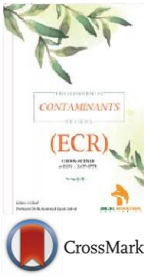
ZIBELINE INTERNATIONAL™ PUBLISHING

ISSN: 2637-0778 (Online)
CODEN: ECRNAE

Environmental Contaminants Reviews (ECR)

DOI: http://doi.org/10.26480/ecr.02.2025.64.68



RESEARCH ARTICLE

ASSESSMENT OF PESTICIDE CONTAMINANTS AND PHYSICOCHEMICAL QUALITY OF SELECTED NATURAL POND ECOSYSTEMS IN MAKURDI LGA BENUE STATE

Ikyurgen, A., Gberikon, G.M., Azua, E.T., Edinoh, D.O*

Environmental Science Unit, College of Biological Sciences, Joseph SarwuanTarka University Makurdi, Benue State, Nigeria
Corresponding Author Email: danedinoh99@gmail.com

This is an open access article distributed under the Creative Commons Attribution License CC BY 4.0, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

ARTICLE DETAILS

Article History:

Received 19 April 2025
Revised 21 May 2025
Accepted 29 June 2025
Available online 23 July 2025

ABSTRACT

Applications of pesticides in agricultural activities is on the increase in the study area. This study determined the physicochemical quality and pesticide profiling of selected natural pond ecosystems in Makurdi LGA Benue State. Water samples from four earthen ponds (Tyo Mun, Industrial layout, IdyeDogo, Aguba and North Core University of Agriculture Makurdi serving as control) were collected for physicochemical analysis pesticide profiling using HPLC. Results showed that the pond water pH values ranged from 7.80 to 8.78. Tyo-mu pond had the highest TDS (290ppm) while Industrial layout pond had the lowest (26ppm). The EC level was between (52 µmohs/cm and 590 µmohs/cm. The dissolved oxygen (DO) concentration ranged between 2.90 to 4.30. Biochemical oxygen demand BOD was low. The nitrate levels in the water samples ranged between 0.01 and 0.11 mg/L, while phosphate concentrations varied from 0 to 1.2 mg/L. Pesticide analysis indicated that Pendio Carb was absent in all samples. Propoxur residues in the water were found at levels ranging from below the detection limit up to 0.97 mg/L. It can be inferred that the water from five ponds and one earth dam contained no detectable pesticide residues, although estimated concentrations remained within acceptable limits. The levels of Pendio Carb, Permethrin, and Propoxur were all below the established maximum residue limits (MRLs), which accounts for the acceptable values observed in the physicochemical properties. Nevertheless, the findings highlight the need for regulatory agencies to enforce monitoring and control measures to prevent pesticide misuse in the area.

KEYWORDS

Pond water, pesticide contaminant, physicochemical analysis

1. INTRODUCTION

Pesticides are known to have effects on the physico chemical and biological properties of water with resultant effect on the overall water quality and aquatic life. Deterioration of aquatic ecosystem as a result of anthropogenic activities has been a threat to the structure, function and sustainability of the aquatic ecosystems. chemical and microbial contaminants. Agricultural activities including application of agrochemicals are implicated. Notable examples are fertilizers, pesticides, and herbicides applied in farmlands. They are leached into the sub soil and transported into surface and underground water, where they have pronounced effects on water quality and aquatic life forms (Yaw, 2010).

Pond water ecosystem plays important rolesas drivers of sustainable urban development, hence need to be well managed as human population increases in the urban areas (Hassall, 2014). Direct and indirect influx of agrochemicals into pond water alter the properties of ponds and render them non productive. The ecology of aquatic species determine the survivorship and productivity of the life forms. Nutrient enrichment of ponds (eutrophication) a result of agrochemicals causes algal bloom, a condition that increases the biochemical oxygen demand (BOD) and anoxic condition leading to the death of aquatic life (Kiran, 2010).

Benue State, popularly known as the food basket of the Nation, is a hub of agricultural activities in Nigeria. Farmers rely solely on the use of agrochemicals in food production. Pesticides are used intensively to protect crops from pathogens and weeds. At the same time, pond water ecosystems are many. Studies on the quality of these ponds as related to the presence or amount of pesticides in the water bodies are limited in the study area. There is need to evaluate the impacts of pesticide application on the properties of ponds.This study determined the physicochemical quality and pesticide profiling of selected natural pond ecosystems in Makurdi LGA Benue State.

2. MATERIALS AND METHODS

2.1 Study Area

The study was carried out in Makurdi, the Capital of Benue State in Nigeria. It hosts one of the largest river in Africa, the river Benue. Presence of pond waster ecosystems is another landmark (Chia et al., 2014). Annual temperature is generally high (26-32^{o}C). The city had a population of 297, 393 as at 2006 census (NPC) with an estimated annual growth rate of 2%.

2.2 Sampling

Water samples (0.5L each) were collected from four earthen ponds namely:

TyoMun, on Gboko Road Makurdi- Pond 1

Industrial layout, Naka Road Makurdi- Pond 2

IdyeDogo, High Level Makurdi - Pond 3

Aguba, Behind Nigerian Breweries Gaadi- Pond 4

Quick Response Code	Access this article online	
	Website: www.contaminantsreviews.com	**DOI:** 10.26480/ecr.02.2025.64.68

Cite The Article: Ikyurgen, A., Gberikon, G.M., Azua, E.T., Edinoh, D.O (2025). Assessment of Pesticide Contaminants and Physicochemical Quality of Selected Natural Pond Ecosystems in Makurdi Lga Benue State. *Environmental Contaminants Reviews, 8(2): 64-68.*

A concrete pond at North Core University of Agriculture Makurdi served as control pond. Water samples were collected using sterile screw capped bottles at approximately 0.3 m below the water surface for physicochemical analysis. Within pond samples were vertically stratified, one about 0.3 m below the surface (limnetic) and the other about 0.3m from the bottom (benthic). Samples were transported to the laboratory and analyzed within 24 hours. pH, conductivity, total dissolved solids, salinity and dissolved oxygen were determined on-site (Sashikesh and Navaratnarajah, 2012).

2.3 Physicochemical Analyses

The parameters were determined using Standard Methods of Analysis of Water and Wastewater (APHA, 1999).

2.4 pH Determination

The pH of the water samples was measured using a HANNA pH meter (UK). The probe was immersed in each sample and readings were recorded after stabilization. Measurements were taken in triplicate, and the average pH was calculated (APHA, 1999).

2.5 Electrical Conductivity Determination

Electrical conductivity was measured using a Crison Conductimeter Basic C30 (UK). The cleaned probe was immersed in 25 ml of water sample, and readings were displayed in µS/cm. The procedure was repeated three times, and the mean value recorded (APHA, 1999).

2.6 Dissolved Oxygen (DO) Determination

Using a HACH DO meter (Model 9071, UK), the probe was zeroed in distilled water, then placed in the sample to record DO levels in mg/L. Measurements were taken in triplicate and averaged (HACH, 1997).

2.7 Biochemical Oxygen Demand (BOD) Determination

BOD was calculated after incubating 5 ml of the water sample in the dark at 20°C for five days (Sashikesh and Navaratnarajah, 2012).

2.8 Turbidity Determination

Turbidity was assessed using a HACH DR/2000 spectrophotometer (UK) set at 750 nm. After calibrating with distilled water, 20 ml of the water sample was placed in a cuvette, inserted into the device, and the NTU reading was recorded. The instrument was recalibrated before each sample (APHA, 1999).

2.9 Total Dissolved Solids (TDS) Determination

TDS was measured with a Crison Conductimeter Basic C30 (UK). After zeroing the probe in distilled water, it was immersed in 25 ml of the sample. The reading in mg/L was recorded. Triplicate tests were conducted and the average value noted (APHA, 1999).

2.10 Sulphate Determination

Sulphate levels were measured using the DR/2000 spectrophotometer (UK) at a wavelength of 450 nm (program 580). After zeroing with 25 ml of deionized water, 25 ml of sample was mixed with SulfaVer 4 reagent, shaken, and left for 5 minutes to develop a white turbidity. The sample was placed in the cell holder, and the reading in mg/L was recorded. The test was done in triplicate (APHA, 1999).

2.11 Nitrate Determination

The NitriVer 5 method was used with the DR/2000 spectrophotometer (program 355, 500 nm). A blank of 25 ml deionized water was used to zero the instrument. Then, 25 ml of sample was mixed with NitriVer 5 powder, allowed to react for 1 minute, and placed in the cell holder. The nitrate concentration in mg/L was recorded. The procedure was repeated three times (HACH, 1997).

2.12 Phosphate Determination

Phosphate content was determined using the PhosVer 3 method on the DR/2000 spectrophotometer at 890 nm. After zeroing with 25 ml of deionized water, the same volume of sample was treated with PhosVer 3 reagent and allowed to react for 1 minute. The reading in mg/L was recorded. The test was repeated in triplicate (APHA, 1999).

2.13 Pesticide Profiling (HPLC)

Pesticide residues were analyzed using HPLC as described by (Chowdhury et al., 2012). A 500 ml water sample was processed using a SHIMADZU LC-10 Avp HPLC system with photodiode array detection at 30°C. Pesticides were identified by comparing sample retention times with those of standard compounds.

2.14 Statistical Analysis

Data were analyzed using ANOVA via MINITAB and SPSS (version 21) to determine statistically significant differences among treatments at a 95% confidence level ($p<0.05$).

3. Results and Discussion

Table 1 presents the average physicochemical characteristics of the pond water. pH values ranged from 7.80 to 8.78, with the highest in Tyo Mu Pond and lowest in Idye Dogo. These results align with studies, highlighting the importance of pH in aquatic ecosystems, where it affects factors like salinity, hardness, and nutrient availability by (Kumar et al., 2021; Sashikesh and Navaratnarajah, 2012). Total Dissolved Solids (TDS) varied across ponds, from 26 ppm in the Industrial Layout Pond to 290 ppm in Tyo Mu Pond, attributed to varying human activities. These values are consistent with findings, but much lower than those reported by (Mohamed, 2023; Abdel-Satar, 2005). Electrical conductivity (EC), which reflects the concentration of dissolved ions, was highest in Tyo Mu (590 µmho/cm) and lowest in the Industrial Layout Pond (52 µmho/cm), aligning with results from (Seetha and Chandran, 2020). Higher EC values generally indicate increased ionized substances in water. Dissolved Oxygen (DO) ranged between 2.90–4.30 mg/L, similar to values from (Seetha and Chandran, 2020; Mohamed, 2023). Low DO levels suggest organic decomposition. BOD values were low across all ponds (0–0.2 mg/L), with the Industrial Layout recording the lowest and Aguba and Control ponds the highest. Nitrate levels ranged from 0.01–0.11 mg/L, with the highest concentration observed in the Industrial Layout Pond, possibly due to sewage input. These levels are within the range reported by (Seetha and Chandran, 2020). Phosphate concentrations ranged from 0–1.2 mg/L, consistent with values reported by (Sashikesh et al., 2012; Mohamed, 2023). Turbidity ranged between 2.23 and 48.45 NTU, with lower values in the concrete Control pond and higher values in earthen ponds, influenced by environmental conditions.

3.1 Pesticide Residue Analysis (Table 2)

Pendio Carb was not detected in any sample, and all pesticide residue levels remained within safety limits (WHO, 1993). Propoxur, analyzed using MSPE–HPLC-PDA, ranged from below detection limits up to 0.97 mg/L, aligning with findings by, where residues were seasonally variable but undetected at the surface (Amine et al., 2019; Ezemonye et al., 2009). Organochlorine pesticides like aldrin and dieldrin were mostly undetected, confirming reports by (Sudi, 2017; Ismaila et al., 2020). However, trace amounts of organophosphates especially chlorpyrifos were present. Chlorpyrifos is notable for its bioaccumulation and toxicity due to its conversion to reactive metabolites (WHO, 2004; USEPA, 2016). Figures 1–8 illustrate correlations between physicochemical parameters and pesticide concentrations, reinforcing the need for continuous environmental monitoring.

Table 1: Mean Physicochemical Parameters of the Studied Pond Water

Parameter	Unit	Sample Location				Sample Mean	±SD	Control Mean	t-test	P-Value
		1	2	3	4					
Ph		8.78	7.99	7.80	7.82	8.10	0.46	8.21	45.11	P>0.05
TDS	Mg/L	292	26	65	141	131.00	117.48	251.00	3.01	P>0.05
EC	μScm^{-1}	590	52	132	284	264.50	237.37	507.00	3.01	P>0.05
DO	Mg/L	3.8	4.3	3.0	2.9	3.50	0.67	3.20	12.93	P>0.05
BOD	Mg/L	0.1	0.0	0.1	0.2	0.10	0.08	0.20	3.16	P>0.05

Table 1 (cont): Mean Physicochemical Parameters of the Studied Pond Water										
NO_3^-	Mg/L	0.01	0.08	0.03	0.11	0.06	0.05	0.01	2.40	P<0.05
PO_4^{3-}	Mg/L	0.09	0.09	0.22	1.2	0.40	0.34	0.00	0.72	P<0.05
Turbidity	NTU	38.71	22.20	47.45	38.87	36.81	10.56	2.23	3.69	P>0.05

Table 2: Mean Pesticide Presence and Concentration of the Studied Pond water		
Pesticide	**Concentration (µg/L)**	**Retention Time (Minutes)**
Pendilin	1.84	11.88
	2.65	12.34
	1.95	12.75
	1.92	16.23
	1.84	16.78
Propoxur	51.09	16.90
	50.08	17.84
	50.23	17.85
	50.98	18.09
	48.66	9.55
Permethrin	1.52	9.70
	2.26	10.51
	1.59	16.12
	1.56	17.21
	1.51	17.80

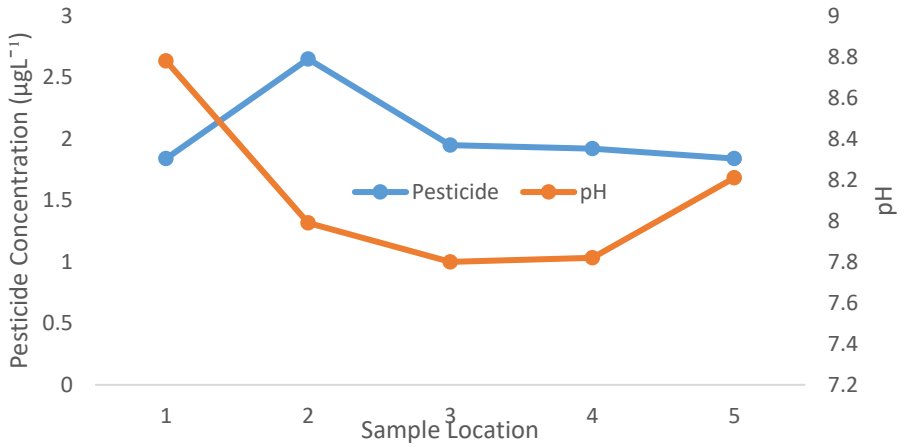


Figure 1: Relationship between Mean Pesticide Concentration and Pond water pH

Key: 1 = Tyo Mu; 2 = Industrial Layout, Naka Road; 3 = IdyeDogo; 4 = Aguba

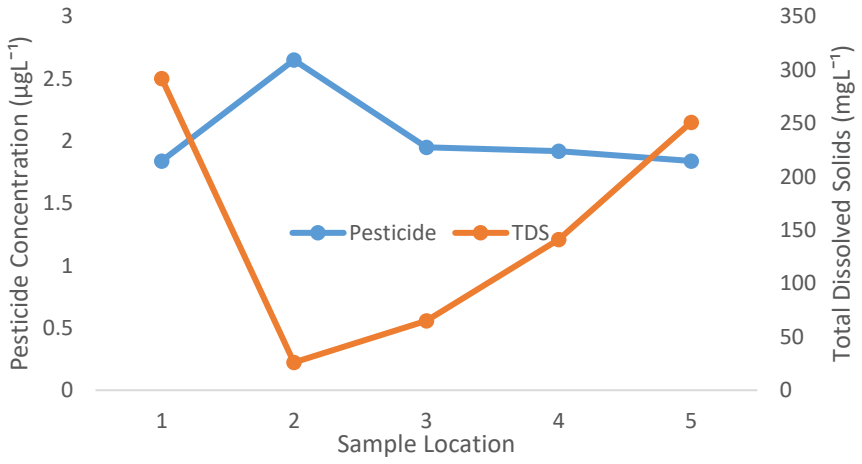


Figure 2: Relationship between Mean Pesticide Concentration and Pond Water Total Dissolved Solids (TDS; mgL^{-1})

Key:1 = Tyo Mu; 2 = Industrial Layout, Naka Road; 3 = IdyeDogo; 4 = Aguba

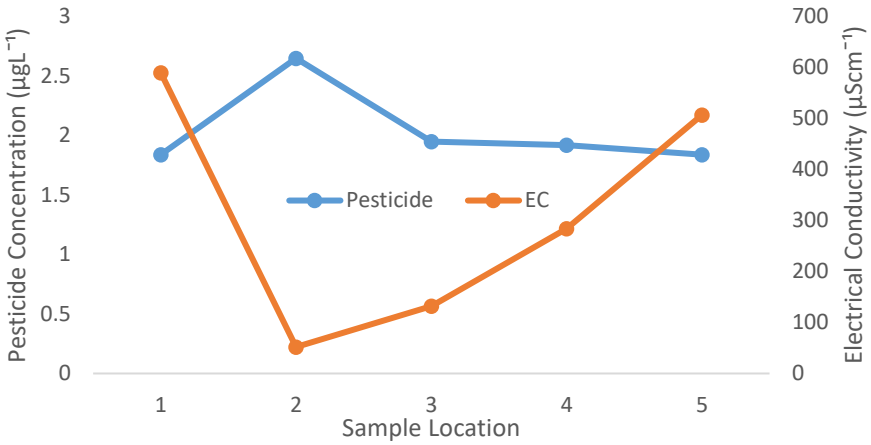


Figure 3: Relationship between Mean Pesticide Concentration and Pond Water Electrical Conductivity (µScm^{-1})

Key: 1 = Tyo Mu; 2 = Industrial Layout, Naka Road; 3 = IdyeDogo; 4 = Aguba

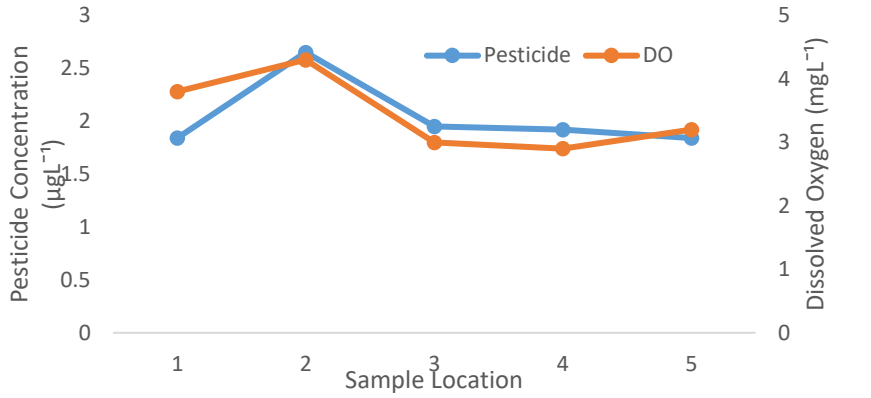


Figure 4: Relationship between Mean Pesticide Concentration and Pond Water Dissolved Oxygen Concentration (mgL^{-1})

Key: 1 = Tyo Mu; 2 = Industrial Layout, Naka Road; 3 = IdyeDogo; 4 = Aguba

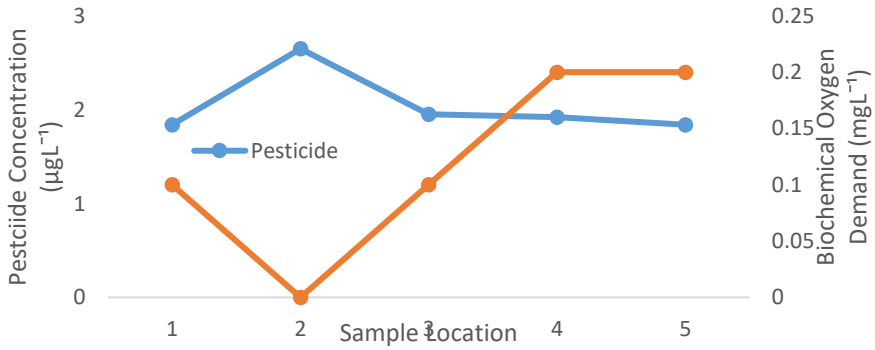


Figure 5: Relationship between Mean Pesticide Concentration and Pond Water Biochemical Oxygen Demand Concentration (mgL^{-1})

Key: 1 = Tyo Mu; 2 = Industrial Layout, Naka Road; 3 = IdyeDogo; 4 = Aguba

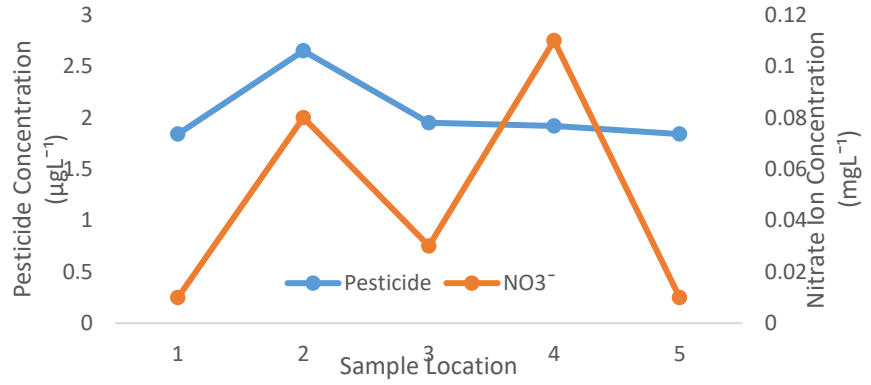


Figure 6: Relationship between Mean Pesticide Concentration and Pond Water Nitrate Ion Concentration (mgL^{-1})

Key: 1 = Tyo Mu; 2 = Industrial Layout, Naka Road; 3 = IdyeDogo; 4 = Aguba

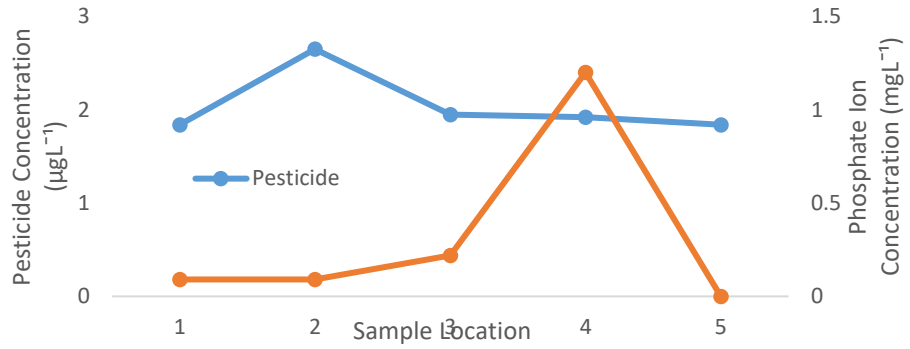


Figure 7: Relationship between Mean Pesticide Concentration and Pond Water Phosphate Ion Concentration (mgL^{-1})

Key: 1 = Tyo Mu; 2 = Industrial Layout, Naka Road; 3 = IdyeDogo; 4 = Aguba

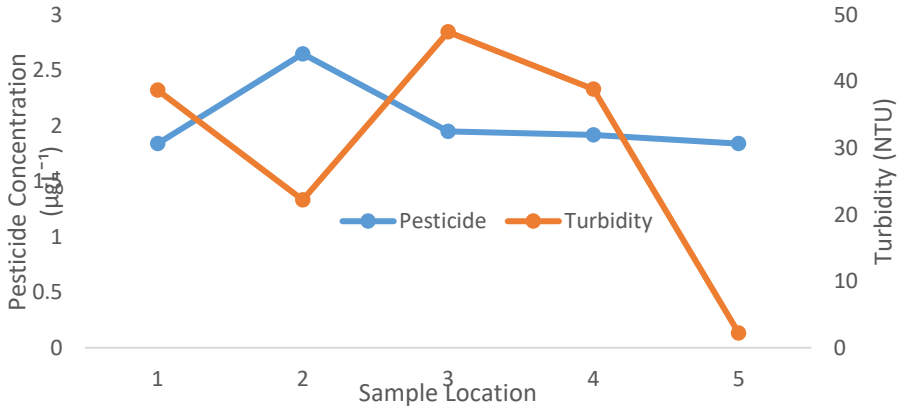


Figure 8: Relationship between Mean Pesticide Concentration and Pond Water Turbidity (mgL^{-1})

Key: 1 = Tyo Mu; 2 = Industrial Layout, Naka Road; 3 = IdyeDogo; 4 = Aguba

4. Conclusion

In conclusion, the water samples from five ponds and one earth dam contained no detectable pesticide residues, although the estimated concentrations remained within acceptable limits.. Pendio Carb, Permetrin and Propoxur pesticides are not above stipulated maximum residue levels (MRLs). Thisis the reason for the accepted values of physicochemical parameters. However, this study suggests monitoring and control systems to be implemented by the authorities to control the misuse of pesticides in the study area.

References

Abdel-Satar, A. M., 2001. Environmental studies on the impact of the drains effluent upon the southern sector of Lake Manzalah. Egypt. Journal of Aquatic Biology and Fisheries, 5 (3): Pp. 17-30.

Amine, G. C., Bilge, S., Halil, İ. U., Erkan, Y. A. K. and Marcello, L., 2019. Analytical Methodology for Trace Determination of Propoxur and Fenitrothion Pesticide Residues by Decanoic Acid Modified Magnetic Nanoparticles National Library of Medicine 8600 Rockville Pike Bethesda, MD 20894

APHA., 1999. Standard Methods for the Examination of Water and Wastewater, 20th edition (1998). American Public Health Association, 800 I Street, NW, Washington, DC 20001-3710. Pp. 73-80

Chia, V. D, Ijir, S. D, Iwar, R and Ndulue, E. R., 2014. The Contending Issues of Domestic Water Supply in Makurdi Metropolis, Benue State, Nigeria. Civil andEnvironmental Research 44: Pp. 1714– 1728.

Chowdhury, M.A.Z, Jahan, S.A, Islam, M.N, Moniruzzaman M., 2012. Occurrence of organophosphorus and carbamate pesticide residues in surface water samples from the Rangpur district of Bangladesh. Bull Environmental Contamination Toxicology, 89: Pp. 202-207

Ezemonye Lawrence, Ikpetsu Thomas, Tongo Isioma, 2009) Distribution of Propoxur in Water, Sediment and Fish from Warri River Niger Delta, Nigeria Turkish Journal of Biochemistry, 34 (3) ; Pp. 121–127.

HACH., 1997. Water analysis handbook. HACH Company, pp. 1309

Hassall, C., 2014. The ecology and biodiversity of urban ponds. Wiley Interdisciplinary Reviews: Water, 1 (2). pp. 187-206.

Ismaila, Y. S., S. A. Orji, M. U. Ahmed, and P. Alexander, 2020. Determination of Pesticide Residues in Pond and Earth Dam Water in Gella Using Gas-Chromatography–Mass Spectrometer (Gc-Ms). FUW Trends in Science and Technology Journal, 5(1): Pp. 315 – 318

Kiran, B.R., 2010. Physico-chemical characteristics of fish ponds of bhadra project at Karnataka. Rasayan Journal of Chemistry, 3: (4) Pp. 671-676

Mohamed H. A., 2023. Physico-chemical characteristics of Abu Za'baal ponds, Egypt, Egyptian Journal of Aquatic Research, 31 (2): Pp. 1-15

Sashikesh, G. and Navaratnarajah, K., 2012. Physicochemical Analysis of Pond Water Samples from Selected Areas in Valukkai Aru Drainage Channel, Jaffna, Sri Lanka. Water Research and Development, 2 (2): Pp. 12-23

Seetha, V. and Chandran, M., 2020. Comparative Analysis of the Physicochemical Parameters of Selected Pond Water Samples in and around Vellore District, India International Journal of Current Microbiology Applied Science 9(4): Pp. 1373-1382

Tyubee, B. T., 2009. The influence of ENSO and North Atlantic sea surface temperature anomaly (SSTA) on extreme rainfall events in Makurdi, Nigeria. Meteorological Climate Science, 7: Pp. 28-33.

Velauthamurthy, K., 2001. Some quality parameters of ground well water in the Jaffna peninsula. Department of Chemistry, University of Jaffna, Sri Lanka. B. Sc. Thesis

Yaw, B. A., 2010. Characterization of Pond Effluents and Biological and Physicochemical Assessment of Receiving Waters in Ghana. Thesis submitted to the faculty of the Virginia Polytechnic Institute and State University. Blacksburg, Virginia. Pp. 23-25