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Investigation of Bird Breeding Site, Soil and Water Physico-Chemistry and Microbiology in Selected Sites in Port Harcourt, Rivers State, Nigeria

Aroloye O. Numbere (Corresponding Author)
Department of Animal and Environmental Biology, University of Port Harcourt, East/West RoadP.M.B. 5323 Choba, Rivers State, Nigeria
Email: aroloyen@yahoo.com

Ruth O. Unuode
Department of Animal and Environmental Biology, University of Port Harcourt, East/West RoadP.M.B. 5323 Choba, Rivers State, Nigeria

Ruth A. Anumah
Department of Animal and Environmental Biology, University of Port Harcourt, East/West RoadP.M.B. 5323 Choba, Rivers State, Nigeria

Glory Williams
Department of Animal and Environmental Biology, University of Port Harcourt, East/West RoadP.M.B. 5323 Choba, Rivers State, Nigeria

Ibitoru P. Banigo
Department of Animal and Environmental Biology, University of Port Harcourt, East/West RoadP.M.B. 5323 Choba, Rivers State, Nigeria

Brighten W. Umah
Department of Animal and Environmental Biology, University of Port Harcourt, East/West RoadP.M.B. 5323 Choba, Rivers State, Nigeria

Ruth K. Konfaa
Department of Animal and Environmental Biology, University of Port Harcourt, East/West RoadP.M.B. 5323 Choba, Rivers State, Nigeria

Gideon I. Izeowayi
Department of Animal and Environmental Biology, University of Port Harcourt, East/West RoadP.M.B. 5323 Choba, Rivers State, Nigeria

Goodluck U. Mbinye
Department of Animal and Environmental Biology, University of Port Harcourt, East/West RoadP.M.B. 5323 Choba, Rivers State, Nigeria

Miracle O. Uzoigwe
Department of Animal and Environmental Biology, University of Port Harcourt, East/West RoadP.M.B. 5323 Choba, Rivers State, Nigeria

Vera Ogadinma
Department of Animal and Environmental Biology, University of Port Harcourt, East/West RoadP.M.B. 5323 Choba, Rivers State, Nigeria

Peace Ngbarabara
Department of Animal and Environmental Biology, University of Port Harcourt, East/West RoadP.M.B. 5323 Choba, Rivers State, Nigeria

Queen N. Oriji
Department of Animal and Environmental Biology, University of Port Harcourt, East/West RoadP.M.B. 5323 Choba, Rivers State, Nigeria

Stanley Okwusike
Department of Animal and Environmental Biology, University of Port Harcourt, East/West RoadP.M.B. 5323 Choba, Rivers State, Nigeria

Omotayo O. Olabisis
Department of Animal and Environmental Biology, University of Port Harcourt, East/West RoadP.M.B. 5323 Choba, Rivers State, Nigeria

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Christain O. Muoghalu
Department of Animal and Environmental Biology, University of Port Harcourt, East/West RoadP.M.B. 5323 Choba, Rivers State, Nigeria

Princess Wome
Department of Animal and Environmental Biology, University of Port Harcourt, East/West RoadP.M.B. 5323 Choba, Rivers State, Nigeria

Abstract

The study of birds in the Niger Delta is limited and yet birds make up a major aspect of the biodiversity population in the coastal and terrestrial areas in the region. The study thus, hypothesized that anthropogenic activities will influence the population, chemistry and microbiology of the study site. We conducted a census of the birds in both coastal and terrestrial locations and collected soil and water samples from the sites. The result shows that urban region (GRA Phase 3) exhibited a Shannon diversity index of 1.75 with an evenness index of 0.59. In contrast, the coastal area (Eagle Island) displayed heightened diversity (Shannon index 2.30) and increased evenness (0.89). A total of 559 birds were identified across both habitats, with 159 birds in the coastal area and 400 in the urban environment. The Spur-winged lapwing (*Vanellus spinosus*) was the most abundant species in the coastal area (Relative abundance= 20.75), while the Intermediate egret (*Egretta intermedia*) dominated the urban landscape (Relative abundance = 55.77). The Ardeidae family was the most abundant in both areas, with GRA Phase 3 having the highest abundance. Soil analysis revealed variations in physiochemical properties, with higher Zinc concentrations observed in Eagle Island compared to GRA Phase 3. Subsequently, THC concentrations followed a similar trend. Similarly, the bird breeding site had higher microbial population compared to the control site while bacterial population is higher than then fungi population. Lastly, birds have influence on the coil chemistry and microbiology of the habitat which may have ripple effect on the proliferation and trophic interaction between other organisms.

Keywords: Breeding site, Coastal environment, Species diversity, Microbiology, Soil chemistry.

1. Introduction

Animal droppings and urine are forms of biological waste, commonly associated with harmful environmental effects. These wastes often carry toxic substances or pollutants that exceed natural tolerance limits, adversely impacting both human health and ecological systems (Muhammad, 2019). Animal waste tends to accumulate at breeding or roosting sites, where it can serve beneficial purposes such as fertilizing the soil, but also poses environmental risks, particularly due to foul odors and chemical imbalances.In the case of birds, especially species that breed in wetlands or near stagnant water bodies, waste management becomes more complex. Bird breeding sites often contain standing water, which birds rely on for drinking and feeding. In such environments, birds interact with local aquatic life, feeding on organisms like tadpoles, small fish, and aquatic insects (Taiwo, 2022). As birds defecate directly into or around these water bodies, their droppings begin to influence the surrounding environment in significant ways.

Bird droppings—also referred to as avian excreta—are byproducts of the birds' digestive processes. They are typically white in appearance due to high uric acid content and can be acidic or mildly corrosive when in contact with surfaces. While bird droppings do not usually carry a strong odor, unlike mammalian feces, an unusually offensive smell may indicate the presence of infections or digestive disorders in birds (Taiwo, 2022). Birds such as cattle egrets, pigeons, gulls, and starlings frequently contribute to large-scale waste accumulation in both urban and rural environments. On average, birds defecate frequently throughout the day. Small birds like lovebirds may defecate over 100 times per day, while medium and larger birds such as macaws may defecate 24 to 48 times daily. This high frequency leads to substantial waste accumulation in nesting or feeding areas, especially in bird colonies.While bird waste can be a nuisance, it also has notable agricultural benefits. In controlled amounts, bird droppings are rich in nitrogen, phosphorus, and potassium—key nutrients for plant growth. Gardeners often use bird manure, specially composted chicken waste, to improve soil fertility and water retention. The nutrient content promotes healthy plant development and enhances soil structure, particularly for green leafy vegetables.However, the negative environmental consequences of excessive bird waste are more concerning in aquatic ecosystems. When large amounts of bird droppings enter stagnant water bodies, they drastically alter the physicochemical properties of the water. Nutrient overloading—especially nitrogen and phosphorus—can lead to eutrophication, a condition where nutrient enrichment causes dense algal and plant growth. This process blocks sunlight, reduces oxygen availability, and results in the death of fish and other aquatic life (Magnus, 2016).

Additionally, as the organic material in bird waste decomposes, it releases ammonia**,** which raises the water's pH and alkalinity. These shifts can create a hostile environment for many aquatic organisms, impairing growth, disrupting reproductive cycles, and in extreme cases, causing mortality. Suspended solids in bird waste also contribute to turbidity, reducing light penetration and inhibiting photosynthesis in submerged plants, further degrading ecosystem productivity.The decomposition process also consumes large amounts of dissolved oxygen through bacterial activity, particularly in stagnant or poorly aerated water. This oxygen depletion can result in fish kills and disturb the natural balance of aquatic ecosystems. Additionally, bird droppings can support the development of biofilms and algal blooms, further reducing water clarity and overall water quality (Philly, 2016).Beyond ecological impacts, bird waste poses public health concerns. When droppings dry out, they can become airborne and be inhaled as dust particles, particularly during cleaning or strong winds. Inhalation can lead to respiratory illnesses such as psittacosis (a flu-like disease caused by *Chlamydia psittaci*) or Salmonella infections that cause gastrointestinal symptoms. In extreme cases, long-term exposure to airborne bird droppings may damage lung tissue due to high ammonia concentrations (Taiwo, 2022).

Contamination of drinking water sources is another serious consequence. Bird waste can introduce harmful bacteria and viruses into reservoirs and treatment plants, raising the risk of waterborne diseases such as gastroenteritis**,** cholera**,** and other intestinal infections (Maxwell, 2018). This is especially problematic in areas where water treatment infrastructure is inadequate or outdated.Moreover, birds can carry invasive plant species or aquatic organisms either in their feathers or digestive tracts. When introduced into new environments via droppings, these non-native species may disrupt the local food web, outcompete native species, and cause long-term ecological imbalances.Importantly, bird waste can also reduce Biological Oxygen Demand (BOD) levels in stagnant water. This reduced BOD affects habitats for aquatic invertebrates, which in turn affects fish and other higher organisms. A decrease in oxygen-dependent species can cause a cascading effect across the aquatic food chain.

Despite these negative impacts, bird droppings can have positive effects under controlled circumstances. They can promote microbial diversity, enhance nutrient cycling, and improve ecosystem functions. Beneficial bacteria and fungi introduced through droppings may help break down organic matter and improve water quality (Williamson, 2019). For small, nutrient-poor ecosystems, moderate input of bird waste might increase productivity and support biodiversity.The overall impact of bird waste on stagnant water depends on multiple factors: the type and population of birds, seasonal migration patterns, and the size, depth, and ventilation of the water body. Enclosed or shallow stagnant waters are particularly susceptible to rapid changes in pH, oxygen levels, and nutrient content. In contrast, larger or flowing water bodies may better withstand or dilute the effects.

The aim of this study is to access the impact of bird waste on the physico-chemistry of stagnant water at a bird breeding site in GRA Phase 3.

The main objectives of this study are as follows:

1. To assess the bird abundance in the study area.
2. To determine the soil and water physico-chemistry
3. To examine the soil and water microbiology

2. Materials and Method

2.1. Description of Study Area

The study was conducted at a selected bird-breeding site located in GRA Phase 3, which is near Rumueme, Port Harcourt, Nigeria. Port Harcourt is a vibrant and significant city located in southern Nigeria and it serves as the capital of Rivers State, one of Nigeria's 36 states, and is a major economic and cultural hub in the country. The study area lies with geographical coordinates of N 04°49.181' and E 006°59.443'and the site is mostly covered with vegetation, including trees and grasses which provides a suitable habitat for various species of birds. The water has a pH of 6.5, a temperature of 30.2±0.1, and salinity of 1.03±0.02 (Numbere and Aigberua, 2022). This ecosystem is home to a wide variety of bird species, plants and other organisms. Bird species found at this study area include; Black heron(*Egretta ardesiaca),*Great egret(*Ardea alba),*Grey heron(*Ardea cinerea),*Intermediate egret(*Ardea intermedia),*western reef heron (*Egretta gularis),* African thrush(*Turdus pelios*), Common bulbul *(Pycnonotus*), Common kestrel (*Falcon tinnunculus*), Long tailed cormorant (*Microcarbo africanus*), Piapiac (*Pitlostomus afer*), Pied crow(*Corvus albus*), Spur-winged lapwing(*Vanellus spinosus*), Yellow-billed kite(*Milvus aegyptius).* The study area is situated in close propinquity to a main road where schools, hotels, offices and residential houses are located and also, in addition, some individuals engage in selling of various items at the end of the land. The site was chosen due to its significant population of breeding birds and the potential for bird waste to impact the nearby stagnant water bodies.

Figure-1. Map of study area at GRA Phase 3, Rivers State, Nigeria

2.2. Experimental Design

Samples were collected at the study area in August 2023, the soil samples were collected from the site starting from the grassy area up to the muddy and marshy area of the study site while water smples were collected from the site. Aside the study area soil and water samples were collected from a control site for analysis. The study area was georeferenced with a Garmin GPS (USA).

2.2.1. Sample Collection

An initial survey was carried out on the site prior to sample collection in order to ensure that problems during sampling would be minimized.

During the sampling, a hand-held technique was used to collect water, eggshell, soil and feather samples from stagnant water bodies of the bird-breeding site. Sampling points were selected strategically to cover different areas around the site and safety boots were worn during the samplings for protection against harmful organisms found on the sites. Sampleswere wrapped in properly labelled polyethylene bags and containers and sent to the laboratory for further analysis.These samples were collected monthly over a period of four months to capture seasonal variations. The collected samples was for the determination of physiochemical parameters, including temperature, pH, salinity, THC and heavy metals. In other to determine the soil chemistry of the study area, physic-chemical analysis of water, eggshell, soil and feather samples were analyzed for the following parameters;pH, Temperature, Total hydrocarbon (THC), Lead (Pb), Magnesium (Mg), Cadmium (Cd) and Zinc (Zn) using standard laboratory for physic-chemical analysis (Oshoma et al., 2017).

2.3. Bird Abundance

The method of data analysis used were in line with the objectives of this study. It evolved around analyzing the abundance bird species at GRA Phase 3 (Urban area) (Figure 2).The diversity of birds within the bird breeding site is to be taken into consideration, the number and different species present in the study area. As it plays an integral part of the research. This was done through the use of bird surveys, the data collected from these surveys can be analyzed using statistical techniques to estimate the richness, abundance and diversity of bird species present at the various site and study area. The abundance of bird species within the study site is to be analyzed.

Figure-2. Different species of bird at the study area

2.4. Laboratory Analysis

2.4.1. Total Hydrocarbon (THC)

A Spectrophotometer was used in determining the total hydrocarbon with a calorimeter (i.e., HACH DR, 890). 2g of the crushed soil sample was added into a glass beaker with 20ml of hexane and then stirred. Afterwards, the mixture was filtered through a glass funnel with wool, silica gel and anhydrous sodium sulphate. 10 ml of organic extract was added to a 10ml sample curvet, it was put into the calorimeter. The detection limit for THC is 0.01mg/1(APHA, 1995).

2.4.2. Heavy Metal Analysis

Heavy metals were extracted following the procedures of Aigberua and Tarawou (2018).0.25g of the soil sample was air dried and then weighed into a Teflon inset of a microwave digestion vessel, 2ml of concentrated (90%) nitric acid was introduced into the soil sample. The metals were extracted using a microwave accelerated reaction system (MARS Xpress, CEM Corporation, Mathews, North Carolina). The detection limit for the two metals analysed in mg/l i.e., Cadmium and Lead were 0.001 and 0.002 respectively (Aigberua and Numbere, 2019).

2.5. Statistical Analysis

An analysis of variance (ANOVA) was conducted since there were multiple samples per block to test whether there was any significant difference in the concentration of hydrocarbon and heavy metals in water, soil, eggshell and feather samples collected within study plots. Logarithmic transformation of the data was performed to meet assumptions of normality and homoscedasticity (Logan, 2010). Similarly, a post-hoc Tukey's HSD test was done to investigate pair wise mean differences between groups. All analyses were performed in R statistical environment, 3.0.1 (R Core Team, 2013).

3. Result

3.1. Bird Abundance

During the study period, a total of 855 different bird species were counted. There are thirteen (13) different bird species in the population (Table 1, Figure 3), and they are listed as follows: African thrush (n=1), Black heron (n=1), Common bulbul (n=15), Common Kestrel (n=37), Great egret (n=1), Great heron (n=1), Intermediate egret (n=601), Long-tailed Cormorant (n=90), Pipiac (n=1), Pied crow (n=1), Spur-winged lapwing (n=1), Western reef heron (n=22) and Yellow billed kite (n=1). Intermediate egret has the highest population followed by long-tailed cormorant and pipiac.

Table-1. Bird abundance in GRA Phase3 in Rivers State, Nigeria.

S/N	Species	Scientific name	Abundance (*n*)
1	African thrush	*Turdus pelios*	1
2	Black heron	*Egretta ardesiaca*	1
3	Common bulbul	*Pycnonotus barbatus*	15
4	Common Kestrel	*Falcon tinnunculus*	37
5	Great egret	*Egretta alba*	1
6	Great heron	*Ardea cinerea*	1
7	Intermediate egret	*Ardea intermedia*	601
8	Long-tailed Cormorant	*Microcarba africanus*	90
9	Pipiac	*Ptilostomus afer*	83
10	Pied crow	*Corvus albus*	1
11	Spur-winged lapwing	*Vanellus spinosus*	1
12	Western reef heron	*Egretta gularis*	22
13	Yellow billed kite	*Milvus aegyptius*	1
	TOTAL		**855**

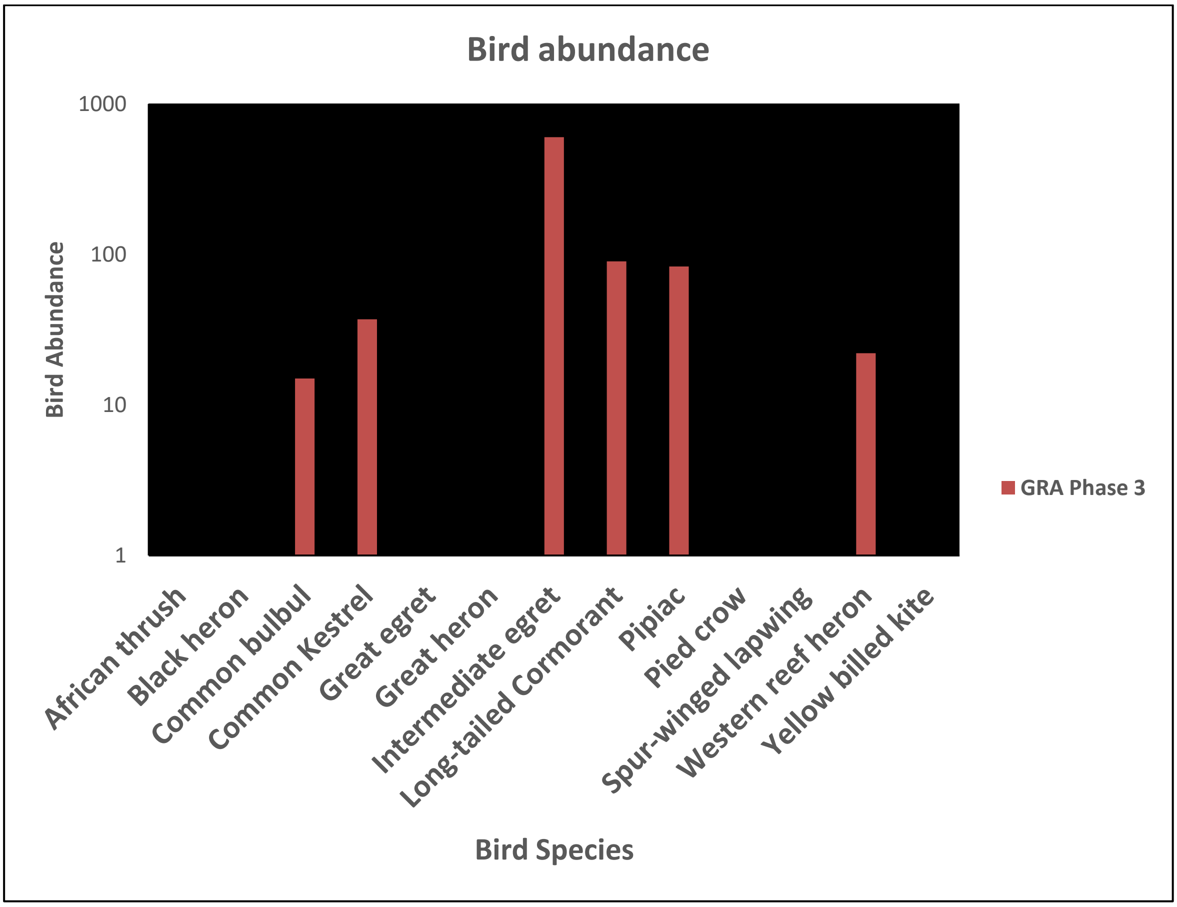

Figure-3. Bird abundance in GRA Phase 3, Rivers State, Nigeria.

3.2. General Physico-Chemistry of Water at Study Site

The study site has the following water characteristics (Table 2):

Table-2. Water characteristics in bird and control sites at Bird Breeding Site, GRA Phase 3, Rivers State, Nigeria

Plots	Coordinates	Elevation	Water types	TOC	Pore water Salinity (%)	pH	Temp (°C)
Bird site water	N04°49.181; E006°59.443	24	Muddy	3.02 ± 0.01	1.03 ± 0.02	6.5 ± 0.1	30.2 ± 0.1
Control	N04°49.186; E006°59.453	23	Clear	2.01 ± 0.01	1.02 ± 0.02	7.1 ± 0.1	27.8 ± 0.1

3.2.1. General Physico-Chemistry of Soil at Study Site

The study site has the following soil characteristics (Table 3):

Table-3. Soil characteristics in bird and control sites at Bird Breeding Site, GRA Phase 3, Rivers State, Nigeria

Plots	Coordinates	Elevation	Soil types	TOC	Moisture content (%)	pH	Temp (°C)
Bird site water	N04°49.181; E006°59.443	24	Silty sand	3.02 ± 0.01	98.5 ± 9.12	7.8 ± 0.1	29.7 ± 0.1
Control	N04°49.186; E006°59.453	23	Sandy	2.01 ± 0.01	95.2 ± 5.22	7.0 ± 0.1	27.7 ± 0.1

3.2.2. Soil and Water Physico-Chemistry at the Site

The ANOVA result of the soil ($P>0.05$ ($F_{2, 21} = 0.59$, $P=0.57$) reveal that there is no significant difference in the concentration of THC and heavy metal in soil and water in the study site (Table 4, Figure 4).

Table-4. Heavy metal and total hydrocarbon concentration in soil and water in a bird breeding site GRA Port Harcourt, Rivers State Nigeria.

	Mg/kg± SE			
Metal	**Cadmium**	**Lead**	**Zinc**	**THC***
Soil water	0.16	0.08	1.57	0.8
Drainage water	0.21	0.03	5.63	0.78
Swamp soil	0.21	0.04	6.55	0.21

*Where THC=total hydrocarbon content

The THC and heavy metal concentration is distributed equally in all materials at the accumulated at the bird breeding site. However, Zinc concentration was the highest in all locations followed by THC, Cadmium and Lead. Therefore, the overall order of THC and heavy metal concentration in the different locations is Zn>THC>Cd>Pb where there was higher concentration of zinc in swamp soil, drainage water and soil water (6.55mg/kg), (5.63mg/kg) and (1.57mg/kg).

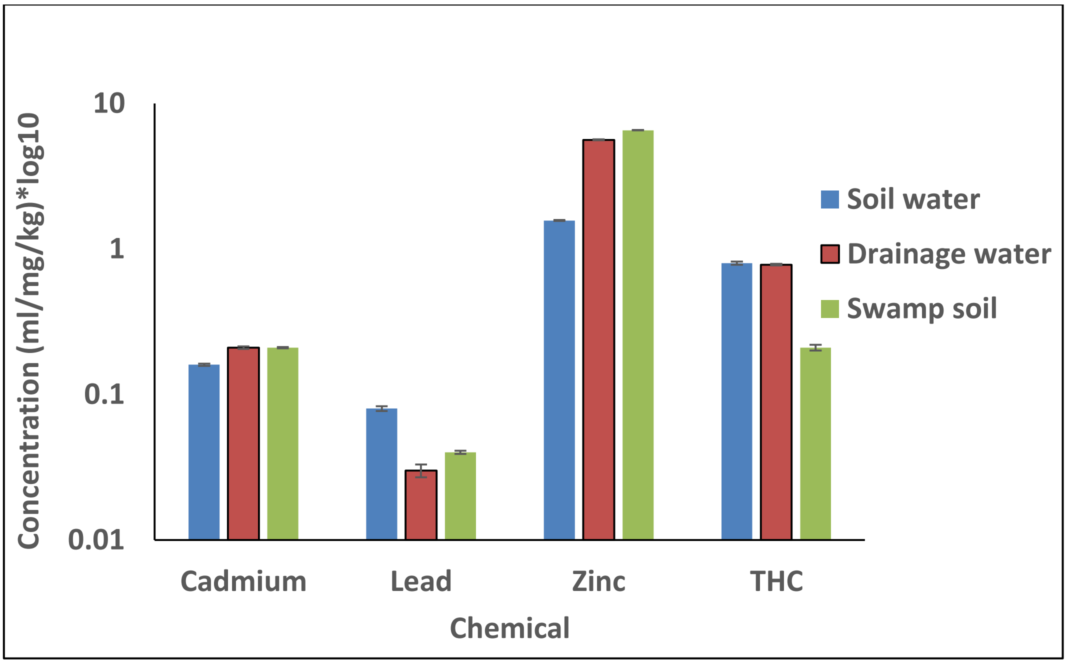

Figure-4. Bar graph of heavy metal and total hydrocarbon concentration in soil and water in a bird breeding site GRA Port Harcourt, Rivers State Nigeria.

Soil water:

Zinc had the highest concentration (1.57mg/kg), followed by THC (0.8mg/kg), followed by Cadmium (0.16mg/kg) and Lead had the least concentration (0.08mg/kg)

Drainage water:

Zinc had the highest concentration (5.63mg/kg±SE), followed by THC (0.78mg/kg), followed by Cadmium (0.21mg/kg) and Lead had the least concentration (0.03mg/kg)

Swamp soil:

Zinc had the highest concentration (6.55mg/kg), followed by THC and Cadmium (0.21mg/kg) and Lead had the least concentration (0.04mg/kg).

Given that a t-test was done to compare the chemical concentration of water in control and bird site, and the result reveal that there is no significant difference in chemical concentration (P=0.490692. Table 5, Figure 5). There is no significant difference in the concentration of THC and heavy metals in water in bird breeding site and control. However, the result reveal that the mean heavy metal (Zinc) concentration is higher in control (5.63±0.04 ml/kg ±SE) than bird site (1.57±0.01 ml/kg ±SE).

Table-5. Total hydrocarbon and heavy metal concentration of water from bird breeding site and control at Eagle Island, Rivers State, Nigeria

		Ml/kg ±SE		
Metal	**Cadmium**	**Lead**	**Zinc**	**THC**
bird site water	0.16±0.003	0.08±0.003	1.57±0.01	0.8±0.01
control	0.21±0.004	0.03±0.003	5.63±0.04	0.78±0.01

The water from the bird site had a higher concentration of zinc (1.57±0.01 Mg/kg) than THC (0.8±0.01 Mg/kg) than cadmium (0.16±0.003 Mg/kg). Lead had the least concentration (0.08±0.003 Mg/kg).

The control water had a higher concentration of zinc (5.63±0.04 Mg/kg) than THC (0.78±0.01 Mg/kg) than cadmium (0.21±0.004 Mg/kg). Lead had the least concentration (0.03±0.003 Mg/kg).

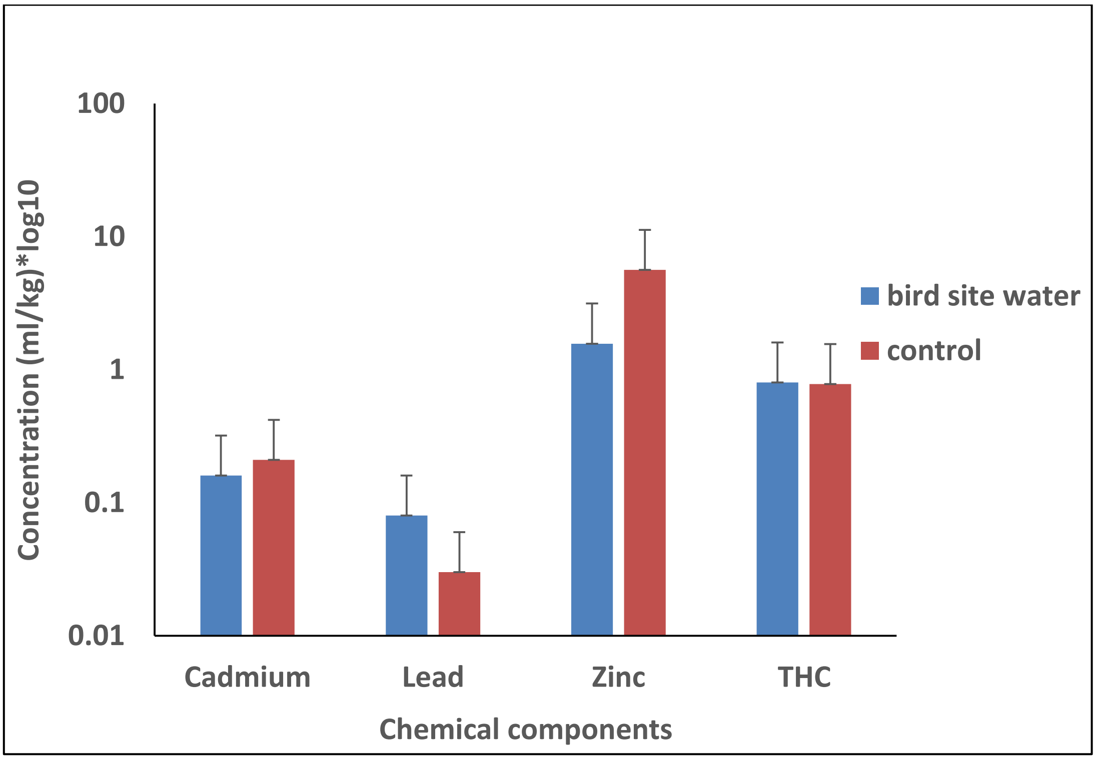

Figure-5. Bar graph of total hydrocarbon and heavy metal concentration of water from bird breeding site and control at GRA Phase 3, Rivers State, Nigeria

3.2.3. Physico-chemistry of Soil Versus WHO Standard

A t-test was done to compare the chemical concentration of soil in control and bird site, and the result revealed that there is no significant difference in chemical concentration (P= 0.64, Table 6, Figure 6). However, the result reveal that bird site had higher concentration of Cadmium, Lead, Zinc and THC as shown in Table 6. In the same vein the chemical parameter were all below the WHO standard.

Table-6. Total hydrocarbon and heavy metal concentration of soil from bird breeding site and control at Eagle Island, Rivers State, Nigeria

		Mg/kg ±SE		
Metal	**Cadmium**	**Lead**	**Zinc**	**THC**
bird site water	0.21±0.002	0.04±0.001	6.55±0.01	0.21±0.01
control	0.15±0.002	0.02±0.001	3.57±0.04	0.19±0.02
WHO standard	0.8	85	<10	50

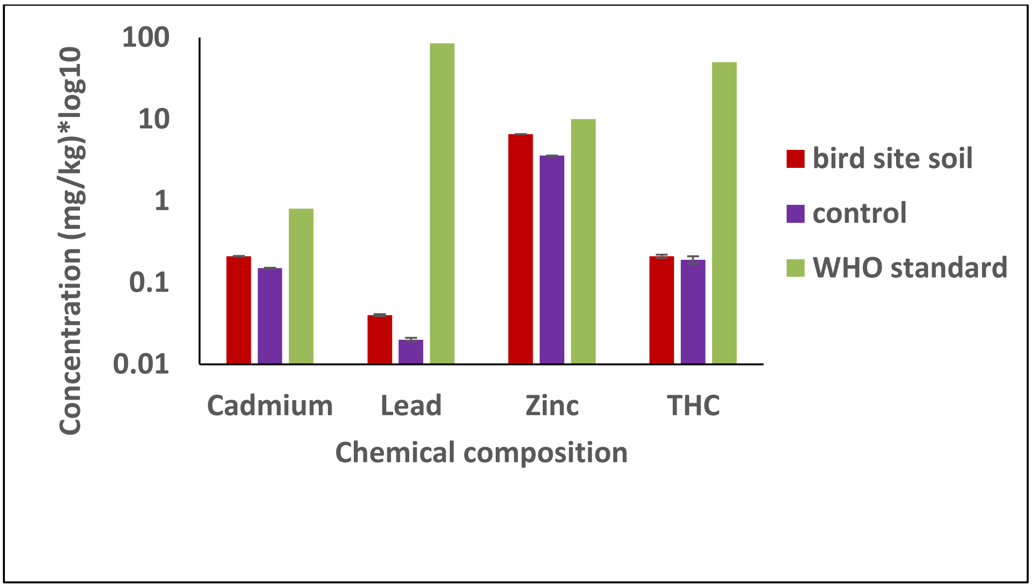

Figure-6. Bar graph of total hydrocarbon and heavy metal concentration of soil from bird breeding site and control at Eagle Island, Rivers State, Nigeria.

3.2.4. The Impact of Bird Dropping on Soil and Water Quality

The ANOVA result reveal that there is no significant difference in the concentration of total hydrocarbon content and heavy metals in soil, water and bird dropping (P>0.05). However, the result show that there is higher concentration of cadmium and zinc in soil than water and bird droppings. Similarly, there is higher concentration of lead in water than soil and bird droppings. There is higher concentration of THC in bird droppings compared to soil and water from study site (Table 7, Figure 7).

Table-7. Concentration of total hydrocarbon and heavy metal in soil and water at Eagle Island, Rivers State, Nigerian.

	Mg/ml/kg ± SE			
Metal	**Cadmium**	**Lead**	**Zinc**	**THC**
bird site soil	0.21±0.002	0.04±0.001	6.55±0.01	0.21±0.01
bird site water	0.16±0.003	0.08±0.003	1.57±0.01	0.8±0.02
bird dropping	0.04±0.001	0.02±0.001	4.55±0.01	3.73±0.001

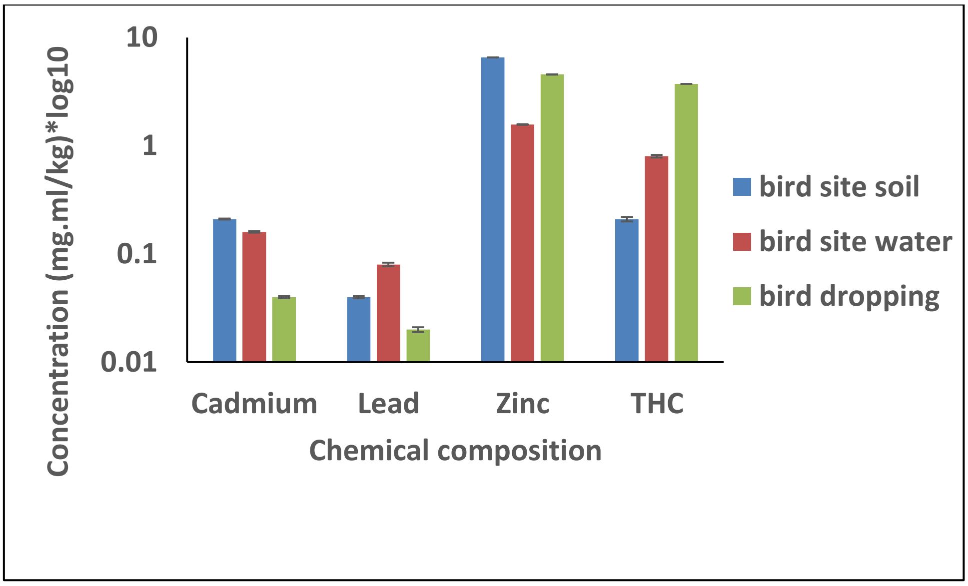

Figure-7. Bar graph of the concentration of total hydrocarbon and heavy metal in soil and water at Eagle Island, Rivers State, Nigerian.

3.3. Microbiology of Soil and Water at Bird Breeding Site

The ANOVA result of soil revealed that there is no significant difference in microbial population ($P > 0.05$). For all sites the bacterial population is greater than the fungal population (Table 8, Figure 8). The bird soil has a highest microbial population compared to drainage and control site. The control site has the least microbial population

Table-8. Population of bacteria and fungi in different soil samples collected from a bird breeding site at GRA Phase 3, Rivers Sate, Nigeria.

	(Cfu/g)*10^5	
Site	**THB**	**THF**
Bird site	2.6±0.2	1.8±0.03
Drainage soil	1.1±0.1	0.7±0.01
Control soil	1.0±0.1	0.3±0.01

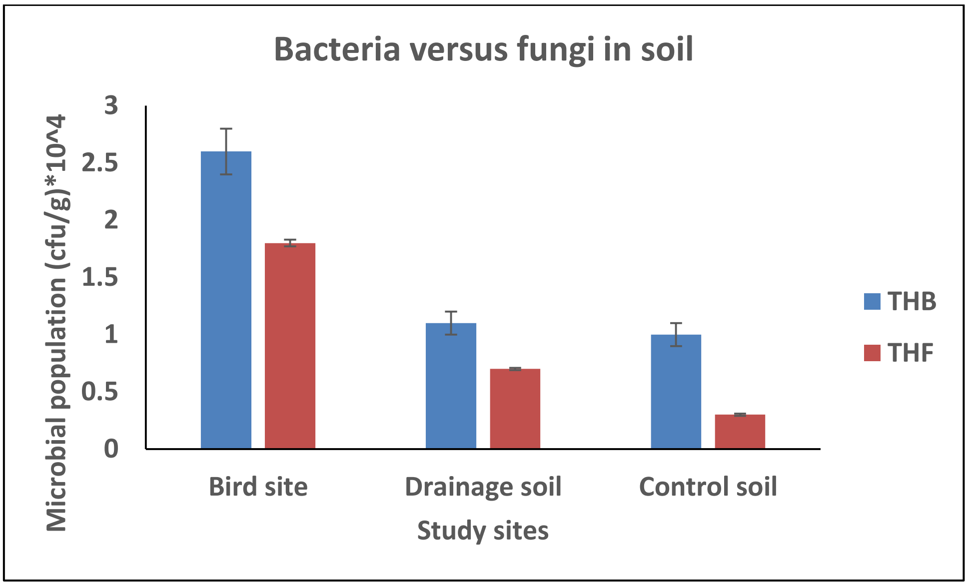

Figure-8. Population of bacteria and fungi in different soil samples collected from a bird breeding site at GRA Phase 3, Rivers Sate, Nigeria.

A t-test was done to compare the microbial population in water in three different sites, and the result revealed that there is a significant difference in microbial population ($P < 0.05$). For all sites the bacterial population in water is greater than the fungal population (Table 9, Figure 9). Similarly, the drainage site has the highest microbial population compared to the bird and control sites. Then control site has the least microbial population.

Table-9. Population of bacteria and fungi in different water samples collected from a bird breeding site at GRA Phase 3, Rivers Sate, Nigeria.

	(Cfu/g)*10^5	
Site	**THB**	**THF**
Bird site	0.6±0.01	0.1±0.01
Drainage soil	2.1±0.2	0.4±0.02
Control soil	1.6±0.1	0.01±0.03

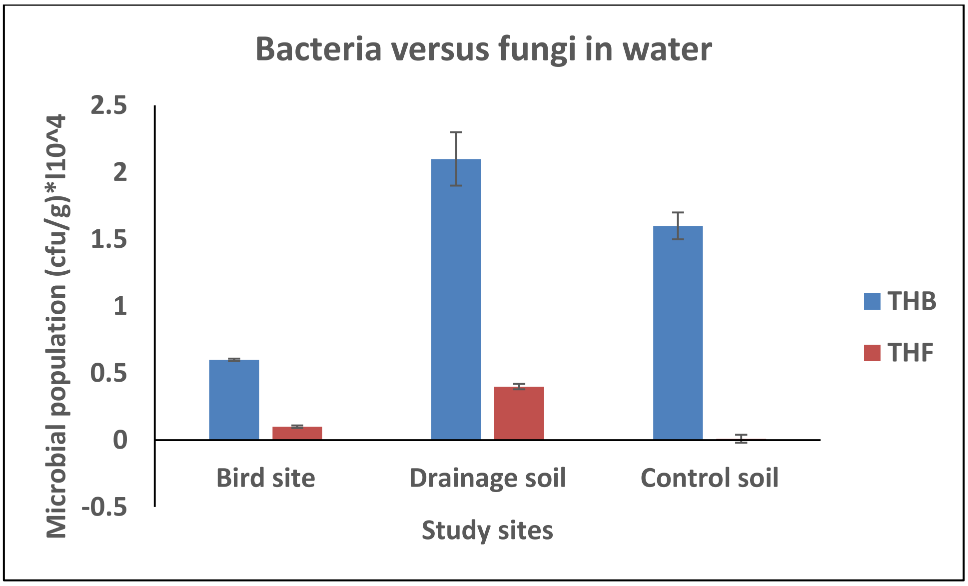

Figure-9. Population of bacteria and fungi in different water samples collected from a bird breeding site at GRA Phase 3, Rivers Sate, Nigeria.

3.4. Correlation of Soil and Water Microbiology

The result of the Pearson correlation test reveal that the microbial population in water and soil are not correlated with a correlation coefficient of -0.023 and p-value of 0.97 (t = -0.045084, df = 4, p-value = 0.9662, Cor= -0.02253604, Figure 8). However, the correlation is slightly negative indicating that when microbial population in soil decreases the microbial population in water decreases (Figure 3).

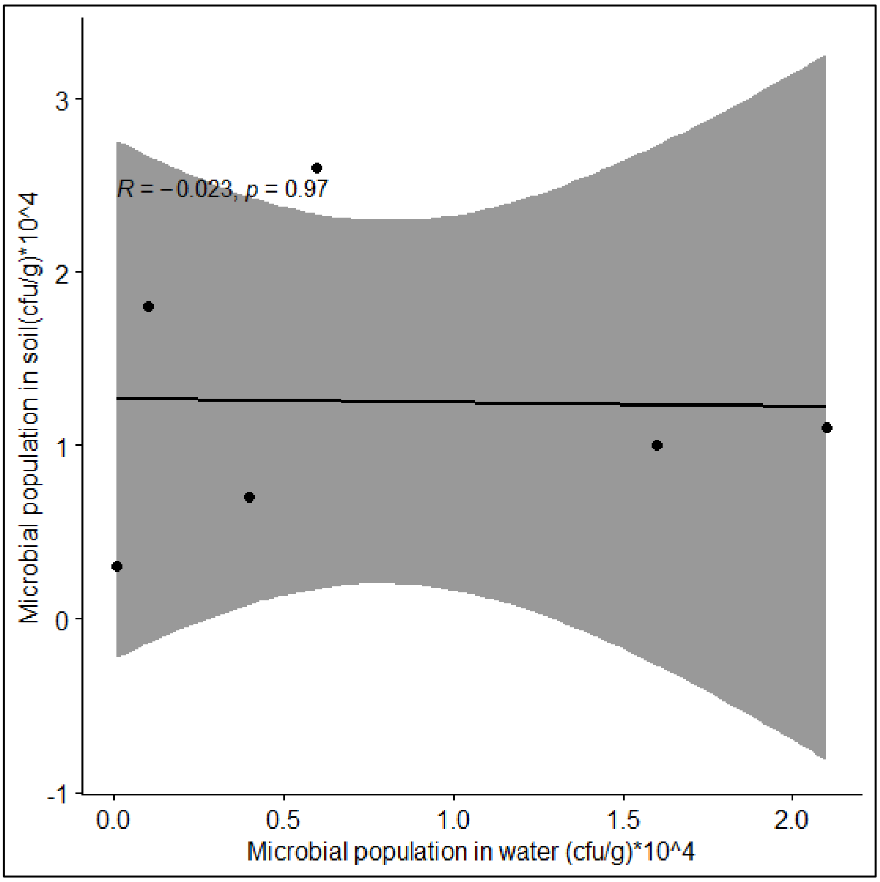

Figure-8. Correlation of microbial population in soil and water at Eagle Island, Rivers State, Nigeria.

4. Discussion

The result in Table 4.1 shows that GRA Phase 3 hosts a noteworthy population of intermediate egrets (601 birds), with the highest count among all observed species. Following closely are long-tailed cormorants (83 birds) and pipiac (55 birds). This prevalence is attributed to the site's status as a breeding ground or habitat for these birds. The key contributing factors identified were the minimal disturbance and limited human impact within GRA

Phase 3. This result is compared to the study of Naoki *et al.* (2012) on the spatial overlap between intermediate egrets and their aquatic prey in rice paddy landscapes. While Naoki *et al*. reported 74 intermediate egrets per field, our findings suggest a higher population in GRA Phase 3. This could be attributed to the unique conditions of the bird breeding site, characterized by reduced disturbance and minimal human activities. The study reinforces the idea that breeding sites with minimal human disturbance provide favorable conditions for certain bird species, influencing their population dynamics. This result is in line with Musa *et al*. (2023) who carried out a study on the Abundance and diversity of dry season avian species in Katsina Metropolis, Katsina State Nigeria and their findings revealed that bird species were abundant, richer and diverse in less disturbed areas and less human activities. According to research, the size and diversity of breeding heron population in 30 colonies of Mediterranean region are largely determined by the quality and the extent of the fresh water available.

The presence of Piapiac, Pied cow, Yellow-billed kite and Common kestrel which are known scavengers indicates proximity to refuse sites or food waste. (Ryan, P, Sinclair, I, 2020). Common krestrel, a small raptor was unusually abundant (n=37) suggesting high prey availability, such as insects or rodents. (Village, 1990). African thrush, black heron, great egret, grey heron, pied crow, spur-winged lapwing and yellow-billed kite were observed once (n=1), these carry ecological significance and provides clues on habitat diversity, foraging niches and disturbances or limitations in the urban habitat. African thrushes are generally shy and easily disturbed by urban activity. The urbanized structure of GRA phase 3 may lack the dense shrubs and leaf litter layer required for feeding and nesting as they forage on the ground for seeds and fruits. Black heron, great egret, grey heron and spur-winged lapwing are found among marshes, wetlands and rivers, hence their presence in the study area. However, their rarity could be as a result of urban encroachment pollution and limited foraging space (Del Hoyo. J et al, (1996), Urban, E.K et al (1986)). Red crows and yellow-billed kites are common scavengers of urban areas, often found around refuse dumps, roads and markets. Their single count is unusual and may have indicate a temporary presence or may have been under recorded due to flight behavior.

Birds are important members of the ecosystems and play crucial roles. Their activities such as nesting, foraging and waste deposition can have both positive and negative implications on soil quality. One of the significant effects of bird abundance on soil quality in breeding site can be evaluated through their waste deposition (i.e. bird droppings). The accumulation of bird waste on soil enriches it with essential nutrient thus supporting soil fertility and vegetation growth. However, excessive accumulation will result soil compaction and depletion. Birds play vital role in supporting the diversity and abundance of biota in breeding site. They feed on insects, which helps control populations of pests that may affect other organisms in the environment. They also disperse seeds and transport microorganisms and other nutrients across the landscape, contributing to nutrient cycling in the ecosystems. Through this activity, they help stimulate growth of microorganisms and plants, thus promoting diversity. Despite the positive environmental implication of high bird abundance in the bird breeding site it has quite a level of negative impacts on the soil quality. High bird abundance at the breeding site leads to soil compaction, erosion, and nutrient depletion due to their large size and frequent movement. This can negatively impact soil quality and fertility, thus making it hard for plants to grow and thrive. Additionally, bird waste increases soil acidity and nutrient imbalances, further causing harm to the soil.

The THC and heavy metal concentrations is distributed in all materials at the accumulated bird breeding site. Most treatments had higher concentration of Zinc. This result is compared to the results of Numbere (2020) who carried out a study on Analysis of total hydrocarbon and heavy metal accumulation in sediment water and associated organisms of Mangrove ecosystem in the Niger Delta. His results concluded that Zinc had the highest concentration there was high zinc concentration in bird droppings of (*B. ibis*), which is as a result of high zinc concentration in the study environment (Numbere, 2019). However, there was higher concentration of THC in the drainage water (0.78mg/kg) because THC is a much smaller molecule than most heavy metals, so it is more likely to leach into the water and may be more abundant than the sources of heavy metals.

The study recorded high level of TOC in soil and water, this could be attributed to bird droppings as the faeces are rich in organic carbon. Similar results were reported by Smith et al (2019). The study showed that bird dropping in urban roost sites led to increased TOC and nitrate leaching into stormwater systems. The high level of TOC, might also signal contaminations especially as it coupled with hydrocarbons and heavy metals which were reported in the study although still within the WHO limit.

The result for the physicochemical comparison of water from bird breeding site and control, shows no significant difference. The result shows that the entire study site is polluted including the control site. Birds feed on aquatic organisms they pick in polluted water body, which makes them serve as pathway for the transfer of pollutants from aquatic to terrestrial sites. Similarly, waste oil, and run off of fuels from vehicles on the road get into the breeding site as it very close to the main road. The reason for high concentration of heavy metal in control is because of accumulation of run-off water from houses, schools, industries or road from the area into the control (drainage). Due to rainfall, water and soil from the bird site can affect water quality of the control.

The bird breeding site exhibited the highest microbial population, likely due to the high organic, particularly nitrogen- and phosphorus – rich bird excreta. Bird droppings are known to enrich soil with nutrients that stimulate microbial activity, especially bacterial growth (Zhang et al, 2021). In a study by Bai et al (2012) on seabird colonies, soils influenced by guano showed significantly higher microbial biomass and enzyme activity compared to nearby non-nesting areas. Moreover, the high microbial population in the bird breeding soil aligns with findings from Maron et al (2011), who reported that nutrient enrichment leads to an increase in Copiotrophic (fast-growing, nutrient- loving) bacterial taxa. This may suppress fungal dominance due to competitive exclusion or shifts in pH and soil chemistry. In contrast, the control site exhibited the lowest microbial counts, which may reflect lower organic input, lower moisture content and reduced microbial substrate availability. This is consistent with the work of Jangid et al (2008), who observed significantly reduced microbial biomass in undisturbed or nutrient-poor control plots.

5. Conclusion

In conclusion, the result obtained from this study shows that there is significant diversity in the abundance of bird species present at the site. Bird waste has a significant impact on the physiochemical properties of stagnant water, including increased concentrations of THC and heavy metals. These changes in the physiochemical properties of stagnant water may pose a risk to human health and the environment. The risks associated with the presence of THC and heavy metals in stagnant water can be mitigated through education, regulation, and filtration systems. The study shows that there are significant differences between the bird breeding site and the control site. This because of the presence of birds and their impact on the soil quality within their habitation.

Recommendations

1. There should be an increased focus on raising awareness about the detrimental impact of bird waste on water quality, employing diverse channels such as community engagement, social media, and educational initiatives.
2. There should be a proactive approach in developing and implementing policies and regulations to minimize the influx of bird waste into waterways.
3. Public education campaigns should be intensified to enlighten communities on the potential health hazards posed by stagnant water contaminated with bird waste, emphasizing preventive measures.
4. There should be an effort to promote the adoption of filtration systems in drainage infrastructure, specifically designed to eliminate THC and heavy metals, thereby contributing to enhanced water quality.
5. Further research should be carried out to evaluate the long-term effects of bird waste on water quality and human health.

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