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| RESEARCH ARTICLE

A Comprehensive Review on Microplastics Pollution in Nigerian Aquatic Environments

Terngu Paul Ugosor[1] ✉ Asaasuen Terngu[2], Winifred Umbur Ukpoko[3], Naku Julius Uko[4], Raymond Lubem Tyohemba[5] and Sesugh Ande[6]

[1]*Department of Chemistry, College of Education, Katsina-Ala, Benue State, Nigeria*
[2]*Department of Geography, College of Education, Katsina-Ala, Benue State, Nigeria*
[3]*Postgraduate Network in Chemistry, Benue State, Nigeria*
[4]*Department of General Studies, College of Health Technology, Calabar, Corss Rivers State, Nigeria*
[5]*Department of Chemistry, Rev. Fr. Moses Orshio Adasu University, Makurdi, Benue State, Nigeria*
[6]*Department of Chemistry, Joseph Sarwuan Tarkaa University (JOSTUM), Makurdi, Benue State, Nigeria*
Corresponding Author: Terngu Paul Ugosor, **E-mail**: paulugosor@gmail.com

| ABSTRACT

Microplastics (MPs), defined as plastic particles smaller than 5 mm, have become persistent contaminants in aquatic environments worldwide. In Nigeria, growing evidence shows that these particles are widespread in rivers, lagoons, estuaries, sediments, and in food and drinking-water products consumed by the population. Their presence results from a wide combination of primary and secondary sources, including the breakdown of poorly managed plastic waste, wastewater discharges, storm-water runoff, industrial activities, and fishing operations. Once released, MPs undergo complex transport and transformation processes, accumulating in surface waters, sediments, and biological organisms. MPs have been found in commercially important fish species, bottled and sachet water, table salt, and river water, raising concerns about ecological degradation and potential human exposure. Documented impacts include physiological stress, reduced feeding efficiency, digestive obstruction in aquatic organisms, and possible human-health risks resulting from chemical additives and sorbed pollutants. This review synthesizes updated knowledge on the sources, pathways, ecological effects, and human-health implications of MPs in Nigeria's aquatic systems. The methodology integrated peer-reviewed scientific literature, credible grey literature, government and non-governmental policy documents, websites, international assessments, and reputable news sources published between 2014 and 2026. It highlights the need for targeted policy actions such as source reduction, strengthened waste management, wastewater filtration improvements, public education, and standardized national monitoring frameworks. These interventions are essential for safeguarding aquatic biodiversity, ecosystem services, and public health in Nigeria.

| KEYWORDS

Aquatic waters, microplastics, contaminants, pollutants, pollution, ecological impacts

| ARTICLE INFORMATION

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1. Introduction

The world has a plastic pollution crisis, driven by exponential growth in plastic production, consumption, and disposal. Globally, plastics are valued for their durability, versatility, and low cost. Since the 1950s, man has produced more than 8 billion metric tonnes (MT) of plastic, more than half of which finds its way into landfills and aquatic ecosystems, with only about 9 % of which was recycled (Browne et al., 2015; Boucher and Friot, 2017). The aquatic environments have become sinks for vast amounts of anthropogenic debris of plastics, including microplastics (MPs). Microplastics are the most abundant and widespread source of aquatic pollutants, accounting for about 60-95 % (Riley et al., 2018; Allen et al., 2021). MPs particles (0.1 µm < 5 mm) have become a significant environmental concern due to their persistence, mobility, and potential ecological and human-health implications (Agata et al., 2024; Marcharla et al., 2024). The global increase of microplastics in aquatic ecosystems is closely associated with the rapid growth of plastic production since the mid-20th century and the continuous breakdown of discarded plastic materials in the environment.

Plastic pollution exhibits strong regional heterogeneity, driven by differences in population dynamics, consumption patterns, waste governance, and hydrological connectivity (Jambeck et al., 2015; Borrelle et al., 2020; UNEP, 2023). Globally, only about 9 – 10 % of plastics are recycled, while the remainder is disposed of through landfilling, incineration, or mismanaged pathways that facilitate environmental leakage (OECD, 2022). It is estimated that over 300 million metric tonnes (Mt) of plastic are produced globally, 4.8 to 12.7 million metric (Mt) enter the ocean each year (Sharma et al., 2021; Ebele et al, 2023; Atiqur et al., 2025). According to Geyer et al (2017), in 2010 alone, an estimated 8 million Mt of plastics found their way into oceans.

Global estimates revealed that about 50 % of plastics in aquatic ecosystems are from single-use plastics (SUPs). Single-use plastics include microbeads, straws, and polystyrene (including food packaging and takeaway containers, PET bottles and cups), plastic bags and carriers films, fishing gears, and cutlery (Riley et al., 2018). Microbeads, manufactured by Dr. John Ugelstad in the 1960s, were not widely used in exfoliants as in personal care products and cosmetics until the 1990s (Environment Canada, 2015). Today, microbeads find wide applications in cleaning products, printer toners, industrial products such as abrasive media (e.g., plastic blasting, textile printing, and automotive molding), and medical applications (Pettipas et al., 2016; Unilever, 2018).

Land-based sources dominate marine plastic pollution, with rivers acting as the principal transport routes from terrestrial environments to coastal and open-ocean systems (Lebreton et al., 2017; Lebreton et al., 2018; Meijer et al., 2021). Recent global assessments indicate that a relatively small number of river systems are responsible for the majority of plastic inputs to the oceans, highlighting the importance of regional and continental-scale interventions.

Asia dominates global plastic pollution, contributing approximately 80 % of riverine plastic emissions to the oceans, with countries like China, Indonesia, Thailand, Vietnam, and the Philippines contributing significantly to the problem (Geyer et al., 2017; Riley et al., 2018; Meijer et al., 2021). According to a 2017 study from the environmental group, Ocean Concervancy, more than half a million Mt of plastic waste from the Philippines, "the world's leading plastic polluter," makes it into the ocean each year. A similar result was obtained in 2021. Rapid urbanization, high population density, and uneven waste management infrastructure from these leading plastic polluters drive this trend. Large river systems, including the Yangtze, Ganges, and Mekong, act as major transport pathways, as reported by the research.

South America accounts for roughly 5 – 6 % of river-based plastic emissions (Meijer et al., 2021). The Amazon River basin plays a significant role in transporting plastic waste to the Atlantic Ocean. Waste management capacity varies widely across the continent, with urban centers being key hotspots.

North America contributes about 4 – 4.5 % of riverine plastic emissions (Jambeck et al., 2015; Meijer et al., 2021; Jambeck et al., 2023). The region has high per-capita plastic consumption, particularly in the United States, but relatively stronger waste collection systems reduce large-scale leakage. However, stormwater runoff and coastal activities remain important sources.

Europe has a comparatively small contribution (~0.5 – 0.6 %) (Meijer et al., 2021; UNEP, 2023) due to advanced waste management and regulatory frameworks. Nevertheless, microplastics from tire wear, synthetic textiles, and industrial processes are widespread across freshwater and marine environments, as noted by the report.

Oceania, including Australia and Pacific Island states, contributes less than 0.5 % of global emissions (Meijer et al., 2021). Despite low local inputs, the region is disproportionately affected by transboundary marine plastic debris transported by ocean currents.

Antarctica has no local plastic production sources, yet microplastics have been detected in snow, ice, and soils, underscoring the global dispersion of plastic pollution via atmospheric and oceanic transport (Auta et al., 2024).

Africa contributes an estimated 7 – 8 % of global riverine plastic emissions (Meijer et al., 2021; Safaa et al., 2024; UNEP, 2024). Although lower than Asia in absolute terms, Africa's plastic pollution profile is shaped by rapid population growth, accelerated urbanization, and persistent deficits in formal waste management infrastructure (UNEP, 2024). Recent assessments (Akindele et al., 2019; Ebere, 2019; Iviwe, 2021; Abdullahi et al., 2022; Allen-Taylor, 2022; Aliyu et al., 2023; Akinhanmi et al., 2023; Tajudeen et al., 2024; Adeyemi et al., 2025; Susan et al., 2025) indicate that plastic waste generation in Africa is increasing faster than waste management capacity, leading to high rates of mismanaged plastics entering drains, rivers, and coastal waters. Single-use plastics, particularly flexible packaging and sachet water materials, dominate the waste stream in many African cities.

Nigeria represents a critical hotspot within the African context. As Africa's most populous country and largest economy, Nigeria generates several million tonnes of plastic waste annually, a substantial proportion of which is inadequately collected or recycled (World Bank, 2024). Sachet water alone represents one of the largest sources of plastic waste in the country. The challenge of microplastics pollution is intensified by rapid urbanization, expanding populations, limited waste-management infrastructure, and heavy dependence on low-cost single-use plastics, particularly sachet water packaging, carrier bags, and Styrofoam food containers. Its popularity stems from limited access to safe potable drinking water and low purchasing power, making it a daily necessity for millions of Nigerians. Also, most of the plastics consumed in Nigeria are imported as raw materials or finished products, while local recycling capacity remains limited (Green Habitat, 2024; Ahmad et al., 2025). Consequently, the plastic lifecycle is linear: production, use, and disposal, rather than circular.

Recent empirical studies (Apata et al., 2022a, 2022b; Ajegi et al., 2026) have reported the presence of microplastics in Nigerian surface waters, lagoon sediments, seafood, estuaries, wetlands, mangrove systems, drinking water sources, and in a variety of aquatic organisms, indicating growing ecological and human health risks (Akindele et al.,2019; Ebere, 2019; Abdullahi et al., 2022; Allen-Taylor, 2022; Aliyu et al., 2023; Akinhanmi et al., 2023; Auta et al., 2024; Tajudeen et al., 2024; Adeyemi et al., 2025; Onyena, 2025; Susan et al., 2025; Terngu et al., 2025). The presence of MPs in drinking-water sources such as sachet water, bottled water, and treated municipal water indicates direct human exposure. The most commonly identified microplastic types are fibres and fragments, largely composed of polyethylene (PE), polypropylene (PP), and polyester, reflecting contributions from domestic waste, textiles, packaging materials, fishing gear, and industrial activities.

Studies published between 2022 and 2026 identify urban centers such as Lagos, Ibadan, Aba, Makurdi, and Port Harcourt as major plastic leakage zones, where plastics obstruct drainage channels, exacerbate urban flooding, and are transported into river systems discharging into the Gulf of Guinea (Nwabuisi and Ihenetu, 2022; Isaac et al., 2023; Yalwaji et a., 2023; Isaac, 2024; Nduka, 2024; Nwafor & Okoye, 2024; Idris et al., 2024; Victoria et al., 2024; Kpikpi et al., 2025; Ajegi et al., 2026). These findings align with broader African trends, where microplastic contamination is increasingly documented across freshwater and coastal ecosystems. As a coastal nation with extensive river networks and wetlands, Nigeria also contributes plastic debris to the aquatic ecosystems, positioning it as a regional hotspot for aquatic plastic pollution in West Africa. Inefficient waste collection systems and informal disposal practices allow large quantities of plastic debris to escape into drainage networks, rivers, and coastal waters. These conditions create ideal pathways for MPs to move through aquatic ecosystems and enter food chains, as noted by the researchers.

Plastics persist in the environment due to their durability, versatility, and non-biodegradability (Wei et al., 2023), taking decades or centuries to degrade and releasing harmful sorption contaminants (e.g., endocrine disruption and persistent organic pollutants) into the environment (Wang et al., 2016; Galloway et al., 2021; Hartz et al., 2025). As larger plastic items fragment through physical, chemical, and biological processes, they release a wide range of micro-sized particles that accumulate across terrestrial, freshwater, and marine ecosystems (Galloway et al., 2021; Liu et al., 2023). Microplastics are reported to be the most abundant plastic in aquatic environments. Mps include both primary microlastics, such as microbeads, and secondary microplastics, such as small plastic fragments from degraded macroplastics like plastic bottles, cutlery, cups, and food containers. It is reported that about 8 trillion microbeads are released into waste water daily, making it difficult to remove from aquatic ecosystems (Ebere, 2019; Horton et al., 2021; Huirong et al., 2021). Microplastics also pose greater threat than macroplastics (> 5 mm) to aquatic organisms such as filter-feeding bivalves and human health (Ragusa et al., 2021; Zhang et al., 2024) due to consumption of microplastics through contaminated water and food with potential health risks mainly associated with toxicity of chemicals that are sorbed from environment or additives that are used in the plastic materials (Nelms, 2021; Leslie et al., 2022; Jiang et al., 2023; Obiakara-Amaechi, 2025). Although the incidences of microplastics pollution were reported decades ago, it has been recognized as a pervasive global concern for governments, non-governmental organizations (NGOs), citizens, and academics only recently.

The economic and aesthetic implications of plastic pollution to aquatic environments amount to a loss of about USD $13 billion in tourism revenues annually due to adverse effects on recreational activities and navigation (Kolemans et al., 2017; European Commission, 2018a, 2018b; Idowu et al., 2019). In Asia alone, tourism, fishing, and shipping industries lost about USD $1.3 billion to plastic debris, while Europe spends approximately ϵ 630 million yearly to clean plastic debris from coastlines (United Nations Environmental Protection, UNEP, 2018a). The cost of damage caused by aquatic plastic pollution in West Africa is estimated to be around $10,000 to $330,000 per Mt of plastic waste (Office of the Secretary of the Federal Government, 2014; World Bank, 2025). These figures are staggering and require clear global plastic pollution attention and action. According to the United Nations Environmental Programme, 2024, a circular economy model could reduce plastic waste by 40 - 50 % and avoid 6.0 to 9.1 million Mt of Carbon (IV) Oxide, CO_2 emissions.

The environmental implications of MPs are far-reaching. Microplastics can cause slow, but certain havoc on the environment in many ways, including leaching toxic chemicals into soil and ground water to directly chocking or poisoning animals which unwittingly ingest them (Obiakara-Amaechi, 2025). While plastic waste on land is undeniably a concern, a large percentage of the plastic that is not recycled, incinerated (which emits air pollutants), or sent to landfills ultimately ends up in aquatic environments, where it creates even larger problems. Aquatic organisms often mistake them for food, which can lead to reduced feeding efficiency, gut blockage, oxidative stress, inflammation, and diminished growth or reproductive performance. According to Ocean Conservancy, 2017 report, within the last 10 years, sixty one (61) whales and dolphins (out of which 4 were pregnant) recovered within the Davao Gulf (southern part of the Island of Mindanao), Philippines, fifty seven (57) died due to ingested plastics. For example, in 2019, a young Cuvier's beaked whale washed ashore in the Philippines, weak, was vomiting blood, and soon died. A necropsy revealed its stomach was clogged by more than 88 pounds (40 kg) of plastic wastes. The report also revealed that three whales or dolphins were found with plastic wastes in their systems. A similar tragedy occurred in Greece in 2021 (Feiyi et al., 2023). MPs can also act as carriers for hazardous substances such as polycyclic aromatic hydrocarbons (PAHs), heavy metals, and pathogenic microorganisms, further increasing ecological risk (Emeka, 2020; Adradi, 2021; Ebele et al., 2023; Li et al., 2023). For humans, potential exposure occurs through seafood consumption (Wu et al., 2017), drinking water, inhalation of airborne microfibres, cosmetics (UNEP, 2015), and contact with contaminated environments. Although long-term health impacts remain uncertain, concerns include inflammation, cellular stress, and the possibility of chemical leaching from plastics.

Plastic pollution is a growing global environmental challenge, posing serious threats to ecosystems, biodiversity, human health, and sustainable development. In response, coordinated global, regional, and national efforts such as The Fifth International Marine Debris Conference (5IMDC), 2011 tagged the *Honolulu Strategy*; Face2face Africa, 2014; Environment Canada, 2025; European Commission, 2015, 2018a, 2018b; Weish Government, 2016; UNEP, 2017a, 2017b, 2017c, 2017d, World Economic Forum, 2017; UNEP, 2018a, 2018b, Federal Ministry of Environment, 2020; UNEP, 2023; AE-Environmental Action, 2023; UNEP and NOAA, 2023 have been intensified to reduce plastic waste and transition toward a circular economy (UNEP, 2023; Magalhaes, 2025). At the global level, the United Nations Environment Programme (UNEP) has spearheaded international action through multilateral cooperation. National and regional governments (The Guardian, 2012, 2013, 2017, and 2018) have introduced policy instruments such as bans on single-use plastics, plastic bag levies, and Extended Producer Responsibility (EPR) schemes, which require producers to take responsibility for post-consumer plastic waste (OECD, 2022).

These policies aim to reduce plastic leakage into the environment while promoting recycling and sustainable product design. For example, the European Union (EC) ON 16th January, 2018 insists that all packaging of single-use plastics, including cutlery, straws, and microbeads must be restricted, reusable, and recyclable by 2030 (European Commission, 2018a, 2018b). A levy of є 0.15 in 2002 by Ireland resulted to immediate reduction of SUPs by 90 %. Similarly, the Wale's five pence levy on single use plastics (SUPs) bags in October 2011 culminated in the reduction of 96 % consumption of the bag in 2012 and an average of 71 % between 2011 and 2014 (Welsh Government, 2016). China, USA, Costa Rica, Canada, Taiwan, Belize, India have since followed the ban and legislation initiatives on importation of recycled film plastics and SUPs such as plastic straws, bottles, cutlery and polystyrene. The Canadian government for example classified microbeads as toxin under the Canadian Environmental Protection Act and banned its use in July, 2018 (World Economic Forum; Xanthos and Wakker, 2018; 2017; UNEP, 2018a). Similarly, non-legislative efforts are also being pursued to create awareness about plastic pollution and mitigation strategies. For example, campaigns such as "straw wars" started in Soho, London in 2012 (first of its kind) was one of such initiatives for a voluntary coalition and commitment to ban or reduce SUPs at food and beverages outlets (The Guardian, 2012).

A major milestone is the ongoing negotiation of a legally binding global treaty on plastic pollution, which seeks to address the full life cycle of plastics, including production, consumption, waste management, and remediation. This treaty represents the most comprehensive global response to plastic pollution to date.

In Africa, plastic pollution remains a significant concern due to rapid urbanization and inadequate waste management infrastructure. Several African countries, including Kenya, Rwanda, and South Africa, have implemented strict plastic bag bans and regulatory frameworks, serving as models for the region (UNEP, 2023). In Nigeria, policy efforts such as the National Policy on Plastic Waste Management and growing stakeholder engagement reflect increasing commitment to addressing plastic pollution through regulation, public awareness, and private-sector participation (Federal Ministry of Environment, 2020). The federal government of Nigeria on 3rd October, 2024 announced phased bans on certain single-use plastics (including, Styrofoam and sachet water in certain contexts), plastic buy-back initiatives, and private-sector-led recycling schemes (World Bank, 2024), 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) (AP News, July 3, 2024; Blessing, 2024).

Technological innovation also plays a key role in global mitigation efforts. Advances in recycling technologies, biodegradable and bio-based plastics, and circular economy models are helping to reduce dependence on virgin plastics and improve waste recovery rates (Jambeck et al., 2023). Partnerships between governments, industries, and research institutions support the development and scaling of these solutions.

Despite these initiatives, challenges persist, particularly in developing countries, where limited infrastructure, weak enforcement, and rising plastic consumption hinder progress. In Nigeria, for example, evidence suggests that enforcement gaps, limited public awareness, and economic constraints continue to hinder large-scale impact. Strengthening regulatory implementation, integrating informal waste pickers into formal systems, improving data-driven monitoring, strengthened international cooperation, increasing funding, and evidence-based policymaking offer promising pathways toward reducing plastic pollution and, promoting circular economy , and achieving sustainable environmental outcomes (UNEP, 2024; Nwafor & Okoye, 2024).

Given Nigeria's reliance on fisheries, freshwater resources, and coastal tourism, microplastics contamination poses threats not only to ecosystem integrity but also to food security, livelihoods, and economic development. Despite increasing awareness, research coverage remains uneven, highlighting the need for comprehensive national monitoring, stronger policy implementation, and coordinated mitigation efforts.

This review synthesizes the current state of knowledge on microplastics in Nigeria's aquatic environments, focusing on their sources, pathways, ecological consequences, human-health risks, and evidence-based mitigation strategies relevant to Nigeria's socio-environmental context.

Table 1: Estimated Contribution of Continents to Ocean Plastic Pollution

Continent	Approx. share of Riverine Plastic Emissions (%)	Key Drivers
Asia	80	Population density, rapid urbanization, major rivers
Africa	7 – 8	Limited waste infrastructure, urban growth, high dependence on low-cost SUPs
South America	5 – 6	Large river basins, urban litter
North America	4 - 4.5	High consumption, storm water runoff
Europe	0.5 - 0.6	Strong regulations, miccroplastics sources
Oceania	0. 3- 0.4	Low population, transboundary debris
Antarctica	Trace	Long-range atmospheric/ocean transport

2. Geopolitical Contribution of Microplastics Pollution in Nigerian Waters

2.1 South-West Nigeria

Aquatic systems in the South-West, particularly the Lagos Lagoon complex, represent Nigeria's most intensively studied microplastics hotspot. Empirical investigations consistently report microplastics in surface waters, bottom sediments and aquatic organisms (Akindele et al., 2019; Allen-Taylor, 2022; Apata et al., 2022a, 2022b; Akinhanmi et al., 2023; Isaac et al., 2024; Adeyemi et al., 2025; Obiakara-Amaechi, 2025). The dominance of fibres and fragmented plastics reflects extensive domestic wastewater discharge, textile fibre loss, degraded packaging materials and intense maritime activities. The lagoon's semi-enclosed nature promotes particle retention, making this zone a critical accumulation area.

2.2 South-South Nigeria (Niger Delta)

The Niger Delta exhibits widespread microplastics contamination across rivers, estuaries and mangrove-fringed creeks. Studies indicate frequent detection in sediments and economically important fish species, suggesting both ecological and food-safety implications (Isaac, 2024; Kpikpi et al., 2025; Onyena, 2025). In addition to municipal plastic waste, industrial activities linked to oil and gas extraction, pipeline corridors and shipping traffic exacerbate plastic inputs. Mangrove root systems further act as physical traps, enhancing microplastics retention.

2.3 South-East Nigeria

Rivers draining the South-East, notably the River Niger around Onitsha, Imo, and the Cross River system, show moderate to high microplastics loads (Nduka, 2024; Victoria et al., 2024). Urban riverbank settlements, open markets and untreated runoff are major contributors. Microplastics are commonly identified in fish, indicating trophic transfer and potential dietary exposure for local communities that depend on inland fisheries.

2.4 North-Central Nigeria

Although fewer studies exist, available evidence confirms the presence of microplastics in rivers and reservoirs within the North-Central zone (Idris et al., 2024; Suan et al., 2025; Ajegi et al., 2026). Given that this region hosts long stretches of the Niger and Benue rivers, it likely functions both as a recipient of upstream waste and a conduit transporting microplastics toward southern ecosystems. Agricultural plastic use and expanding urban centers increase vulnerability, underscoring the need for systematic basin-scale monitoring.

2.5 North-West Nigeria

Research from parts of the North-West has documented microplastics in river water and, in some cases, in treated or packaged drinking water (Abdullahi et al., 2022; Aliyu et al., 2023). The prevalence of fine fibres suggests contributions from textile washing, urban dust, and inadequate waste handling. However, spatial coverage remains limited, and most river systems in this zone are yet to be comprehensively assessed.

2.6 North-East Nigeria

The North-East remains the most under-studied zone with respect to microplastics in aquatic environments. Seasonal rivers, reservouirs, and Lake Chad tributaries are susceptible to plastic inputs from settlements and flood-mediated transport, but targeted field data are scarce. This data gap constrains understanding of regional exposure and downstream impacts.

Overall, microplastics contamination in Nigeria displays a south–north gradient, with higher reported concentrations and stronger evidence in southern coastal and riverine zones. Inland northern regions are likely contributors and transport pathways rather than isolated systems, emphasizing the need for a nationally harmonized monitoring framework that spans all geopolitical zones.

Table 2: Zone-by-zone summary of microplastics occurrence in Nigerian aquatic environments

Geopolitical Zone	Representative Aquatic System	Status of MPs Concentration	Predominant Forms & Polymer	Key Anthropogenic Drivers	Level of Evidence
South-West	Logos Lagoon, Ogun River, coastal creeks	Consistently high abundance in surface water, sediments and aquatic organisms	Fibres and fragments; polyethylene (PE), polypropylene (PP), polyester	Dense urbanization, industrial effluents, ports, intense fishing activities	High
South-South	Niger Delta rivers (Forcados, Nun, Bonny, Qua Iboe), estuaries	High and spatially widespread contamination across water, sediment and biota	Fragments, films and fibre; PE and PP dominate	Municipal waste leakage, oil and gas operations, shipping, mangrove retention	High-moderate
South-East	River Niger (Onitsa reach), Cross River	Moderate to high occurrence in rivers and fish species	Fibres and fragments; packaging-related polymers	Riverbank settlements, open markets, surface runoff	Moderate
North-Central	Rivers Niger and Benue, major reservoirs	Presence confirmed, but spatial distribution poorly resolved	Likely fibres and fragments transported downstream	Agricultural plastics, urban runoff, basin-scale transport	Low-Moderate
North-West	Kaduna River, Sokoto-Rima system, reservoirs	Detected in river water and some treated/drinking water sources	Fine fibres and small fragments	Urban waste mismanagement, textile fibre release	Low
North-East	Seasonal rivers, reservoirs, Lake Chad tributaries	Largely undocumented; contamination inferred rather than quantified	Poorly characterized due to data scarcity	Plastic litter, flooding, transboundary inflow	Very Low

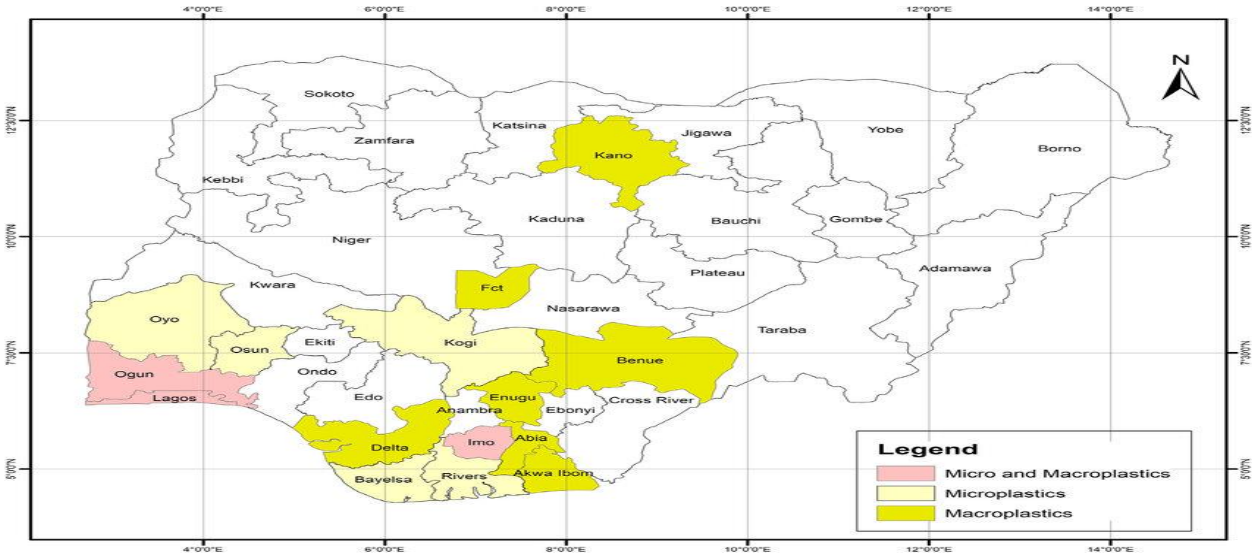

Figure 1: Distribution of environmental plastic pollution studies across Nigerian states (Yalwaji et al., 2022)

Figure 2: Some images of plastic pollution in Nigeria

3. Methodology

This review employed a narrative systematic approach to examine the occurrence, characteristics, impacts, and mitigation strategies related to microplastics in Nigerian aquatic environments. The methodology integrated peer-reviewed scientific literature, credible grey literature, government and non-governmental policy documents, websites, international assessments, and reputable news sources published between 2014 and 2026.

3.1 Literature search and strategy

Literature was retrieved from reputable research databases such as ResearchGate, Google Scholar, Web of Science, IEEE Xplore, ScinceDirect, arXiv, ProQuest, JSTOR, EBSCOhost, Crossref, DOAJ, Semantic Scholar, Web of Science, SpringerLink, Wiley Online Library, Taylor & Francis Online, PubMed/Environmental Science repositories and Scopus using a combination of search keywords like "plastic pollution," "microplastics pollution," "sources of microplastics in aquatic systems," "pathways of microplastics in aquatic ecosystems," "impacts of microplastics pollution on aquatic environments, "environmental and economic implications of plastic pollution," and "plastic pollution mitigation strategies".

3.2 Inclusion and exclusion criteria

Approximately 150 to 160 sources were screened for relevance, with 129 references meeting the inclusion criteria. This methodology ensures a comprehensive, context-sensitive review that reflects the research problem. Studies were included if they were conducted in Nigeria or contained data relevant to Nigerian microplastics pollution in aquatic systems, investigated MPs in water bodies, sediments, aquatic organisms, drinking water, or food products, provided empirical measurements, polymer characterization, or documented ecological/health implications, and were published in peer-reviewed journals, institutional repositories, or credible technical reports.

Excluded materials included studies without clear methodological descriptions, papers focusing solely on terrestrial environments unless directly linking to aquatic pathways and articles lacking full text or providing speculative content without empirical evidence.

3.3 Data extraction and synthesis

For each selected study, the following information was extracted: Sampling location, ecosystem type, and year of study, sample types (water, sediment, fish, invertebrates, drinking water products), sampling and analytical methodologies (e.g., density separation, FTIR, Raman spectroscopy), microplastics categories, size ranges, concentration levels, and polymer types, observed ecological or physiological impacts, identified sources and pathways of MPs, and policy or management recommendations.

A qualitative synthesis was used to compare patterns across regions and studies, identify common sources, highlight emerging trends, and pinpoint research gaps. Where possible, findings were grouped by ecosystem type (freshwater, estuarine, and marine), organism group, and geographical distribution.

3.4 Strength of evidence

Priority was given to systematic reviews and meta-analyses, studies employing spectroscopic polymer identification, multi-season sampling surveys, and research with clear quality-control measures to minimize contamination.

Grey literature, including government directives, NGO reports, and reputable media publications, was incorporated to reflect Nigeria's evolving policy landscape, especially on plastic bans and waste-management reforms.

3.5 Scope and limitations

Although the available studies provide valuable insights, variations in sampling techniques, particle-size limits, digestion methods, and analytical tools across Nigerian research make quantitative comparison difficult. The scarcity of long-term monitoring data and limited nanoplastic assessments also constrain national-scale generalizations.

Nonetheless, the reviewed evidence is sufficient to outline dominant trends, environmental risks, and urgent policy needs for managing microplastic pollution in Nigeria.

4. Findings and Discussion

4.1 Occurrence of Microplastics in Nigerian Aquatic Environments

4.1.1 Surface waters and sediments

Recent national and international assessments estimate that Nigeria generates approximately 2.5 – 3.0 million Mt of plastic waste annually, representing a substantial fraction of municipal solid waste streams in major cities (Geyer et al., 2017; Ebere, 2019; Idowu et al., 2019; Federal Ministry of Environment, 2020). Research conducted by Enyoh et al (2019) revealed that 50 % of marine debris collected from five rivers in South-East Nigeria contained microplastics ranging from 440 – 1,556 particles/L. In another research by Yahaya et al., 2022 on water and sediment samples from Badagry logoon, Lagos state, abundance of Mps was reported, ranging from less than 100 – 5000 µm. A higher concentration (283 – 315 particles/kg) of MPs was recorded in sediment than in surface water samples (108 - 199 particle/L). A similar study on the Lagos lagoon by Olarinmoye et al (2020) reported MPs ranging from 139 -303 particles/L and 310 -2319 particle/kg in water and sediment samples, respectively.

Ilechukwu et al (2019) conducted research on water and sediment samples from Eleko, Lekki, Alpha, and Oniru beaches in Logos, Nigeria. The result revealed that Eleko recorded 170 ± 21 particle/50 g; Lekki: 141 ± 36 particles/50 g; Alpha: 133 ±16, and Onuru: 121 ±38 particle/50 g. Idowu et al (2024) investigated the presence of microplastics in the river Osun, focusing on the ingestion of microplastics by freshwater gastropods, with evidence of microplastic contamination in the river. The study found concentrations reaching 22,079 particle/L (the highest reported values so far for a river), highlighting the impact of microplastics pollution on aquatic life. Polymer materials reported included acrylonitrile butadiene styrene (ABS) and ethylene vinyl acetate (EVA), with silver catfish (*Chrysichthys nigrodigitatus*) containing significant levelsof MPs. Tajudeen et al (2024) conducted research on Rivers Dukku and Kalgo, Kebbi state, Nigeria, with emphasis on the impact of MPs pollution on aquatic life and found significant concentrations of MPs in both rivers, with the Dukku river showing concentrations ranging from 125.00 particles/L to 160.30 particles/L and Kalgo river ranging from 119.30particle/L to 134.70 particle/L.

Abdullahi et al (2022) and Yahaya et al (2024) investigated the physicochemical properties and diversity of microalgae, and the abundance, characterization, and health risks evaluation of microplastics in Dukku River and borehole waters in Birnin Kebbi, Nigeria, respectively, confirming varying concentrations of microplastics in the water sources.

Research carried out by Akinhanmi et al (2023) and Akinhanmi (2024) on Lagos Lagoon sediments consistently found fibers, fragments, and films, with polyethylene (PE), polypropylene (PP), and polyester as the dominant microplastics. Spatial hotspots typically coincided with densely populated landing sites and drainage outfalls.

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 revealed MPs ranging from 25 to 36 particle/L in treated water, 1.4 - 3.7 particle/L in bottled water, 153 particle/L in raw water, and 0.13 to 0.27 particles/L in salt. Water and salt samples contained polymers like 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 microplastics 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. A similar research by Isaac (2024) on assessing concentrations of microplastics on emerging environmental pollutants, a case study of Otuoke River, showed microplastics concentrations in surface water (MCSW) ranging from 15 to 32 particles/L and 102 to 356.4 particles/kg in sediment (MCPS) in the dry season. According to the research, no significant spatial variability was shown among the locations ($p > 0.05$). However, seasonal changes showed significantly greater concentrations during the season ($p < 0.05$), where MCPS were consistently greater than MCPW, implicating sediments as the sinks for MPs. The main microplastics types were fragments and fibres, indicating inputs from local garbage and textile products.

In another research by Nduka et al (2024) on the Otammiri River, Imo state, Nigeria, polypropylene (PP), polyethylene (PE), polyethylene terephthalate (PET), polystyrene (PS), and polyurethane were the major MPs in surface water samples and sediments, with spatial gradients indicating higher loads near urban drainage outlets and downstream estuarine zones.

Kpikpi et al (2025) confirmed microplastic contamination in surface water of the lower Forcados Rivers, Burutu, Delta state, Nigeria. The result showed abundance and composition MPs in the surface water as 44 items/L with microfiber 14(31.81 %), microfragments 6 (13.63 %), microfilms 7 (15.90 %), microfilaments 12 (27.27 %), and microfoams 5 (11.36 %), accounting for densities ranging from microfilms ($\rho = 0.00001$) to microfragments ($\rho = 6.6$) and filament showing a similar blueprint to the microfilms in the study.

A study conducted by Idris et al (2024) on the assessment of Microplastics in Water and Sediment of the River Benue Troughs, Benue State, Nigeria, revealed the presence of varying microplastics in the river. Sediment samples showed significant peaks at 3622 cm^{-1} (O-H stretch, indicating alcohols and phenols) and 2326 cm^{-1} (C=N stretch, indicating nitriles). The Pollution Load Index (PLI) and Risk Quotient (RQ) analyses confirmed varying levels of microplastics contamination, with potential environmental and health risks due to the leaching of toxic additives. Similarly, Susuan et al (2025) investigated microplastic contamination in the surface water of River Benue in Makurdi, Benue State, Nigeria. The water samples collected from five locations: Brewery, Wadata market, Rice mill Wadata, New bridge, and Old bridge, as the selected sites of the river Benue within Makurdi metropolis revealed widespread contamination, with microplastic concentrations varying along the river's course. The abundance of microplastics was found to be 51.32± 0.49 in old bridge (OD), 54.02 ±0.46 in Wadata market (WD), 53.98 ± 0.26 in Rice mill (RM), 39.98 ±0.72 in New bridge (NB), and 49.77± 0.52 in Brewery Site (BW) particles/kg in sediment, and 7.64 ± 0.22 in water sample in Old bridge (OD), 10.46 ± 0.72 in Wadata market (WD), 7.96 ± 0.22 in Rice mill Wadata (RM), 3.92 ± 0.44 in New bridge (NB), and 13.14 ± 0.28 in Brewery site (BW) particles/L in water. The most prevalent MPs were polyethylene terephthalate, polypropylene, polyvinyl chloride, polyamide, and polyester.

Odediran (2025) investigated the seasonal variation of microplastic pollution in the River Benue, focusing on spatio-temporal trends and environmental drivers. Water and sediment samples were collected across different seasons and analyzed for MP abundance, characteristics (size, shape, polymer type), and spatial distribution. Findings revealed widespread MPs contamination, with concentrations exhibiting significant seasonal and spatial variability. Higher MP levels were generally observed during the dry season, due to reduced water volume and increased anthropogenic activities, while the wet season showed dilution effects. Polymer analysis identified polyethylene (PE) and polypropylene (PP) as the most prevalent, with fibers and fragments being the most dominant shapes. Hotspots of pollution were consistently linked to urban and industrial areas, indicating the influence of localized waste management practices. A comprehensive risk assessment, incorporating hazard identification, exposure assessment, and hazard characterization, highlighted the potential of ecological and human health risks associated with MP ingestion and contaminant adsorption. Similarly, research conducted by Ajegi et al (2026) on the distribution of microplastics in the sediment profiles of River Benue, North Central Nigeria, revealed a total of 70 MPs, ranging from 0.5 – 5.0 mm. The result showed that the southern bank samples exhibited a higher abundance of MPs (43 items/kg) and 27 items/kg (northern bank), with fragments and films as the dominant morphotypes. Surface sediments from the southern bank showed mean and particle concentration of 2.8 ± 1.9 items/kg and 20.3 ± 10.8 mg/kg d.w, decreasing to 0.8 ± 1.0 items/kg and 3.0± 4.3 mg/kg d.w in the deeper layers. A mean particle and mass concentration of 1.9 ± 2.6 items/kg and 17.1 ± 20.7 mg/kg d.w, decreasing to 0.3 ± 0.58 items/kg and 4.2 ± 9.9 mg/kg d.w at depth, was recorded on the north bank surface layers. The polymers identified from the research included polyamide, polystyrene, and polyethyne terephthalate. A preliminary risk assessment indicated contamination factor values of 1- 19 and pollution load index values of 1- 4.36, with a PLI_{zone} of 2.28, indicating MPs pollution.

A rapid systematic research on plastic pollution in the environments in Nigeria by Yawalji et al (2024) reported the distribution, levels, and/or effects of microplastics (MPs), macroplastics or both in water, sediment, biota, food and/or land. Plastic sources present were tire wear, cigarette butts, fishing ropes and gears, plastic bags, water sachets and e-wastes. Biological effects of MPs reported in the research were oxidative stress, neurotoxicity, reduced plant root biomass of virgin MPs in crab, African catfish and lime tree. Similar effects of MPs in aquatic organisms were reported by Ebele et al (2023) to include starvation, entanglement, suffocation, growth retardation, oxidative stress, cytotoxicity, reproductive and metabolic disorders, damage of the digestive tract, and mortality. The study reported adverse biological effects of MPs in human to include induced apoptosis, effect of the metabolism of sex hormones, and increase the risk of cancer and metabolic disorder.

A comprehensive empirical study by Victoria et al (2024) on the assessment the abundance, distribution, and composition of MPs in fishes, sediment, and water from some inland rivers: Rivers Yauri, Benue, Argungu, Jamare, Ogun, Ethiope and Orashi across the six geopolitical zones in Nigeria revealed the presence of MPs in all the fishes, sediments and river waters. The abundance and composition of MPs varied with sample types. The result indicated that fibers was the most abundant shape in both water and fish samples. PET, PP, and PE were the most prevalent types of plastics found in fish samples, while PE/PA/Nylon, PVA, and PVC were predominant in water samples. PA/Nylon, PUR, PVC, and PET were the most common MPs in sediment samples. Source analysis showed that the presence of MPs was mainly influenced by local anthropogenic activities. However, estimated daily intakes were generally low, indicating that daily consumption of the samples is not likely to be harmful.

River systems such as River Niger, Onitsha, Forcados River; Ogun River; Otuoke and Ovia Rivers also documented MPs in both water and sediments and, in some cases, in tissues of fish and benthic invertebrates sampled for human consumption as reported by Kpikpi et al., 2025. Concentrations in these rivers varied by site and season, with higher loads near urban centers and river mouths.

Plastic waste in Nigerian aquatic ecosystems as documented by various researches is dominated by sachet water packaging, accounting for approximately 40 – 50 % of visible plastic litter in urban environments, carrier bags and plastic films, contributing about 20 – 25 %, PET bottles, representing roughly 15 – 20 %, while food packaging and miscellaneous plastics, make up the remaining fraction. The widespread use of sachet water is closely linked to inadequate access to safe and affordable piped drinking water, making it a structural driver of plastic pollution rather than a purely behavioral issue.

Despite this high generation rate, formal recycling capacity remains low, with less than 15 % of plastic waste recycled nationwide. The remaining proportion is disposed of through open dumping, uncontrolled landfilling, burning, or is lost directly into the environment. Informal recycling activities, primarily driven by waste pickers play an important role but are insufficient to offset the volume of waste produced (Rummel et al., 2017; Sunny et al., 2025).

During rainfall events, plastic waste accumulated on streets and in open drains is transported into rivers, lagoons, and coastal waters. Blocked drainage channels contribute to urban flooding, particularly in cities such as Lagos, Port Harcourt, Makurdi, and Onitsha. Coastal activities, fishing operations, and marine transport further contribute to marine debris through lost gear and improper waste disposal. Surveys conducted in major water bodies such as Lagos Lagoon, River Benue, Osun River, Otammiri River, Otuoke River, the Forcados system, and various rivers in Kaduna, Kebbi, and Delta States consistently show microplastics in both water and sediment samples. Concentrations vary across regions but are often highest near urban drainage outlets, markets and landing sites, densely populated coastal zones, and industrial discharge points.

Sediments frequently act as long-term sinks, particularly in low-energy zones such as mangroves, estuaries, and lagoon bottoms. Seasonal variations also influence distribution, with rainy-season floods redistributing particles and increasing transport from inland to coastal areas (Idris et al., 2024; Odediran, 2025; Osamah et al., 2025; Pal et al., 2025).

The percentage composition of plastic waste in Nigeria is shown in Figure 4

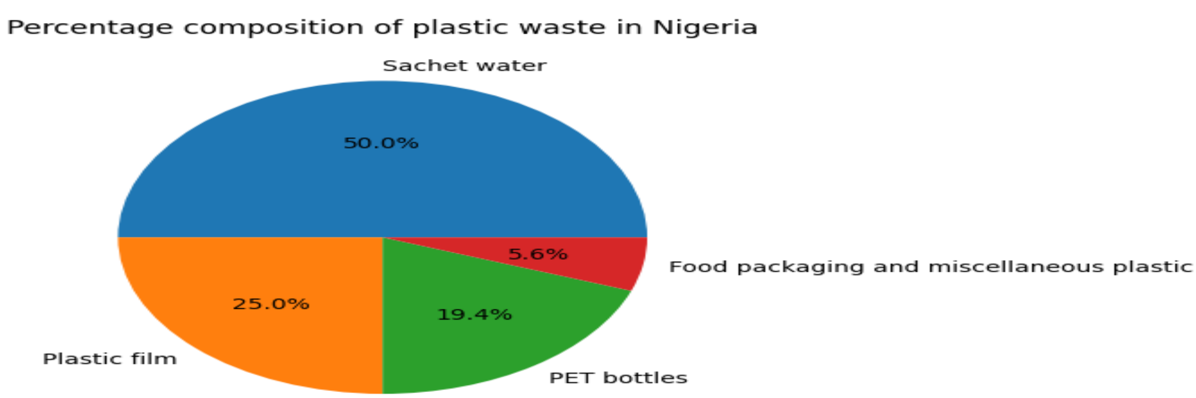

Figure 3: Percentage composition of plastic waste in Nigeria

Table 4: Compact table summarizing key Nigerian field studies on microplastics pollution in the Nigerian aquatic environments

S/N	Study/Authors	Location	Sample Type	Method Used	Key Findings
1.	Enyoh et al., 2019	South-East	Surface water samples	Composite sampling, density floatation, microscopic examination	MPs ranging from 440 - 1,556 particles/L
2.	Ilechukwu et al., 2019	Eleko, Lekki, Alpha & Oniru beaches, Lagos state	Surface water samples, sediment	Composite sampling, density floatation, microscopic examination	Eleko:170 ± 21 particles/ 50g Lekki: 141±36 particles/50 g Alpha:133 ±16 particles/50 g Oniru: 121 ± 38 particles/50 g
3.	Olorinmoye et al., 2020	Lagos lagoon, Lagos state	Surface water samples, sediment	Sieving (50 μm), Density floatation, hydrogen peroxide digestion, microscopic examination	Sediment MPs ranging from 310 – 2319 particles/kg; water: 139 – 303 particle/L
4.	Yahaya et al., 2022	Badagry Logoon, Lagos state	Surface water samples, sediment	Sieving (50 μm), Density floatation, hydrogen peroxide digestion, microscopic examination	MPs particle size < 100 – 5000 μm; water: 108 -199 particles/L; Sediments: 283 – 315 particles/kg
5.	Akinhammi et al., 2023, 2024.	Lagos Lagoon (Epe, Makoko, Sagbokoji, Badagry)	Surface water, sediments, fish organs	Composite sampling; Raman polymer identification; histological examination in fish	Fibres fragments were dominant. PE, PP, and polyester were common polymers.
6.	Isaac, 2024	Otuoke River, Bayelsa State	Surface water and sediments	Sieving (50 μm), Density floatation,	Water samples (MCPW): 15 – 32 particles/L;

				hydrogen peroxide digestion, microscopic examination	Sediments (MCPS): 102 – 346.4 particles/kg. no significant spatial variability among locations. Seasonal changes- Significant MPs concentrations. MCPS >MCPW. Main MPs: fragments & fibres
7.	Aliyu et al., 2023	Kaduna Metropolis	Raw river, treated water, sachet, bottled water, and table salt	Chemical digestion; density separation; visual counting; polymer confirmation	MPs detected across all products. Raw water contained153 particle/L; treated water, 25-36 particles/L; bottled water,1.4-3.7 particles/; salt,0.13-0.23 particle/g. Polymers included PE, PP,PET, PVC, and polyester.
8.	Nduka, 2024	Otammiri River, Imo State	Surface water and sediments	NOAA trawling techniques; NaCl density separation; visual and spectroscopic identification	MPs detected at all sampling sites, with higher loads near urban drainage outlets. Fragments and fibres were dominant. Predominant polymers included PP, PE, PET, PS, and

					polyurethane
9.	Idowu et al., 2024	River Osun, Osun state	Water, sediment, and fish species	FTIR	Abundance of MPs in water at a max. of 22,079 ±134 particle/L (Highest reported value in river water samples) Polymers: acrylonitrile butadiene styrene (ABS), and ethylene vinyl acetate (EVA). MPs ranged from 407 ± 244-1691.7 ± 443 particles in gasrto-intestinal tract (GIT) of six fish species, with silver catfish (*Crysichthys nigrodigitatus*) having highest concentration.
10.	Kpikpi et al., 2025	Lower Forcados River, Delta State.	Surface water (12months sampling)	Multiple-sites routine sampling; NOAA protocols; visual counts; polymer identification	Average abundance: 44 items/L. Composition: 24microfibers (31.8 %), fragments (13.6 %), films (15.9 %),filaments (27.3 %),foams (11.4 %).Seasonal variations noted, with higher loads near populated downstream zones.
11.	Isaac et al., 2023-	Southwestern Nigeria	Surface water,	FTIR analysis;	Sediment MPs

	2024	Rivers (including Otuoke)	sediments	density separation, wet and dry season comparative sampling	ranged 5.69-22.9 particles/kg; water (6.71-22.73 particle/L. Fibres dominated (67-71%).PE and PP were the most common polymers; foam had the lowest prevalence.
12.	Tajudeen et al., 2024	Dukku and Kalgo Rivers, Kebbi State	Surface water	Visual microscopy; density separation; polymer identification	Dukku River: 125-160.3 particles/L; Kalgo River: 119.3-134.7 particles/L. Supported by related studies reporting MPs in borehole water. Indicates contamination of drinking water systems.
13.	Abdullahi et al., 2022	Dukku River, Kebbi State	Surface water, microalgae	FTIR; physiochemical assessment	Documented presence of MPs influencing microalgal diversity and water physicochemical characteristics.
14.	Akindele., et al., 2019	Osun River, Osun State	Gastropods (bioindicators)	Hand sampling; µFTIR analysis	First empirical freshwater MP study in Nigeria. MPs present in gastropods and river water; concentrations up to 22,079 particle/L reported in follow-up studies.

15.	Adeogun et al., 2020	Eleye lake, Oyo state	Fish species		Mps in7of 8 fish species, with highest prevalence (34 %) in *Oleochromis niloticus*
16.	Convenant University e-Print Review,2024	National Synthesis (Lagos-focused)	Literature review	Review of published studies	Confirmed rising MPs contamination nationwide; emphasized need for harmonized monitoring protocols.
17.	Idris et al., 2024	River Benue Trough, Benue State	Sediments	FTIR	Significant levels of MPs with potential environmental and health risks.
18.	Victoria et al., 2024	Inland Rivers: Yauri, Benue, Argungu, Jamare, Ogun, Ethiope, and Orashi in the six geopolitical zones, Nigeria	Fishes, sediments, and water	Microscopy and FTIR	Abundance of MPs in all samples with fibres being more prevalent in fishes and water. PET, PE, PVC, PVA, PA/Nylon, PUR, and PP present.
19.	Susuan et al., 2025	River Benue, Makurdi, Benue state	Surface water	FTIR	Varying concentration of MPs along the river course, with polyethyne terephthalate, polypropylene, polyvinylchlorid e, polyamide, and polyester being the most prevalent.
20.	Ebele et al., 2023	Rivers in Nigeria	Water and fish	FTIR	MPs contamination in all samples

					with potential adverse biological effects
21.	Yalwaji et al., 2024	Six geopolitical zones of Nigeria	Water, sediments, and biota	Peer review	MPs contamination with potential adverse biological effects
22.	Odediran,2025	River Benue, Makurdi, Benue state	Water and sediment samples	FTIR	MPs contamination with PE, PP most prevent, while fibres and fragments, the most dominant shapes.
23.	Ajige et al, 2026	River Benue, North Central, Nigeria	Sediments samples	NaCl/NaI density separation and Hydrogen peroxide oxidation; FTIR and SEM-EDS	A total of 70 MPs, ranging from 0.5 -5.0 mm, with the southern bank exhibiting higher abundance of MPs (43 items/kg) and northern bank (27 items/kg). Dominant morphytypes: fragments & firms. Southern bank sediments: 2.8 ± 1.9 item/kg and 20.3 ± 10.8mg/kg d.w, with a decrease of 0.8 ± 1.0 items/kg and 3.0 ± 4.3 mk/kg d.w in deeper layers. North bank sediments: 1.9 ± 2.6 items/kg and 17.1 ± 20.7

				items/kg d.w, decreasing to 0.3 ± 0.58 items/kg at depth. Polymers identified: polyamide, polystyrene, and polyethylene terephthalate. Contamination factor: 1-19 and pollution load index (1 – 4.36), with a PLI_{zone} of 2.28, indicating MPs pollution.

4.1.2 Biota and fisheries

Microplastics have been found within the gastrointestinal tracts of several fish species harvested for human consumption (Ebele et al., 2023; Victoria et al., 2024; Akinhammi et al., 2023, 2024; Idowu et al., 2024; Yalwaji et al., 2024). Adeogun et al (2020) reported the presence of MPs (124 µm – 1.53 mm) in the stomach of seven out of eight commercial fish species sampled from Eleyele Lake, Oyo state, with the highest prevalence of 34 % in *Oreochromis niloticus*.

Fibres, likely from laundry wastewater and degraded textiles, are the most common particles ingested. In some cases, histological changes have been observed in fish tissues, including inflammation, epithelial damage, altered gut morphology, starvation, and reduced reproduction (Akinhammi et al., 2023). These biological responses indicate that MPs are not merely ingested but may have physiological consequences for aquatic organisms. Given the importance of fishing in Nigerian coastal and riverine communities, this has direct implications for food security, livelihoods, and human exposure.

4.1.3 Drinking water and food Products

Research shows that MPs occur in sachet water, bottled water, table salt, treated municipal water, and raw river water used for domestic purposes (Aliyu et al., 2023; Nduka, 2024; United States & International Studies, 2024). Particle counts vary widely depending on methodology, but the consistent presence across product types confirms routine human ingestion. This is particularly concerning because sachet water is widely consumed across urban and rural areas.

4.2 Sources of microplastics in water

Microplastics in aquatic systems originate from two major categories: primary or secondary. Primary microplastics are intentionally manufactured in small sizes, typically 1 < 5 mm, for specific industrial or commercial uses such as cosmetic microbeads, industrial abrasives, and pre-production plastic pellets (Sharma, Sharma & Chatterjee, 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).

Generally, microplastics sources in Nigerian aquatic waters are as follows:

4.2.1 Land-based sources

Land-based activities account for the majority of plastic pollution in Nigeria. Major sources include:

(a) Household waste

Household waste is a major and persistent source of plastic pollution worldwide. Daily domestic activities such as food consumption, cleaning, personal care, and shopping generate large volumes of plastic materials, many of which are designed for single use. Common household plastics include packaging materials, plastic bags, bottles, food containers, sachets, and disposable utensils. When these materials are not properly managed after use, they enter the environment and contribute significantly to plastic pollution. In many communities including Nigeria, waste segregation is either poorly implemented or entirely absent, leading to plastics being mixed with organic and other wastes. This reduces the chances of recycling and often results in plastics being dumped in open spaces, burned, or washed into drainage systems. During rainfall, improperly disposed household plastics are easily transported through gutters, canals, and rivers, eventually reaching lakes, wetlands, rivers, streams, and oceans.

Inadequate waste collection and recycling infrastructure further exacerbate the problem. Where regular waste collection services are lacking or inefficient, households may resort to uncontrolled dumping or open burning of plastic waste. Dumped plastics degrade slowly and fragment into smaller particles (microplastics), which persist in soil and water for long periods. These microplastics can be ingested by aquatic organisms and enter the food chain, posing risks to ecosystems and human health (Akindele et al., 2023; Akinhanmi et al., 2023).

Consumer behavior at the household level also plays a critical role. The increasing preference for convenience products, such as packaged foods and bottled water, has led to a surge in plastic consumption. Low awareness of the environmental consequences of plastic waste often results in careless disposal habits. Additionally, reusable alternatives are sometimes overlooked due to cost, availability, or lack of awareness, further increasing reliance on disposable plastics.

(b) Markets and commercial centers

Markets and commercial centres are significant sources of plastic pollution in Nigeria due to the high volume of daily trading activities and the widespread use of disposable plastic materials. Open markets, shopping complexes, roadside stalls, and small retail shops rely heavily on plastic packaging for the sale of food items, household goods, and consumer products. Common plastics generated in these locations include nylon bags, sachet water wrappers, plastic bottles, food packaging films, and takeaway containers (Idowu et al., 2024).

A major factor contributing to plastic pollution from markets is the extensive use of single-use plastics for convenience and cost effectiveness. Traders often package goods in multiple layers of plastic to prevent spillage or contamination, while customers frequently request plastic bags even for small purchases. As a result, large quantities of plastic waste are generated daily within market environments.

Poor waste management practices in many Nigerian markets further worsen the situation. Waste bins are often insufficient, poorly maintained, or entirely absent, leading traders and customers to dispose of plastic waste indiscriminately. Plastics are commonly thrown on the ground, into open drains, or piled in unmanaged heaps within market premises. During rainfall, these plastics are easily washed into drainage channels, causing blockages and transporting waste into nearby rivers, lagoons, and coastal waters.

In addition, limited recycling systems around commercial centres contribute to the accumulation of plastic waste. Informal waste pickers collect only high-value plastics, leaving low-value materials such as thin nylon bags and sachet water wrappers to accumulate in the environment. The absence of organized waste sorting at the source reduces recycling efficiency and increases the likelihood of plastics being burned or dumped in open spaces.

Markets and commercial centres, therefore, play a substantial role in plastic pollution in Nigeria through high plastic usage, inadequate waste disposal infrastructure, and weak enforcement of environmental regulations. Reducing plastic pollution from these sources requires improved waste collection services, provision of waste segregation facilities, promotion of reusable packaging, and stronger public awareness campaigns targeting traders and consumers.

(c) Industrial and commercial activities

Industrial and commercial activities are major contributors to plastic pollution in Nigeria due to the extensive production, use, and disposal of plastic materials across multiple sectors (Yalwari et al., 2022). Manufacturing industries, food and beverage companies, construction firms, and retail businesses rely heavily on plastics for packaging, storage, transportation, and product protection. Common plastic wastes generated from these activities include packaging films, plastic bottles, industrial sacks, containers, shrink wraps, and disposable product casings.

One key source of plastic pollution from industrial activities is poor waste handling during production and distribution processes. Plastic offcuts, defective products, pellets, and packaging materials are often inadequately collected or improperly disposed of within and around industrial zones. In many cases, these wastes escape into the surrounding environment through wind dispersion (Allen et al., 2021), surface runoff, or direct dumping, contaminating nearby land and water bodies.

Commercial activities further intensify plastic pollution through the widespread distribution of plastic-packaged goods. Supermarkets, wholesalers, restaurants, and fast-food outlets generate large volumes of single-use plastic waste, such as shopping bags, food containers, cups, and cutlery. Weak enforcement of waste management regulations in commercial areas allows these plastics to accumulate in open drains, roadsides, and informal dumpsites, where they can persist for long periods due to their non-biodegradable nature.

Another important factor is the limited recycling capacity and poor integration of industries into a circular economy system. While some large companies engage in recycling initiatives, many small and medium-scale enterprises lack access to structured waste recovery systems. As a result, industrial and commercial plastic waste often ends up being burned openly or disposed of in landfills and waterways, contributing to air pollution, soil degradation, and marine plastic contamination.

(d) Informal settlements

Informal settlements contribute significantly to plastic pollution in Nigeria due to rapid urbanization, population pressure, and inadequate basic infrastructure. These settlements, often located on city outskirts, floodplains, or waterfronts, are typically characterized by limited access to organized waste collection services. As a result, plastic waste generated from daily household and commercial activities accumulates within the environment.

One major factor is the high dependence on single-use plastics in informal settlements. Residents frequently consume sachet water, packaged foods, and low-cost consumer goods wrapped in plastic because they are affordable and readily available. This leads to the generation of large quantities of plastic waste, including sachet wrappers, nylon bags, and plastic containers, which are often disposed of indiscriminately due to the absence of waste bins or collection points.

Poor drainage systems further exacerbate plastic pollution in these areas. Plastics discarded on streets and open spaces are easily washed into gutters, streams, and canals during rainfall. Over time, these materials block drainage channels, increase flooding, and transport plastics into larger water bodies such as rivers, lagoons, and coastal environments. This process significantly contributes to both land-based and aquatic plastic pollution.

In addition, open dumping and burning of plastic waste are common practices in informal settlements. Open burning releases toxic substances into the air, while dumped plastics degrade slowly and fragment into microplastics that contaminate soil and water. Limited environmental awareness and weak enforcement of waste management regulations also contribute to persistent plastic pollution in these communities.

4.2.2 Urban runoff and drainage systems

During rainfall events, plastic waste accumulated on streets and in open drains is transported into rivers, streams, lakes, lagoons, and coastal waters. Blocked drainage channels contribute to urban flooding, particularly in cities such as Lagos, Makurdi, Port Harcourt, and Onitsha.

4.3 Aquatic and coastal pathways

Nigeria's extensive river systems, including the Niger and Benue Rivers, serve as major conduits transporting plastic waste from inland regions to the Atlantic Ocean (Auta et al., 2024; Idris et al., 2024). Coastal activities, fishing operations, and maritime transport further contribute to marine plastic debris through lost gear and improper waste disposal.

A significant proportion of plastic waste generated in Nigeria leaks into the environment due to a limited number of engineered landfills, insufficient material recovery facilities, high dependence on informal waste collectors, and low investment in recycling technologies. In many cities, waste collection coverage is estimated to be below 50 %, particularly in informal settlements and peri-urban areas (Nwafor and Okoye, 2024). Plastic waste accumulates in open spaces and drainage channels, which are subsequently flushed into rivers and lagoons during rainfall events.

4.3.1 Dominant Entry Routes

Major pathways by which MPs enter aquatic systems include:

4.3.1.1 Mismanaged waste and single-use plastics

Mismanaged waste and single-use plastics are the primary sources of plastic pollution in aquatic environments (Agata et al., 2024). These materials originate mainly from land-based human activities and are transported into rivers, lakes, wetlands, and oceans through multiple interconnected pathways. Single-use plastics such as bags, bottles, sachet wrappers, food containers, and packaging materials are particularly problematic because they are produced in large quantities, used briefly, and often discarded without proper waste management. Nigeria's dependence on sachet water, plastic bags, Styrofoam food containers, and disposable packaging contributes significantly to plastic leakage.

One major pathway is surface runoff during rainfall events. Plastics that are improperly disposed of on streets, open dumps, markets, and residential areas are easily mobilized by rainwater. These materials are carried into roadside drains, canals, and stormwater systems, which often discharge directly into nearby streams and rivers. In urban areas with poor drainage infrastructure, this process rapidly transfers plastic waste from land to water bodies.

Improper waste disposal along riverbanks and coastal areas also contributes directly to aquatic pollution. Open dumping near water bodies allows plastics to be blown or washed into the water, especially during floods and high-flow conditions. In many developing regions, waste is deliberately dumped in wetlands or waterways as a disposal shortcut, accelerating plastic accumulation in aquatic systems.

Another important pathway is through inefficient landfill management. Poorly designed or unmanaged landfills often lack containment systems, allowing lightweight plastic waste to escape through wind dispersal or leachate overflow (Allen et al., 2021). These plastics are eventually transported into nearby water bodies, where they persist and gradually break down into smaller fragments.

Once in aquatic environments, larger plastic items undergo physical and chemical degradation, fragmenting into microplastics due to sunlight exposure, wave action, and mechanical abrasion (Abdullahi et al., 2022). These microplastics remain suspended in the water column or settle into sediments, where they are ingested by aquatic organisms and incorporated into food webs (Ajegi et al., 2025).

4.3.1.2 Urban runoff and storm-water drainage

Urban runoff and storm water drainage are increasingly recognized as important pathways through which plastics and microplastics enter aquatic environments (Adeyimi et al., 2025). In urban areas, a wide range of plastic materials accumulate on roads, rooftops, pavements, and open spaces as a result of daily human activities. These materials include fragments from packaging, disposable food containers, plastic bags, synthetic textile fibers, tire wear particles, and degraded construction materials. Over time, exposure to sunlight, heat, and mechanical abrasion causes larger plastic items to fragment into smaller particles, including microplastics (Abdullahi et al., 2022)

During rainfall events, stormwater mobilizes these plastic residues from urban surfaces and transports them into drainage systems. Unlike natural filtration processes in soils and vegetation, many urban landscapes are dominated by impervious surfaces such as asphalt and concrete, which enhance surface runoff and limit the retention of pollutants (Allen-Yaylor, 2022). As a result, plastics and microplastics are efficiently washed into gutters, drains, and stormwater channels. In cities with combined or poorly maintained drainage systems, stormwater may bypass treatment facilities entirely, discharging directly into nearby rivers, lakes, lagoons, and coastal waters.

Stormwater drainage infrastructure can also act as a temporary reservoir for plastics. Sediments within drains and channels often trap plastic particles, which are later resuspended and transported during high-flow conditions or flooding events (Adeyemi et al., 2025). This episodic release can deliver large pulses of microplastics into aquatic environments, particularly during intense storms associated with climate variability. In addition, aging or damaged drainage systems may leak or overflow, further increasing the transfer of plastic debris into surrounding water bodies.

Once plastics and microplastics reach aquatic systems, they persist for long periods due to their resistance to degradation. Their small size enhances bioavailability, making them accessible to a wide range of aquatic organisms (Abdullahi et al., 2022). As reported by Akindele et al (2019), microplastics transported via urban runoff can also act as carriers for other contaminants, such as heavy metals, hydrocarbons, and pathogens, thereby amplifying their ecological impacts.

4.3.1.3 Wastewater and laundry effluents

Wastewater and laundry effluents are important pathways through which pollutants, including detergents, nutrients, chemicals, and microplastics, enter aquatic environments (Ahmad et al., 2024; Adeyemi et al., 2025). These effluents originate from households, commercial facilities, and industrial operations where water is used for cleaning, washing, and sanitation. In many regions, inadequate wastewater treatment systems allow these effluents to be discharged directly into natural water bodies.

One major route is the discharge of untreated or partially treated domestic wastewater. In areas lacking centralized sewage systems, wastewater from bathrooms, kitchens, and laundries is often released into open drains, soakaways, or nearby streams. These drains commonly connect to rivers and lakes, especially during rainfall events, enabling pollutants from laundry and household activities to enter aquatic ecosystems.

Laundry effluents are a significant source of contamination due to the release of detergent residues, surfactants, phosphates, bleaching agents, and microfibres shed from synthetic clothing during washing (Apata et al., 2022a). When wastewater treatment is inadequate or absent, these substances are not effectively removed and are transported directly into surface waters. In urban areas, stormwater systems often carry laundry wastewater mixed with runoff into rivers and coastal waters without prior treatment.

Another pathway is through leakage and overflow from septic tanks and sewage systems (Yalwaji et al., 2022). Poorly constructed or poorly maintained septic systems allow wastewater to seep into groundwater, which eventually discharges into rivers, wetlands, and lakes. During flooding, sewage systems may overflow, releasing large volumes of untreated wastewater and laundry effluents into surrounding aquatic environments.

In addition, wastewater treatment plants that operate below capacity or lack advanced filtration technologies may release effluents containing residual pollutants (Gao et al., 2022; Zhang et al., 2024). Microfibres and dissolved chemicals are particularly difficult to remove during conventional treatment processes, allowing them to persist in treated wastewater that is discharged into receiving water bodies.

4.3.1.4 Fishing and marine activities

Fishing and other marine-related activities are significant sources of plastic pollution in aquatic environments due to the widespread use of plastic-based equipment and materials (Galloway et al., 2021). Modern fisheries, aquaculture operations, shipping, and coastal recreational activities rely heavily on durable plastics because of their low cost, strength, and resistance to corrosion. However, when these materials are lost, abandoned, or improperly disposed of, they become persistent pollutants in marine and freshwater ecosystems.

A major source of plastic pollution from fishing activities is abandoned, lost, or discarded fishing gear, often referred to as "ghost gear." Items such as fishing nets, lines, ropes, traps, and floats are commonly made from synthetic polymers that do not readily degrade (Boucher and Friot, 2017). These materials are frequently lost during storms, gear conflicts, or poor handling practices and can remain in the water for years, continuing to trap fish and other aquatic organisms while gradually fragmenting into microplastics.

Marine transportation and harbor activities also contribute to plastics in aquatic environments. Plastic waste generated onboard fishing vessels and ships, including packaging materials, food containers, bottles, and protective wraps, may be deliberately or accidentally discharged into the water. Inadequate waste reception facilities at ports and landing sites further increase the likelihood of improper disposal of plastic waste into nearby waters (Boucher and Friot, 2017; Auta et al., 2024)

Aquaculture operations represent another pathway for plastic entry (Boucher and Friot, 2017). Fish cages, feed bags, buoyancy devices, and protective covers are commonly made of plastic materials. Damage, wear, or poor maintenance of these structures can release plastic fragments into surrounding waters, particularly in coastal and inland aquaculture systems.

In addition, recreational marine activities such as boating and coastal tourism contribute to plastic pollution through littering and improper waste disposal (Atiqur et al., 2025). Plastics left on beaches or coastal areas can be transported into the water by wind and wave action, adding to the overall plastic load in aquatic environments.

4.3.1.5 Atmospheric deposition

Atmospheric deposition is an increasingly recognized pathway through which plastic particles enter aquatic environments. Plastics, particularly microplastics and synthetic fibres, can become airborne through various land-based and industrial activities and are later transported by wind before being deposited into rivers, lakes, wetlands, and oceans (Allen et al., 2021). This pathway allows plastics to reach aquatic systems even in areas far from direct human activity.

One major source of airborne plastics is the fragmentation and weathering of larger plastic items on land. Plastics exposed to sunlight, mechanical stress, and temperature fluctuations gradually break down into smaller particles that can be lifted into the air by wind (Allen et al., 2021; Andrady, 2021). Urban environments, open dumpsites, road surfaces, and construction areas serve as important release points for these lightweight plastic fragments.

Textile fibres represent another significant source of atmospheric plastic deposition. Synthetic fibres shed from clothing during wear, drying, and handling can become airborne, particularly in densely populated areas (Andrady, 2021). These fibres are easily transported by wind and eventually settle on land and water surfaces. When deposited directly onto rivers, lakes, or coastal waters, they become part of the aquatic plastic load.

Industrial activities and open waste burning also contribute to atmospheric plastic emissions (Allen et al., 2021). Manufacturing processes, plastic handling, and uncontrolled burning of plastic waste release fine plastic particles and residues into the atmosphere. These particles can travel long distances before being deposited through dry settling or precipitation, such as rainfall and dust storms.

Once deposited into aquatic environments, atmospheric plastics can remain suspended in the water column or settle into sediments (Ajegi et al., 2026). Over time, they may be ingested by aquatic organisms or transported further through water currents, contributing to widespread plastic contamination.

4.3.1.6 Transport Mechanisms and Environmental Sinks

Once introduced into the environment, MPs are distributed by river currents, wind-driven mixing, tidal flows, storms, and seasonal flooding (Geyer et al., 2017; Huirong et al., 2017). Low-density polymers such as PE and PP tend to float, while denser polymers (e.g., PVC, PET) sink into sediments. Biofouling can cause initially buoyant particles to settle at the bottom. Over time, sediments become major reservoirs, especially in estuaries, mangrove systems, sheltered bays, and lagoon floors. These sinks act as long-term storage zones but can also become sources during disturbances such as dredging or flooding.

4.4 Ecological Impacts

4.4.1 Effects on aquatic organisms

Microplastics have emerged as a widespread contaminant in aquatic ecosystems, with growing evidence of their adverse effects on a wide range of aquatic organisms. Due to their small size and persistence, microplastics are easily ingested by organisms across different trophic levels, from plankton and benthic invertebrates to fish and higher predators. In many cases, microplastics are mistaken for food because they resemble natural prey in size, shape, or color. For example, Bakir et al (2014) detected PBDEs in *Puffinus tenuirostris*, while Fossi et al (2017) found mono-2-ethylhexyl phthalate in *Cetorhinus maximus*. Some of these chemicals are mutagenic and carcinogenic, which can adversely affect reproduction by impairing gamete quality, lowering egg production, and decreasing hatching success (Mathieu-Denoncourt et al., 2015; Rillig and Bonkowski, 2018). Toxic microbes may also adhere to plastics, acting as vectors in the aquatic ecosystem (Osborn and Stojkovic, 2014; Harrison et al., 2018b). Some aquatic animals mistake plastic substances for food and ingest them. The ingested microplastics can accumulate in the aquatic animal, causing physical harm or become transferred along the trophic levels of the aquatic food chain and ultimately to humans (Lavers et al., 2014; Fossi et al., 2016). Behavioral changes such as altered feeding patterns, reduced predator avoidance, oxidative stress, and impaired swimming performance have also been observed, potentially increasing vulnerability to predation and reducing survival in natural environments.

Sharp or irregular particles may damage digestive tissues, while the accumulation of particles in the gut can block food passage, reduce feeding efficiency, create a false sense of satisfaction, and damage the digestive track which may lead to death (Nichols et al., 2021). These effects often lead to reduced energy intake, lipid peroxidation, slower growth rates, impaired development, and increased mortality, particularly in early life stages such as larvae and juveniles (Jiang et al., 2023).

Beyond physical impacts, microplastics can disrupt physiological and biochemical processes. Many plastic particles contain additives such as plasticizers, flame retardants, and stabilizers, which may leach into body tissues after ingestion (Osborn and Stojkovic, 2014). In addition, microplastics can adsorb toxic substances from the surrounding water, including heavy metals, pesticides, and persistent organic pollutants (Fossi et al., 2016). When ingested, these contaminants can be transferred into organisms, causing oxidative stress, inflammation, endocrine disruption, and damage to vital organs.

4.4.2 Food-web disruptions

At the community and ecosystem levels, the impacts of microplastics can disrupt food webs and ecological interactions at multiple trophic levels (Fossi et al., 2016). As microplastics move through trophic levels, they can accumulate and be transferred from prey to predators, leading to biomagnification of associated contaminants, ultimately influencing ecosystem stability and even human health. This process may alter species composition, reduce biodiversity, and compromise ecosystem functions such as nutrient cycling and energy transfer (Mathieu-Denoncourt et al., 2015).

At the primary producer and primary consumer levels, microplastics are frequently ingested by phytoplankton, zooplankton, filter-feeding invertebrates, and small fish. Many of these organisms mistake microplastics for natural food particles. Once ingested, plastics can physically obstruct feeding structures, reduce nutrient absorption, and alter energy allocation (Akindele et al., 2019). This often leads to reduced growth rates, lower reproductive output, and increased mortality in these organisms. When the productivity of plankton and other basal species declines, the overall energy available to higher trophic levels is reduced, weakening the structure of the entire food web.

As microplastics move upward through the food chain, they bioaccumulate and biomagnify (Mathieu-Denoncourt et al., 2015). Predatory invertebrates, fish, seabirds, and marine mammals consume multiple prey items containing plastic particles, resulting in progressively higher concentrations in their tissues (Fossi et al., 2016). Microplastics can also adsorb and transport toxic chemicals such as pesticides, hydrocarbons, and heavy metals. These contaminants may be released into the digestive systems of predators, causing oxidative stress, endocrine disruption, immune impairment, and organ damage (Akindele et al., 2019). Such physiological stress can alter predator–prey dynamics by affecting feeding efficiency, survival rates, and reproductive success.

Microplastics also influence food web pathways indirectly. For instance, their presence in sediments can alter benthic communities by changing habitat structure and oxygen availability (Atiqur et al., 2025). According to Brown et al (2015), shifts in species composition, such as reductions in sensitive species and increases in more tolerant organisms, modify trophic interactions and nutrient cycling. In some systems, this results in simplified or unstable food webs that are less resilient to environmental stress.

Ultimately, because humans harvest aquatic organisms for food, microplastics and associated chemicals can transfer into human diets. This creates a feedback loop in which environmental contamination intersects with public-health concerns. Their effects are not limited to individual organisms but extend throughout ecosystems, making microplastics a significant and persistent ecological stressor.

4.4.3 Human exposure and health implications

Microplastics have been found in some gastropods (Akindele et al., 2019), several fish species (Adeogun et al., 2020), and also in table salts and water (Aliyu et al., 2023; Nduka, 2024; United States & International Studies, 2024). Nigerians may be exposed to MPs through drinking water, consumption of contaminated fish and seafood, inhalation of airborne microfibers, and foods contaminated during processing or packaging.

Since microplastics are not biodegradable and persist in the environment, they could accumulate and pose potential long-term harm to human health when consumed directly or through the secondary food chain (Peng et al., 2020). A study by Abbasi et al (2018) indicated that an average of about 5 pieces of MPs could be taken up by humans daily. MPs can enter the blood vessels and form a protein-plastic complex, enabling them to evade the human defense system and exert geno- and cytotoxicity (Gopinath et al., 2019). Ruenraroengsak and Tetley (2015) and Pedersen et al (2020) reported that human exposure to MPs and NPs could induce oxidative stress, cause inflammation, immune system disruption, translocation of nano-sized particles into tissues, and apoptosis (Inkielewicz-Stepniak et al., 2018), hinder iron transport (Merga et al., 2020), influence the up-regulation of cytokines (Forte et al., 2016) and adversely affect the metabolism of sex hormones (Mathieu-Denoncourt et al., 2015). A chemical component of plastic, Bisphenol A (BPA) is reported to increase the risk of recurrent miscarriages, prostate and breast cancer, polycystic, ovarian syndrome, obesity, endometrial hyperplasia and metabolic disorders (Kehinde et al., 2020).

In addition, burning of plastic wastes releases soot, greenhouse gases (contributing to global warming) and toxic substances such as polychlorinated biphenyls, dioxins, furans and mercury, which are hazardous to humans and biota (Ogundairo et al., 2021) and also negatively affect water, soil and air quality. (Verma et al., 2016; Huirong et al., 2021; Apata et al., 2022a, 2022b; Agata et al., 2024; Auta et al., 2024). Given the popularity of sachet water and local fish consumption, exposure levels may be significant to human health.

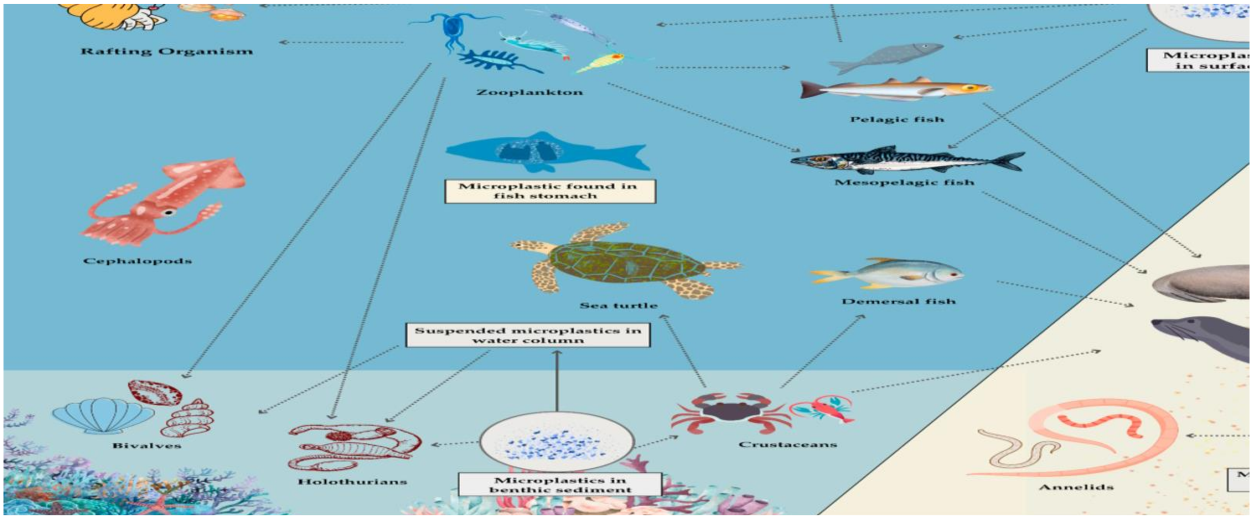

Figure 4: Conceptual illustration of microplastics pathways and trophic transfer in aquatic ecosystems (Atiqur et al., 2025).

4.5 Existing Policies, Recent National Actions, and Mitigation Strategies

Microplastics pollution in Nigeria has prompted increasing attention from government agencies, environmental organizations, and research institutions (Federal Ministry of Environment, 2020; Blessing, 2024; Office of the Secretary to the Government of the Federation, 2024; Reuters, 2024; World Bank, 2024 and World Bank Group, 2025). While national efforts are growing, their effectiveness relies on coordinated implementation, enforcement, and public participation. This section outlines the current landscape of policies and practical measures aimed at reducing microplastics pollution in Nigerian aquatic systems.

4.5.1 Policies and regulatory actions

4.5.1.1 National and state-level plastic restrictions

Beginning in 2024 – 2025, the Federal Government and several state governments announced phased restrictions on specific categories of single-use plastics, including styrofoam food containers, certain classes of plastic bags, single-use items in federal institutions, and improved controls on sachet water packaging (Federal Ministry of Environment, 2020; Office of the Secretary to the Government of the Federation, 2024; World Bank, 2024 and World Bank Group, 2025).

These policy shifts build upon the National Policy on Plastic Waste Management (2020) and align with global movements to reduce plastic dependence. Lagos State, for example, has enacted bans targeting major sources of plastic litter due to recurring urban flooding and clogged drainage systems (The Punch, 2024, October 3). 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.

4.5.1.2 Waste management and circular economy frameworks

Nigeria has started adopting a circular-economy approach, emphasizing recycling and material recovery, integration of informal waste collectors, establishment of community recycling hubs, and plastic buy-back programmes.

These interventions aim to reduce plastic leakage, promote economic opportunities, and lower environmental contamination.

4.5.1.3 Extended producer responsibility (EPR)

EPR is being expanded through regulatory bodies such as the National Environmental Standards and Regulations Enforcement Agency (NESREA). Producers are expected to redesign packaging, to reduce shedding and waste, support take-back schemes, fund recycling initiatives, and ensure safer end-of-life disposal.

4.5.1.4 International Commitments

Nigeria participates in global conversations such as the UN Plastics Treaty negotiations, which aim to establish worldwide standards for controlling plastic pollution. This positions the country to benefit from international funding, technical support, capacity building, and technology transfer.

4.6 Waste Management and technological interventions

4.6.1 Improvement of waste collection and recycling infrastructure

Strengthening municipal waste systems is critical because a high percentage of plastic waste in Nigeria remains unmanaged. Effective strategies include deployment of waste bins in strategic urban locations, establishment of sorting stations, enforcement of anti-littering laws, support for community-led cleanups, and conversion of dumpsites into engineered landfills.

4.6.2 Drainage and storm-water control

Installing trash traps, booms, and screens at drainage outlets can capture macroplastic debris before it breaks down into microplastics or enters rivers and lagoons**.**

4.6.3 Wastewater and water treatment upgrades

Conventional treatment plants do not effectively remove small plastics. Recommended upgrades include membrane filtration, rapid sand filtration, dissolved air flotation, tertiary polishing units, and microfibre filters in laundries. These technologies can significantly reduce the release of microplastics into water bodies.

4.6.4 Emerging biotechnological solutions

Innovations show promise in future mitigation efforts, such as enzymes capable of degrading PET and other polymers, microbial consortia that break down plastic fragments, and bio-based sponges and absorbents that capture MPs from wastewater. Although promising, these solutions require further testing for feasibility in Nigeria’s socio-economic context.

4.6.5 Behavioural and educational interventions

Public involvement is essential for long-term success. Key approaches include nationwide awareness campaigns on plastic pollution, encouraging reusable containers and alternatives to sachet water, Eco-Clubs in schools promoting responsible waste handling, transparent labeling of products that shed microfibers, and incentives for communities that participate in recycling programmes. Behaviour change, combined with accurate information, can significantly reduce the generation and release of microplastics at the household level.

4.6.6 National monitoring and research development

Nigeria currently lacks a coordinated national framework for microplastic monitoring. Establishing such a system would require harmonized sampling protocols (FTIR/Raman verification), designated regional laboratories, creation of baseline datasets across river basins and coastal ecosystems, and periodic reporting to policymakers. A national technical working group comprising universities, ministries, research centers, NGOs, and environmental agencies would improve coordination and ensure evidence-based decision-making.

4.7 Challenges, Research Gaps, and Priorities for Nigeria

Despite the growing body of evidence, significant challenges hinder Nigeria’s ability to address microplastics pollution effectively, as highlighted below:

4.7.1 Methodological and technical limitations

Wide variations in sampling tools, digestion methods, and size-detection limits lead to inconsistent data. In addition, few laboratories possess advanced analytical equipment such as micro-FTIR, Raman microscopes, or clean-air facilities required for nanoplastic analysis. Limited expertise in polymer identification reduces the accuracy of results.

4.7.2 Incomplete coverage across ecosystems

Current research is concentrated in southern Nigeria (Lagos, Delta, Ogun, Imo, Bayelsa, Rivers), with minimal data for northern rivers, wetlands, reservoirs and dams, drinking-water treatment plants, and groundwater systems. This uneven coverage limits national-scale assessments.

4.7.3 Limited human health and long-term ecotoxicology studies

Critical knowledge gaps, including chronic effects of long-term, low-dose exposure, combined effects of MPs and co-contaminants (e.g., heavy metals, PAHs), occupational exposure in waste workers, and nano-sized plastics and their ability to cross biological barriers, still exist in Nigeria.

4.7.4 Waste management and enforcement challenges

Poor waste-collection capacity, open dumping and burning of plastics, weak enforcement of existing bans, lack of affordable alternatives to single-use items, and socio-economic dependence on sachet water. These realities make policy enforcement difficult without simultaneous social support policies.

4.8 Priority Actions for Nigeria

4.8.1 Nationwide baseline assessment

There is a need to establish uniform protocols, sentinel monitoring sites, and periodic sampling campaigns across major water bodies.

4.8.2 Strengthening waste management infrastructure

Investment is required in recycling plants, engineered landfills, collection logistics, and integration of informal waste pickers.

4.8.3 Advancing research and capacity building

Equipping laboratories with the necessary instruments and providing training for researchers and technicians is urgently needed.

4.8.4 Exposure and risk assessment studies

Nigeria needs to focus on drinking water, fish consumption, occupational exposure, and vulnerable groups (children, coastal communities) for risk assessment studies.

4.8.5 Evaluation of mitigation technologies

There is a need to conduct cost-benefit and life-cycle analyses of wastewater upgrades, trash traps, and new plastic alternatives to determine what is viable in Nigeria's socio-economic setting.

5. Conclusion

Microplastic pollution has become a pervasive environmental challenge in Nigeria's aquatic ecosystems, affecting rivers, lagoons, lakes, estuaries, coastal waters, sediments, aquatic organisms, and humans. Evidence consistently shows that fibres and fragments, primarily polyethylene, polypropylene, and polyester, dominate microplastic contamination in the country. These particles originate largely from mismanaged plastic waste, wastewater effluents, storm-water runoff, fishing activities, and the breakdown of everyday plastic products.

The ecological effects of microplastics are increasingly evident. They impair feeding, growth, reproduction, and physiological functioning in a wide range of aquatic organisms. By adsorbing toxic chemicals and pathogenic microbes, MPs introduce additional layers of risk to biodiversity and food webs. Their presence in drinking water, local seafood, and processed products such as table salt further suggests that human exposure is ongoing, even though the long-term health consequences remain uncertain.

Nigeria has taken important steps toward addressing plastic pollution through policy reforms, restrictions on single-use plastics, and commitments to circular-economy initiatives. However, substantial gaps persist in enforcement, national monitoring, scientific capacity, and public awareness. Effective mitigation will require an integrated strategy that prioritizes upstream prevention, efficient waste management, improved wastewater treatment, behaviour change, and accessible alternatives to single-use plastic items. In addition, coordinated national monitoring frameworks and robust ecotoxicological and human-health studies are essential to guide evidence-based policy decisions.

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