Kaduna State University Environmental Science Journal (KESJ)
Website: *https://kesj.org.ng* ***ISSN:*** *2734-2751*

Volume 5, Issue 2, December 2025
DOI: https://doi.org/10.66884/kesj.2025.0w1ddtkh

Hydro-chemical Characterization of Domestic Wastewater Quality using Nemerow Pollution Index and Geo Accumulation Index within Greater Jos, Plateau State, Nigeria.

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ABSTRACT

Purpose: *Water is becoming an increasingly scarce resource and water resources planners and managers are compelled to cogitate any source of water which might be used parsimoniously and efficiently to promote development, in line with this the reuse of treated domestic wastewater for agriculture amongst other uses is currently receiving attention as a reliable water source. This study was carried out to characterize wastewater, determine its pollutant load index, contributing factor and also to generate data on wastewater management in Greater Jos metropolis.*

Design/methodology/approach: *The field survey method was adopted with collection of wastewater samples from 660 representative households was channeled into detention basin and then discharged into drainages. The sample collection and laboratory analysis were carried out within 2 weeks for a research period of 4 years, and a range of water quality parameters were measured and compared with NESREA discharge limits.*

Findings: *Laboratory, Nemerow's pollution index and Geo accumulation index values indicated that Total Suspended Solids, Chemical Oxygen Demand, Total Phosphate, Ammonia, Oil and grease, total and feacal coliform in the wastewater samples were quite high and have exceeded the maximum discharge limits of NESREA.*

Research limitations/Implications: *Since domestic wastewater is not treated before release into the environment in developing countries, it may lead to eutrophication in receiving water bodies and also create environmental conditions that aid spread of waterborne pathogens of toxin-producing cyanobacteria which have effects on plants when used for irrigation.*

Practical Implications: *To regulate the discharge of domestic wastewater into receiving freshwater bodies and the environment in general, regular monitoring and appropriate legislations are necessary.*

Keyword: Domestic wastewater, Geo accumulation index, Nemerow's pollution index, contributing factors.

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1.0 INTRODUCTION

The impediments associated with sewage disposal have become a major problem of the urban world due to human population explosion as well as rapid urbanization**.** The cohesion of sewage related problems throughout urban areas of the world is significant since urban areas are inhabited by over 60% of the human population. Consequently, domestic wastewater discharges are considered one of the most significant threats to the environment worldwide. Similarly, rapid urbanization in developing countries poses sanitation issues and these challenges are related to domestic wastewater management and treatment for the protection of human health and the environment. Domestic wastewater management has long been regarded as a barrier to environmental and freshwater bodies improvement (Lüthi, McConville & Kvarnström, 2010; Katukiza *et al.*, 2015)**.** Hence, domestic wastewater pollution can occur as a result of indiscriminate wastewater disposal or a broken pipe. This could happen as a result of human activities in the environment. When wastewater is channeled into the soak away, it pollutes the environment. There will be no infiltration into the soil once the soil infiltration capacity has been reached as a result, total saturation occurs and this causes the septic tank or soakaway to overflow, consequently, the concentration of these substances in the environment have reached levels that may cause discomfort or harm to humans, fauna, or flora (Abdullateef *et al.*, 2020). Because of poor domestic wastewater management has an impact on the environment and public health, Nigeria requires special attention and solutions for domestic wastewater management. Ineffective wastewater management has become more recognized as a resource rather than waste in recent years, in addition to being connected to environmental deterioration and major health problems. (Morel & Diener, 2006). Although, it has been reported that domestic wastewater contaminants such as pathogenic microorganisms, oil, fat, soaps and detergent, and household chemicals (Morel and Diener, 2006), It is further reported that humans are regularly exposed to Quaternary Ammonium Compounds (QACs). QACs are disinfectants that are widely used in hospitals, restaurants, and the food manufacturing industry (US EPA, 2006). They can also be found in a variety of household cleaning products, Their widespread use has resulted in significant pollution of the environment (Hrubec *et al.*, 2021). QAC disinfectants have traditionally been thought to be low in toxicity. Although constant exposure may cause contact dermatitis, hypersensitivity ocular irritation, inflammation, and asthma (Bernstein *et al.*, 1994; Hong & Bielory, 2009). The use of such household cleaning and personal care products, without a doubt, contributes to the amount of domestic wastewater discharged into the environment daily (Dwumfour-Asare *et al.*, 2020). It is on the basis on the issues raised above, that this study aims at presenting the findings of the study on household wastewater using Nemerow's Pollution Index (NPI) and Geo Accumulation Index (GAI) on domestic wastewater as well as the contributing factors to the poor quality of domestic wastewater in Greater Jos metropolis.

2.0 THE STUDY AREA

The study area is the Greater Jos metropolis, the capital of the State. It is bounded by the latitudes N 9º 45′ and N 10º 00′ and longitudes E 8º 55′ and E 9º 00′ (Figure 1). The study area covers: (a) Jos North and Jos South Local Government Areas and (b) Parts of Jos East, Bassa, Riyom and Barkin Ladi Local Government Areas (Figure 1). The total area covers approximately 1,362 square kilometres, made up of scattered inselbergs, settlements, numerous streams and burrow pits or mining ponds that are interspersed by expansive relatively flat and undulating land (Fola Consult, 2009). This area is largely covered by the topographical sheet Naraguta NE 168. It is bounded by Bauchi plains to the North, Barkin-ladi (Jos South) in the south, Bassa Local Government in the west and Jos East Local Government.

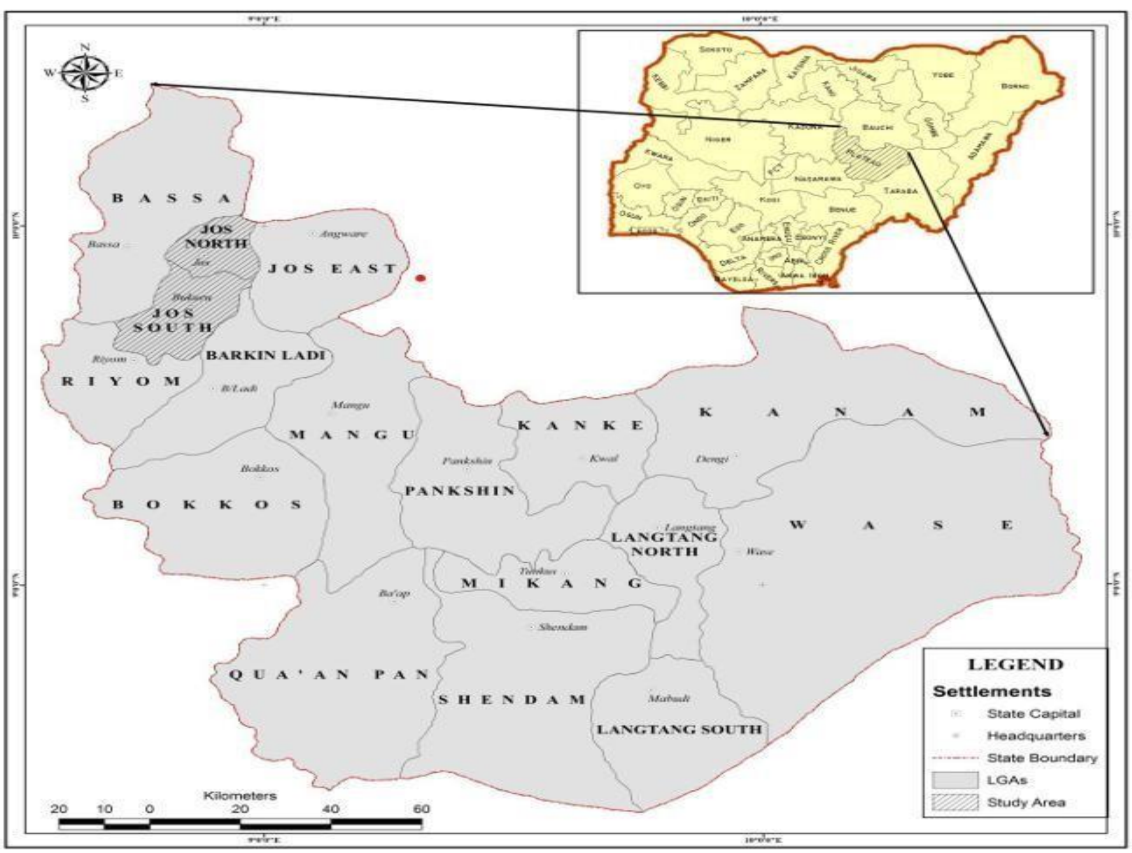


Figure 1: Plateau State showing the Greater Jos Urban Area Metropolis,
Source: GIS Unit, Department of Environmental Management, Kaduna State, University. (2023)

3.0 MATERIALS AND METHODS

The Plateau State Water Board delineated greater Jos metropolis into 21 water supply districts. To determine the sample size, the Krejcie and Morgan (1970) table was used, resulting in a sample of 378 respondents at a 95% confidence level and a 5% margin of error. Due to the large population, a systematic sampling approach was employed. First, all 21 districts were listed alphabetically. Then, every third district was selected, resulting in seven districts with a total of 8,402 piped water connections. The number of respondents from each selected district was then proportionally allocated based on the number of connections in each district.

In the study area, wastewater from the household laundry, bathroom and kitchen sink sources was channelled and connected to the detention basin via a PVC pipe of about 3 to 5 inches wastewater samples from the households were collected through a pipe by gravity from the experimental site to the detention basin. The samples were collected and analysed in triplicates and flow rate measurement and other sample analyses. The domestic wastewater collection was carried out mainly in the morning between 6 am for (48 months).

The domestic wastewater samples were collected with a sterilized plastic container daily from 8 am for 2 weeks intervals for 4 months from the pipe household channelled to the detention basin. The sample was analysed immediately, after sample collection and the rest sample was carried to the laboratory with an icebox for analysis instantly**.** The selected physical parameters measured onsite include pH, temperature, turbidity (NTU), electric conductivity (EC), and total dissolved solids (TDS) using the plainest pH meters although the other chemical and microbial parameters determined in the laboratory are Total Suspended Solids (TSS), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Nitrate (TN), Total Phosphate (TP). Ammonia, Oil/Grease, Total Coliform (TC), and Faecal Coliform (FC). The above mention parameters were analysed in accordance with the standard method of examination of water and wastewater according to the 22nd edition (APHA, 2012) protocols.

4.0 POLLUTANTS ASSESSMENT METHODS

There are numerous ways to evaluate household wastewater quality. In this study, Nemerow's Pollution Index (NPI) calculation and Geo Accumulation Index (GAI) were employed to assess the level of contamination in household wastewater.

a. Nemerow's Pollution Index (NPI) Calculation.

Nemerow's Pollution Index (NIP) is a simple pollution index developed by Nemerow (Rathod, Shantilal., Mohsin, & Farooqui, 2011). NPI is used to assess the overall pollution status of physical, chemical, and microbial parameters because different parameters can have different effects on the same station(Shen *et al.*, 2019; Ajani, Popoola, & Oyatola, 2021). As a result, NPI values for a wastewater parameter can be evaluated and calculated using NPI, which is advantageous in terms of providing a quick and simple assessment of domestic wastewater results. The NPI is one of the simplified pollution indexes and can be calculated using the following equation. Meanwhile, Nemerov's Pollution Index values help in determining or identifying parameters are responsible for polluting or deteriorating domestic wastewater (Swati & Umesh, 2015; Lamare & Singh, 2016).

$$NPI = \frac{C_i}{L_i} \qquad \text{........ (1)}$$

Where;

Ci is the measured concentration of i^{th} parameter, Li is the discharge limit of i^{th} parameter.

Nemerow has no limits, Li values for different domestic wastewater parameters are shown in Table 4. If the NIP of domestic wastewater parameters value is less than one it indicates no pollution but when it is greater than one it indicates there is pollution. Meanwhile, parameters that are greater than one, are known for contributing pollution in wastewater.

b. Geo Accumulation Index (GAI) Calculation

The Geo Accumulation Index is used to calculate the degree or level of contamination. Muller (1969), pioneered the use of GAI. It is also used as a tool to summarize and interpret raw analyzed data into a single GAI index value, which then specifies the parameter concentration level in samples. Initially, the main focus of this index method was to determine the heavy metal concentration in sediment samples, but later on, a few researchers used it to determine heavy metal contamination levels in various components of the environment, such as soil, water, and sediments, and so on (Raj & Jayaprakash, 2008; Cai *et al.*, 2015; Abdullateef *et al.*, 2020; Kowalik, Latosińska & Gawdzik, 2021).

The GAI index is designed to determine the concentration of a single physical, chemical, microbial and heavy metal parameter at a time. The GAI is a tool for summarizing and interpreting any raw data into a single GAI value, which then specifies and represents the contamination level of any specific parameters of interest. As a result, the GAI index is interned to calculate the concentration of a single physical, chemical, microbial and heavy metal at a time. Furthermore, the GAI method is divided into seven grades or classes, with index classes ranging from 0 – 6 (Muller, 1969).

Table 1: Classification of Geo Accumulation Index

GAI value	Class	Level of Pollution
< 0	0	Uncontaminatied
0 -1	1	Uncontaminated to moderatly contaminatied
1 -2	2	Moderately contaminated
2 – 3	3	moderately to heavily (strongly contaminated)
3- 4	4	Heavily (strongly contaminated)
4 -5	5	Heavily (strongly) to extremely contaminated
> 5	6	extremely contaminated

Adopted from Muller G, (1969)

This represents the GAI values; thus, it will be from the calculation, and the value obtained from the calculation will fall under the GAI value. Following the calculation, it will be discovered that if the GAI value of each parameter is negative, there is no contamination, whereas if the GAI value is positive, there is contamination contributing to the pollution. And if the level of contamination continues to rise or escalate as the GAI value rises.

GAI will be used to determine the degree of contamination level for the household wastewater. The GAI value will be computed using the provided equation.

$$GAI = log2 \frac{Cn}{15 * Bn} \quad \textbf{………... (2)}$$

Where;

Cn = Mean concentration of a given parameter in domestic wastewater sample analyzed.

NB = 1.5 value is a factor used as a constant for possible variation.

B_{n} = is obtained by using the standard discharge limit prescribed by NESREA.

5.0 RESULTS AND DISCUSSION

Table 2: Data collation from the selected households through a survey

Household characteristic	Measures Volumes of SDM items distribution

(N= 660)

Household code	Hh	Hh1 – Hh660	
Sex of respondents	Female	All-female	
Respondent age		44.6	Average
		56	Maximum
and Mohammed Tukur YAKUBU			
		34	Minimum
Household number		5.42	Average
		7	Maximum
		4	Minimum
Youngest household member		9.2	Average
		20	Maximum
		2	Minimum
Oldest household member		44.6	Average
		56	Maximum
		34	Minimum
Water sources	Groundwater (Borehole pipe)	660	
Domestic wastewater disposal	Discharges into Soak away	292	
	Discharge into surface drain	368	
Household cleaning products	Detergent	120	
	Hand sanitizer	168	
	Dishwashing liquid	112	
	Bar Soap	102	
	Disinfectants (Bleach)	92	
	Antiseptics	66	
Personal care products	Hair cream	232	
	Body cream	191	
	Body spray	79	
	Lip stick	83	
	Shampoo	46	

Hair conditioner	29

Source: Field Survey, (2024)

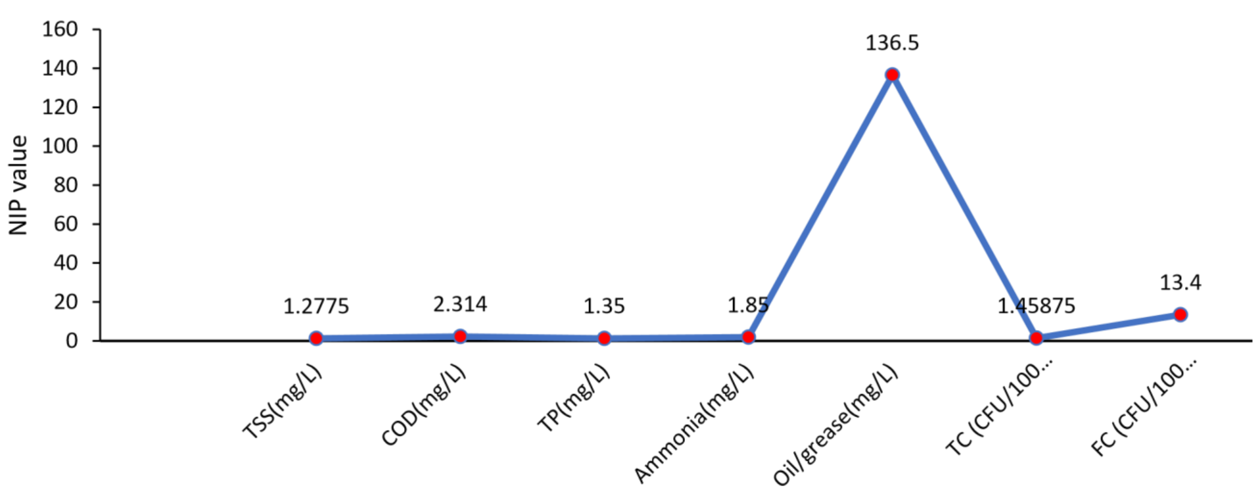
Table 3: Domestic wastewater characteristics

Parameters	Units	Minimum	Maximum	Average ±S D	NESREA Discharge Limit
pH		6.0	7.5	6.7 ± 0.52	6.5 – 9
Temperature	ºC	23.7	26.9	25.7 ± 1.23	
EC	(µS/cm)	143	302	248.3 ± 60.88	1500
TDS	(mg/L)	71.2	154	129.8 ± 32.48	1000
Turbidity	(NTU)	3.3	56.4	46.1 ± 18.11	75
TSS	(mg/L)	20	134	63.9 ± 55.30	50
BOD	(mg/L)	20	38	28.0 ± 6.68	50
COD	(mg/L)	540	602	578.5 ± 31.89	250
TP	(mg/L)	2.63	2.7	2.7 ± 0.04	2.0
TN	(mg/L)	2.41	3.41	3.0 ± 0.52	50
Ammonia	(mg/L)	1.8	1.9	1.9 ± 0.05	1.0
Sulphate	(mg/L)	42	43	42.4 ± 0.52	200
Oil/grease	(mg/L)	580	780	682.5 ± 69.23	5
Total coliform	(CFU/100 mg/L)	540	602	583.5 ± 27.17	400
Faecal coliform	(CFU/100 mg/L)	120	168	133.5 ± 19.27	10

Source: Laboratory Analysis, (2024)

Table 4: Domestic wastewater data and calculation of Nemerow's Pollution Index values

Parameters	Units	Domestic wastewater value (Cn)	Discharge limits (Ln)	NIP value
pH		6.7	6.5 -9	0.89333333
EC	(µS/cm)	248.25	1500	0.1655
TDS	(mg/L)	130	1000	0.13
Turbidity	(NTU)	46.0875	75	0.6145
TSS	(mg/L)	63.875	50	**1.2775**
BOD	(mg/L)	28	50	0.56
COD	(mg/L)	578.5	250	**2.314**
TP	(mg/L)	2.7	2	**1.35**
TN	(mg/L)	3.0975	50	0.06195
Ammonia	(mg/L)	1.9	1	**1.85**
Sulphate	(mg/L)	42.375	200	0.21187



				5
Oil/grease	(mg/L)	682.5	5	**136.5**
Total coliform	(CFU/100 mg/L)	583.5	400	**1.45875**
Faecal coliform	(CFU/100 mg/L)	134	10	**13.4**

Source: Laboratory Analysis and Statistical Computation, (2024)

Figure 2: Nemerow's Pollution Index for Domestic wastewater Source: Field Survey, (2024)

Table 5: Calculation of Geo Accumulation Index for Domestic wastewater in Greater Jos Metropolis

B Parameters	Units	Domestic wastewater (Cn) Mean Concentration untreated	Constant value	Discharge limits (Bn)	Constand *Bn	Cn/constant*Bn	GAI value $log2$ Cn/Constant*
pH		6 – 9	1.5	7.5	11.25	0.596	-0.748
Electrical conductivity	(µS/cm)	248.25	1.5	1500	2250	0.110	-3.180
Total Dissolve Solid	(mg/L)	130	1.5	1000	1500	0.087	-3.528

Turbidity	(NTU)	46.0875	1.5	75	112.5	0.410	-1.287
TSS	(mg/L)	63.875	1.5	50	75	0.852	-0.232
BOD	(mg/L)	28	1.5	50	75	0.373	-1.421
COD	(mg/L)	578.5	1.5	250	375	1.543	0.625
Total Phosphate	(mg/L)	2.7	1.5	2.0	3	0.900	-0.152
Total Nitrate	(mg/L)	3.0975	1.5	50	75	0.041	-4.598
Ammonia	(mg/L)	1.9	1.5	1.0	1.5	1.233	0.303
Sulphate	(mg/L)	42.375	1.5	200	300	0.141	-2.824
Oil/grease	(mg/L)	682.5	1.5	5	7.5	91.000	6.508
Total coliform	(CFU/100 mg/L)	583.5	1.5	400	600	0.973	-0.040
Faecal coliform	(CFU/100 mg/L)	134	1.5	10	15	8.933	3.159

Source: Laboratory Analysis and Statistical Computation, (2024)

Table 6: Result for Geo Accumulation Index (Pollution Levels of Domestic wastewater in Greater Jos Metropolis)

Parameters	Units	GAI Value	GAI Class	GAI Pollution levels
pH		-0.75	0	Unpolluted
Electrical conductivity	(µS/cm)	-3.18	0	Unpolluted
Total Dissolve Solid	(mg/L)	-3.53	0	Unpolluted
Turbidity	(NTU)	-1.29	0	Unpolluted
TSS	(mg/L)	-0.23	0	Unpolluted
BOD	(mg/L)	-1.42	0	Unpolluted
COD	(mg/L)	0.63	1	Unpolluted to moderately polluted
Total Phosphate	(mg/L)	-0.15	0	Unpolluted
Total Nitrate	(mg/L)	-4.60	0	Unpolluted
Ammonia	(mg/L)	0.30	1	Unpolluted to moderately polluted
Sulphate	(mg/L)	-2.82	0	Unpolluted
Oil/grease	(mg/L)	6.51	6	Extremely polluted
Total coliform	(CFU/100 mg/L)	-0.04	0	Unpolluted
Faecal coliform	(CFU/100 mg/L)	3.16	4	Heavily (strongly polluted)

Source: Field Survey, (2024)

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The wastewater generated by the household's kitchen sink, laundry, and bathroom was characterized. The following factors influenced the information and data. The gender of the respondent (female or male); in this case, females were the lead respondent, with ages ranging from 56 to 34. The water source was groundwater accessed using boreholes, which served as the primary water supply source in Greater Jos metropolis since water supply from the municipal water supply authority is erractic. Furthermore, because the household borehole water supply is unlimited, the amount consumed could not be determined. In addition, wastewater from the houses is channeled through a PVC pipe and discharged into drainages. Cleansing products (chemical), such as bleach, izal, detergent, hand sanitizer, dishwashing liquid, and antiseptics, and personal care products (hair and body cream, body spray, lipstick, shampoo, and hair conditional), all play a role and are also affected by people's lifestyles as presented in Table 2. As a result, chemical and biological degradation occur during domestic wastewater transportation, storage and discharge (Eriksson *et al.*, 2002). Meanwhile, surfactants, sulphate, chlorine, and nutrients are abundant in cleansing and personal care products derived from household wastewater. The chemicals derived from the household wastewater are extremely toxic to plants and aquatic ecosystem when used for irrigation, and are discharged into the river without treatment (Boyjoo, Pareek, & Ang, 2013).

It was observed that detergent, bar soap, dishwashing liquid, hand sanitizer, disinfectants (bleach), and hair and body creams were the most commonly used cleansing and personal care products. Antiseptic, body spray, shampoo and hair conditioner, and lipstick are the least used cleansing and personal care products as shown in Table 1. As a result of the use of these cleansing and personal care products, anionic surfactants, nutrients, organic substances, microbial contaminations, sulphate, alkali salts of long-chained fatty acids from the soap, and other pollutants are likely to be present in household wastewater (Eriksson *et al.*, 2002; Albalawneh & Chang, 2015; Dwumfour-asare, Nyarko & Essandoh, 2020).

The statistical parameters for the household wastewater sample in the study area are presented in Tables 3. The observed value for pH of domestic wastewater range between 6.0 -7.5 and an average value of 6.7. This may be related to the household activities performed, which include washing plates, laundry, and bathing, this also may be due to the presence of alkaline materials found in the detergents used for washing and cleaning (Jakobi, 1987; Vivan, et al; 2023b).The pH of 6.0 – 7.5 is considered suitable for the treatment of domestic wastewater (Shah *et al.*, 2014). And also, favourable for nutrient absorption and the biochemical reaction of the living organisms (Qin *et al.*, 2016). The minimum value of temperature in the wastewater sample was 23.7ºC whereas, the maximum value was 26.9ºC and an average wastewater temperature of 25.7 ± 0.52ºC was recorded during the study. Also, the high temperature in the wastewater may originate from the activities performed in the household such as cooking, bathing, and laundry with warm water (Oteng-Peprah, Acheampong, & deVries, 2018).The turbidity has a minimum value of 3.3NTU and a maximum value of 56.4NTU, with an average of 46.1 ± 18, which is primarily influenced by household activities. Because of the presence of suspended matter, domestic wastewater, which gets the majority of its nutrients from the kitchen and laundry, is likely to be turbid. But in this case, it is within the discharge limit. Electrical Conductivity is a measure of the salinity of all dissolved ions present in domestic wastewater. Though, electrical conductivity is commonly associated with groundwater sources due to dissolved materials (Vivan, et al; 2023a). The type of pipe (old) used to connect water to the houses may also contribute to an increase in electrical conductivity caused by leaching into groundwater. Electrical conductivity recorded a minimum and maximum value of 143 (µS/cm) and 302 (µS/cm) respectively. While the average value of 248.3 ± 60.88(µS/cm). Total dissolved solids represent the various minerals types found in domestic wastewater. The TDS are organic salts compounds dissolved in domestic wastewater that include Ca^{+2}, Mg^{+2}, $SO4^{2-}$, $^{K+}$, $Na^{+,}$ $HCO3^{-}$, Cl^{-} and a small amount of organic matter. The amount of TDS detected

could be due to household activities. As a result, it can be found in the chemicals and organic waste from the kitchen and laundry as well as in household water pipe, heaters, and boilers. TDS levels ranged from 71.2mg/L and 154mg/L with an average of 129.8 ± 32.48mg/L. AS a result, the EC and TDS are all below the discharge limit. Total suspended solids values ranges from 63.9 ± 55.30 with a minimum 20mg/L and maximum of 134 mg/l, It is therefore above NESREA maximum permissible limits, this findings concur with findings of a study by Vivan, et al (2020). This could be due to the organic waste from the kitchen sink. Biochemical oxygen demand in domestic wastewater measured the amount of organic compounds oxidized biologically rather than chemical, whereas COD measures also the amount of the oxidized chemically rather than biological. The BOD and COD content indicated the risk of oxygen depletion due to organic matter degradation during transportation. The BOD level ranged from 28.0 ± 6.68mg/L with a minimum of 20mg/L and maximum of 38mg/L, which fell within NESREA discharge limits. While COD levels also ranged from 578.5 ± 31.89mg/L with a minimum of 540mg/L and maximum of 38mg/L, which is above NESREA discharge limits. The total phosphate level ranged from 2.7 ± 0.04mg/L with a minimum of 2.63mg/L and maximum of 2.7mg/L. Ammonia with a minimum of 1.8mg/L and maximum of 1.9 and average range of 1.9 ± 0.05, which are all above NESREA discharge limits. The total Nitrate levels has a minimum of 2.41mg/L and a maximum of 3.41mg/L with a an average level of 3.0 ± 0.52. Sulphate level range of 42.4 ± 0.52mg/L and a minimum of 42mg/L and maximum of 43mg/L, which are all within NESREA discharge limits. Oil and grease levels ranged from 682.5 ± 69.23mg/L with a minimum of 580mg/L and a maximum of 780mg/L, this exceeds NESREA discharge limits. The high oil and grease content in domestic wastewater within the study area is as a result of cooking oil, personal care product such as hair and body cream, and spray being used by the household, this is in line with the findings of Vivan et. al (2012) in study titled "Effects of Effluent discharge of Kaduna Refinery on the Water Quality of River Romi". Total coliform and a minimum of 540CFU/100mg/L and maximum 602CFU/100mg/L with an average range of 583.5 ± 27.17 CFU/100mg/L and faecal coliform and a minimum of 120 CFU/100mg/L and maximum 168CFU/100mg/L with an average range of 133.5 ± 19.27CFU/100mg/L, indicating that they are all above NESREA discharge limits The high feacal and total coliform levels in the domestic wastewater may contain a variety of microorganisms as a result of uncooked food and raw meat and fish contamination from kitchen sink.

Table 4 and figure 2 revealed the NIP results of the parameter that indicated the presence of the surplus amount of concentration. Also, a particular parameter has the potential of contributing pollution to the household wastewater. Therefore, the following parameter shows the NIP value which is responsible for deteriorating the household wastewater.: TSS value of 1.2775, TP 1.35, total coliform 1.45875, Ammonia 1.85, COD 2.314, faecal coliform 13.4 and oil/grease 136.5. With oil/grease and faecal coliform having the greatest contributing values after calculation.

Tables 5 and 6 presents the GAI value degree of contamination of the wastewater from households within Greater Jos metropolis. The negative GAI value is due to relatively low levels of contamination in domestic wastewater: pH, EC, TDS, turbidity, TSS, BOD, TP, TN, sulphate, and total coliform and they show no degree of pollution. However, high GAI values for COD, ammonia, oil/grease, and faecal coliform indicated that domestic wastewater is contaminated and showed a wide range of pollutants.

COD and ammonia are unpolluted to moderately contaminate. The high COD and ammonia contamination found in domestic wastewater originated from the decay of organic kitchen waste, and laundry water containing high chemical concentrations from bar soap, and powder detergents (WHO, 2006).Oil/grease is extremely polluted whereas faecal coliform is heavily (strongly contaminated) with a higher degree of pollutant.

5.1 Contributing factors

The major contributing factors for domestic wastewater is eutrophication, which can stimulate the growth of algae, increased water purification cost, interference with the recreational value of water, health risks to humans and livestock, excessive loss of oxygen and undesirable changes in aquatic populations others are detergent, bar soap, dishwashing liquid, hand sanitizer, disinfectants (bleach), and hair and body creams were the most commonly used cleansing and personal care products. Similarly, the high use of hand sanitizer, Antiseptic, body spray, shampoo and hair conditioner, lipstick and other personal care products when washed off constitute the major components of domestic wastewater. As a result of the use of these cleansing and personal care products, anionic surfactants, nutrients, organic substances, microbial contaminations, sulphate, alkali salts of long-chained fatty acids from the soap, and other pollutants are present in household wastewater and are the major contributing factors in domestic wastewater contamination

5.2 Public Health Risk Assessment

Diseases caused by bacteria, viruses and protozoa are the most common health hazards associated with untreated drinking and recreational waters. The main sources of these microbial contaminants in wastewater are human and animal wastes. These contain a wide variety of viruses, bacteria, and protozoa that may get washed into drinking water supplies or receiving water bodies.

Microbial pathogens are considered to be critical factors contributing to numerous waterborne outbreaks. Many microbial pathogens in wastewater can cause chronic diseases with costly long-term effects, such as degenerative heart disease and stomach ulcer amongst other diseases.

From the results of the laboratory analysis of the domestic wastewater samples collected in Greater Jos metropolis, it was found that the following parameters Total Dissolved Solids (TSS), Chemical Oxygen Demand (COD) Ammonia, Oil/Grease, Total Coliform and Feacal Coliform are far and above the NESREA discharge limits and have severe health implications if discharged into the environment without being treated. High TSS in household wastewater can have effects on human health as high TSS decreases water's dissolved oxygen levels and increase water temperature.

Exposure to high levels of ammonia causes immediate burning of the eyes, nose, throat and respiratory tract and can result in blindness, lung damage or death in humans. Oil and grease in high concentrations when consumed have poisonous effects to the human body causing serious illness. Waterborne gastroenteritis amongst other diseases is frequently reported in human, with the susceptible agent being bacterial. Some potential sources of this disease are *E. coli* and certain strains of *Pseudomonas*, which may affect the newborn and have also been implicated in gastrointestinal disease outbreaks. Also, highly adaptable, protozoa, are widely distributed in natural waters, although only a few aquatic protozoa are pathogenic. Protozoal infections are usually characterized by gastrointestinal disorders of a milder order than those from bacterial infections

6.0 CONCLUSIONS

Direct use of domestic wastewater (untreated wastewater) may not be healthy for numerous uses except it undergoes certain wastewater treatment process. Household wastewater is major contributors to a variety of water pollution problems. Some of these problems include eutrophication, which can stimulate the growth of algae, increased water purification cost, interference with the recreational value of water, health risks to humans and livestock, excessive loss of oxygen and undesirable changes in aquatic populations. Since large amounts of wastewater effluents are passed through sewage. The water quality parameters in the domestic wastewater samples collected that did not meet the NESREA discharged limits are: TSS, COD, TP, Ammonia, Oil and Grease, Total and Feacal Coliform. Nemerow's pollution index showed that household wastewater samples were generally contaminated with, Total Suspended Solids (TSS), Chemical Oxygen Demand (COD), Ammonia, Total Phosphate, Oil and Grease, Total Coliform, and Faecal Coliform. They are the parameters that contributed to the contamination of the household wastewater. This resulted from household activities that generated a large sum of chemicals from cleaning and personal care products as well as organic waste from the kitchen, laundry, and bathing.

The Geo Accumulation Index also indicated high-level contamination of the wastewater with COD, ammonia, oil/grease, and faecal coliform. Furthermore, faecal coliform and oil/grease were found to be the most predominant pollutants in the wastewater, as these pollutants originate from cleaning products, personal care products, and organic waste. The study found that chemicals and microbial concentrations were a source of pollution in the household sample collected.

The Nemerow's Pollution Index and Geo Accumulation Index values also indicated that domestic wastewater in the study area were contaminated with chemicals and microbiological parameters. The results demonstrated that the method used was accurate and practical, since large amounts of wastewater effluents are passed through sewage treatment systems on a daily basis, there is a need to remedy and diminish the overall impacts of these effluents in receiving water bodies. In order to comply with wastewater legislations and guidelines, wastewater must be treated before discharge. This can be achieved through the application of appropriate treatment processes, which will help to minimize the risks to public health and the environment. To achieve unpolluted wastewater discharge into receiving water bodies, there is the need for careful planning, adequate and suitable treatment, regular monitoring and appropriate legislation. This is will enhance science-based decisions and ensure the sustainability of the environment and the health of plants and animals. There is also a need to ensure that effluents standards and limitations, as set by regulatory bodies are not compromised.

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