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Microplastics Pollution in Nigerian Aquatic Ecosystems: Sources, Pathways, Impacts, and Mitigation Strategies. A Review

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ABSTRACT

Microplastics, MPs (< 5mm) are ubiquitous plastic contaminants in freshwater and marine environments. MPs have been increasingly documented across Nigerian aquatic systems, including rivers, lagoons, estuaries, sediments, seafood, and drinking waters. They arise from multiple primary and secondary sources, undergo complex transport and transformation pathways, and affect organisms across trophic levels. Evidence indicates widespread contamination with fibers and fragments dominated by polyethylene, polypropylene, and polyester at urban drainage and estuarine sinks, and detectable particles in sachet/bottled water and commercially harvested fish. Reports showed that land-based inputs dominate marine microplastic loads, which are transported into subsurface and Polar Regions by currents with effects ranging from physiological stress in organisms to potential human exposure through seafood and drinking water. This review synthesizes recent findings on major sources and environmental pathways, ecological and human-health impacts, and mitigation strategies tailored to Nigeria's socio-environmental context. The article recommended targeted source-reduction (including enforcement of single-use plastic restrictions and alternatives for sachet water), technological upgrades in wastewater and stormwater trash capture at drainage outfalls and treatment, coordinated upstream interventions (product design, waste management, extended producer responsibility), exposure and health risks studies for high-risks occupational and coastal communities, long-term toxicology for chronic low-dose exposures (including nanoplastics), and standardized national monitoring framework. These steps are urgent to protect aquatic ecosystem services and public health in Nigeria.

INTRODUCTION

Microplastics (MPs), commonly defined as plastic particles <5 mm, are persistent environmental contaminants that pose ecological and human-exposure concerns worldwide (Huirong *et al*., 2021). According to Iviwe (2021), the increase in MPs pollution in the aquatic environments is attributed to the exponential rise in plastic production since the mid-20th century. Continuous fragmentation and direct release of small plastic particles have created an environmental problem recognized globally as microplastic contamination or pollution. Microplastics (MPs) pollution of aquatic ecosystems is a worldwide challenge because of its negative impacts on the aquatic ecosystem and human health). In Nigeria, rapid urbanization, extensive use of single-use plastics (notably sachet water and styrofaom), gaps in municipal waste collection, and informal waste economies have created conditions that favour plastic leakage to waterways. Recent field surveys and monitoring studies across multiple Nigerian states document MPs in surface waters, sediments, commercial fish, bottled/sachet waters and drinking supplies, indicating both environmental and direct human exposure routes (Ebere, 2019; Akindele *et al.,* 2019; Idowu *et al*., 2019; Apata *et al.,* 2022a; Apata *et al.,* 2022b). Similar, researches by Isaac *et al.,* (2023), Akinhanmi *et al.* (2023), Aliyu *et al.* (2023), Akinhanmi (2024), Nduka *et al.* (2024), Obiakara-Amaech, 2025), Onyena (2025), and Kpikpi *et al.* (2025) collaborated similar findings.

MPs are found in surface waters, sediments, organisms, sea ice, and drinking water sources, provoking concern about ecological damage and potential human health risks. The presence of microplastics in aquatic ecosystems such as sediments (Ahmad *et al.,* 2025), sea beds/ocean floors (Hartz *et al*., 2025) and biota (Witczak *et al.,* 2024) has been recorded worldwide. A review of related literature has shown that MPs pollution is increasing geometrically in aquatic ecosystems, threatening aquatic life, biodiversity, degradation, and human health. Aquatic organisms often mistake MPs as food and ingest them, resulting in altered metabolic functions and serious health challenges (Atiqur *et al.,* 2025; Pal *et al*., 2025; Sunny *et al.,* 2025). Microplastics are distributed and transported in an aquatic environment through various patterns and sources either as primary or secondary. Primary microplastics are manufactured in small sizes (e.g., pellets, microbeads) usually present in beauty care products and abrasives which enter the environment directly.

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Secondary microplastics result from the fragmentation of larger plastic items (e.g., packaging, fishing gear, tyres (Wu *et al.,* 2023; Marcharla *et al.,* 2024; Zhang *et al.*, 2024). The impacts of MPs on biota and human health through food chain are also well documented (Rummel *et al.,* 2017; Nelms *et al.,* 2021; Ragusa *et al.,* 2021, and Toussaint *et al.,* 2023). The persistence and inability of Microplastics to biodegrade as well as serve as potential vectors of other toxic pollutants (Wei *et al.*, 2023) have serious health implications to aquatic life and human health.

According to estimates (UNDP, 2022; Atiqur *et al.,* 2025), 80 million tonnes of plastics found their way into the aquatic environments in 2015 where Africa alone contributed 21 % of the figure. Available records showed that approximately 85 % of plastics wastes is unregulated in Africa, which is above the global average of 47% (Atiqur *et al.,* 2025). According to a report by Safaa., (2024), Egypt, Nigeria, South Africa, and Algeria ranked 7th, 9th, 11th,and 13th respectively in global plastics wastes mismanagement. Most of these wastes eventually end up in the aquatic ecosystems with the attendant consequences. The level of microplastics pollution in aquatic ecosystems is expected to increase if deliberate measures are not taken to mitigate it. It is worthy of note that African freshwaters (especially Nigeria) are gradually dwindling due to plastics pollution and climate change. Accordingly, the presence of microplastics in fishes, crustaceans, amphibians, insects, freshwater birds, Jellyfish/sea jellies, turtles, seaweed/kelp, mollusks, coral/anemones, and marine worms are increasingly being documented by researchers Sun *et al.,* 2022; Tiwari *et al.*, 2023).

Many communities in Nigeria depend on fishing and fish farming for their livelihood. Thus, microplastic pollution in these Nigerian aquatic ecosystems (dams, lakes, rivers, seas, and oceans) will no doubt result to devastating consequences on aquatic life, biodiversity, human health, and food insecurity. Again, Nigeria is home to a number of stunning beaches: Elegushi beach, La Campagna Tropicana Beach Resort, Bar Beach, Tarkwa Bay and Lekki beach (Lagos state); Ibeno beach (Akwa Ibom state); Calabar beach (Cross River state); Asaba beach (Delta state); Patigi beach (Kwara state); Finima and Ifoko beaches (Rivers state), and Ndibe sand beach (Ebonyi state) among others. These beaches are perfect for relaxation, recreation, and cultural experiences, offering a mixture of urban vibes, cultural heritage, and natural beauty. The beaches make Nigeria a great destination for beach lovers and also attract tourists all over the world, generating revenue for the government. Therefore, microplastics pollution or plastics washed up on beach sediments will render these aquatic ecosystems unattractive for tourist attraction, hindering economic development. It is therefore important to create awareness on the negative impacts of microplastics pollution on aquatic environments in Nigeria. Information on MPs pollution of Nigerian aquatic ecosystems will help to educate and provide a platform for legislations and regulations that will assist in curbing the menace of microplastics pollution in the country. Literature searches have revealed only a handful of researches on microplastics pollution in Nigerian aquatic environments, resulting to difficulty in appreciating the associated ecological consequences of microplastics pollution.

This review summarizes up-to-date knowledge on the sources, and pathways of MPs into Nigerian aquatic systems, their observed impacts on aquatic organisms, human health, and ecosystems, and practical mitigation strategies supported by recent research and technological developments.

MATERIALS AND METHODS

This is a narrative systematic review of peer-reviewed literature and authoritative published reports from 2019 to 2025 that measured microplastics in Nigerian aquatic environments or food/water products. Both peer-reviewed articles and credible gray literature (university repositories, government notices, reputable news reporting on national policy) were included to reflect the rapidly evolving local evidence base. Priority was given to meta-analyses, systematic reviews, high-impact empirical studies, and authoritative reviews. The most relevant studies were extracted to produce a comparative table summarizing sampling location, year, compartment sampled, analytical methods, and key findings.

RESULTS AND DISCUSSION

Occurrence and Characteristics of Microplastics in Nigeria

Surface Waters And Sediments

Microplastics pollution in Nigerian aquatic environments is a pressing environmental issue, with several studies highlighting the severity of the problem. Idowu *et al.* (2019) conducted studies on River Osun (A UNESCO World Heritage site), focusing on microplastics pollution. They investigated the presence of microplastics in the river, specifically looking at the ingestion of microplastics by freshwater gastropods. The study found evidence of microplastics contamination in the river with concentrations reaching 22,079 particle/L, highlighting the impact of microplastic pollution on aquatic life.

A research conducted on Rivers Dukku and Kalgo, Kebbi state by Tajudeen *et al.* (2024) on the impact of MPs pollution on aquatic life found significant concentrations of MPs in both rivers

with the Dukku river showing concentrations ranging from 125.00 particles/L to 160.30 aprticles/L and Kalgo river ranging from 119.30particle/L to 134.70 particle/L. Similar researches conducted by Abdullahi *et al.* (2022) on the physocochemical properties and diversity of microalgae, in Dukku River, Birnin Kebbi, Nigeria and Yahaya *et al.,*(2024) on the abundance, characterization, and health risks evaluation of microplastics in borehole water in Birni Kebbi, Nigeria confirmed varying concentrations of microplastics in the water sources.

Lagos Lagoon surveys and sediments sampling consistently found microplastics in surface water and sediments. Common morphologies included fibers, fragments and films, with polyethylene (PE), polypropylene (PP), and polyester frequently reported. Spatial hotspots typically coincide with densely populated landing sites and drainage outfalls (Akinhanmi *et al.,* 2023; Akinhanmi, 2024).

A research conducted by Aliyu *et al* (2023) on the assessment of MPs contamination on River water, sachet water, and branded table slat samples in Kaduna metropolis showed Mps ranged 25 to 36 particle/L in treated water, 153 particle/L in raw water, 1.4-3.7 particle/L for bottled water and 0.13 to 0.27 particles/L in salt samples. Water and salt samples contained five different types of polymers: polyethylene, polypropylene, polyester, polyvinyl chloride, and polyethylene terephthalate. The result also indicated that fragments were more prevalent in both raw and treated water, while fragments and fibres predominated in bottled water and table salt samples.

Another research conducted by Isaac *et al.* (2024) on microplastic particles in river sediments of southwestern Nigeria showed abundance of microplastic in surface sediments and water samples across all locations, ranging from 12.82 particle/kg to 22.90 particle/kg dw and 6.71 particle/L to 17.12 particle/L during the dry season and 5.69 particle/kg to 14.38 particle/kg dw and 12.41 particle/L to 22.73 particle/L during the wet season respectively. The result revealed that on the average, fibre constituted the highest percentage of MPs in sediments (71 %) and water (67 %), while foam recorded the lowest value of 0.6 % and 1.7 % respectively, with polypropylene (PP) and polyethylene (PE) being the main MPs across all the locations.

Similarly, riverine studies in Imo (Otammiri River) by Nduka *et al.* (2024) confirmed the presence of MPs in surface water samples and sediments, with spatial gradients indicating higher loads near urban drainage outlets and downstream estuarine zones. The results revealed that polypropylene (PP), polyethylene (PE), polyethylene terephthalate (PET), polystyrene (PS), and polyurethane were the predominant polymers found across the river.

Kpikpi *et al.* (2025) confirmed microplastic contamination in the surface water of the lower Forcados River, Burutu, Delta State, Nigeria. The result revealed the abundance and composition in the surface water as 44 items/L and microfiber 14(31.81 %), microfragments 6 (13.63 %), microfilms 7 (15.90 %), microfilaments 12 (27.27 %), and microfoams 5 (11.36 %) which also accounted for densities ranging from microfilms (ϱ = 0.00001) to microfragments (ϱ = 6.6) and filament showing a similar blueprint to the microfilms in the study.

A covenant University ePrint review, (2024) also confirmed progressive increase in MP detections and called for harmonized methods and monitoring to reduce the negative impacts of microplastics pollution in Nigerian surface waters(Reuters, 2024; OSGF, 2024; AP news, 2024).

River systems (e.g., River Niger at Onitsha; Forcados River; Ogun River; Otuoke and Ovia rivers) document MPs in both water and sediments and, in some cases, in tissues of fish and benthic invertebrates sampled for human consumption. Concentrations vary by site and season, with higher loads near urban centers and river mouths (Kpikpi *et al.,* 2025). According to researches, the major sources of microplastic in such environments came from single-use plastics such as carrier bags and Styrofoam; breakdown of larger plastic items; manufacturing processes generating plastic pellets and nurdles and domestic and industrial wastes. The patterns point to strong local sources and riverine transport to coastal sinks. These researches are significant as the water sources are vital in supporting various ecosystems and human activities. The research findings underscore the need for effective plastic waste management and conservation efforts to mitigate microplastics pollution in Nigerian aquatic environments so as to reduce aquatic ecosystems degradation, aquatic life and human exposures.

Table 1: Compact table summarizing key Nigerian field studies on microplastics pollution in the Nigerian aquatic environments.

S/N	Study	Location	Sample Type	Method	Key Findings
1.	Akinhami *et al.*, 2023/2024	Lagos Lagoon (Epe, Mokoko, Sagbokoji, Badagry)	Surface water & sediments: fish organs	Composite sampling; visual sorting and FTIR/Raman polymer ID/ histology for fish	Fibres and fragment dominant; PE/PP/ polyester common; hotspots near urban drain outlets; evidence of MPs in fish organs.
2.	Kaduna assessment, 2023	Kaduna metropolis	Raw river water, treated municipal water, sachet & bottled water, table salt	Standard digestion, visual counting (size cutoff reported)	MPs detected in raw water (up to 153 particles/L), treated water (25-36 Particle/L), bottled water/sachet water measurable.

3.	Otammiri River microplastics, 2024	Otammmiri River, Imo state	Surface water	NOAA trawling protocol; size range(0.3- 5 mm); density separation (NaCl); visual & spectroscopic ID	MPs present across sites; fragments and fibres: recommended further monitoring.
4.	Lower Forcado River, Burutu, 2022-2-23 sampling (published, 2025)	Forcado River, Delta state	Surfacewater (monthly for 12 months)	Multi-site sampling,NOAA protocols; visual counts & polymer ID	Seasonal trends; higher concentrations near downstream and urban zones; identified fragments, films
5.	Convenant University ePrint review, 2024	Review/Lagos focus	Synthesis of Lagos studies	Literature synthesis	Confirms progressive increase in MPs detections; calls for harmonized method sand monitoring
6.	Akindele *et al.*, (2019)	Osun River, Osun state	Invertebrates,	Hand detaching, μFTIR	MPs in the river
7.	Ja'afar *et al.*,(2022)	Dukku and Kalgo Rivers, Kebbi state	surface and bottom water	FTIR	High levels of MPs
8.	Idowu *et al.*, (2019)	Major Rivers, Southwestern Nigeria	Sediments and surface water	FTIR-ATR	High MPs in samples

Biota and Fisheries

Field sampling and analysis from Lagos coastal waters and lagoons, has detected MPs within the gastrointestinal tracts of commercially important fish species (Akinhanmi, 2024). Some studies also report associated histopathological signs in fish organs (Akindele *et al.*, 2019; Atiqur *et al.,* 2025; Ahmad *et al.,* 2025; Ahmad & Siti Salami, 2025). These findings imply direct trophic exposure and potential food-safety concerns for consumers relying on locally caught fish.

Biota contamination taken together, the Nigerian evidence base confirms widespread occurrence of MPs in multiple environmental compartments and in food/water items consumed by people.

Drinking Water and Food Products

Analyses in Lagos, Kaduna, Imo, Delta, Osun and other urban centers report MP particles in raw river water, treated municipal water, sachet and bottled water, and market table salts, showing human exposure pathways via ingestion. Reported particle counts for treated water ranged from tens of particles per liter, depending on analytical cutoffs and methods. Methodological variability across studies (size limits, digestion procedures, polymer ID) complicates direct numerical comparisons but the repeated detection across product types is robust.

Sources and Environmental Pathways of MPs

Primary and Secondary Microplastics

Microplastics (MPs) are classified based on their origin as primary or secondary. Primary microplastics are intentionally manufactured in small sizes, typically <5 mm, for specific industrial or commercial uses such as cosmetic microbeads, industrial abrasives, and pre-production plastic pellets (Sharma *et al.*, 2023). They enter aquatic systems directly through wastewater effluents and stormwater discharges.

Secondary microplastics, on the other hand, result from the fragmentation of larger plastic debris (e.g., packaging, fishing gear, tyres) through physical, chemical, and biological degradation processes, including UV radiation, wave action, and microbial activity (Koelmans *et al.,* 2022). Common sources include degraded plastic bags, fishing nets, and bottles. Unlike primary MPs, secondary MPs vary widely in composition and morphology, influencing their persistence and interactions with aquatic organisms (Zhang *et al.,* 2024).Recent surveys indicate that secondary MPs: fibres and fragments are the dominant shapes found in surface waters and sediments globally, reflecting widespread breakdown of macroplastics and textile fibre shedding (Allen *et al.,* 2021).

Dominant sources of microplastics in Nigerian aquatic ecosystems include widespread single-use plastics and sachet water packaging, informal dumping, poor municipal collection, and lost fishing gear. Once in the aquatic system, buoyant plastics disperse and concentrate at sheltered bays and estuarine mouths, while biofouling and aggregation with organic flocs encourage sinking to benthic sediments typical of Niger Delta mangrove and estuarine zones (Lesley, 2020; Nwabuisi & Ihenetu, 2022; Green Habitat Nigeria, 2024). Seasonal rains amplify transport (flood pulses) and resuspension of Mps inaquatic environments.

Major Entry Routes Into Aquatic Systems

Microplastics enter aquatic environments through direct and indirect pathways. Major entry routes are land-based sources (urban runoff, mismanaged waste, storm drains, wastewater treatment plant effluents, industrial discharges) account for the majority of microplastic inputs to freshwater and marine systems (Pal *et al*., 2025). Several country-specific drivers of MPs in aquatic systems include:

Single-Use Plastic Proliferation and Informal Disposal

Nigeria's high reliance on low-cost single-use items (including the ubiquitous small water sachets) and limited formal waste collection infrastructure mean that large volumes of plastics escape capture and degrade in the environment. The federal government announced measures and phased bans on categories of single-use plastics in 2024–2025, aiming to reduce such inputs (Reutere, 2024; OSGF, 2024).

Urban Runoff and Drainage

Stormwater systems in major cities (Lagos, Port Harcourt, Onitsha, Kaduna) often discharge directly to rivers and lagoons without effective trash capture; road runoff and street litter transport fragmented plastics into waterways. Studies identify drainage mouths and landing sites as MPs hotspots.

Wastewater and Informal Laundries

Although centralized sewage coverage is limited, wastewater and effluents from industrial, commercial, and household sources (including laundromats) contribute synthetic fibers and primary microplastic particles to local waters; conventional water treatment and informal treatment systems vary widely in effectiveness.

Maritime and Fishing Activities

Lost or discarded fishing gear, nets, and aquaculture materials produce secondary MPs that accumulate near coasts and estuaries.

Atmospheric Deposition and Agricultural Plastics

Although less studied in Nigeria, airborne fibers and degraded agricultural plastics: mulch, greenhouse covers (Allen *et al.,* 2021) are plausible supplementary inputs that merit investigation.

Transport And Sinks

The environmental fate of MPs in Nigeria broadly mirrors global patterns but is strongly modulated by local hydrology and seasonal rains. Once released, microplastics are distributed vertically and horizontally by currents, wind-driven mixing, and biophysical interactions. MPs undergo complex transport and transformation processes governed by size, density, and hydrodynamic conditions (Nelms *et al.,* 2021). Lighter polymers particles (E.g. polyethylene and polypropylene) and fibers often remain suspended or float, moving with currents and accumulating at sheltered bays, lagoon inlets and around river mouths whereas denser polymers such as polyvinyl chloride (PVC) tend to sink and accumulate in sediments (Atiqur *et al.,* 2025). Observed surface and shoreline accumulations in Lagos and Delta coastal zones reflect this behavior. Biofouling, aggregation with organic matter and flocculation during high-turbidity events encourage sinking of MPs into sediments, creating benthic sinks, especially in estuaries and mangrove sediments characteristic of the Niger Delta (Rummel *et al.,* 2017).

Seasonal resuspension during floods redistributes particles upstream and downstream. Small particles and fibers are readily ingested by zooplankton, bivalves and small fish, leading to trophic transfer and potential retention in tissues consumed by humans and predators (Tiwari *et al.,* 2023). Field detections in fish from Lagos Lagoon and other coastal waters confirm trophic exposure pathways.

Recent measurements reveal substantial subsurface and polar accumulations transported by subsurface currents and high-latitude circulation, meaning MPs are not confined to surface gyres but penetrate the water column and accumulate in remote regions. Sediments and coastal deposits act as long-term sinks. Although country-level toxicological field studies remain limited, the presence of MPs in key habitats and in commercial fish suggests likely ecological impacts similar to those documented globally: ingestion and physical harm to invertebrates and fish, vectors for hydrophobic contaminants and pathogens, and potential disruptions of benthic processes in sediment sinks. In the Niger Delta, the intersection of oil-related contaminants and MPs may compound ecological risk.

Ecological and Human Health Impacts

Field data from Nigeria on toxicological endpoints remain limited compared with laboratory studies, but a combination of field observations and regional lab work points to several concerns.

Effects on Aquatic Organisms

Microplastics can induce physical, chemical, and biological effects on aquatic life. Ingestion of MPs has been documented across taxa: zooplankton, bivalves, fish, seabirds, and megafauna. Physical effects of MPs have been reported to include reduced feeding efficiency, gut blockage, reduced growth, oxidative stress, altered behaviour, and impaired reproduction. Size, shape, polymer type, and associated sorbed chemicals modulate toxicity (Wang *et al.,* 2022). Chemically, MPs adsorb hazardous pollutants such as polycyclic aromatic hydrocarbons (PAHs), heavy metals, and persistent organic pollutants (POPs), which can be transferred to organisms upon ingestion (Allen *et al.,* 2021).

Additionally, MPs can act as vectors for heavy metals, hydrophobic/persistent organic pollutants and pathogenic microbes, potentially altering exposure profiles for organisms (Wu *et al.,* 2023). Laboratory studies have reported oxidative stress, inflammation, and

Delta, where oil-related pollution coexists with plastic debris, combined stressors could amplify toxicity. A few Nigerian studies measure co-contaminant burdens associated with plastics, signaling compounded risks.

Food-Web and Ecosystem-Level Concerns

Microplastics infiltrate the aquatic food web through ingestion by lower trophic organisms such as zooplankton and bivalves (Nelms *et al.,* 2021). MPs that are retained by lower trophic organisms can be transferred up food chains (trophic transfer), potentially altering energy flow and contaminant dynamics. Subtle sublethal effects (e.g., reduced fitness, immune impairment) could scale up to population-level consequences in sensitive species. Sediment and benthos-associated MPs may also alter benthic habitat functioning. This leads to bioaccumulation and biomagnification of plastics and associated contaminants across food chains. Consequently, top predators, including fish consumed by humans, often exhibit elevated MP concentrations (Witczak *et al.,* 2024). Ecosystem-level impacts include alterations in nutrient cycling, primary productivity, and sediment structure due to the physical presence of MPs (Akinhanmi *et al.,* 2023). Furthermore, microplastics may modify microbial communities essential for ecosystem functioning. These disruptions threaten ecological stability, fisheries productivity, and ecosystem services critical to human welfare.

The sources, fate, and trophic level transfer of microplastics in aquatic environments are shown in figure 1.

Figure 1: Sources, fate, and trophic level transfer of microplastics in aquatic environments (Osamah *et al.*, 2025).

Human Exposure and Health Uncertainties

Human Exposure

Humans are exposed to microplastics primarily through seafood consumption, drinking water, inhalation, food packaging contamination, and possibly dermal contact (Toussaint *et al.,* 2024).

Drinking Water (Sachet, Bottled, Treated Municipal)

Detection of nano- and microplastics in bottled and tap water has raised concerns, but definitive evidence linking environmentally relevant exposures to specific human disease outcomes remains limited. Potential risks include inflammation, oxidative stress, and cytotoxicity arising from particle accumulation and chemical leaching (Wu *et al.,* 2023; Toussaint *et al.,* 2024).

Studies in Kaduna (Aliyu *et al.,* 2023) and other towns (Idowu *et al.,* 2016; Apata *et al.,* 2022a and b; Isaac *et al.,* 2023; Kpikpi *et al.,*2025) report MPs in sachet and bottled waters and in treated drinking water at detectable levels, implying regular ingestion exposures across the population that consumes these products. Studies have confirmed the presence of MPs in human feces, placenta, and blood, suggesting systemic exposure (Onyema, 2025). Methodological differences across studies (size cutoffs, digestion protocols) make cross-study comparisons challenging, but the repeated detection across independent studies strengthens the conclusion that exposure exists.

Nano-sized plastics (<100 nm) can penetrate biological barriers, raising concerns about translocation into tissues and interference with cellular metabolism. Emerging toxicological studies indicate inflammatory responses and immunomodulation in animal models and cell systems, but long-term human epidemiological data are lacking. Although the extent of chronic health effects is still under investigation, the ubiquity of microplastics in the human environment underscores the need for precautionary measures and further toxicological research.

Seafood Consumption

Detection of MPs in fish species consumed locally suggests dietary exposure for coastal communities and urban consumers buying locally sourced fish. The fraction of plastics that translocate to edible tissues versus remaining in viscera is an active research question; existing Nigerian studies report MPs mainly in visceral tissues but also sometimes in edible parts.

Inhalation And Occupational Exposure

Urban dust, fibers released during handling of plastics, and emissions from informal recycling sites may create inhalation exposures for waste workers and residents near dumps, but robust exposure measurements in Nigeria are scarce.

Health Uncertainties

Globally, the toxicology of micro- and nano-plastics in humans is under development. Multiple studies detect MPs in drinking water (including sachet/bottled water) and in fish sold for consumption, indicating dietary exposure. However, critical uncertainties remain on exposure dose (numbers, sizes, polymers), translocation of MPs from gut to edible tissue, and long-term health effects in human populations. While systemic exposure (blood, placenta) has been reported in other countries, causal links to chronic disease remain unestablished. Although country-level toxicological field studies remain limited, the presence of MPs in key habitats and in commercial fish suggests likely ecological impacts similar to those documented globally: ingestion and physical harm to invertebrates and fish, vectors for hydrophobic contaminants and pathogens, and potential disruptions of benthic processes in sediment sinks. In the Niger Delta, the intersection of oil-related contaminants and MPs may compound ecological risk. For Nigeria, the urgent priorities are quantitative exposure assessment (how many particles, what sizes, which polymers), co-exposure to chemical contaminants (e.g., PAHs, heavy metals), and population health studies in high-exposure groups (fishers, waste workers, and communities dependent on local water supplies).

Given the economic importance of small-scale fisheries (especially around Lagos, Benue, and the Niger Delta), contamination of commercial species has implications for marketability, consumer confidence, livelihoods, and food security if contamination becomes widespread or highly publicized.

Existing Policies and Recent National Actions

Single-Use Plastic Bans and National Policy

In 2024, the federal government of Nigeria announced phased bans on certain single-use plastics (including, Styrofoam and sachet water in certain contexts), adopted measures limiting single-use plastics in federal government procurement and announced staggered national restrictions aimed at reducing single-use items, building on the 2020 National Policy on Plastic Waste Management and local actions (e.g., Lagos state bans) (The Punch, 2024, October 3; Blessing, 2024). This ban was part of measures by the state government to put in place policy guidelines for plastic utility in further ensuring a sustainable management of plastic wastes, healthy, safe, and sustainable environment. According to the report, plastic waste materials make up significant proportion of solid wastes (about 60 % of the monthly 13,000 tones) of wastes generated in Lagos, causing everything from ecosystem degradation to drainage clogs and flooding. The ban followed increasing prevalence of plastic wastes and its negative effects on the environment in recent years.

Waste Management and Circular Economy Measures

Strengthening municipal collection, formalizing waste-pickers and recycling value chains, and investment in material recovery facilities reduce environmental leakage (Magalhaes, 2025; Sun *et al.,* 2022). For Nigeria, pragmatic interventions (community-level waste traps at drainage mouths, river cleanup campaigns, and plastic buy-back schemes) can have near-term benefits for microplastics pollution mitigation in hotspot areas.

Water Treatment Upgrades and Point-of-Use Actions

Improving treatment plant filtration, installing fine screens and membrane processes where feasible, and encouraging household-level filtration for drinking water can lower human exposure via drinking water. However, costs and maintenance challenges require adaptive locally appropriate approaches.

Research, Monitoring and Standardization

Nigeria needs a coordinated national monitoring framework for MPs (harmonized sampling and analysis protocols, reference labs, and data sharing) so that trends can be assessed and policy efficacy evaluated. Several recent regional studies provide a starting point for designing such a programme.

Nigeria recently State-level actions complement national moves, but enforcement, affordable alternatives, and systemic waste-management investment remain key challenges to translating policy into reduced environmental MP loads. However, an effective response spans the full lifecycle of plastics: reduce production of harmful items, improve product design, optimize waste management, treat urban and industrial effluents, and remediate existing environmental loads.

Mitigation Strategies

Mitigating microplastics pollution requires integrated strategies encompassing prevention, removal, and policy interventions. At the source level, banning or restricting microbeads in personal care products, promoting biodegradable alternatives, and improving product design can significantly reduce primary MP generation (UNEP, 2022).

The following mitigation strategies are key towards curbing Nigeria's microplastic pollution in the aquatic ecosystems:

Upstream Interventions (Source Reduction And Design) Policy Instruments

Bans on unnecessary microbeads (successful in many jurisdictions), restrictions on single-use plastics (e.g. styrofoam), while supporting affordable alternatives for small businesses and sachet water distribution and product standards that mandate durability and recyclability.

Product Redesign

Reducing polymer shedding (textile innovations, tyre formulations), designing for recyclability, and substitution with low-emission materials.

Extended Producer Responsibility (EPR)

Shifting lifecycle waste costs to producers incentivizes design for reduced leakage. These upstream approaches are foundational and cost-effective compared with downstream cleanup.

Waste Management and Circular Economy

Improved collection, sorting, and recycling reduce plastic leakage to the environment. Informal-sector integration and investments in material recovery in low- and middle-income countries (LMICs) are critical because most mismanaged waste originates there.

Avoiding open burning and leak-prone landfills reduces fragment generation. Strategic waste infrastructure deployment combined with behaviour-change campaigns reduces inputs to rivers and coasts.

Wastewater and Stormwater Treatment Improvements

Wastewater treatment optimization can significantly reduce MP loads via primary (screening, grit removal) and secondary (settling, filtration) processes, and advanced tertiary options (membrane filtration, dissolved air flotation, advanced oxidation) (Magalhaes, 2025). Urban stormwater management, green infrastructure, and riverine clean-up programs are also critical. On a broader scale, extended producer responsibility (EPR) policies, plastic waste recycling, and public awareness campaigns can minimize plastic leakage into the environment.

Emerging biotechnological approaches, such as enzymatic and microbial degradation of polymers, offer promising future solutions (Wei *et al.,* 2023). International collaboration under frameworks like the UN Plastics Treaty (2024) is essential to harmonize monitoring, research, and policy implementation globally. However, no single technology is universally optimal: trade-offs include cost, energy, and concentrate/sludge management. Removing MPs from effluents concentrates them in sludge, which requires safe disposal or further treatment to prevent secondary release (e.g., via agricultural land application). Technologies such as membrane bioreactors, rapid sand filtration, advanced tertiary filters, and coagulation/flocculation are promising when appropriately configured and maintained. Thus investment in drainage trash capture (screens/booms) at urban outfalls and pilot community buy-back, formalization programs for waste pickers will reduce leakage, and promote household point-of-use measures where appropriate.

Innovative Remediation and Product-Level Solutions

Recent advances include engineered absorbents and bio-based sponges that capture suspended MPs with high efficiency (laboratory/field-scale tests show promising removal rates) (Magalhaes, 2025). For example, composite sponges made from natural polysaccharides/chitin show high microplastic uptake in trials, suggesting potential for localized remediation and integration into filtration systems (e.g., washing machine filters). However, scalability, lifecycle impacts, and cost-effectiveness need thorough assessment.

Behavioural and Societal Measures

Consumer-level interventions (washable microfibre filters for laundry, promoting reusable items, improved public waste practices) combined with public education campaigns reduce microplastics generation. Industry transparency and labeling (e.g., microfibre shedding rates) may drive competition toward low-shedding products.

Above all, there is the need to implement a standardized national MP monitoring network with harmonized sampling (size classes, digestion, polymer ID by FTIR/Raman), sentinel sites (Lagos, Niger Delta, Anambra/Onitsha, Kaduna) and prioritize exposure assessments for drinking water (treatment plant influent/effluent, sachet and bottled products) as well as dietary exposure through common fish species.

Challenges, Research Gaps, and Priorities for Nigeria

Key barriers to decisive action include methodological heterogeneity (sampling, size-class definitions, analytical detection limits), limited understanding of nanoplastics, sparse long-term ecotoxicology and epidemiology, and incomplete socio-economic evaluations of mitigation pathways.

Based on the current evidence and the country's socio-environmental context, the following priorities are recommended:

Nationwide Baseline and Monitoring Network
Standardize of sampling methods, extraction, and analytical protocols (especially for particles <100 µm and nanoplastics), digestion, polymer ID, and implement representative sampling across major river basins, estuaries, coastal zones and drinking water sources. Use sentinel sites in Lagos, Niger Delta, Anambra/Onitsha, Kaduna and coastal states.

Exposure and Health Risk Assessments
Quantify human exposures via diet and water (particle counts and polymer identification), and design epidemiological and long-term toxicological studies focusing on chronic low-dose exposures and mixture effects (MPs plus sorbed pollutants) for high-risk occupational groups.

Source-Focused Interventions and Evaluation
Pilot and evaluate interventions (sachet alternatives, extended producer responsibility pilots, stormwater trash traps) using measurable environmental endpoints (MP loads at drainage outfalls).

Capacity Building and Stakeholder Engagement
Strengthen laboratory capacity (FTIR/µ-FTIR, Raman) in universities and government labs; engage local communities, fisherfolk and informal waste sectors in co-designed mitigation.

Integrated Monitoring and Policy Implementation
Translate national bans into enforceable local regulations, incentivize alternatives, and combine regulatory actions with education and economic supports for affected workers and small businesses. There is urgent need for routine, comparable national monitoring programmes to track trends and measure policy effectiveness.

Efficiency and Life-Cycle Analysis
Efficacy and life-cycle analyses of mitigation technologies (WWTP upgrades, novel sorbents) to ensure solutions do not create secondary harms.

Socio-Economic Interventions
Scaling socio-economic interventions in LMIC contexts where waste leakage is highest.

CONCLUSION

Microplastic pollution is pervasive and persistent in aquatic environments. Evidence from aquatic ecosystems in Nigeria demonstrates widespread presence of microplastics across aquatic compartments and exposure pathways relevant to ecosystem integrity and public health. The evidence justifies a precautionary, multi-pronged mitigation approach that prioritizes upstream prevention and improved waste management while deploying targeted technological fixes (e.g., WWTP upgrades, filters) and encouraging innovation (bio-based sorbents).

A coherent national strategy combining standardized monitoring and regulatory measure (bans, EPR), targeted source reduction (including practical alternatives to sachet plastics), improved waste infrastructure, investment in circular-economy infrastructure, water treatment efficacy or enhancements, and research into exposure and health outcomes is necessary to manage this emerging contaminant effectively.

International collaboration will be important because microplastics cross political boundaries via rivers, oceans, and the atmosphere. Continued monitoring and adaptive management, informed by improved data on environmental distributions and effects are essential to manage and reduce risks.

Sustainable management requires coordinated efforts across scientific, industrial, and policy domains to transition towards a circular plastic economy and protect aquatic integrity for future generations. Nigeria need to convene an MP technical working group (FEPA/ Nigerian Environment Ministry, universities, Colleges of Educations, Monotechnics/Polytechnics and NGOs) to adopt a national MP monitoring protocol (size ranges, digestion, polymer ID), designate sentinel sites, and leverage existing climate and plastic pollution funds, international technical assistance (GEF, UNEP programs), and public-private partnerships for pilot investments to reduce MPs pollution in aquatic environments while ensuring policies are equitable and feasible in Nigeria's socio-economic context.

REFERENCES

Abdullahi, M. T., Mubarak, A., Jibrin, N. K., Abdulralman, S. K., Malik, A. I., Adepoju, O. A., & Attahiru, M. S. (2022). Physocochemical properties and diversity of microalgae in Dukku River, Birnin Kebbi, Nigeria. *International Journal of Science Research in Biological Sciences, 9*(2).

Ahmad, B., & Siti Salami, I. R. (2024). Microplastics as emerging vectors of climate change: A critical review of impacts, interactions, and research gaps. *ITB Graduate School Conference, 4*(1). https://gcs.itb.ac.id/proceeding-igsc/index.php/articlw/view/238

Ahmad, O. A., Jamal, M. T., Almalki, H. S., Alzahrani, A. H., Alatawi, A. S., & Haque, M. F. (2025). Microplastic pollution in the marine environment: Sources, impacts, and degradation. *Journal of Advanced Veterinary and Animal Research, 12*(1), 260–279.

Akindele, E. O., Ehlers, S. M., & Koop, J. H. F. (2019). First empirical study of freshwater microplastics in West Africa using gastropods from Nigeria as bioindicators. *Science of the Total Environment, 755*, 142422.

Akinhanmi, F. O., Ayanda, O. I., & Dedeke, G. A. (2023). Occurrence and characteristics of microplastics in the surface water and sediment of Lagos Lagoon, Nigeria. In *Biotechnological Approaches to Sustainable Development Goals* (pp. 103–118). Springer.

Aliy, A. O., Okunola, O. J., Awe, F. E., & Musa, A. A. (2023). Assessment of microplastics contaminations in river water, bottled water, sachet water, and branded table salt samples in Kaduna metropolis, Nigeria. *Journal of Applied Sciences and Environmental Management, 27*(6), 1105–1118.

Allen, S., Allen, D., Moss, K., Le Roux, G., Phoenix, V. R., & Sonke, J. E. (2021). Examination of the ocean as a source for atmospheric microplastics. *Nature Geoscience, 14*(3), 221–226. https://doi.org/10.1038/s41561-021-00761-8

Allen-Taylor, K. O. (2022). Assessing the environmental problems of plastic waste in Lagos State, Nigeria. *Open Journal of Environmental Research, 3*(1), 11–22. https://doi.org/10.52417/ojer.v3il.379

Andrady, A. L. (2021). The plastic in microplastics: A review. *Marine Pollution Bulletin, 170*, 112675.

AP News. (2025, July). *One of the world's most polluted cities has banned single-use plastics.* AP News.

Apata, A., Ololade, I. A., Oladoja, N. A., Alabi, B. A., & Ololade, O. O. (2022a). Polycyclic aromatic hydrocarbons in selected southwestern Nigeria: Seasonal distribution, source apportionment, and potential risks assessment. *Regional Studies in Marine Science, 52*, 102318.

Apata, A., Ololade, I. A., Oladoja, N. A., Alabi, B. A., & Ololade, O. O. (2022b). Seasonal cogener survey for polychlorinated biphenyls in sediments of southwestern rivers, Nigeria: Occurrence, source, and ecotoxicological risks. *Regional Studies in Marine Science, 55*, 102623.

Atiqur, R. S., Sharif, A. S., Mohammed, H. M., Mahmudul, H. M., Monayem, H., Antonio, R., & Md Khurshid, A. B. (2025). Microplastics in aquatic ecosystems: A global review of distribution, ecotoxicological impacts, and health risks. *Water, 17*(12). https://doi.org/10.3390/w17121741

Blessing, J. (2024). *Lagos State to ban pure water, PET bottles in January 2025.* MSME Africa.

Boucher, J., & Friot, D. (2017). *Primary microplastics in the oceans: A global evaluation of sources.* IUCN.

Browne, M. A., Galloway, T. S., & Thompson, R. C. (2015). Microplastic—An emerging contaminant of potential concern? *Integrated Environmental Assessment and Management, 11*(4), 559–566.

Ebere, E. C. (2019). *Macrodebris and microplastics pollution in Nigeria: First report on marine litter and microplastics.* Marine Pollution Bulletin.

Emeka, D., & Lesley, H. (2020). *The challenge of plastic pollution in Nigeria.* https://doi.org/10.1016/B978-0-12-817880-5.00022-0

Galloway, T. S., Cole, M., & Lewis, C. (2021). Interactions of microplastic debris throughout the marine ecosystem. *Nature Ecology & Evolution, 5*(8), 1026–1037.

Gao, D., Li, X., Chen, M., & Zhou, Z. (2022). Removal efficiency and mechanisms of microplastics in wastewater treatment plants: A review. *Science of the Total Environment, 806*, 150570.

Green Habitat Nigeria. (2024). *Drowning in plastic: How plastic pollution is destroying Nigeria.*

Hartz, L., Lisa, G., & Samir, S. (2025). Microplastic pollution in aquatic environments: A meta-analysis. *Frontiers in Environmental Science, 13*, 1600570.

Horton, A. A., Walton, A., Spurgeon, D. J., Lahive, E., & Svendsen, C. (2021). Microplastics in freshwater and terrestrial environments. *Science of the Total Environment, 757*, 143878.

Idowu, O., Adewole, A., & Otunla, A. (2019). Why Nigeria should ban single-use plastics. *Journal of Hazardous Materials and Advances, 1*(2), 1–9.

Isaac, A. O., Abiodun, A., Nurudeen, A. O., Bosede, A. O., & Oluwanranti, O. O. (2023). Microplastic particles in river sediments and water of southwestern Nigeria. *Environmental Science and Pollution Research, 31*, 1314–1330.

Isaac, I. U. (2024). Assessing concentrations of microplastics along the Otuoke River, Niger Delta, Nigeria. *Regional Journal of Physical Sciences and Technology, 7*(6), 9–21.

Iviwe, M. (2021). A comprehensive review on microplastic pollution in African aquatic systems. *Environmental Advances, 5*. https://doi.org/10.1016/j.envadv.2021.100107

Jiang, Y., Yang, F., & Wang, J. (2023). Biological effects of microplastics on aquatic organisms. *Ecotoxicology and Environmental Safety, 257*, 114921.

Koelman, A., Paula, E. R., Nur, H. M. N., Hadiza, M. N., Vera, N., Svenja, M. M., & Merel, K.(2022). Risks assessment of microplastic particles. *Nature Reviews Materials, 7*(2), 138–152.

Koelmans, A. A., Kooi, M., Law, K. L., & van Sebille, E. (2022). A top-down mass budget of plastic at sea. *Environmental Research Letters, 17*(3), 034068.

Kpikpi, P. B., Bubu-Davies, O. A., & Daka, E. R. (2025). Microplastic contamination in surface water of the Lower Forcados River. *Trends in Environmental Science, 1*(2), 124–132.

Lebreton, L. C. (2018). Evidence that the Great Pacific Garbage Patch is rapidly accumulating plastic. *Scientific Reports, 8*(1), 4666.

Leslie, H. A. (2022). Discovery and quantification of plastic particles in human blood. *Environment International, 163*, 107199.

Li, W. C., Tse, H. F., & Fok, L. (2023). Plastic waste in the marine environment: A review. *Science of the Total Environment, 855*, 158749.

Liu, S., Huang, H., & Xu, Z. (2023). Riverine transport of microplastics. Environmental Pollution, 317, 120640.

Magalhães, S. (2025). Innovative approaches to mitigating microplastic pollution. *Sustainability, 17*(20), 9014.

Marcharla, E. (2024). Microplastics in marine ecosystems. *Environmental Research, 256,* 119181.

Nduka, C. (2024). Characterization of microplastics from Otammiri River, Imo State. *Asian Journal of Environment & Ecology, 23*(7), 231–239.

Nelms, S. E. (2021). Investigating microplastic trophic transfer. *Environmental Pollution, 274*, 116935.

Nwabuisi, S. O., & Ihenetu, S. C. (2022). State of plastic pollution in Nigeria. *Journal of Industrial Pollution*

Control, 38(5).

Obiakara-Amaechi, A. I. (2025). Ecological risk assessment of microplastic contamination in Lagos Lagoon sediments. *Journal of Environmental Science & Health Studies.*

Office of the Secretary to the Government of the Federation. (2024, August). *Ban on the use of single-use plastics in government-owned facilities.*

Onyena, A. P. (2025). *Baseline characterization of microplastics in the Escravos Estuary.* Science of the Total Environment.

Osamah, A. A. (2025). Microplastic pollution in the marine environment. *Journal of Advanced Veterinary and Animal Research, 12*(1), 260–279.

Pal, S., Kumar, P., & Kumar, R. (2025). Microplastics in aquatic systems: A comprehensive review. *Environmental Science and Pollution Research.*

Ragusa, A. (2021). Plastic particles in human tissues. *Environmental Science & Technology, 55*(11), 7330–7338.

Reuters. (2024, June 26). *Nigeria to ban single-use plastics next year.* Reuters Sustainability.

Rummel, C. D. (2017). Biofilm formation and microplastics. *Environmental Science & Technology Letters, 4*(7), 258–267.

Safaa, A. G. (2024). Microplastics pollution in Egypt coastal waters. *Egyptian Journal of Aquatic Biology & Fisheries, 28*(2), 553–583.

Sharma, S., Sharma, V., & Chatterjee, S. (2021). Microplastics in the Mediterranean Sea. *Frontiers in Marine Science, 8*, 634934.

Sun, J. (2022). Microplastics in wastewater treatment plants. *Water Research, 222*, 118827.

Sunny, A. R. (2025). A comprehensive review of microplastics pollution in aquatic environments. *Environmental Science and Pollution Research.*

Tajudeen, Y. (2024). Microplastics in two main rivers in Birnin Kebbi, Nigeria. *Iranica Journal of Energy & Environment, 13*(1).

The Punch. (2024, October 3). *Lagos to ban single-use plastics, sachet water from January 2025.*

Tiwari, M., Rathore, C., & Singh, R. P. (2023). Sediment as a sink for microplastics. *Environmental Advances, 9*, 100330.

Toussaint, B. (2024). Micro- and nanoplastic contamination in the food chain. *Food and Chemical Toxicology, 185*, 113611.

UNEP. (2022). From pollution to solution: A global assessment of marine litter and plastic pollution.

United States & International Studies (2024). *Nanoplastics in bottled water.* Associated Press.

Wei, R., Song, C., & Zimmermann, W. (2023). Biodegradation of plastics. *Nature Reviews Earth & Environment, 4*(2), 78–91.

Witczak, A. (2024). Microplastics as a threat to aquatic ecosystems and human health. *Environmental Toxicology and Chemistry, 12*(8).

Wu, P., Zhang, X., Dai, Y., Li, Y., & Shi, H. (2023). Microplastics as vectors of pathogens. *Journal of Hazardous Materials, 443*, 130275.

Yahaya, T. (2024). Microplastics in borehole water in Birni Kebbi, Nigeria. *Environmental Analysis Health and Toxicology, 39*(2).

Yuirong, Y., Guanglong, C., & Jun, W. (2021). Microplastics in marine environments. *Toxics, 9*(2), 41.

Zhang, T., Liu, X., & Xu, J. (2024). Secondary microplastics: Formation, distribution, and ecological effects. *Environmental Pollution, 327*, 121606.