highest value in well 1 with a value of 14.00mg/l with the least value of 9.20mg/l recorded in well 3. Paraquat as a pesticide residue as observed on the table in well 1 recorded 3.80mg/l, well 2 recorded 2.00mg/l, well 3 recorded 1.8mg/l, well 4 recorded 2.24mg/l and well 5 recorded 4.20mg/l of paraquat. Paraquat had its highest value of 3.80mg/l in well 1 with its least value of 1.8mg/l in well 3. Aldrin also as a pesticide residue as observed on the table in well 1recorded 10.22mg/l, well 2 recorded 8.01mg/l, there is no indication of aldrin in well 3, well 4 recorded 1.22mg/l and well 5 recorded 2.22mg/l. Aldrin had its highest value in well 1 with a value of 10.22mg/l with the least value of 1.22mg/l in well 4. Chlordane as observed in table showed that in well 1 recorded 2.20mg/l of chlordane,

well 2 recorded 1.00mg/l, well 3 recorded 0.98mg/l, well 4 recorded 1.22mg/l and well 5 recorded 2.22mg/l. Chlordane had its highest amount of 2.20mg/l in well 1 and its least in well 3 with a record of 0.98mg/l.

Table 4: Pesticides Residue, Water Quality of Groundwater sources in Ishiagu and WHO Permissible Limit.

Parameters	Well G1	Well G2	Well G3	Well G4	Well G5	WHO
pH	7.00	6.73	6.90	6.75	7.11	6.5 – 8.5
Temperature (^{0}C)	28.6	27.8	28.0	28.5	28.6	30 – 32
Conductivity (µS/cm)	550	516	419	693	443	400
Resistivity (mΩ)	1.80	1.94	2.39	1.45	2.27	NIL
Salinity (mg/l)	0.27	0.25	0.20	0.34	0.22	NIL
Total Dissolved Solid (mg/l)	368	349	283	474	300	500
Dissolved Oxygen (mg/l)	2.61	1.92	1.08	3.89	1.36	5
DDT (mg/l)	34.56	13.41	8.20	30.69	42.33	0.001
GAMMALINE 20 (LINDANE) (mg/l)	4.33	6.00	1.55	3.23	1.96	0.002
ATRAZINE (mg/l)	2.0	0.98	0.24	1.8	2.00	0.002
CARBONFURAN (mg/l)	2.44	2.66	-	-	2.00	0.007
ELTRAZINE (mg/l)	14.00	-	9.20	11.29	12.00	-
PARAQUAT (mg/l)	3.80	2.00	1.8	2.24	4.20	-
ALDRIN (mg/l)	10.22	8.01	-	8.89	17.00	0.00003
CHLORDANE (mg/l)	2.20	1.00	0.98	1.22	2.22	0.0002

Table 4 shows the water quality results and pesticide residue of groundwater system in Ishiagu and world health organization standard for water quality. From the table it is observed that the pH value in the sampled well which ranges between 6.73 - 7.11 but the pH value is within 6.5-8.5 on the basis of this there all fall within the WHO acceptable limit.

Temperature as shown on the table ranges between 27.8^{0}C -28.6^{0}C and there are all within the WHO acceptable limits. Conductivity as observed ranges between 419 μS/cm - 693μS/cm, which are all above the WHO acceptable limits. Resistivity and salinity as observed do not have any WHO set limits and as such is not used to determine the quality of the water.

Total Dissolved solids as observed from the table ranges between 283mg/l -368mg/l while the WHO acceptable limit is 500mg/l. this however shows that TDS in the sampled wells are within the WHO acceptable limit. Dissolved oxygen as observed also ranges between 1.08mg/l -3.89mg/l while the WHO acceptable limit is 5mg/l , this however shows that the Dissolved Oxygen level of the sampled waters from the wells are within WHO acceptable limits.

DDT as observed on the table ranges between 8.20mg/l -42.33mg/l while the WHO acceptable limit is 0.001mg/l. This shows that the entire well tested have DDT values higher than the WHO acceptable limit. Gammaline as observed ranges between 1.55mg/l -6.00mg/l with the WHO acceptable limit of 0.002mg/l. The level of Gammaline in the wells sampled is higher than the WHO acceptable limit. This however is the same in the case of Atrazine and Carbonfuran except for wells 3 and 4 which show no presence of the residue.

Eltrazine and Paraquat as observed do not have any set limit by the World Health Organization, while in the case of aldrin, the table shows that it ranges between 8.01mg/l - 17.00mg/l with WHO acceptable limit of 0.00003 which however shows that the water sample are above the WHO set limit. Conclusively, Chlordane as observed ranges between 1.00mg/l – 2.20mg/l with a WHO acceptable limit of 0.0002mg/l. This however show that the water samples from the wells have chlordane value above the WHO acceptable limit.

The above table shows that the quality of groundwater from the wells in Ishiagu is polluted and as such has potential health effects on the consumers. Been the wells that are presently in use by residents of the area, there is evidence of health effects on the people.

Hypothesis Testing

H_0: There is no statistically significant variation in Pesticides residues pollutants in the different groundwater sources in Ishiagu.

Table 6: Result of ANOVA for variation in Pesticide Residue pollutants in the different groundwater sources in Ishiagu.

Source	SS	df	MS	F	P-value	F crit
Between Groups	339.467	4	84.86676	0.921245	0.462614	2.641465
Within Groups	3224.262	35	92.12176			
Total	3563.729	39				

The ANOVA table above reveals that calculated F statistic value for the analysis is 0.921245 while the critical value is 2.641465. Therefore, since the calculated F statistic value of 0.921245 is less than the critical value of 2.641465 at $F^4{}_{39}$ degree of freedom, the null hypothesis H_0 of no significant variation is accepted and the alternate hypothesis H_1 is rejected. From the result the study has revealed that there is no statistically significant variation in Pesticides residues pollutants in the different groundwater sources in Ishiagu.

Discussion of Findings

Firstly, the physico-chemical parameters of the water quality were tested and this showed that the following parameters were found to be in the groundwater in Ishiagu, pH, Temperature, Conductivity, Resistivity, Salinity, TDS and Dissolved Oxygen. These parameters were found to be in high concentration in the different wells sampled for the study. From the water quality analysis report, it was observed that pH had its highest value at well 5 located at Obinagu Ishiagu with a pH value of 7.11. It was the same for temperature with a value of 28.6^0C.

Conductivity as observed had its highest value in well 4 locate at Ihenetu Ishiagu, with a value of 693µS/cm while Resistivity was observed to by highest well 3 located in Amauzu Amaeze Ishiagu. In well 3 located in Amauzu Amaeze Ishiagu, salinity was highest with a value of 2.39mg/l.

Total Dissolved Solids as observed had its highest value in well 4 located at Ihenetu Ishiagu, with a value of 474mg/l and Dissolved Oxygen with a value of 3,89mg/l.

From the reports its observed that three out of the seven parameters tested in Ishiagu had their highest value in Ihentu Ishiagu where well 4 is located amongst them are; TDS, DO and Conductivity, this is followed by well 3 located in Amauzu-Amaeze Ishiagu which had the following parameter at the top most which are resistivity and salinity as well as well 5 which also had pH and Temperature value most. It is therefore observed that these three wells out of the five are more polluted than the others and show cases that well 1 and 2 seems better off than the others.

As observed in table 4.2 DDT, Gammaline, Altrazine, Carbonfuran, Eltrazine, Paraquat, Aldrin and Chlordane was all the pesticide residue of interest to this study. From the study it is seen that not all the pesticides residue is present in the sampled wells. Well 1 and well 5 had the entire pesticides residue present in them while well 2 experienced the absence of Eltrazine. Well 3 and 4 observed the absence of Carbonfuran. The absence of some of the pesticide indicates a reduced level of pollution compared with the other wells.

Eight pesticides residue were actually tested for in this study and their concentration showed that the concentration of DDT which is dichlorodiphenyltrichloroethane was more in well 5 with a value of 42.33mg/l, it was also observed that Gammaline concentration was more than the others in well 2 with a value of 6.00mg/l.

Altrazine was noted to be more in well 1 and well 5 with a value of 2.00mg/l respectively, Carbonfuran was observed to be highly concentrated in well 2 with a value of 2.66mg/l but was absent in well 3 and well 4. Eltrazene was more concentrated in well 1 with a value of 14.00mg/l and was found to be absent in well 2.

Paraquat also one amongst the pesticide residue tested was more concentrated in well 5, Aldrin was more concentrated in well 5 with a value of 17.00mg/l with well 2 not having any indication of its presence. Conclusively, Chlordane was found to be more concentrated in well 5 with a value of 2.22mg/l.

From the above, it is observed that amongst the pesticide residues tested in the different wells, well 5 was found to have a high concentration of more pesticide residues than the

other wells amongst which are DDT, Altrazin Paraquat, Aldrin and Chlordane. This is an indication of high level of pollutants in from the pesticide residue in the Ishiagu area.

pH, temperature, Resistivity, salinity, Total Dissolved Solids, Dissolved Oxygen are all within the WHO acceptable limits, Conductivity as observed from the different well exceeds the WHO acceptable limits.

For the pesticides residue, it is observed that Eltrazine and Paraquat have no set WHO standards. The other 6 pesticides residues in the sampled wells have values that are all above the WHO acceptable limits. The presence of excess DDT in water being consumed is an indication of pollution which however has significant impact on human. DDT presence is a causative factor to reproduction defect. In a study by Longnecker, Rogan, and Lucier it was discovered that the presence of DDT creates lower serum bilirubin and slightly elevated serum levels of selected liver functions. This however indicates that people in the area are exposed to these health effects.

In the case of Gammaline studies by the Agency for Toxic substances and Disease registry (2005) have it on a good account that exposure to these pesticides in large amounts can harm the nervous system producing a range of symptoms from headache and dizziness to seizures, convulsions, and more rarely, death and that there is possibility to cause cancer in humans.

Altrazine was also found to be in high amount which have detrimental health effects on man, this results were complemented by the results of the works of Grandjean and Landrigan, (2006); Goldman, (1997) who found out that Atrazine causes hormonal imbalances and sexual irregularities among other effects, reduced sperm count and male sterility has been documented as part of its effects.

Carbonfuran was also found to be in excess volume in all the sampled wells and its presence is a threat to human life. This agrees with the report of Rehman, Mohd, Sha, Hussain, Oyler, et al (2016) and Popovska-Gorevski, Dubocovich, Rajnarayanan (2017) who identified that Carbofuran has one of the highest acute toxicities to humans of any insecticide widely

used on field crops and occupational exposure to the Carbofuran has been reported that it impacts human health and well-being as much as the development of diabetes.

Aldrin also was found in excess amount in the wells in the study area Ishiagu, this also is an indication of water pollution which has health implications on the consumers. This finding agrees with the report of W.H.O (2003) which states that aldrin is highly toxic to humans, the target organs being the central nervous system and the liver. Severe cases of both accidental and occupational poisoning and a number of fatalities have been reported. Conclusively the study found that Chlordane was also in excess of WHO recommended level, this also reveals that the water is polluted and not suitable for consumption as it possess health effects on the consumers. The Agency further bolstered this for Toxic Substances and Disease Registry (1994) report, which affirms that most health effects in humans linked to chlordane exposure are on the nervous system, the digestive system, and the liver. Large amounts of chlordane taken by mouth can cause convulsions and death.

The findings of the study revealed the following;

1.That Conductivity amongst the physico-chemical parameters tested was the only parameter that the wells' value exceeded the WHO acceptable limits.

2.That the water quality of the wells in Ishiagu is polluted.

3.That well 4 amongst others is more polluted and that well 1 and 2 seems to be better than the others.

4.That well 5 located in Obinagu Ishiagu was found to have high concentration of more of the pesticide residues than the other wells amongst which are DDT, Altrazin, Paraquat, Aldrin and Chlordane.

5.The presence of DDT, Gammaline, Chlordane, Aldrin, Carbonfuran and Altrazine in concentration level above the WHO acceptable level shows potential impact of water consumption from the area.

6.Statistically, the study showed no significant variation in Pesticides residues pollutants in the different groundwater sources in Ishiagu. That difference exists in the sampled wells' water quality and the WHO acceptable limits for water quality.

Conclusion/Recommendation

Although so much studies have been done with respect to water quality and its attending health implication, but little or no attention have been given to pesticides residue within the study location which is a complete agrarian society with low level enlightenment level of the use, application and detrimental effects of these pesticides. The study therefore contributes to opening up a new area of interest with the study location on the essence of application of pesticides due to its agro benefits but with reverence to its effects both on human health and soil quality when applied wrongly as well as the need for cordoning the environment of application to reduce surface runoff which brings about surface water pollution and other effects. Comprehensive work has so far been done to justify the purpose for this exercise and on this, the following recommendations are made.

1.There is a need for Government intervention in the area of potable water provision having found that the water available to the people is polluted.

2.Agro education and enlightenment should be vigorously pursued in the area to ensure that pesticides are applied rightly in quantity and in accordance to land size.

3.Application of pesticides should be done professionally to ensure that Ban pesticides that have been found to have detrimental effects both on the environment and Human health such as Aldrin are no longer used.

4.There is also a need for periodic water test that the water consumed meets

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