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Assessment of Microplastic Pollution, Seasonal Dynamic and Polymer Composition in Water, Sediment, and Fish from Mairuwa Reservoir, Funtua, Katsina Northwestern Nigeria

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ABSTRACT
Microplastic (MP) pollution has emerged as a critical global environmental challenge, yet empirical data from Nigerian freshwater ecosystems remain scarce. This study evaluated microplastic contamination in Mairuwa Reservoir, Katsina State, Nigeria, across six months (April–September 2025). Water, sediment, and fish samples (*Clarias gariepinus* and *Oreochromis niloticus*) from nine stations were analyzed using wet peroxide oxidation, density separation, vacuum filtration, and Fourier-transform infrared spectroscopy (FTIR). Physicochemical analysis revealed significant seasonal variation: temperature decreased from 34.00°C to 27.70°C. Turbidity peaked at 75.56 NTU, dissolved oxygen declined from 6.44 to 3.09 mg/L, pH remained alkaline (8.00–9.71). Total MP concentrations were 307 counts/L (water), 272 counts/kg (sediment), 298 counts/fish (*C. gariepinus*), and 253 counts/fish (*O. niloticus*). FTIR identified six polymers: polyethylene (PE), polypropylene (PP), polyethylene terephthalate (PET), polystyrene (PS), polyamide (PA/nylon), and polyvinyl chloride (PVC). Distinct distribution patterns emerged: water was dominated by PET (18.57%) and PP (18.24%); sediment by PA (22.06%) and PE (21.32%); *C. gariepinus* by PS (19.80%) and PVC (17.11%); and *O. niloticus* by PET (19.37%) and PA (20.95%). Water ingestion posed the highest risk, approximately ten times higher than fish consumption. The study concludes that Mairuwa Reservoir is significantly contaminated with microplastics originating from packaging materials, textile fibers, and fishing gear, with seasonal runoff exacerbating pollution during rainy months. Urgent interventions including water filtration, improved plastic waste management, and regulatory frameworks are recommended to safeguard public health and the reservoir ecosystem.

Keywords: Microplastics, Freshwater, Pollution, FTIR spectroscopy, Polymer characterization

INTRODUCTION

Microplastics (plastic particles <5 mm) originate from the degradation of larger plastic debris, industrial processes, and consumer products, posing significant environmental and health risks due to their widespread presence in aquatic ecosystems and potential for bioaccumulation in food webs (Atugoda *et al.*, 2021; Koelmans *et al.*, 2019). Plastics persist for hundreds of years before fragmenting into microplastics or nanoplastics via mechanical and photochemical processes (Espinosa *et al.*, 2016). Polyethylene (PE) and polypropylene (PP) are the most common polymers globally, while polyethylene terephthalate (PET) accounts for approximately 18% of production (Leng *et al.*, 2018). Ineffectively disposed plastic waste infiltrates aquatic environments and travels great distances, leading to global pollution (Geyer *et al.*, 2017).

With an annual global output exceeding 320 million tons, plastics have become indispensable to modern civilization (Ragusa *et al.*, 2021). However, their resilience and longevity pose serious threats to human health and the environment, particularly through the accumulation of plastic waste in rivers, landfills, and oceans. Approximately 8 million tons of plastic debris are estimated to reach the ocean each year (Mendoza *et al.*, 2019). Once in aquatic settings, larger plastic materials break down into microplastics through mechanical forces, radiation exposure, and microbiological activity (Wang *et al.*, 2021; Silva *et al.*, 2018). These microplastics present serious threats to ecosystems and human health (Emenike *et al.*, 2023). The bulk of plastic waste comprises single-use plastics and packaging materials, of which approximately half are categorized as disposable (Brachner *et al.*, 2020; Joystu and Moharana, 2018).

While marine microplastic pollution has received extensive attention, freshwater systems particularly artificial reservoirs remain comparatively understudied, despite serving as primary drinking water sources for billions worldwide (Eerkes-Medrano *et al.*, 2015; Li *et al.*, 2020). Reservoirs act as "sediment traps" and "pollution sinks," accumulating contaminants from upstream catchments, including microplastics from urban runoff, wastewater effluents, agricultural drainage, and atmospheric deposition (Di and Wang, 2018; Zhang *et al.*, 2022). Their longer hydraulic retentionZ1 times compared to rivers facilitate particle settling, increasing microplastic accumulation in sediments, where they become available to benthic organisms (Klein *et al.*, 2015; Su *et al.*, 2016).

Freshwater microplastic pollution is closely linked to terrestrial sources, as rivers receive wastewater from plastic-producing industries and sewage emissions (Wong *et al.*, 2020). Farmland constitutes another significant source, with microplastics entering water bodies via fertilizer application, agricultural irrigation, and plastic film degradation (Kumar *et al.*, 2020). Atmospheric deposition has also been verified as a microplastic source (Dris *et al.*, 2016). Sewage treatment plants remove up to 72% of microplastics, but the remainder

enters sludge applied to crops (Iyare *et al.*, 2020). Microplastics act as carriers for heavy metals, hydrophobic chemicals, and pathogenic microorganisms, and trophic transfer has been documented across nearly 700 aquatic species (Carbery *et al.*, 2018; Godoy *et al.*, 2019).

Mairuwa Reservoir (Latitude: 11.5204° N, Longitude: 7.3116° E) is a critical freshwater source in Funtua, Katsina State, Nigeria, supporting domestic, agricultural, and industrial activities for thousands of residents. The reservoir is situated within a catchment characterized by increasing urbanization, agricultural intensification, and inadequate solid waste management practices (Vanapalli *et al.*, 2021). These anthropogenic activities represent potential pathways for microplastic entry into the reservoir through surface runoff, direct littering, atmospheric deposition, and effluent discharge from surrounding settlements. The reservoir's importance as a drinking water source and fishing ground makes it particularly vulnerable to contamination, with serious implications for public health and food security. However, no empirical data exist on the extent of microplastic pollution in this critical water body.

Pathways of microplastic entry into Mairuwa Reservoir are numerous and interconnected. Urban runoff from Funtua town and surrounding settlements carries plastic debris, microfibers from textiles, and microbeads from personal care products directly into the reservoir during rainfall events. Agricultural activities in the catchment contribute through plastic mulch film degradation, fertilizer application, and irrigation with contaminated water (Kumar *et al.*, 2020). Atmospheric deposition of microplastics from urban and industrial dust further contributes to the contaminant load (Dris *et al.*, 2016). Additionally, inadequate waste disposal practices, including open dumping and burning of plastics, create secondary sources of microplastic pollution. Fishing activities within the reservoir introduce synthetic nets and ropes, which degrade into microplastic fibers over time. These multiple pathways collectively contribute to the reservoir's vulnerability to microplastic contamination, yet the relative contribution of each source remains unquantified.

Previous studies on microplastic pollution in Nigerian freshwater systems are limited but growing. Oladeji *et al.* (2025) reported seasonal dynamics in Aarin River, Southwestern Nigeria, where microplastic levels were notably higher during the rainy season due to increased runoff. Yahaya *et al.* (2024) employed FTIR spectroscopy in Birnin Kebbi rivers, Nigeria, reporting polyamide as the dominant polymer (50%) in water samples. Amana *et al.* (2025) assessed microplastic risks in *Clarias gariepinus* and *Oreochromis niloticus* from River Niger, Lokoja, finding species-specific accumulation patterns. Ololade *et al.* (2024) reported on microplastic particles in river sediments and water of southwestern Nigeria. Omoigberale *et al.* (2025) documented microplastics in sediment of the Ovia River, Benin City. Onaji (2025) analyzed microplastic contamination in *Oreochromis niloticus* and *Clarias gariepinus* from Lagos and Epe Lagoons. These studies collectively indicate that Nigerian freshwater systems are significantly contaminated, but the majority focus on rivers and coastal lagoons, leaving reservoirs largely unexplored.

Despite the growing body of research on microplastics in Nigerian aquatic systems, no comprehensive study has been conducted on Mairuwa Reservoir a critical water source serving thousands of residents. The seasonal dynamics of microplastic pollution, polymer characterization using FTIR for human populations reliant on the reservoir remain completely unknown. This knowledge gap hinders the development of evidence-based policies for water quality management and public health protection. Furthermore the species-specific accumulation patterns in fish species commonly consumed by local communities have not been investigated, limiting our understanding of potential dietary exposure risks.

This study was therefore designed to evaluate and characterize microplastic contamination in Mairuwa Reservoir, Funtua, Katsina State, Nigeria. The specific objectives were to determine the physicochemical parameters of water samples, Concentration and distribution of microplastics in water, sediment, and fish tissues. This study provides the first comprehensive assessment of microplastic pollution in Mairuwa Reservoir and establishes a critical baseline for future monitoring and mitigation efforts.

MATERIALS AND METHODS

Study Area

Mairuwa Reservoir (Latitude: 11.5204° N, Longitude: 7.3116° E) is a critical freshwater source in Funtua, Katsina State, Nigeria, supporting domestic, agricultural, and industrial activities. The reservoir is susceptible to microplastic pollution due to urban runoff, agricultural discharge, and inadequate waste management (Vanapalli *et al.*,, 2021). The reservoir has had a positive impact on the local economy by creating job opportunities in agriculture and related sectors. It has also improved the living standards of residents by enhancing food availability and access to water. Geographic coordinates were recorded using a GPS device (Garmin GPSMAP 64s) to ensure precise sampling locations (Xiang *et al.*,, 2022).

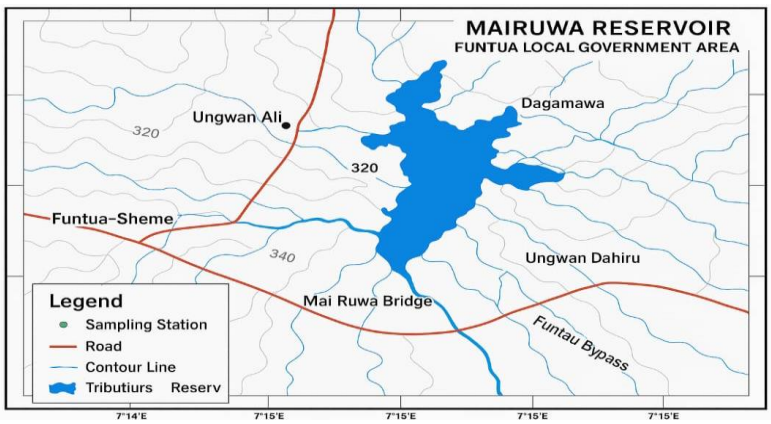

Figure 1: Map showing Mairuwa reservoir in Funtua, Katsina State

Sampling Sites
Nine (9) sampling sites 100 m apart were selected for the collection of water and sediment in the reservoir to ensure spatial representation:
Inlet Zone – Near the primary water inflow, Shoreline Zone – Adjacent to human settlements, Central Zone – Deepest section of the reservoir, Outflow Zone – Near the discharge point, Agricultural Zone – Close to farming activities. Site selection was based on proximity to potential pollution sources (Xiang *et al.,,* 2022).

Study Design
A cross-sectional field and laboratory-based study was adopted to assess microplastic contamination. The design ensures systematic data collection and analysis, following protocols established in similar studies (Ragusa *et al.,* 2021).

Sample Collection
Water Samples for Physicochemical Parameters
In order to prevent plastic contamination, surface water samples (1 L each) were taken using glass bottles from nine (9) key locations inside the reservoir (Silva *et al*., 2022). To avoid deterioration, samples were brought to the laboratory in previously cleaned glass bottles (Wang *et al*., 2023).

pH Determination
pH was measured immediately in the field using a pH meter calibrated with standard buffer solutions (pH 4.0, 7.0, and 10.0). The electrode was rinsed with distilled water, immersed in the water sample, and the reading was recorded when stable as described by APHA (2017), Standard Methods for the Examination of Water and Wastewater, Method 4500-H^+ B.

Temperature Determination
A thermometer was submerged in water for 2–3 minutes, and the temperature was recorded in degrees Celsius following WHO (2011), Guidelines for Drinking-water Quality, 4th edition.

Turbidity Measurement
Turbidity was measured using a turbidimeter calibrated with standard formazin solutions. A clean cuvette was filled with the sample and inserted into the meter. Turbidity was recorded in NTU (Nephelometric Turbidity Units) as described by APHA (2017), Method 2130 B.

Dissolved Oxygen (DO) Determination
The DO meter probe was calibrated in water-saturated air or zero-oxygen solution. The probe was submerged, and the stabilized DO reading was recorded following USGS (2016), National Field Manual for the Collection of Water-Quality Data.

Sediment Samples
Sediment samples were collected using a Van Veen grab sampler at depths of 0–10 cm (Barboza *et al.,,* 2023). Samples were stored in aluminum foil and kept at −20°C until analysis (Kutralam-Muniasamy *et al.,,* 2023).

Fish Sampling
A total of 120 fish specimens were collected from Mairuwa Reservoir across the six-month study period (April–September 2025). Two commercially important fish species were targeted: *Clarias gariepinus* (African catfish) and *Oreochromis niloticus* (Nile tilapia). Each month, ten (10) specimens of *C. gariepinus* and ten (10) specimens of *O. niloticus* were randomly captured from the reservoir using gill nets and baited traps, giving a monthly total of 20 fish and an overall total of 120 fish across the six months. The fish was rinsed with clean water to remove external debris and particles, placed in ice slurry for preservation, and transported to the laboratory for further analysis (Zhang *et al.,* 2023).

Laboratory Analysis (Microplastic Extraction and Identification)
Water Samples
The water samples were filtered through a 250 μm mesh brass sieve to remove suspended materials. The sieve was thoroughly rinsed with distilled water three times, with each rinse lasting approximately five minutes per sample. To ensure uniform consistency, the water sample was stirred using a stirring plate. Organic matter was removed using the wet peroxide oxidation (WPO) method, where 250 mL of the water sample was measured into a clean, dried 500 mL beaker, followed by addition of 20 mL of 0.05 M Fe(II) solution and 20 mL of 30% hydrogen peroxide (H_2O_2). The mixture was heated at 75°C on a stirring hotplate for 30 minutes, with the beaker loosely covered with tinfoil to prevent atmospheric deposition while allowing gases to escape. An additional 20 mL of 30% H_2O_2 was added as needed during the process until no visible natural organic material remained. The samples were then left covered to digest for 24 hours. After digestion, the water samples were filtered using a 45 μm filter membrane with a suction machine (Yang *et al.,* 2023; Anderson *et al*., 2017). The Fe(II) solution was prepared by dissolving 6.95 g of $FeSO_4 \cdot 7H_2O$ in 500 mL of water with 3 mL of concentrated sulfuric acid (Anderson *et al*., 2017).

Sediment Samples
The sediment samples were first oven-dried at 40°C to achieve a consistent weight for analysis. The dried sediment was then homogenized using a mortar and pestle or a mechanical grinder, and a representative subsample (50–100 g) was sieved through meshes (20–300 μm) to isolate microplastics within the desired size range. The sieved material underwent density separation by mixing with a sodium chloride solution (1.2 g/cm³) and gently agitating the mixture. After 24 hours of settling, the less dense microplastics floated to the surface while denser particles settled at the bottom. The floating layer was carefully extracted and transferred to a clean container. Organic matter was removed using the wet peroxide oxidation (WPO) method, where the sample was treated with 20 mL of 0.05 M Fe(II) solution and 20 mL of 30% hydrogen peroxide (H_2O_2) on a hotplate at 75°C for 30 minutes, loosely covered with foil to allow gas escape while preventing contamination. Additional H_2O_2 was added as needed until complete organic matter digestion was achieved. After 24 hours of digestion, the samples were vacuum-filtered through a 45 μm membrane using a suction machine (Fischer *et al.,,* 2020). The microplastics collected on the filters were analyzed under a stereomicroscope for shape and type. Advanced techniques, such as Fourier-transform infrared spectroscopy (FTIR), were utilized for detailed polymer identification.

Fish Samples
The fish samples were rinsed with distilled water before dissection. Using sterile stainless-steel tools, the flesh, liver, and gills were carefully separated. Tissue samples (5–10 g wet weight) were placed in clean glass beakers and oven-dried. The dried samples were then homogenized using a mortar and pestle.

For chemical digestion, 2 g of homogenized tissue was treated with 100 mL of 10% potassium hydroxide (KOH) solution to break down proteins and lipids. The beakers were covered with aluminum foil to prevent contamination and incubated at 50–60°C for 24 hours. Following primary digestion, 200 mL of 30% hydrogen peroxide (H_2O_2) was added to decompose remaining organic material. The mixture was heated on a stirring hot plate at 50°C for 1–3 hours to accelerate the reaction before being cooled to room temperature.

The digested solution was transferred to a separation funnel, where 300 mL of saturated NaCl solution was added. The mixture was gently shaken and left undisturbed for 24 hours to allow microplastics to float to the surface. The supernatant containing floating particles was carefully collected by decanting. This solution was then vacuum-filtered through a membrane filter (1–5 µm pore size) using a suction filtration system. The filter was placed in a labeled Petri dish for examination.

Microplastics were identified and characterized under a stereomicroscope, with particles categorized by types and shapes. Polymer identification was performed using Fourier-transform infrared spectroscopy (FTIR) to confirm particle composition (Collard *et al.,,* 2015; Masura *et al.,,* 2015; Rochman *et al.,,* 2019).

Fourier-Transform Infrared Spectroscopy (FTIR)

Extracted microplastics were analyzed using FTIR (PerkinElmer Spectrum Two) to determine polymer types (polyamide (PA), polyethylene (PE), polyethylene terephthalate (PET), polypropylene (PP), polystyrene (PS), and polyvinyl chloride (PVC)) (Zhang *et al.,,* 2023). Spectral data were compared with reference libraries (Nizzetto *et al.,,* 2023).

RESULTS AND DISCUSSION

Physicochemical Characterization of Mairuwa Reservoir

Descriptive statistics were computed to establish the baseline environmental conditions across the sampling months (April, May, June, July, August, and September). The results showed significant seasonal fluctuations in all measured physical parameters.

Table 1 presents the mean monthly variation of physicochemical parameters. Water temperature decreased progressively from April (34.00 ± 0.82°C) to September (27.70 ± 0.52°C), with April and May showing significantly higher values ($p < 0.05$) compared to the rainy season months (June–September). Turbidity increased sharply from April (8.67 ± 4.80 NTU) to a peak in June (75.56 ± 16.24 NTU), followed by a gradual decline through September (46.11 ± 1.20 NTU). The high turbidity during rainy months is attributed to surface runoff, erosion, and sediment resuspension.

Dissolved oxygen (DO) exhibited a steady decline from April (6.44 ± 0.55 mg/L) to September (3.09 ± 0.38 mg/L), with all months showing significant differences (different alphabets a–f). The lowest DO recorded in September indicates increased organic matter decomposition and reduced photosynthetic activity during the rainy season. pH was highest in May (9.71 ± 0.17) and lowest in September (8.00 ± 0.17), with a clear decreasing trend from the dry to rainy season.

Table 1: Mean Monthly Variation of Physicochemical Parameters in Mairuwa Reservoir, Katsina State, Nigeria for April–September 2025

Months	Temp (°C)	Turbidity (NTU)	DO (mg/L)	pH
Apr	34.00 ± 0.82[a]	8.67 ± 4.80[a]	6.44 ± 0.55[a]	9.37 ± 0.25[a]
May	30.27 ± 0.07[b]	45.00 ± 4.33[b]	6.00 ± 0.60[b]	9.71 ± 0.17[b]
Jun	27.68 ± 0.33[c]	75.56 ± 16.24[c]	5.33 ± 0.61[c]	8.74 ± 0.17[c]
Jul	27.93 ± 0.64[c]	50.11 ± 1.58[b]	4.78 ± 0.56[d]	8.40 ± 0.15[d]
Aug	27.83 ± 0.60[c]	49.39 ± 1.48[b]	3.61 ± 0.23[e]	8.20 ± 0.15[e]
Sep	27.70 ± 0.52[c]	46.11 ± 1.20[b]	3.09 ± 0.38[f]	8.00 ± 0.17[f]
Total	29.23 ± 2.67	62.47 ± 56.89	4.87 ± 1.16	8.74 ± 0.64

Note: Means along the same column with the same alphabet are not significantly different (p > 0.05, ANOVA followed by Tukey's HSD).

Table 2 presents the mean values of physicochemical parameters across the nine sampling stations. Spatially, temperature remained relatively uniform across all nine stations (28.72–29.07°C), with no significant difference, indicating well-mixed thermal conditions in the reservoir. Turbidity also showed no significant spatial variation ($p > 0.05$), ranging from 59.08 ± 49.44 NTU (SP6) to 68.33 ± 62.14 NTU (SP1).

However, dissolved oxygen exhibited a significant downstream decline ($p < 0.05$). Stations SP1–SP3 had higher DO values (5.62–5.85 mg/L), while SP4–SP6 showed intermediate levels (5.02–5.52 mg/L), and SP7–SP9 recorded the lowest DO (4.50–4.72 mg/L). Similarly, pH decreased significantly from upstream stations SP1–SP3 (9.10–9.25) to mid-stations SP4–SP6 (8.78–8.88, superscript [b]) and further to downstream stations SP7–SP9 (8.43–8.58).

Table 2: Mean Values of Physicochemical Parameters across Stations in Mairuwa Reservoir, Katsina State, Nigeria

Sampling Points	Temp (°C)	Turbidity (NTU)	DO (mg/L)	pH
SP1	29.07 ± 2.63[a]	68.33 ± 62.14[a]	5.85 ± 1.25[a]	9.25 ± 0.74[a]
SP2	29.00 ± 2.63[a]	63.50 ± 53.54[a]	5.73 ± 1.24[a]	9.13 ± 0.72[a]
SP3	29.03 ± 2.66[a]	63.83 ± 51.90[a]	5.62 ± 1.23[a]	9.10 ± 0.69[a]
SP4	29.00 ± 2.63[a]	62.58 ± 54.92[a]	5.52 ± 1.21[a]	8.88 ± 0.69[b]
SP5	28.95 ± 2.67[a]	61.10 ± 56.79[a]	5.18 ± 1.15[b]	8.85 ± 0.68[b]
SP6	28.97 ± 2.68[a]	59.08 ± 49.44[a]	5.02 ± 1.13[b]	8.78 ± 0.66[b]
SP7	28.92 ± 2.67[a]	61.25 ± 56.72[a]	4.72 ± 1.09[c]	8.55 ± 0.63[c]
SP8	28.75 ± 2.70[a]	62.55 ± 58.87[a]	4.62 ± 1.08[c]	8.43 ± 0.62[c]
SP9	28.72 ± 2.71[a]	61.07 ± 55.93[a]	4.50 ± 1.07[c]	8.58 ± 0.64[c]

Sampling Points	Temp (°C)	Turbidity (NTU)	DO (mg/L)	pH
Total	28.93 ± 2.67	62.48 ± 55.70	5.19 ± 1.19	8.95 ± 0.68

Note: Means along the same column with the same alphabet are not significantly different ($p > 0.05$).

Characterization of Polymer Types

The frequency of polymer types across four sample categories *Clarias*, *Oreochromis*, sediment, and water were analyzed to understand the distribution of microplastic pollution. Polyamide (PA), polyethylene (PE), polyethylene terephthalate (PET), polypropylene (PP), polystyrene (PS), and polyvinyl chloride (PVC) showed distinct patterns across the sampled matrices. Sediment samples exhibited the highest frequency of PA (60) and PE (58). In contrast, water samples showed a more balanced distribution, with PET (57) and PP (56) being notably prevalent. In *Clarias* species, PS was the most frequent polymer detected (59), while *Oreochromis* showed a higher affinity for PA (53) in Fig 2.

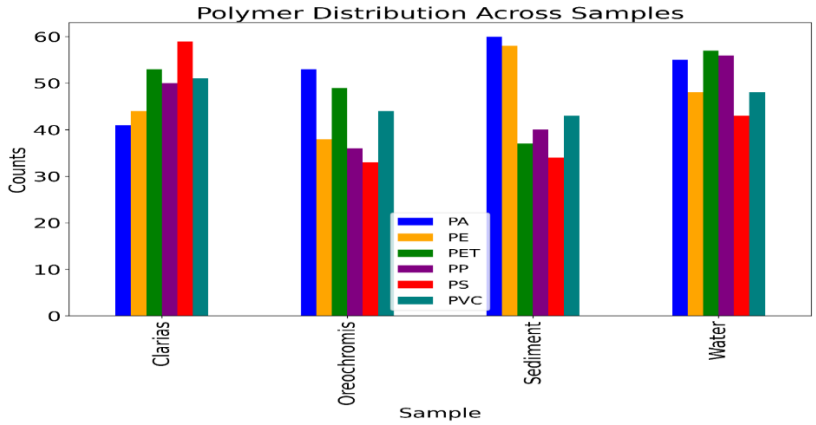

Figure 2: Presents the frequency distribution of six microplastic polymer types

Relative Abundance (%) of Microplastics

Sediment dominance showed PA (22.06%) and PE (21.32%) representing the primary microplastic constituents in the reservoir's benthos. In *Clarias*, PS accounted for the highest percentage of the total MP burden at approximately 19.80%. For *Oreochromis*, PA was the dominant polymer at 20.95%. The pelagic zone (water) showed a relatively even split, with PET (18.57%) and PP (18.24%) being the most significant contributors.

3.4 Monthly Distribution of Microplastic Polymer Types

Table 3 presents the monthly distribution of six polymer types in water samples. In April, PET (13.00 ± 0.90 counts/L) and PVC (12.00 ± 0.80 counts/L) were most abundant, while PE was lowest (6.00 ± 0.50 counts/L). May saw dominance of PP (14.00 ± 1.00) and PE (13.00 ± 0.90), with PET dropping sharply (3.00 ± 0.40). June recorded the highest PE (14.00 ± 1.00) and PS(10.00 ± 0.70) levels. July showed a dramatic decline in PE (1.00 ± 0.20) but increased PET (10.00 ± 0.70). August had moderate levels of most polymers, with PVC lowest (4.00 ± 0.50). September recorded high PP (13.00 ± 0.90), PET (12.00 ± 0.80), and PA (12.00 ± 0.80). PE and PP (light polymers) dominate in dry months, while PET and PS (denser polymers) appear more during rainy periods, possibly due to runoff carrying fragmented packaging materials.

Table 3: Monthly distribution of microplastic polymer types in water samples from Mairuwa Reservoir, Katsina State

Month	PE	PP	PET	PS	PA	PVC
Apr	6.00 ± 0.50^{b}	12.00 ± 0.80^{a}	13.00 ± 0.90^{a}	9.00 ± 0.60^{b}	10.00 ± 0.70^{b}	12.00 ± 0.80^{a}
May	13.00 ± 0.90^{a}	14.00 ± 1.00^{a}	3.00 ± 0.40^{c}	5.00 ± 0.50^{c}	8.00 ± 0.60^{b}	8.00 ± 0.60^{b}
Jun	14.00 ± 1.00^{a}	4.00 ± 0.50^{c}	11.00 ± 0.80^{b}	10.00 ± 0.70^{b}	9.00 ± 0.60^{b}	8.00 ± 0.60^{b}
Jul	1.00 ± 0.20^{c}	5.00 ± 0.50^{b}	10.00 ± 0.70^{a}	3.00 ± 0.40^{b}	8.00 ± 0.60^{a}	8.00 ± 0.60^{a}
Aug	11.00 ± 0.80^{a}	8.00 ± 0.60^{b}	8.00 ± 0.60^{b}	10.00 ± 0.70^{a}	8.00 ± 0.60^{b}	4.00 ± 0.50^{c}
Sep	3.00 ± 0.40^{c}	13.00 ± 0.90^{a}	12.00 ± 0.80^{a}	6.00 ± 0.50^{b}	12.00 ± 0.80^{a}	8.00 ± 0.60^{b}

Note: Values are mean counts/L ± SD. Different superscripts indicate significant differences ($p < 0.05$, ANOVA).

Table 4 presents the monthly distribution of polymer types in sediment samples. In April, PA dominated (13.00 ± 0.90 counts/g), while PP and PET were very low (1.00 each). May recorded the highest PVC (14.00 ± 1.00) and elevated PE (10.00 ± 0.70). June showed moderate levels across most polymers, with PA again prominent (10.00 ± 0.70). July saw high PP (11.00 ± 0.80), PET (10.00 ± 0.70), and PVC (10.00 ± 0.70). August recorded peak PP (13.00 ± 0.90) and PET (11.00 ± 0.80). September had the highest PP (14.00 ± 1.00), PS (12.00 ± 0.80), PA (13.00 ± 0.90), and PVC (12.00 ± 0.80), indicating increased polymer accumulation at the end of the rainy season.

Table 4: Monthly distribution of microplastic polymer types in sediment samples from Mairuwa Reservoir, Katsina State

Month	PE	PP	PET	PS	PA	PVC
Apr	6.00 ± 0.50^{b}	1.00 ± 0.20^{c}	1.00 ± 0.20^{c}	2.00 ± 0.30^{c}	13.00 ± 0.90^{a}	8.00 ± 0.60^{b}
May	10.00 ± 0.70^{a}	2.00 ± 0.30^{c}	8.00 ± 0.60^{b}	1.00 ± 0.20^{c}	7.00 ± 0.50^{b}	14.00 ± 1.00^{a}
Jun	4.00 ± 0.50^{c}	7.00 ± 0.50^{b}	6.00 ± 0.50^{b}	2.00 ± 0.30^{c}	10.00 ± 0.70^{a}	4.00 ± 0.50^{c}

Month	PE	PP	PET	PS	PA	PVC
Jul	8.00 ± 0.60^{b}	11.00 ± 0.80^{a}	10.00 ± 0.70^{a}	9.00 ± 0.60^{b}	7.00 ± 0.50^{b}	10.00 ± 0.70^{a}
Aug	4.00 ± 0.50^{c}	13.00 ± 0.90^{a}	11.00 ± 0.80^{a}	1.00 ± 0.20^{c}	9.00 ± 0.60^{b}	8.00 ± 0.60^{b}
Sep	8.00 ± 0.60^{b}	14.00 ± 1.00^{a}	9.00 ± 0.60^{b}	12.00 ± 0.80^{a}	13.00 ± 0.90^{a}	12.00 ± 0.80^{a}

Note: Values are mean counts/g dry weight ± SD. Different superscripts indicate significant differences ($p < 0.05$, ANOVA).

Table 5 presents the monthly distribution of polymer types in *Clarias gariepinus*. April recorded high PE (14.00 ± 1.00) and PP (13.00 ± 0.90). May showed elevated PS (14.00 ± 1.00). June had high PS (12.00 ± 0.80), PA (13.00 ± 0.90), and PVC (11.00 ± 0.80). July recorded the highest PET (14.00 ± 1.00) and high PA (12.00 ± 0.80). August again showed high PET (14.00 ± 1.00). September recorded high PS (14.00 ± 1.00) and moderate levels of other polymers. The significant monthly differences indicate that *C. gariepinus* ingests different polymers depending on seasonal availability and sediment resuspension.

Table 5: Monthly Distribution of Microplastic Polymer Types in *Clarias Gariepinus* from Mairuwa Reservoir, Katsina State

Month	PE	PP	PET	PS	PA	PVC
Apr	14.00 ± 1.00^{a}	13.00 ± 0.90^{a}	7.00 ± 0.50^{b}	10.00 ± 0.70^{b}	3.00 ± 0.40^{c}	5.00 ± 0.50^{c}
May	10.00 ± 0.70^{b}	10.00 ± 0.70^{b}	8.00 ± 0.60^{b}	14.00 ± 1.00^{a}	7.00 ± 0.50^{c}	10.00 ± 0.70^{b}
Jun	5.00 ± 0.50^{c}	9.00 ± 0.60^{b}	2.00 ± 0.30^{c}	12.00 ± 0.80^{a}	13.00 ± 0.90^{a}	11.00 ± 0.80^{a}
Jul	8.00 ± 0.60^{b}	8.00 ± 0.60^{b}	14.00 ± 1.00^{a}	5.00 ± 0.50^{c}	12.00 ± 0.80^{a}	6.00 ± 0.50^{c}
Aug	2.00 ± 0.30^{c}	2.00 ± 0.30^{c}	14.00 ± 1.00^{a}	4.00 ± 0.50^{c}	1.00 ± 0.20^{c}	9.00 ± 0.60^{b}
Sep	5.00 ± 0.50^{c}	8.00 ± 0.60^{b}	8.00 ± 0.60^{b}	14.00 ± 1.00^{a}	5.00 ± 0.50^{c}	10.00 ± 0.70^{b}

Note: Values are mean counts/fish ± SD. Different superscripts indicate significant differences ($p < 0.05$, ANOVA).

Table 6 presents the monthly distribution of polymer types in *Oreochromis niloticus*. April had high PS (12.00 ± 0.80), PA (13.00 ± 0.90), and PVC (11.00 ± 0.80). May recorded very high PET (13.00 ± 0.90). June showed peak PET (14.00 ± 1.00) and high PA (10.00 ± 0.70). July had high PE (10.00 ± 0.70) and PS (9.00 ± 0.60). August recorded high PP (14.00 ± 1.00) and PET (14.00 ± 1.00). September showed high PE (10.00 ± 0.70), PET (13.00 ± 0.90), and PVC (14.00 ± 1.00). The dominance of PET and PE in *O. niloticus* reflects its filtration of water column particles, where these lighter polymers are more abundant.

Table 6: Monthly Distribution of Microplastic Polymer Types in *Oreochromis Niloticus* from Mairuwa Reservoir, Katsina State

Month	PE	PP	PET	PS	PA	PVC
Apr	6.00 ± 0.50^{b}	3.00 ± 0.40^{c}	5.00 ± 0.50^{b}	12.00 ± 0.80^{a}	13.00 ± 0.90^{a}	11.00 ± 0.80^{a}
May	2.00 ± 0.30^{c}	1.00 ± 0.20^{c}	13.00 ± 0.90^{a}	2.00 ± 0.30^{c}	9.00 ± 0.60^{b}	9.00 ± 0.60^{b}
Jun	5.00 ± 0.50^{b}	1.00 ± 0.20^{c}	14.00 ± 1.00^{a}	4.00 ± 0.50^{b}	10.00 ± 0.70^{a}	3.00 ± 0.40^{c}
Jul	10.00 ± 0.70^{a}	4.00 ± 0.50^{c}	7.00 ± 0.50^{b}	9.00 ± 0.60^{a}	1.00 ± 0.20^{c}	3.00 ± 0.40^{c}
Aug	9.00 ± 0.60^{b}	14.00 ± 1.00^{a}	14.00 ± 1.00^{a}	7.00 ± 0.50^{b}	5.00 ± 0.50^{c}	6.00 ± 0.50^{b}
Sep	10.00 ± 0.70^{b}	1.00 ± 0.20^{c}	13.00 ± 0.90^{a}	3.00 ± 0.40^{c}	1.00 ± 0.20^{c}	14.00 ± 1.00^{a}

Note: Values are mean counts/fish ± SD. Different superscripts indicate significant differences ($p < 0.05$, ANOVA).

Spatial Distribution of Microplastic Polymer Types

Table 7 presents the spatial distribution of polymer types in water samples across nine stations. Across all stations, polymer concentrations showed remarkable uniformity. PET was consistently the most abundant polymer across stations (range: 8.80–9.20 counts/L), followed by PVC (9.20–9.60 counts/L). PE, PP, PS, and PA showed similar mean values (7.00–8.70 counts/L) with no significant spatial differences.

Table 7: Spatial distribution of microplastic polymer types in water samples across sampling points in Mairuwa Reservoir, Katsina State

Station	PE	PP	PET	PS	PA	PVC
SP1	8.00 ± 4.20^{b}	7.50 ± 4.60^{b}	9.00 ± 3.80^{a}	8.20 ± 3.10^{b}	8.30 ± 2.50^{b}	9.50 ± 2.00^{a}
SP2	8.50 ± 4.00^{b}	7.00 ± 4.80^{b}	9.20 ± 3.70^{a}	8.40 ± 3.00^{b}	8.70 ± 2.30^{b}	9.60 ± 2.10^{a}
SP3	7.80 ± 4.50^{b}	7.20 ± 4.90^{b}	8.80 ± 3.90^{a}	8.10 ± 3.20^{b}	8.60 ± 2.60^{b}	9.20 ± 2.20^{a}
SP4	8.30 ± 4.30^{b}	7.60 ± 4.70^{b}	9.10 ± 3.80^{a}	8.50 ± 3.10^{b}	8.40 ± 2.40^{b}	9.40 ± 2.00^{a}
SP5	8.10 ± 4.10^{b}	7.40 ± 4.60^{b}	8.90 ± 3.70^{a}	8.30 ± 3.20^{b}	8.50 ± 2.50^{b}	9.30 ± 2.10^{a}
SP6	8.20 ± 4.20^{b}	7.30 ± 4.80^{b}	9.00 ± 3.80^{a}	8.40 ± 3.10^{b}	8.60 ± 2.40^{b}	9.40 ± 2.00^{a}
SP7	8.40 ± 4.10^{b}	7.50 ± 4.70^{b}	9.20 ± 3.90^{a}	8.60 ± 3.00^{b}	8.70 ± 2.50^{b}	9.50 ± 2.10^{a}
SP8	8.00 ± 4.30^{b}	7.20 ± 4.90^{b}	8.80 ± 3.80^{a}	8.20 ± 3.20^{b}	8.50 ± 2.60^{b}	9.20 ± 2.20^{a}
SP9	8.30 ± 4.20^{b}	7.40 ± 4.80^{b}	9.10 ± 3.90^{a}	8.50 ± 3.10^{b}	8.60 ± 2.50^{b}	9.40 ± 2.10^{a}

Note: Values are mean counts/L ± SD. Different superscripts indicate significant differences ($p < 0.05$, ANOVA).

microplastic contamination is well-mixed across the Table 8 presents the spatial distribution of polymer types in sediment samples. Similar to water, sediment samples showed no significant spatial variation for most polymers. PVC was

consistently the most abundant polymer across all stations (range: 10.40–10.80 counts/g), followed by PA (8.70–9.00 counts/g) and PP (8.10–8.50 counts/g). PET (6.00–6.30 counts/g) and PS (6.50–6.80 counts/g) were moderately present, while PE (7.50–7.90 counts/g) showed intermediate levels. The uniform spatial distribution confirms that sediment reservoir.

Table 8: Spatial distribution of microplastic polymer types in sediment samples across sampling points in Mairuwa Reservoir, Katsina State

Station	PE	PP	PET	PS	PA	PVC
SP1	7.50 ± 3.10^{b}	8.20 ± 4.70^{b}	6.00 ± 4.00^{c}	6.50 ± 4.30^{c}	8.80 ± 3.50^{b}	10.50 ± 2.60^{a}
SP2	7.80 ± 3.20^{b}	8.40 ± 4.80^{b}	6.20 ± 4.10^{c}	6.70 ± 4.40^{c}	8.90 ± 3.60^{b}	10.70 ± 2.70^{a}
SP3	7.60 ± 3.30^{b}	8.10 ± 4.60^{b}	6.10 ± 4.20^{c}	6.60 ± 4.50^{c}	8.70 ± 3.50^{b}	10.40 ± 2.60^{a}
SP4	7.90 ± 3.20^{b}	8.50 ± 4.70^{b}	6.30 ± 4.00^{c}	6.80 ± 4.30^{c}	9.00 ± 3.40^{b}	10.80 ± 2.70^{a}
SP5	7.70 ± 3.10^{b}	8.30 ± 4.80^{b}	6.20 ± 4.10^{c}	6.70 ± 4.40^{c}	8.80 ± 3.60^{b}	10.60 ± 2.60^{a}
SP6	7.80 ± 3.20^{b}	8.40 ± 4.70^{b}	6.10 ± 4.00^{c}	6.60 ± 4.30^{c}	8.90 ± 3.50^{b}	10.70 ± 2.70^{a}
SP7	7.60 ± 3.30^{b}	8.20 ± 4.60^{b}	6.00 ± 4.20^{c}	6.50 ± 4.50^{c}	8.70 ± 3.60^{b}	10.50 ± 2.60^{a}
SP8	7.90 ± 3.20^{b}	8.50 ± 4.80^{b}	6.30 ± 4.10^{c}	6.80 ± 4.40^{c}	9.00 ± 3.50^{b}	10.80 ± 2.70^{a}
SP9	7.70 ± 3.10^{b}	8.30 ± 4.70^{b}	6.20 ± 4.00^{c}	6.70 ± 4.30^{c}	8.80 ± 3.40^{b}	10.60 ± 2.60^{a}

Note: Values are mean counts/g dry weight ± SD. Different superscripts indicate significant differences ($p < 0.05$, ANOVA).

Table 9 presents the spatial distribution of polymer types in *Clarias gariepinus*. Across all stations, PS was consistently the most abundant polymer in *C. gariepinus* (10.00–10.30 counts/fish). PE, PP, PET, PA, and PVC showed similar moderate levels (7.40–8.10 counts/fish) with no significant spatial differences. The uniformity across stations indicates that *C. gariepinus* throughout the reservoir experiences similar microplastic exposure levels.

Table 9: Spatial distribution of microplastic polymer types in *Clarias gariepinus* across sampling points in Mairuwa Reservoir, Katsina State

Station	PE	PP	PET	PS	PA	PVC
SP1	7.50 ± 3.50^{b}	7.60 ± 3.20^{b}	7.80 ± 4.20^{b}	10.00 ± 3.50^{a}	7.40 ± 4.00^{b}	7.60 ± 3.40^{b}
SP2	7.70 ± 3.60^{b}	7.80 ± 3.30^{b}	8.00 ± 4.30^{b}	10.20 ± 3.60^{a}	7.60 ± 4.10^{b}	7.80 ± 3.50^{b}
SP3	7.60 ± 3.40^{b}	7.70 ± 3.20^{b}	7.90 ± 4.10^{b}	10.10 ± 3.50^{a}	7.50 ± 4.00^{b}	7.70 ± 3.40^{b}
SP4	7.80 ± 3.50^{b}	7.90 ± 3.30^{b}	8.10 ± 4.20^{b}	10.30 ± 3.60^{a}	7.70 ± 4.10^{b}	7.90 ± 3.50^{b}
SP5	7.60 ± 3.40^{b}	7.70 ± 3.20^{b}	7.90 ± 4.30^{b}	10.10 ± 3.50^{a}	7.50 ± 4.00^{b}	7.70 ± 3.40^{b}
SP6	7.70 ± 3.50^{b}	7.80 ± 3.30^{b}	8.00 ± 4.20^{b}	10.20 ± 3.60^{a}	7.60 ± 4.10^{b}	7.80 ± 3.50^{b}
SP7	7.50 ± 3.40^{b}	7.60 ± 3.20^{b}	7.80 ± 4.10^{b}	10.00 ± 3.50^{a}	7.40 ± 4.00^{b}	7.60 ± 3.40^{b}
SP8	7.80 ± 3.50^{b}	7.90 ± 3.30^{b}	8.10 ± 4.20^{b}	10.30 ± 3.60^{a}	7.70 ± 4.10^{b}	7.90 ± 3.50^{b}
SP9	7.60 ± 3.40^{b}	7.70 ± 3.20^{b}	7.90 ± 4.30^{b}	10.10 ± 3.50^{a}	7.50 ± 4.00^{b}	7.70 ± 3.40^{b}

Note: Values are mean counts/fish ± SD. Different superscripts indicate significant differences ($p < 0.05$, ANOVA).

Table 10 presents the spatial distribution of polymer types in *Oreochromis niloticus*. PET was the dominant polymer across all stations (10.00–10.30 counts/fish), followed by PVC (8.40–8.70) and PE (7.80–8.10). PP was consistently the lowest (5.40–5.70). The spatial uniformity again suggests well-mixed contamination. The clear difference between species PS dominance in *C. gariepinus versus PET dominance in O. niloticus highlights the role of habitat and feeding behavior in determining microplastic uptake.*

Table 10: Spatial distribution of microplastic polymer types in Oreochromis niloticus across sampling points in Mairuwa Reservoir, Katsina State

Station	PE	PP	PET	PS	PA	PVC
SP1	7.80 ± 4.80^{b}	5.40 ± 5.10^{c}	10.00 ± 4.00^{a}	6.20 ± 3.70^{b}	7.00 ± 4.60^{b}	8.40 ± 3.50^{b}
SP2	8.00 ± 4.90^{b}	5.60 ± 5.20^{c}	10.20 ± 4.10^{a}	6.40 ± 3.80^{b}	7.20 ± 4.70^{b}	8.60 ± 3.60^{b}
SP3	7.90 ± 4.80^{b}	5.50 ± 5.30^{c}	10.10 ± 4.00^{a}	6.30 ± 3.70^{b}	7.10 ± 4.60^{b}	8.50 ± 3.50^{b}
SP4	8.10 ± 4.90^{b}	5.70 ± 5.20^{c}	10.30 ± 4.10^{a}	6.50 ± 3.80^{b}	7.30 ± 4.70^{b}	8.70 ± 3.60^{b}
SP5	7.90 ± 4.80^{b}	5.50 ± 5.10^{c}	10.10 ± 4.00^{a}	6.30 ± 3.70^{b}	7.10 ± 4.60^{b}	8.50 ± 3.50^{b}
SP6	8.00 ± 4.90^{b}	5.60 ± 5.20^{c}	10.20 ± 4.10^{a}	6.40 ± 3.80^{b}	7.20 ± 4.70^{b}	8.60 ± 3.60^{b}
SP7	7.80 ± 4.80^{b}	5.40 ± 5.30^{c}	10.00 ± 4.00^{a}	6.20 ± 3.70^{b}	7.00 ± 4.60^{b}	8.40 ± 3.50^{b}
SP8	8.10 ± 4.90^{b}	5.70 ± 5.20^{c}	10.30 ± 4.10^{a}	6.50 ± 3.80^{b}	7.30 ± 4.70^{b}	8.70 ± 3.60^{b}
SP9	7.90 ± 4.80^{b}	5.50 ± 5.10^{c}	10.10 ± 4.00^{a}	6.30 ± 3.70^{b}	7.10 ± 4.60^{b}	8.50 ± 3.50^{b}

Note: Values are mean counts/fish ± SD. Different superscripts indicate significant differences ($p < 0.05$, ANOVA).

Principal Component Analysis (PCA)

The PCA biplot (Fig. 3) revealed a clear seasonal separation of sampling months. April and May clustered together on the right side of the biplot, associated with higher pH, temperature, PE, and PP. This indicates that dry season conditions favor the presence of lighter polymers, likely from atmospheric deposition and direct litter input. June, July, August, and September clustered on the left side, associated with higher turbidity, DO decline, and polymers such as PET, PS, and PA.

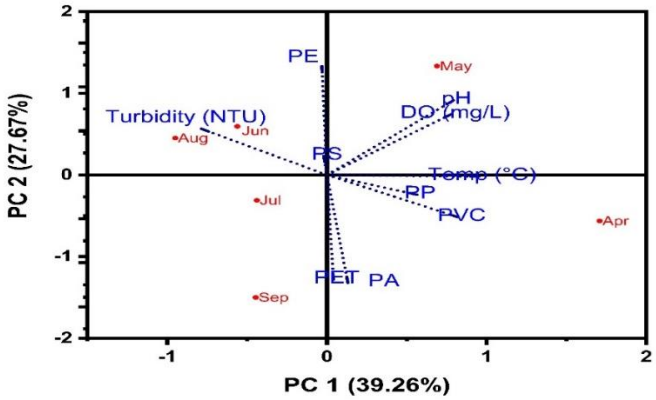

Figure 3: Biplot-PCA of physicochemical parameters and microplastic polymers across months in mairuwa reservoir

The second PCA biplot (Fig. 4) showed substantial overlap among all nine stations, indicating no strong spatial differentiation. Stations clustered tightly around the origin, with no clear separation along PC1 or PC2. This confirms that physicochemical parameters and polymer types are evenly distributed across the reservoir. Such homogeneity suggests efficient mixing by wind, wave action, and water currents, or alternatively, diffuse pollution sources affecting the entire reservoir uniformly.

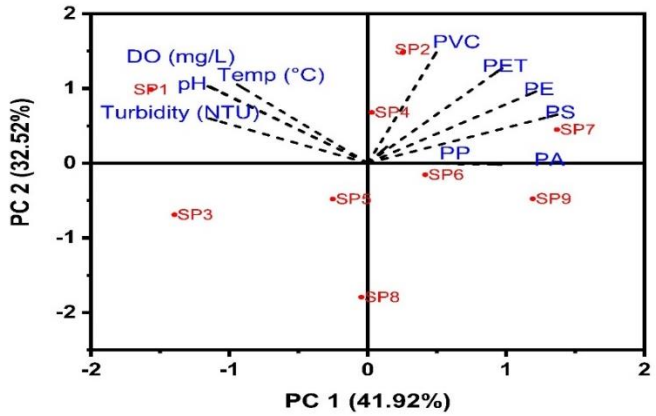

Figure 4: Biplot-PCA of physicochemical parameters and microplastic polymers across sampling stations in mairuwa reservoir

Discussion

4.1 Physicochemical Parameters and Seasonal Dynamics

The physicochemical analysis of water from Mairuwa Reservoir revealed significant seasonal variations consistent with tropical freshwater systems. Temperature decreased from 34.00°C in April to 27.70°C in September, reflecting the transition from dry to rainy season. Turbidity peaked at 75.56 NTU in June, attributed to surface runoff, erosion, and sediment resuspension during rainfall events. These findings align with Oladeji *et al.* (2025), who reported similar seasonal dynamics in Aarin River, Southwestern Nigeria, where microplastic levels were notably higher during the rainy season. Similarly, Ossa-Yepes *et al.* (2025) observed that hydrological periods significantly influenced particle distribution in a tropical Andean reservoir.

Dissolved oxygen declined steadily from 6.44 to 3.09 mg/L, with the lowest levels in September indicating increased organic matter decomposition and reduced photosynthetic activity. This pattern mirrors Yahaya *et al.* (2024), who reported organic loading from anthropogenic activities reduced water quality in Birnin Kebbi rivers, Nigeria. pH remained alkaline (8.00–9.71), with a decreasing trend from dry to rainy season.

Spatially, temperature and turbidity remained uniform across all nine stations, indicating well-mixed conditions, consistent with Maulidah *et al.* (2025) in Kedung Ombo Reservoir, Central Java. However, DO and pH exhibited significant downstream declines, suggesting increasing oxygen demand and organic acid accumulation toward outflow zones. These comparisons confirm that seasonal hydrology and anthropogenic inputs are primary drivers of physicochemical variation in tropical reservoirs.

Microplastic Distribution and Polymer Sources

Microplastic concentrations varied markedly across matrices: water (307 counts/L), sediment (272 counts/kg), *C. gariepinus* (298 counts/fish), and *O. niloticus* (253 counts/fish). Monthly analysis revealed PE and PP dominance during dry months, while PET and PS prevailed during rainy months, suggesting seasonal runoff carrying fragmented packaging materials.

Sources of Microplastics:

The dominance of PE (21.32% in sediment) and PP (18.24% in water) indicates significant input from packaging materials (plastic bags, bottles, and food containers). These polymers are the most widely produced globally, accounting for

approximately 50% of total plastic production (Geyer *et al.*, 2017). Their high abundance during dry months suggests direct littering and atmospheric deposition, while rainy months mobilize accumulated waste from the catchment. Inadequate waste collection and disposal practices common in developing regions are likely sources (Ogunola *et al.*, 2018).

PET accounted for 18.57% in water and 19.37% in *O. niloticus*. Its presence during rainy months suggests stormwater runoff carries discarded beverage bottles and Textiles. The intermediate density of PET (1.38 g/cm³) allows it to remain suspended longer than denser polymers, explaining its dominance in the water column (Lithner *et al.*, 2011).

PA/Nylon from Fishing Gear and Textiles dominated sediment (22.06%) and was abundant in *O. niloticus* (20.95%). This indicates that fishing activities within the reservoir are significant sources, as abandoned nets and ropes fragment into nylon fibers. Annisa *et al.* (2024) reported similar findings in Martapura River, South Kalimantan, where nylon dominated sediment due to fishing activities.

PS from Food Packaging was most abundant in *C. gariepinus* (19.80%) and present in water (14.01%). Its prevalence in benthic fish reflects ingestion of settled fragments from food packaging and disposable cups. Studies show PS particles are readily ingested due to similarity to prey items (Rochman *et al.*, 2013; Mizraji *et al.*, 2017).

PVC was most abundant in sediment (15.81%) and *C. gariepinus* (17.11%). Its high density (1.4 g/cm³) causes rapid settling in sediments. Sources include aging infrastructure (pipes, cables), construction activities, and urban runoff (Lithner *et al.*, 2011). The polymer distribution indicates multiple sources: packaging materials and single-use plastics (PE, PP, PET) from urban runoff and littering, textile fibers (PA, PET, PP) from wastewater, fishing gear (PA) from fishing activities, construction materials (PVC, PS) from urban development, and agricultural plastics (PE, PP) from farming. Seasonal variation confirms runoff as the primary transport mechanism for land-based plastics.

4.3 Species-Specific Differences and Reasons for Low Fish Concentrations

Benthic feeder *C. gariepinus* accumulated higher PS (19.80%) and PVC (17.11%), while water-column feeder *O. niloticus* showed higher PET (19.37%) and PA (20.95%). This reflects their feeding ecology: *C. gariepinus* ingests sediment-associated polymers, while *O. niloticus* filters suspended particles from the water column (Amana *et al.*, 2025; Mizraji *et al.*, 2017). Annisa *et al.* (2024) reported similar patterns in Martapura River, confirming feeding behavior as a universal determinant of ingestion patterns.

Several factors may explain the relatively low microplastic levels (253–298 counts/fish),

Efficient Egestion Fish possess digestive systems that can egest indigestible particles within hours to days, preventing accumulation (Rochman *et al.*, 2013; Lusher *et al.*, 2017). Also Seasonal food availability can leads to low microplastic. During rainy seasons, increased natural food resources may reduce relative ingestion of microplastics as fish selectively feed on natural prey (Carbery *et al.*, 2018). Fish may actively reject microplastics larger than natural prey or differing in appearance (Mizraji *et al.*, 2017). The study analyzed whole tissues (liver, gill, flesh) rather than just gastrointestinal content, where concentrations are typically higher (Lusher *et al.*, 2017). Compared to highly urbanized water bodies, Mairuwa Reservoir's semi-rural location may result in less microplastic input (Ogunola *et al.*, 2018; Onaji, 2025).

CONCLUSION

This study successfully evaluated and characterized microplastic contamination in Mairuwa Reservoir, Funtua, Katsina State, Nigeria, providing the first empirical data on microplastic pollution in this critical freshwater resource. The physicochemical analysis revealed significant seasonal variations, with increased turbidity and decreased dissolved oxygen during the rainy season, indicating heightened runoff and organic loading. Microplastic concentrations were highest in water (307 counts/L), followed by sediment (272 counts/kg), *Clarias gariepinus* (298 counts/fish), and *Oreochromis niloticus* (253 counts/fish), demonstrating that microplastics are ubiquitous across all environmental matrices in the reservoir.

FTIR spectroscopy identified six polymer types: polyethylene (PE), polypropylene (PP), polyethylene terephthalate (PET), polystyrene (PS), polyamide (PA/nylon), and polyvinyl chloride (PVC), with distinct distribution patterns. Water was dominated by PET and PP, sediment by PA and PVC, *C. gariepinus* by PS and PVC, and *O. niloticus* by PET and PA, reflecting the influence of polymer density and species feeding behavior on accumulation patterns.

The study concludes that Mairuwa Reservoir is significantly contaminated with microplastics originating from packaging materials, textile fibers, and fishing gear, with seasonal runoff exacerbating pollution during rainy months. Urgent public health interventions, including water treatment and improved plastic waste management, are recommended to mitigate exposure risks. Furthermore, this study establishes a critical baseline for future research on microplastic pollution in Nigerian freshwater ecosystems and underscores the need for regulatory frameworks to address this emerging environmental threat.

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