Scientific Research Publishing

Journal of Environmental Protection, 2026, 17(11), 1175-1230
https://www.scirp.org/journal/jep
ISSN Online: 2152-2219
ISSN Print: 2152-2197

Occurrence and Distribution of Microplastics in the African Marine Environment: A Review

Thies Thiemann

Department of Chemistry, College of Science, United Arab Emirates University, Al Ain, UAE
Email: thiesthiemann@yahoo.de, thies@uaeu.ac.ae

How to cite this paper: Thiemann, T. (2026) Occurrence and Distribution of Microplastics in the African Marine Environment: A Review. *Journal of Environmental Protection*, **17**, 1175-1230.
https://doi.org/10.4236/jep.2026.1711060

Received: October 1, 2026
Accepted: November 8, 2026
Published: November 11, 2026

Copyright © 2026 by author(s) and Scientific Research Publishing Inc.
This work is licensed under the Creative Commons Attribution International License (CC BY 4.0).
http://creativecommons.org/licenses/by/4.0/

Open Access

Abstract

Microplastics are an emerging contaminant of concern in African marine waters, posing potential risks to marine organisms and, through their incorporation into marine food webs, to human health. This study provides an overview of microplastic concentrations reported in African coastal sediments, nearshore waters, and offshore surface waters. In addition, the major sources and transport pathways of microplastics in African marine environments are discussed.

Keywords

Plastic Pollution, Microplastics, Marine Environment, Beach, Sediment, Africa

1. Introduction

Microplastics (MPs), generally defined as plastic particles smaller than 5 mm, have emerged over the past two decades as pervasive contaminants of aquatic and terrestrial ecosystems and are a major focus of environmental research. Although scientific interest in MPs is relatively recent, their occurrence is closely linked to the rapid expansion of plastic production and the widespread use of synthetic polymers over the past century. Small plastic particles were first reported in marine environments as early as the 1970s [1], while the term "microplastics" and its modern scientific concept gained prominence following the work of Thompson *et al.* [2]. Earlier research on plastic pollution focused primarily on larger debris and documented impacts including the entanglement of marine organisms in fishing gear and the ingestion of plastic by aquatic and terrestrial species [3]-[5]. The recognition of MPs as a distinct and ubiquitous contaminant subsequently expanded research towards their sources, distribution, transport, persistence, en-

vironmental fate, and potential biological effects.

Marine environments are major recipients of plastic pollution and receive MPs through diverse and interconnected pathways. MPs may be generated directly in coastal and marine environments through the fragmentation and weathering of larger plastic debris [6], or released from activities such as fishing through the abrasion and degradation of fishing gear [7] and from ships through the weathering of protective coatings [8] [9]. Tourism and other recreational activities may also contribute to plastic inputs along coastlines [10]-[12]. However, a substantial proportion of marine plastic pollution originates from land-based sources. Rivers [13]-[16], urban drainage, and surface runoff [17] transport plastic debris and MPs from terrestrial environments into coastal waters and, ultimately, the open ocean. Atmospheric deposition provides an additional pathway for the transfer of MPs between terrestrial and marine environments [18] [19].

Once in the marine environment, the fate of MPs is governed by their physical and chemical properties and by environmental processes. Currents, waves, wind, tides, and river discharge can transport particles over considerable distances [20]. Depending on polymer density, particle size and shape, and biofouling, MPs may remain at the surface, become suspended within the water column, undergo repeated vertical transport [21], or eventually settle into sediments [22]. Marine sediments and the deep ocean are consequently recognized as important reservoirs for MPs. Their distribution therefore reflects not only the magnitude and proximity of sources but also the complex interaction between transport processes and environmental conditions.

The implications of marine MP contamination are particularly relevant to Africa, where fisheries and marine resources play an important role in food security, livelihoods, and economic development. Seafood provides an important source of protein and essential nutrients for many African populations [23] [24], while fisheries and aquaculture support approximately 12 - 13 million jobs across the continent [25]. African capture fisheries produced approximately 10.6 million tonnes in 2022, including about 7.3 million tonnes from marine waters [26]. The widespread occurrence of MPs in marine ecosystems therefore raises concerns regarding the exposure of fish and other commercially important organisms to plastic particles and their transfer through seafood and marine food webs [27] [28]. Indeed, microplastics have been detected throughout the food chain [29] and in a wide range of human tissues and organs, including the placenta [30] [31], heart [32], brain [33] [34], and lung [35], among others. Also, MPs have been found in blood [36] and the lymphatic system [37]. Although the current understanding of the toxicity and biological impacts of microplastics remains limited, MPs have been linked to chronic inflammation [38], immune dysregulation [39], cardiovascular disease [40], respiratory effects [41] and metabolic disorders [42]. These concerns have made research into the occurrence, sources, sinks, and environmental transport of microplastics in the natural environment an urgent scientific priority.

Africa presents a particularly important context for investigating marine plastic pollution because of the combination of extensive coastlines, densely populated coastal areas, rapid urbanization, industrial development, fishing activities, and widespread challenges in solid-waste and wastewater management. Although overall plastic consumption across Africa remains moderate compared with many other regions, several African countries rank among the global leaders in mismanaged plastic waste (**Table 1**) [43]. Egypt, Nigeria, and South Africa, for example, are among the 20 countries globally generating the largest quantities of mismanaged plastic waste. However, only a fraction of this waste ultimately reaches the marine environment. Plastics can enter coastal waters directly through maritime activities or coastal sources, or indirectly through rivers [13]-[16], surface runoff [44] [45], drainage systems, and atmospheric transport [18]. The contribution of individual sources is further modified by hydrodynamic and sedimentary processes, meaning that marine MP concentrations do not necessarily correspond directly to population density or proximity to urban centres, of which there are many along the African coastlines (**Figure 1**).

Table 1. Plastic consumption and mismanaged plastic waste in African countries bordering marine waters.

Use of plastic (for 2025)			Mismanaged plastic waste		
World rank overall	Country	Amount of plastic (in million tons)	Mismanaged Waste Index	Amount of mismanaged plastic (in million tons)	World rank overall
23	Egypt	2.0	86.86%	1.8	9
30	Nigeria	1.5	89.09%	1.3	14
34	South Africa	1.3	59.4%	0.774	19
44	Morocco	0.749	61.27%	0.459	28
45	Algeria	0.745	24.91%	0.186	59
56	Kenya	0.448	87.22%	0.391	32
58	Ghana	0.430	86.35%	0.371	35
69	Tanzania	0.355	90.46%	0.321	41
79	Tunisia	0.249	51.2%	0.127	69
81	Angola	0.235	89.67%	0.210	49
87	Ivory Coast	0.201	94.81%	0.191	58
89	Senegal	0.189	91.73%	0.174	63
99	Mozambique	0.160	95.21%	0.152	65
100	Togo	0.155	87.49%	0.136	66
101	Libya	0.146	64.98%	0.095	85
102	Sudan	0.145	78.29%	0.114	77
103	DR Congo	0.144	93.3%	0.134	67

Continued

106	Cameroon	0.133	85.19%	0.113	78
115	Eritrea	0.093	97.34%	0.091	88
119	Mauritania	0.087	87.33%	0.076	94
124	Guinea	0.083	90.28%	0.075	97
127	Somalia	0.070	90.31%	0.064	103
131	Madagascar	0.062	94.01%	0.058	105
133	Benin	0.058	85.63%	0.050	113
138	Namibia	0.054	94.07%	0.051	111
141	Rep. Congo	0.049	84.13%	0.041	119
146	Sierra Leone	0.035	94.25%	0.033	123
147	Liberia	0.032	93.31%	0.030	130
150	Gambia	0.031	89.29%	0.028	131
151	Equatorial Guinea	0.030	65.89%	0.020	143
152	Mauritius	0.027	48.87%	0.013	152
156	Gabon	0.025	85.06%	0.021	139
166	Djibouti	0.015	84.35%	0.013	155
170	Guinea-Bissau	0.012(3)	95.4%	0.011(7)	157
176	Cape Verde	0.007(2)	80.56%	0.005(8)	167
178	Comoros	0.006(3)	92.16%	0.005(8)	166
183	Seychelles	0.004(6)	26.13%	0.001(2)	189
202	Sao Tome and Principe	0.001(7)	83.92%	0.001(4)	185

Despite growing scientific interest, knowledge of MP contamination across Africa remains geographically uneven. Some of the earliest observations of marine debris, including small plastic debris, and its ingestion by seabirds began in the mid-1980s [46]-[48], although incidental reports of plastic ingestion pre-date this (Hughes, 1970, 1974 cited in ref. [49]. Over the past decade, research has expanded considerably. Nevertheless, studies remain concentrated in certain regions, particularly South Africa [50]-[52], whereas substantial knowledge gaps persist for many African coastal and marine environments. Differences in sampling strategies, analytical methods, particle-size ranges, and reporting units also complicate comparisons among studies and limit the ability to assess continental-scale patterns.

Although a number of reviews on MPs in the African aquatic environment [53]-[57], including in the African marine environment [57], a comprehensive synthesis of existing evidence is still welcome to clarify the extent and distribution of MP contamination across African marine environments, identify major sources and transport pathways, and evaluate the environmental factors governing MP accu-

mulation and persistence. This review synthesizes available research on the occurrence, distribution, sources, transport, and environmental fate of MPs across Africa's Atlantic, Mediterranean, Red Sea, and Indian Ocean coastal environments. Particular attention is given to spatial patterns, major contamination pathways, environmental sinks, and methodological differences that influence the comparability of reported MP concentrations. By bringing together evidence from across the continent, this review aims to provide a clearer understanding of the current state of knowledge and identify priorities for future monitoring, research, and mitigation of marine plastic pollution in Africa.

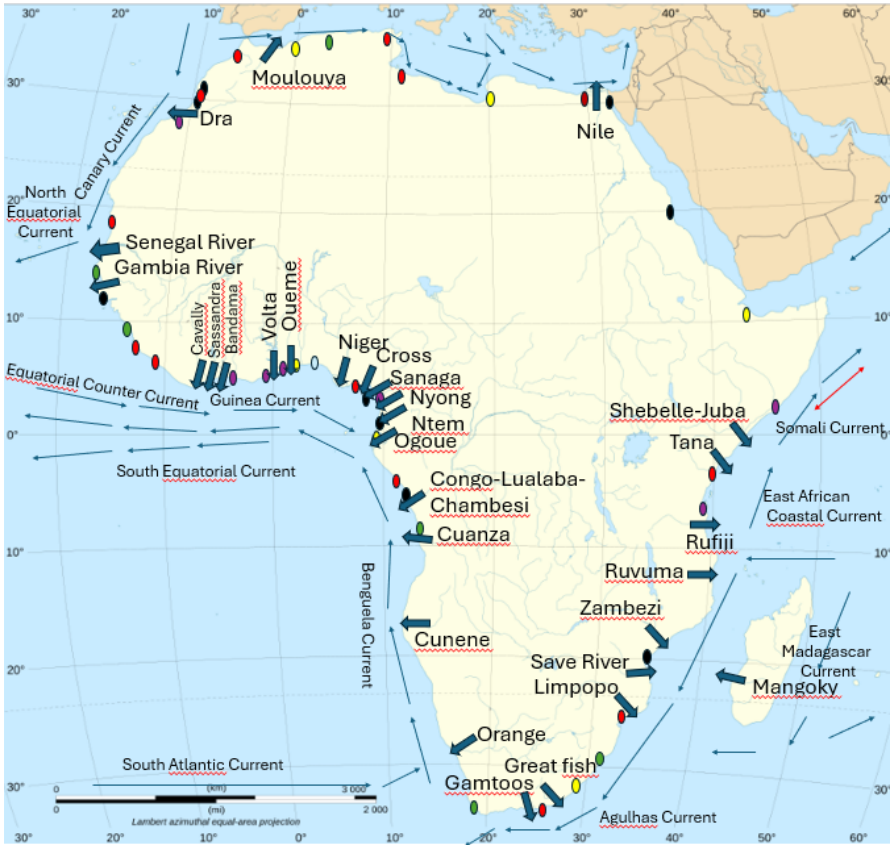


Figure 1. Major ocean currents, population centers along the African coast and some of the main African rivers discharging into the marine environment.

2. Methodology

The databases Scopus®, Scifinder® and Web of Science® were used for this review. The literature search was last conducted on October 1, 2026. Typical keyword combinations used were "Africa AND microplastic", "Africa AND plastic", "Africa AND microplastic AND beach", Africa AND microplastic AND sediments", "Indian Ocean AND beach AND microplastic", Indian Ocean AND sediment AND microplastic" to give as an example 81 entries, 26 entries, 30 entries, and 38 entries, respectively, in Web of Science®. In addition, combinations that included the name of African countries that have a coastline AND microplastic were looked

for, also. Thus, the combination of search entries "South Africa" and "microplastics" found 182 documents in the database Scopus®. Of these, the scientific information of 32 documents was integrated into this review. The remainder of the documents were found not to include relevant work on the topic at hand. Publications by governmental organizations, Intergovernmental Organizations (IGOs) and or Nongovernmental Organizations (NGOs), which are often not abstracted by the databases named above, were searched for on the world-wide-web, utilizing the search words above. Abstracts of all entries were examined. When the abstract indicated that a quantitative analysis of microplastic along the African coast, or of microplastic in near-shore and off-shore waters was presented, the paper was obtained through the UAEU University library. All pertinent references in the given papers were analyzed for any missed publications. The "forward" citations given in the databases for the entries found in the databases were also examined for any missed publications. Papers were included in this review that detail quantitative analyses of microplastic in water, beaches/coasts and sediments along the coast of Africa. No review was discarded on the basis of the actual data presented. Where data seemed to be in conflict with other published data, the conflict was stated in the review without evaluation of the actual data. This is the second review in a series of three reviews. Data on MPs in biota have largely been excluded, as they will be addressed in a separate review as will be data on MPs in African freshwater systems.

3. Note to the MP Extraction Procedures and Identification Used in the Reviewed Research

To date, no standardized protocol has been established for sampling microplastics (MPs) from aquatic environments, resulting in considerable methodological variability among studies [58]. This variability is also evident in the reviewed studies from the African region. Surface-water MPs are most commonly collected using Neuston or manta nets, which vary in mesh size and dimensions. In open-water environments, these nets are generally towed at different speeds and for varying durations; however, procedures for transferring the collected material into storage containers are often insufficiently described. Alternatively, water samples may be collected directly using metal buckets or sampling canisters. Direct water sampling frequently yields higher MP concentrations than net-based approaches, largely because smaller particles are more readily captured. Less commonly, continuous pumping systems installed on research vessels are used to filter large volumes of water during navigation. This approach is generally limited to offshore environments, including the Atlantic and Indian Oceans surrounding Africa.

Following collection, water samples are sometimes filtered on site through metal sieves with different mesh sizes. In some studies, samples undergo oxidative digestion with hydrogen peroxide (H_2O_2) or alkaline digestion with aqueous potassium hydroxide (KOH) to remove organic matter before final filtration. Filtration is typically performed using metal sieves and membrane or paper filters, with

cellulose acetate and cellulose nitrate filters among the most frequently used materials.

Sediment samples are generally collected using metal scoops or corers. Quadrats are often used to delineate the sampling area, and sediments are commonly collected to standardized depths of approximately 5 - 10 cm. Samples may initially be sieved to remove coarse material before density separation using high-density salt solutions, such as saturated sodium chloride (NaCl), sodium iodide (NaI), or zinc chloride ($ZnCl_2$). The density of the separation solution can substantially influence MP recovery because higher-density polymers may only become buoyant in sufficiently dense fluids and would otherwise continue to adhere to the other solid material collected such as soil/sediment. The resulting supernatant containing buoyant MPs is subsequently filtered. To remove residual organic matter, recovered particles may undergo an additional digestion step using H_2O_2, KOH, or Fenton's reagent (H_2O_2 and Fe(II) salt, usually $FeSO_4$). The remaining material is then filtered, dried, and prepared for subsequent MP identification and characterization. The sampling and analytical procedures reported in the individual studies are summarized in Tables S1-S9.

MP contamination in sediments, for instance in beach sediments, is most commonly expressed as the number of particles per kilogram of dry sediment (MP/kg dw), although some studies report concentrations per gram or per 50 g of sediment. These values can readily be converted to MP/kg dw. Less commonly, MP abundance is reported per unit volume of sediment, for example as particles per 500 mL, or per unit area of sampled sediment. For area-based measurements, the mean sampling depth is typically provided to indicate the volume of sediment represented by the sampled area.

The majority of the reviewed papers reported quality control procedures, including the use of blank samples to evaluate background contamination arising from the experimental setup.

MPs are generally identified and characterized initially by microscopic examination, whereas polymer composition is most commonly determined using micro-Fourier-transform infrared (μ-FTIR) spectroscopy. Raman spectroscopy and pyrolysis-gas chromatography-mass spectrometry (Py-GC-MS) are used less frequently for polymer identification.

Microplastics can be categorized into shapes. This is most often done by microscopic examination. Most often the following six categories are used: fibers (long, thin, thread-like), fragments (angular, irregular, jagged), films (flat, thin, often flexible), spheres (rounded or spherical), foams (porous, light weight), and granules (relatively uniform, spherical or rectangular). Fibers can be composed of synthetic polymers, such as polyamides, polyesters, polyalkenes, and elastanes (polyurethanes), or natural materials, such as cellulose (a polysaccharide) and wool (a keratin-based protein). These are generally referred to as synthetic and natural fibers, respectively. However, many studies do not distinguish between natural and synthetic fibers when reporting total fiber abundance. It is important to note

that so-called natural fibers may also undergo substantial processing and treatment, including the application of additives and coatings designed to impart water, oil, and stain repellency to textiles. These industrial treatments can significantly influence the environmental persistence and biodegradability of these fibers.

4. Environmental and Anthropogenic Factors Influencing MP Distribution in the African Marine Environment: Population Concentrations along the African Coast, Ocean Currents, and River Discharges

4.1. Population Concentrations along the African Coast (Table 2)

Some of the most populous African cities are situated along the coastline. They are not equally distributed, though, with many of the populous centers situated

Table 2. African coastal cities among the 50 largest African cities and the most populous African city on the Red Sea [59].

No.	City, country	Population (2026)	Coastline
2	Lagos;Nigeria	21,900,000	Gulf of Guinea/Atlantic Ocean
6	Luanda, Angola	10,400,000	Atlantic Ocean
8	Abidjan, Ivory Coast	7,300,000	Gulf of Guinea/Atlantic Ocean
9	Accra, Ghana	7,050,000	Gulf of Guinea/Atlantic Ocean
10	Dar es Salaam, Tanzania	6,900,000	Indian Ocean
11	Alexandria, Egypt	6,350,000	Mediterranean Sea
15	Cape Town, RSA	5,200,000	South Atlantic Ocean
17	Casablanca, Morocco	4,500,000	Atlantic Ocean
19	Algiers, Algeria	4,400,000	Mediterranean Sea
20	Dakar, Senegal	4,375,000	Atlantic Ocean
23	Conakry, Guinea	4,000,000	Gulf of Guinea/Atlantic Ocean
24	Durban, RSA	3,975,000	Indian Ocean
25	Douala, Cameroon	3,950,000	Gulf of Guinea/Atlantic Ocean
35	Tunis, Tunisia	2,775,000	Mediterranean Sea
36	Lomé, Togo	2,725,000	Gulf of Guinea/Atlantic Ocean
38	Maputo, Mozambique	2,650,000	Indian Ocean
41	Mogadishu, Somalia	2,325,000	Indian Ocean
42	Port Harcourt, Nigeria	2,300,000	Gulf of Guinea/Atlantic Ocean
43	Cotonou, Benin	2,225,000	Gulf of Guinea/Atlantic Ocean
44	Rabat, Morocco	2,150,000	Atlantic Ocean
48	Monrovia, Sierra Leone	2,000,000	Gulf of Guinea/Atlantic Ocean
49	Tripoli, Libya	1,930,000	Mediterranean Sea
99	Suez, Egypt	690,000	Red Sea

in the Gulf of Guinea, along the South African coast and along the Kenyan and Tanzanian Indian Ocean coastlines and in certain regions along the Mediterranean Sea. While fewer main cities lie on the African coast of the Red Sea, it must be remembered that on the Arabian side of the Red Sea lie the Saudi Arabian cities of Jeddah (4,000,000), Jazan (Metro: 1,400,000) and Yanbu (350,000), the Yemini city of Hodeidah (Metro: 812,000) and the Jordanian city of Aqaba (100,000). Also, while not on the list of the 50 most populous cities in the world, Hurghada (Egypt, 250,000) and Port Sudan (Sudan, Metro: 550,000) are sizable cities, too, that are situated on the African coast of the Red Sea.

4.2. Ocean Currents

The coastlines of Africa bordering the Atlantic and Indian Oceans are influenced by several major ocean currents. Along the eastern and southern African coast, the principal currents are the southward-flowing Agulhas Current and its feeder currents, the East Madagascar Current and Mozambique Current. Along the Atlantic coast, the major currents include the northward-flowing Benguela Current, the eastward-flowing Guinea Current, and the southwestward-flowing Canary Current, a wind-driven eastern boundary current associated with the North Atlantic Gyre.

4.2.1. Currents in the Indian Ocean

The Agulhas Current is the western boundary current of the southwest Indian Ocean, flowing southward along the east coast of Africa from approximately 27˚S to 40˚S. It is narrow, fast, and powerful, with an estimated transport of around 70 - 100 Sv, making it one of the largest western boundary currents in the world. The current is supplied mainly by the East Madagascar Current, the Mozambique Current, and recirculated water from the southwest Indian Ocean gyre. Its flow is strongly constrained by the continental shelf as it follows the African coast southward. Along its path, the current frequently develops meanders and large offshore bulges known as Natal Pulses. These instabilities can generate Agulhas rings, which detach from the main current and move westward into the South Atlantic. Near the southern tip of Africa, the Agulhas Current turns back toward the Indian Ocean at the Agulhas Retroflection, where it interacts with the Antarctic Circumpolar Current. Most of its water returns to the Indian Ocean through the Agulhas Return Current, while a smaller portion enters the South Atlantic through Agulhas Leakage, primarily in the form of surface filaments and large eddies. This leakage contributes to the transfer of warm, saline Indian Ocean water into the South Atlantic.

4.2.2. Currents in the Atlantic Ocean

The Benguela Current is a broad, cold, northward-flowing current along the southwest coast of Africa and forms the eastern boundary current of the South Atlantic gyre. It extends approximately from Cape Point to the Angola-Benguela Front near 16˚S and is driven primarily by the southeasterly trade winds. These

winds also induce coastal upwelling, bringing cold, nutrient-rich water from depths of approximately 200 - 300 m to the surface. The resulting high nutrient availability supports substantial phytoplankton growth and makes the Benguela Upwelling System one of the most productive marine ecosystems in the world. The Benguela Current is approximately 200 - 300 km wide and contains numerous eddies and meanders. Its waters originate mainly from deep Atlantic upwelling and are supplemented by nutrient-poor South Atlantic waters and, occasionally, by warm-water eddies originating from the Agulhas Current. Around southern Africa, the interaction between the cold Benguela waters and the warm Agulhas waters produces strong temperature gradients and complex oceanographic conditions.

The Canary Current is a cold, southwestward-flowing eastern boundary current along the northwest African Atlantic coast. It branches southward from the North Atlantic Current and flows toward the coast of West Africa, reaching approximately as far south as Senegal before turning westward and contributing to the North Equatorial Current. The Canary Current is part of the North Atlantic Gyre and is strongly influenced by the prevailing trade winds. In the region off northwest Africa, it is accompanied by a poleward-flowing coastal countercurrent, commonly referred to as the Mauritania Current. The Guinea Current is a slow-moving, warm ocean current that flows eastward along the coast of Guinea in West Africa. It affects the coastlines of many West African countries such as Ghana and Nigeria.

4.2.3. Currents in the Mediterranean and the Red Sea

The Mediterranean Sea is characterized by a complex large-scale circulation of interconnected sub-basin and mesoscale gyres, bounded by currents and jets that exhibit strong seasonal and interannual variability [60]. Surface circulation is initiated by the inflow of cool, relatively low-salinity Atlantic water through the Strait of Gibraltar, which flows eastward along the North African coast. This large-scale circulation directly influences coastal and shelf dynamics, as the Mediterranean's relatively narrow shelves are separated from deep waters by steep shelf breaks. Consequently, basin-scale currents can intrude into coastal areas, enhancing the exchange and transport of material between the coast and open ocean. This process can facilitate the redistribution of land-derived pollutants.

For the Red Sea, detailed current data are limited because the currents are weak and highly variable in both space and time. Their variability is largely wind-driven: during summer, northwesterly winds push surface waters southward for approximately four months at 15 - 20 cm/s, while winter winds reverse the flow, driving water from the Gulf of Aden into the Red Sea. Because the winter inflow predominates, the overall circulation is directed northward along the Red Sea.

4.2.4. African River Discharging into the Neighboring Oceans

Table 3 summarizes the major African rivers discharging into the Atlantic and Indian Oceans and the Mediterranean Sea. No major perennial rivers discharge

into the Red Sea from the African side. The distribution of major rivers along the African coastline is highly uneven, with a particularly high concentration of river systems along the Gulf of Guinea. In contrast, several extensive stretches of the African coastline lack major perennial rivers. Along the approximately 1500 km-long Namibian coast, for example, no major perennial river reaches the Atlantic between the Kunene River at the Angolan-Namibian border in the north and the Orange River at the Namibian-South African border in the south. Similarly, none of the approximately 1770 km of Libyan coastline is drained by a perennial river, while in Egypt the Nile is the only perennial river discharging into the Mediterranean. Western Sahara likewise has no perennial rivers along its approximately 1000 km-long Atlantic coastline. Epheremal rivers such as seasonal wadis can exist in these areas and contribute to the transport and release of plastics, including microplastics.

Table 3. The 20 major African rivers discharging into marine waters. Different reference periods can move rivers such as the Sassandra, Cavally, Mangoky, Ruvuma and Save considerably up or down the ranking. Other major rivers are shown in **Figure 1**; see also ref. [61].

No.	River	Marine Receiving Water	Approx. mean discharge (m^3/s)
1	Congo	Atlantic Ocean	40,500
2	Niger	Gulf of Guinea/Atlantic Ocean	6100 - 6900
3	Ogooué	Atlantic Ocean	4800 - 5150
4	Zambezi	Indian Ocean	3400
5	Nile	Mediterranean Sea	2640
6	Sanaga	Gulf of Guinea/Atlantic Ocean	2070
7	Volta	Gulf of Guinea/Atlantic Ocean	1260
8	Cuanza (Kwanza)	Atlantic Ocean	950
9	Rufiji	Indian Ocean	800
10	Senegal	Atlantic Ocean	690
11	Gambia	Atlantic Ocean	250 - 300
12	Sassandra	Gulf of Guinea/Atlantic Ocean	355
13	Cavally	Gulf of Guinea/Atlantic Ocean	390
14	Bandama	Gulf of Guinea/Atlantic Ocean	170 - 390
15	Mangoky	Indian Ocean	440 - 485
16	Ruyuma	Indian Ocean	450
17	Save River	Indian Ocean	440
18	Ntem	Gulf of Guinea/Atlantic Ocean	380
19	Nyong	Gulf of Guinea/Atlantic Ocean	195 - 200
20	Limpopo	Indian Ocean	170

Strokal *et al.* [13] report significant plastic transport from sub-basins by African rivers, with estimated loads of 10.1 - 50 kg/km^2/year in several regions of the Gulf

of Guinea, including the Cavally, Sassandra, Bandama, Volta, and Ouémé rivers, as well as in Central-Western Africa, including the Congo and Cuanza rivers. In the case of the Niger and Cross Rivers, plastic transport from the basin is estimated to exceed 50 kg/km^2/year. Along the East African coast, the Limpopo and Rufiji rivers are also estimated to transport between 10.1 and 50 kg/km^2/year. By weight, however, more than 70% of the transported plastic consists of macroplastics. With regard to plastic inputs, Lebreton *et al.* [15] identify the Cross River (Cameroon/Nigeria; ranked 5th), Imo River (Nigeria; ranked 12th), and Kwa Ibo River (Nigeria; ranked 20th) among the 20 rivers with the highest estimated contributions to global plastic pollution. Notably, these rankings do not necessarily correspond to river size or discharge; the Imo River and the Kwa Ibo River do not rank among the top 25 African rivers by average discharge.

5. Microplastic (MP) Contamination and Transport in African Off-Shore Waters

5.1. Transport of MPs in African Off-Shore Waters

Work by F. Andersen and colleagues [62] in the Atlantic Ocean along the African coastline indicates that microplastic (MP) concentrations are influenced by the proximity of sampling locations to the coastline. This is particularly relevant outside the North Atlantic garbage patch, which extends approximately from 22˚N to 38˚N, although its western and eastern boundaries remain poorly defined and its northern and southern boundaries shift seasonally. Despite a fivefold increase in global plastic production over a 22-year period, plastic concentrations within the North Atlantic garbage patch have remained relatively stable. In the study of Andersen *et al.* [62], the sampling sites in the equatorial currents were located comparatively far from land, and the authors reported low MP concentrations in these currents. The coastline of West Africa is influenced by the Guinea Current, a warm, westward-flowing current that regulates nearshore circulation, temperature, and salinity patterns [63] [64]. The current drives obliquely breaking southwesterly waves. Cross-shore sediment transport occurs through alternating swash (onshore) and backwash (offshore) processes, which are enhanced under high-energy wave conditions during the rainy season [64] [65].

The Benguela Current is an important driver of material transport along the southwestern African coastline. It extends northward toward the Angola-Benguela Front, a persistent frontal feature located between approximately 15˚ and 17˚S off the coasts of Angola and Namibia. From there, the current feeds into the South Equatorial Current, thereby circumventing the South Atlantic Gyre.

An important issue for the distribution in the Southeastern Atlantic Ocean, the Southeast Indian Ocean and the Antarctic waters (Southern Ocean) is the surface circulation around southern Africa, which is primarily governed by two major current systems: the Agulhas Current System along the east coast and the Benguela Current System along the west coast. The Agulhas Current, the principal western boundary current of the Southern Hemisphere, generally follows the nar-

row continental shelf in the northern region before turning offshore where the shelf widens. Near the southern tip of the African continent, most of the current retroflects and flows eastward into the South Indian Ocean as the Agulhas Return Current. During this retroflection, large anticyclonic eddies, known as Agulhas Rings, are shed and propagate into the South Atlantic, where they interact with the Benguela Current system. The Benguela Jet, a strong, narrow, equatorward-flowing shelf-edge current that extends around the Cape Peninsula toward Cape Columbine, plays an important role in transporting material from the Agulhas Bank into the southern Benguela region [66]. It also is a conduit to channel particles from the Indian Ocean into the Atlantic Ocean. Collins and Hermes [67] have now postulated based on modeling that low- and high-density polyethylene, floating at the surface of the ocean, will be mostly exported towards the accumulation zones in the South Atlantic and South Indian Ocean. PET and PVC, plastics with higher density, will more readily sink and, drifting deeper in the water column, are more likely to accumulate along the coast and continental shelf.

Collins and Hermes [67] find that HD particles released off Cape Town are transported seaward across the continental shelf by a poleward-flowing undercurrent along the western margin of the Agulhas Bank. From there, the particles enter the highly variable circulation south of the Agulhas Bank, which subsequently carries them into the Indian, Atlantic, and Southern Oceans. HD particles released along the southern and eastern coasts are transported southward along the continental shelf by the Agulhas Current. Upon reaching the southern tip of the Agulhas Bank, these particles, similar to those released off Cape Town, enter the variable circulation south of the bank and are subsequently dispersed into the Indian, Atlantic, and Southern Oceans. Transport into the Atlantic Ocean occurs predominantly via the Agulhas Extension. Particles reaching the Indian Ocean appear to follow two pathways: some are transported eastward by the Agulhas Return Current, while others follow the continental shelf within the Agulhas Undercurrent. Overall, a third of the HD particles released around the South African coast is exported into the Indian Ocean and less than 10% is transported to the Atlantic and Southern Ocean.

Only a small proportion of the LD particles released around South Africa is exported to the South Indian Ocean. Particles exiting the eastern boundary of the model domain originate predominantly from the two release sites along the east coast. Approximately 10% of the LD particles released off Richards Bay are transported into the Indian Ocean, compared with only about 3% of those released off Durban [67]. In contrast, more than one-third of the LD particles released around the South African coast are exported to the South Atlantic Ocean. The majority (>80%) of particles released off Cape Town are transported into the Atlantic Ocean, while none are exported to the Indian Ocean. For particles released along the southern and eastern coasts, less than 10% are transported to the South Atlantic, with Richards Bay being the notable exception. More than 20% of the particles released off Richards Bay are exported to the South Atlantic Ocean. Only a very small fraction (<1%) of LD particles released along the South African coast reaches

the Southern Ocean [67].

Interestingly, along the South African coastline, exceptionally high concentrations of plastic were observed along the west coast, particularly in areas north of St Helena Bay, offshore of Saldanha Bay, and near Cape Point. In contrast to the decline in plastic abundance with increasing distance from the coast reported by Ryan in 1988 [47], a survey of 2014 conducted along a transect between Cape Town, Tristan da Cunha, and Gough Island in the South Atlantic Ocean found that only approximately 30% of the litter collected—predominantly plastic—was located in coastal waters over the African continental shelf. The remaining 70% was recorded farther offshore [68].

MP circulation with prevailing currents in the Southern Tropics carries MPs westward across the Indian Ocean, seasonally eastward in the Northern Tropics, and southward along the African coast. Thus, islands in the Western Indian Ocean such as the Seychelles are affected by plastic litter originating from Southeast Asia. Modeling combined with physical inventories of plastic on shorelines has shown the scale of plastic transport throughout the Indian Ocean. Thus, 52.4% of Kenyan mismanaged plastic that reaches the Indian Ocean ends up on the beaches of 26 countries, with India, Myanmar and Indonesia most affected [69]. In contrast, much of the South African mismanaged plastic that has been sweptout to sea via its Indian Ocean shoreline is moved with the Agulhas current southward [69]. Much of the plastic litter found on the Seychelles Island chain stems from South East Asia [70] [71].

In the Mediterranean Sea, the Libeccio wind contributes to eastward-directed winds over the Ionian-Meridional sub-basin, potentially promoting the transport of marine and atmospheric MPs towards the eastern Mediterranean. In addition, northerly winds, particularly the Etesian winds originating from the north and northwest, strongly influence the transport and distribution of marine MPs within the Levantine-Aegean sub-basin, the southern border of which is the Egyptian coastline, especially during the summer months [72] [73].

The presence of MPs in surface seawater samples from the Red Sea has been documented even in areas located far from major urban centers. Nevertheless, MP concentrations in the Red Sea are generally relatively low and exhibit temporal variability. To date, no study has specifically investigated the influence of seasonal variability over multiple years on the occurrence and distribution of MPs. During winter, strong southerly winds drive MPs towards the western (African) coast of the Red Sea, where they can accumulate on sandy beaches [74]. This pattern is supported by sediment analyses along the Red Sea coastline, which have reported higher MP concentrations along the eastern coast of Egypt compared with the eastern coast of the Red Sea [74].

5.2. Selected Investigations on MP Concentrations in Off-Shore Waters in the Atlantic Ocean, Indian Ocean, Mediterranean Sea and the Red Sea along the African Coast

Kanhai *et al.* [75] investigated the abundance, distribution, and composition of

microplastics in the Atlantic Ocean along a transect extending from the Bay of Biscay to Cape Town, South Africa. MPs were collected from subsurface waters using the underway sampling system of the RV Polarstern. Potential MPs were isolated from the samples and analysed by FT-IR spectroscopy to determine their polymer composition. Of the particles analysed, 63% were identified as cellulose and 37% as other synthetic polymers. Among the synthetic polymers, polyesters accounted for 49%, while blends of polyamide or acrylic with polyester represented 43%. Fibers were the predominant particle type, accounting for 94% of all particles. The mean MP abundance across the Atlantic Ocean was 1.15 ± 1.45 particles m^{-3}. Of the 76 samples collected, 14 originated from the Benguela upwelling region. No statistically significant difference in microplastic abundance was found between upwelled and non-upwelled waters.

Table 4. Studies on MP presence in offshore waters in the Atlantic and Indian Ocean and the Mediterranean and Red Sea.

Voyage/date	Location	MP concentration	Sampling technique	Digestion	Major polymer types	Co-investigation of living organisms	Reference
	Off the Atlantic coast of Africa 14 samples were taken from the Benguela upwelling	Mean concentration: 1.15 ± 1.45 P.m^{-3} Range of concentration: 0 - 8.5 P.m^{-3}	continuous intake located at the keel of the ship (depth 11 m) pumped onboard at a flow rate of 25 m^3 h^{-1} then passed through a primary filter (pore size 2 mm), then through a covered stainless steel sieve (250 µm), then through a Whatman filter, pore size: 1.2 µm		Mainly PES (≈50%), also PP, PS, PVC, PU	(−)	Kanhai *et al.*, 2017 [75]
RV Polarstern Nov. 2015 Bremerhaven (Germany) to Cape Town (RSA)	off the west coast of Morocco	6 - 6.5 P m^{-3}					
	offshore of Namibia	8.5 P m^{-3}					
R/V Akademik Tryoshnikov/Nov.-Dec., 2016	Bremerhaven (Germany) to Cape Town; sampling between Canary Islands to Cap Verde; between Gambia and Namibia (Sierra Leone Rise to Walvis Ridge)		200 µm neuston net (Aquatic BioTechnology©) equipped with a 80 × 30 cm rectangular frame opening, towed for about 15 min at a speed of 2 - 2.5 knots.			(−)	Suaria *et al.*, 2023 [76]
S.A. Agulhas II/July 2017	along the SAMBA line (Southeast Atlantic, Cape Town) at 34.5˚S from 0 to 17.5˚E						
Bark Europa [Scheveningen (NL) to Montevideo (Uruguay)]	Canary Current (off Morocco)	0.00261 - 0.05758 P m^{-3}	Manta trawl of mesh size of 500 µm with cod end of mesh size 333 µm	sodium dodecyl sulfate (SDS 10%) and H_2O_2	HDPE, PP, LDPE, PEST, EP	(−)	Andersen *et al.*, 2024 [62]
	off Cabo Verde	0.00035 - 0.00092 P m^{-3}			HDPE, PP, SEB		
Research vessel Sonne (SO270 cruise, MASCARA) during a transect in the Indian Ocean from Hong Kong SAR to Port Louis	Indian Ocean, ca. 1200 km east of the Northern tip of Madagascar	43.5 P m^{-3}	Water pumped in and filtered on board of the ship	Proteinase K, then Fenton reagent, then Chitinase	Acrylate/PU/Varnish, PET	(−)	Hildebrandt *et al.* 2022 [77]
Jaywun Nov.-Dec., 2022 Vigo, Spain to Abu Dhabi (through the Mediterranean Sea, the Red Sea and the Arabian Sea	Mediterranean Sea (off the African coast)	15.5 ± 9.6 MPs L^{-1}	Steel bucket	KOH, then H_2O_2	PET > nylon > LDPE > microrubber	(−)	Al Hashmi *et al.*, 2026 [78]
	Red Sea (off the African coast)	24.5 ± 11.0 MPs L^{-1}			PET > PVC > nylon = EPS = LDPE		

Suaria *et al.* [76] reported on the distribution of floating plastics in the eastern and southern sectors of the Atlantic Ocean based on 35 neuston net trawl samples collected during two research cruises in 2016 and 2017.A transect between 0 and 18˚E along 35˚S in the South Atlantic Ocean revealed higher densities farther west, supporting the accumulation of floating plastics in the South Atlantic gyre, mainly west of 10˚.

E. Andersen *et al.* [62] investigated the abundance, distribution, and characteristics of MPs in surface waters along a transect spanning six major ocean current systems in the Atlantic Ocean, extending from Scheveningen (the Netherlands) to Montevideo (Uruguay). Along the west African coast, sampling sites were located within the Canary Current, the North Equatorial Current, and the Equatorial Counter Current, all of which are situated in the North Atlantic Ocean. Except for the sampling in the Canary Current off the Moroccan coast and the North Atlantic current near Cabo Verde, the sampling sites were distant from the African coastline. A Manta trawl (mouth area: 40.5 cm^2, net mesh size: 500 µm; cod end mesh size: 333 µm) was used to sample surface water for MPs.

Suspended particulate matter was collected by Hildebrandt *et al.* [77] from subsurface waters at a depth of 6 m along an east-west transect across the tropical Indian Ocean using a specialized, inert, plastic-free fractionated filtration system. The sampling point closest to the African coast is about 1000 km off the North Madagascan coast. Here, 43 MP m^{-3} were found with acrylates/PU/varnish and PET particles making up the vast majority.

Al Hashmi *et al.* [78] published data gained from the collection of MPs along shipping routes off the African Mediterranean coast and off the African coast in the Red Sea. Here, the collection was performed with steel buckets while taking utmost precautions against aerial MP deposition and against contamination from the vessel itself. The found concentrations were quite high, with 15.5 ± 9.6 MPs L^{-1} in the Mediterranean Sea and 24.5 ± 11.0 MPs L^{-1} in the Red Sea (**Table 4**).

6. MPs in African Near-Shore Surface Waters, and in African Coastal and Beach Sediments

6.1. North Africa

6.1.1. Egypt

MP contamination has been documented extensively along both the Mediterranean and Red Sea coasts of Egypt. Sayed *et al.* [74] assessed MP contamination in surface waters and sediments at eight sites, comprising four Mediterranean locations—Marsa Matruh, Alexandria, Damietta, and Port Said—and four Red Sea locations—Ras Gharib, Ain Sukhna, Hurghada, and Marsa Alam. MPs were detected in both environmental compartments at all sites, confirming their widespread distribution along the Egyptian coastline.

In surface waters, MP abundances ranged from 46.66 ± 2.27 particles 100 mL^{-1} at Marsa Matruh to 69.3 ± 1.08 particles 100 mL^{-1} at Damietta in the Mediterranean, and from 50.66 ± 0.57 particles 100 mL^{-1} at Ain Sukhna to 66 ± 2 particles

100 mL^{-1} at Ras Gharib in the Red Sea. Sediment concentrations showed comparable spatial variability. Mediterranean sites ranged from 48 ± 5 particles 100 g^{-1} at Marsa Matruh to 76.6 ± 4 particles 100 g^{-1} at Damietta and Port Said, whereas Red Sea sites ranged from 38.6 ± 3 particles 100 g^{-1} at Ain Sukhna and Hurghada to 50.6 ± 4 particles 100 g^{-1} at Ras Gharib. The relatively high abundances at Damietta, Port Said, and Ras Gharib were associated with intense urban, industrial, shipping, and other anthropogenic pressures, although local hydrodynamic and sedimentary processes likely also contributed to MP accumulation. Overall, the study demonstrates that MP contamination is widespread along both Egyptian coastlines and that local sources interact with environmental processes to control MP transport and deposition.

In the Eastern Harbor, Shabaka *et al.* [79] conducted a preliminary assessment at ten stations, examining both harbour water and sediments. Sediments contained 242 particles kg^{-1} dry weight in the 0.5 - 5 mm fraction, while smaller MPs (<0.5 mm) occurred at concentrations of 33 - 108 transparent particles and 107 - 174 coloured particles 100 g^{-1} dry weight. A diverse range of polymers was identified, including PET, ABS, PP, PS, PEVA, PTFE, LDPE, LLDPE, HDPE, and nylon, with PET and PP predominating. The diversity of particle sizes, morphologies, and polymer types indicates heterogeneous contamination associated with consumer products, packaging, industrial activities, and other anthropogenic sources.

6.1.2. Libya

Kateesh *et al.* [80] surveyed the MP contamination in nearshore waters and sediments at two sites along the northeastern Mediterranean coast of Libya: the urbanized Sousa site, approximately 30 km northeast of Al Bayda, and the semi-urban Alhaniyah site, approximately 25 km northwest of Al Bayda. Mean MP abundances in surface waters were 2.5 ± 2.6 particles L^{-1} at Sousa and 0.7 ± 1.3 particles L^{-1} at Alhaniyah. Sediment concentrations were similarly higher at Sousa, with mean abundances of 254 ± 57 particles kg^{-1} dry weight compared with 212 ± 23 particles kg^{-1} at Alhaniyah. The higher concentrations at the more urbanized Sousa site suggest an important influence of local anthropogenic activities on MP contamination in both coastal waters and sediments.

6.1.3. Tunisia

Tunisia provides some of the strongest evidence for substantial spatial variability in coastal MP contamination in North Africa. Abidli *et al.* [81] reported particularly high sediment concentrations in the northern Bizerte lagoon-channel complex, ranging from 3000 to 18,000 items kg^{-1} dry sediment. The highest abundance occurred at Menzel Abderrahmane, followed by Carrier Bay, Menzel Jemil, and the Bizerte Channel. These elevated concentrations were associated with intensive textile, plastic, and electronic industries, as well as fishing and shellfish production.

The same research group [82] subsequently investigated the South Lake of Tu-

nis, North Lake of Tunis, Carthage, La Goulette, and Menzel Bourguiba. MP concentrations ranged from 141.2 ± 26.0 to 461.3 ± 29.7 items kg^{-1} dry weight. Fibers generally dominated, followed by fragments, expanded polystyrene, films, and pellets. Higher concentrations at Menzel Bourguiba, the South Lake of Tunis, and La Goulette were associated with industrial activities, commercial and fishing harbours, and urban wastewater discharges. In contrast, lower concentrations at the North Lake of Tunis and Carthage were attributed to reduced anthropogenic pressure and environmental rehabilitation. The substantially lower concentrations relative to the northern Bizerte lagoon-channel complex emphasize the importance of local pollution sources and hydrodynamic conditions in determining MP accumulation.

Missawi *et al.* [83] extended the assessment to sediments at eight coastal sites spanning the Bizerte Lagoon, Gulf of Tunis, Gulf of Hammamet, and Gulf of Gabes. MPs ranging from 1.2 μm to 1 mm were detected at all locations, with concentrations of 129 - 606 items kg^{-1}. Although these concentrations were lower than those reported for the heavily impacted Bizerte lagoon-channel complex, their ubiquitous occurrence confirms the widespread distribution of MPs along the Tunisian coastline and the importance of local anthropogenic activities in controlling sediment contamination.

The contribution of land-based inputs was further demonstrated by Toumi *et al.* [84], who investigated sediments of seven streams draining into the Bizerte Lagoon. MP abundances ranged from 2340 ± 227.15 particles kg^{-1} dry weight in the Khima Stream to 6920 ± 395.98 particles kg^{-1} in the Jedara Stream. Higher concentrations occurred in streams draining densely populated areas and receiving municipal and industrial wastewater. All recovered particles were secondary MPs, with fibers predominating and PE and PP representing the major polymers. These findings identify urban runoff, wastewater, and industrial discharges as important pathways transporting MPs from terrestrial environments into the lagoon.

Chouchene *et al.* [85] investigated MP contamination in sediments at 35 sites along a 4.2-km coastal section of Sidi Mansour, Sfax, southeastern Tunisia, during ongoing dredging activities. MP abundances ranged from 252 to 5332 particles m^{-2}, demonstrating substantial spatial variability over a relatively short distance. Fragments were the most abundant morphology, reaching up to 5332 particles m^{-2}, followed by granules/pellets (3516 particles m^{-2}), fibers/lines (1553 particles m^{-2}), foams (589 particles m^{-2}), and tubular structures (252 particles m^{-2}). The diversity of particle shapes and sizes indicates contributions from multiple sources and degradation processes.

The relatively high MP abundance recorded at Sidi Mansour Harbour suggests considerable plastic contamination within this semi-enclosed environment. Local sediment characteristics and hydrodynamic conditions may strongly influence MP retention, with sandy sediments potentially promoting accumulation through interactions among particle properties, sediment dynamics, and local water circu-

lation. The semi-enclosed nature of the Gulf of Gabes may further favour retention and accumulation. Regional circulation, potentially influenced by the Kerkennah Islands and restricted water exchange, may facilitate both the transport and deposition of MPs from local and more distant sources. Thus, MP contamination in Tunisian sediments appears to result from the interaction of anthropogenic inputs, sediment properties, and regional hydrodynamic processes rather than from local emissions alone.

6.1.4. Algeria

Moving westward along the North African Mediterranean coast, Setiti *et al.* [86] investigated the occurrence, composition, and seasonal variability of MPs in surface seawater in Bou-Ismail Bay, Algeria. Seasonal samples collected in 2018 from six stations approximately 2 - 4 km offshore contained MPs in every sample. Mean concentrations ranged from 0.36 items m^{-3} in summer to 1.26 items m^{-3} in spring, with an overall mean of 0.86 ± 0.35 items m^{-3}, equivalent to approximately 101,146 ± 38,580 items km^{-2}.

Fibers were the predominant morphology (32%), followed by fragments (27%), films (16%), foams (13%), and granules (12%). PE and PP dominated the identified polymers, accounting for 68.2% and 24.7%, respectively, while PS represented 4.1%. The predominance of PE and PP is consistent with their extensive use in packaging, fishing-related materials, and other consumer and maritime applications.

The highest concentration occurred in spring, when surface currents were relatively strong (0.052 - 0.20 $m{\cdot}s^{-1}$) and predominantly directed west-southwest. These currents may facilitate transport and redistribution of floating debris within the bay. Seasonal changes in the spatial distribution of MPs further suggest that shifts in current direction influence particle retention and transport. The lowest concentrations occurred in summer, when circulation was predominantly directed from the northwest towards the coast, potentially promoting shoreline deposition or stranding and thereby reducing offshore concentrations. Overall, the study demonstrates that MP abundance in Algerian coastal waters is strongly influenced by seasonal hydrodynamic conditions and cannot necessarily be attributed solely to local sources.

Taïbi *et al.* [87] complemented these observations by investigating plastic debris in beach sediments along 124 km of the western Algerian coast, from Sidi Mansour to Bahara. Plasticdebris ≥ 1 mm was surveyed at nine beaches, with abundances ranging from 7.6 ± 18.8 to 66 ± 107.28 items m^{-2}. Fragments represented 83.27% of recovered items, pellets 14.93%, and films 1.03%. The highest abundances generally occurred near coastal villages, indicating an important contribution from local anthropogenic activities. Micro- and microplastic fragments co-occurred at most sites, although MPs predominated at most beaches. Bahara was an exception, where macroplastics were dominant.

The predominance of fragments indicates that secondary plastics generated through the degradation and weathering of larger items constitute an important

component of beach contamination. Their accumulation near coastal settlements further highlights the role of land-based sources. The coexistence of micro- and macroplastics also suggests an ongoing fragmentation process in which larger debris generates smaller particles that can subsequently be redistributed by waves, currents, wind, and sediment dynamics.

Further evidence was provided by Tata *et al.* [88], who investigated macroplastic and MP contamination in the Gulf of Annaba, an area characterized by high population density and intensive industrial activity. Surface sediments contained mean concentrations of 182.66 ± 27.32 macroplastic items kg^{-1} and 649.33 ± 184.02 MP items kg^{-1} dry sediment. MP abundance varied considerably among sites and was strongly influenced by proximity to densely populated areas, wastewater discharge points, and industrial facilities. Shoreline exposure and complex tidal circulation also appeared to influence transport, redistribution, and accumulation.

Fibers represented 70% of MPs, followed by fragments (21%), pellets (5%), films (2%), and foams (2%). Polymer composition was dominated by PE (48%) and PP (16%), followed by PET (14%), PS (9%), butylbranham (7%), polythenepropylene (3%), and cellulose triacetate (3%). The dominance of PE and PP is consistent with their widespread use in packaging, consumer products, fishing materials, and industrial applications. Collectively, the Algerian studies demonstrate that MP contamination occurs across surface waters, beach sediments, and subtidal environments and is governed by the interaction of land-based sources, wastewater, industrial activity, hydrodynamic transport, and sedimentary processes.

6.1.5. Morocco

Bouadil *et al.* [89] looked at MP contamination in surface waters of Al Hoceima Bay on Morocco's Mediterranean coast between September 2019 and 2021. Samples were collected annually at nine stations extending from nearshore waters to approximately 6 km offshore. MP abundances ranged from 1 to 15 items m^{-3}, with a mean of 4.70 ± 4.50 items m^{-3}. PE was the dominant polymer (67.4%), followed by PP (23.2%), PS (7.1%), and PET (2.3%).

Spatial variability reflected the influence of hydrodynamic conditions and multiple land- and sea-based sources. The Oued Ghiss and Oued Nekor rivers have highly irregular flow regimes, with episodic floods capable of transporting substantial quantities of sediment and associated plastic debris into the bay. Other potential sources included the regulated landfill, wastewater-treatment facilities, fishing activities, rural household waste, and tourism. Overall, MP contamination in Al Hoceima Bay appears to result from the combined influence of episodic riverine transport, waste-management practices, wastewater, fishing, and tourism.

Abelouah *et al.* [90] investigated anthropogenic macro- and mesolitter on three beaches along the northern coastline of Agadir. Plastics represented 79% of all collected items, including caps and lids, food containers, cigarette butts and filters, polystyrene fragments, small plastic bags, and beverage bottles. Taghazout and Aourir beaches were classified as clean to moderately clean according to the Clean

Coast Index, whereas Anza Beach exhibited substantially greater litter pollution.

Ben-Haddad *et al.* [91] assessed MP contamination in sediments from a highly urbanized beach along the Taghazout coast. Mean MP abundances increased from 915 particles kg^{-1} in 2018 to 1448 particles kg^{-1} in 2019. The highest concentrations occurred in the southern part of the Taghazout coast, particularly near facilities and areas heavily used by beachgoers, suggesting a contribution from recreational activities and associated anthropogenic pressures.

Abelouah *et al.* [92] further examined surface waters off Agadir-Ida-Outanane Province during March-May 2021. MPs were detected at all 25 sampling sites, including locations up to 15 km offshore. Concentrations ranged from 0.048 to 3.305 items m^{-3}, with a mean of 0.987 ± 1.081 items m^{-3}. Concentrations were highest in urban areas relative to village and rural sites, indicating an influence of local anthropogenic activities. Polyester (PET) was the predominant polymer, followed by PP, PA, PS, PVC, EVA, PUR, and polyacrylates.

Haddout *et al.* [93] investigated MPs in surface waters and sediments of the Sebou Estuary and adjacent Atlantic coastline near Kenitra. Water concentrations ranged from 10 to 168 particles m^{-3}, while sediment concentrations ranged from 10 to 300 particles kg^{-1}. Sites near Kenitra City exhibited significantly higher abundances than those along the more exposed Atlantic coast, probably reflecting greater population density and anthropogenic pressure. The Sebou Estuary was consequently identified as a potential MP hotspot, emphasizing the importance of urban and estuarine environments as pathways and accumulation zones for plastic pollution.

6.2. West Africa

6.2.1. Mauritania

Lourenço *et al.* [94] investigated MP contamination in sediments at Ebelk Aznaya and Baie d'Aouatif within the Bancd'Arguin, Mauritania, reporting a mean concentration of 4.3 ± 4.90 MP mL^{-1}. The Bancd'Arguin consists of extensive shallow waters and tidal flats along the tropical Saharan coast and covers more than 500 km^2. It is a fossil estuary without freshwater inputs and is located within a sparsely populated semi-arid environment. Approximately 1500 people live in a small number of fishing villages. Given the limited population and absence of riverine freshwater inputs, MP contamination is likely influenced primarily by marine transport, local fishing activities, and retention within the extensive tidal-flat and shallow-water environments.

6.2.2. Senegal

Sonko *et al.* [95] examined macroplastics and MPs in nearshore waters around Dakar, generally within 500 m of the coast. Six sites were sampled around the Cap-Vert Peninsula. Cambérène was by far the most contaminated site, with approximately 945,607 MPs km^{-2} and 189,995 macroplastic items km^{-2}. In contrast, MP abundances at the Îles de la Madeleine and Ouakamwere 12,641 and 34,236 MPs km^{-2}, respectively, and no macroplastics were recovered at either site. The excep-

tionally high contamination at Cambérène may be associated with its proximity to a wastewater-treatment plant that discharges effluent directly into the sea. Fibers predominated, supporting the potential contribution of wastewater and domestic sources.

These findings complement those of Tavares *et al.* [96], who examined meso- and microplastic debris on beaches south of Dakar. Plastic debris was considerably more abundant at an urbanized beach than at a semi-urbanized site. Surface densities were 3.63 items m^{-2} and 0.20 items m^{-2}, respectively, while sediment densities at 10 cm depth reached 207.29 and 36.46 items m^{-2}. Plastic accounted for 97.62% of recorded debris, with plastic bags and clothing-derived plastics among the dominant categories.

Together, the two studies demonstrate a strong association between urbanization, land-based inputs, wastewater discharge, and plastic accumulation in Dakar's coastal environment. However, the strong spatial differences among sites also show that source intensity alone does not determine MP distribution. Hydrodynamic processes, coastal transport, and distance from direct inputs substantially influence where plastics ultimately accumulate.

6.2.3. Ghana

In Ghana, early evidence of plastic pollution came from studies of resin pellets on beaches. Surveys conducted between 2009 and 2013 examined pellets at 11 beaches around Accra and Tema, including Prampram, Sakumono, Korle Lagoon, Winneba, and Cape Coast [97]. Pellets were predominantly composed of polythene and polypropylene and contained 1 - 69 ng PCB g^{-1} pellet. Dumping and recycling sites, particularly e-waste recycling sites, were identified as likely sources of PCB contamination.

Nuamah *et al.* [98] subsequently investigated coastal surface waters at Sekondi, Cape Coast, Tema, and Denu between January and February 2021. The overall mean MP concentration was 1.9 ± 1.7 particles m^{-3}. Concentrations generally decreased with increasing distance from shore, particularly at Cape Coast, Tema, and Denu. Population size alone did not explain the observed distribution, as Denu, despite having the smallest population, recorded relatively high MP abundance. Industrialization appeared to be an important factor, particularly at Sekondi and Tema, where extensive industrial activity may contribute to coastal plastic contamination. Fragments represented 46.47% of MPs, followed by pellets (22.55%) and fibers (13.03%). PP was the dominant polymer (47%), followed by PE (37%) and PS (16%).

A subsequent sediment study [99] reported a mean MP concentration in sediments of 0.144 ± 0.061 MP g^{-1} dry weight, with pellets and transparent particles predominating. Concentrations ranged from 0.078 ± 0.020 MP g^{-1} at Sekondi to 0.217 ± 0.012 MP g^{-1} at Denu.

Faseyi *et al.* [100] investigated MPs in sediments from the Pra and Ankobra estuaries. MPs occurred at all sampling stations. Fragments predominated in the Pra Estuary, with 38.00 ± 25.47 MP 10 g^{-1} dry weight, whereas microsheets were

most abundant in the Ankobra Estuary, at 20.60 ± 12.59 MP 10 g^{-1} dry weight.

Chico-Ortiz *et al.* [101] analyzed MPs in the Mukwei and Kpeshie lagoons between Accra and Tema. MP abundances in Kpeshie Lagoon werebetween16.39 ± 3.26 MP 10 cm^{-3} and 25.94 ± 3.13 MP 10 cm^{-3}, the latter abundance recorded within a remnant mangrove forest. The higher abundance there is consistent with the role of mangrove systems as sinks for plastic debris. Complex root structures can trap plastics transported by runoff and tidal waters, while sandbars and other physical barriers can further restrict particle movement within lagoonal environments.

6.2.4. Togo

Microplastic contamination along the Togolese coast remains comparatively understudied. Aziade *et al.* [102] provided a baseline assessment using 30 samples collected from sediments at six sites representing different environmental conditions and levels of anthropogenic activity. MPs ranging from 0.3 to 5 mm were detected at all sites using ATR-FTIR analysis. Mean abundances ranged from 16 ± 20 to 61 ± 51 particles m^{-2}, equivalent to 2 ± 3 to 11 ± 13 particles kg^{-1}. Fragments predominated (67%), while PE was the dominant polymer (48%), followed by PP (34%) and PS (14%).

6.2.5. Nigeria

Nigeria, particularly the Lagos coastal and lagoon systems, represents another important West African region where widespread MP contamination has been documented. Fred-Ahmadu *et al.* [103] investigated 1 - 5 mm MPs in psammitic sediments from five beaches: Badagry, Oniru, Elegushi, Atican, and Eleko. MP abundance varied significantly among depositional zones, with the high-waterline accounting for 58.84% of recovered MPs. No MPs were detected at the current-waterline. This distribution indicates that waves, currents, wind, and other hydrodynamic processes strongly influence particle transport and deposition. Fragments predominated, followed by fibers and pellets, suggesting an important contribution from the fragmentation of larger debris.

Olarinmoye *et al.* [104] conducted the first assessment of MPs in both water and sediments of the Lagos Lagoon, sampling at Liverpool, Agbowa, Ojo, and Makoko. MPs occurred throughout the study area at 139 - 303 particles L^{-1} in water and 310 - 2319 particles kg^{-1} in sediments. Higher sediment concentrations at Makoko were partly associated with fine-grained sediments that favour MP retention. Fibers dominated the water column (92.6%) and represented 32.5% of sedimentary MPs. PE and PP were the principal polymers.

Akinhanmi *et al.* [105] subsequently sampled Epe, Makoko, SagboKoji, and Badagry and reported mean concentrations of 65.2 particles L^{-1} in surface water and 3906 particles kg^{-1} in sediments. Fibers again dominated. The substantially higher mean sediment concentration relative to that reported by Olarinmoye *et al.* [104] illustrates the considerable spatial variability within the lagoon but also the methodological variability and highlights the importance of sampling loca-

tion, sediment characteristics, and analytical procedures, when comparing MP datasets.

Dada and Bello [106] similarly reported fiber dominance in Lagos Lagoon water and fragment dominance in sediments, implicating recreational, industrial, and domestic plastic waste as important contributors. Collectively, these studies demonstrate extensive contamination across Lagos beaches, lagoon waters, and sediments, with fibers particularly important in the water column and fragments more prominent in sediments. The lagoon functions both as a transport pathway for suspended MPs and as a reservoir for longer-term accumulation.

Yakub *et al.* [107] determined the MP contamination along three regions of the Nigerian coast in 2024: the Eastern Zone (EZ) along Akwa Ibom State, the Central Zone (CZ) encompassing the Niger Delta, and the Western Zone (WZ) along the Benin-Owena coast. Surface-water concentrations were highest in the EZ (705 particles L^{-1}), followed by the WZ (223 particles L^{-1}) and CZ (212 particles L^{-1}). Sediment concentrations showed the same pattern, reaching 1033 particles kg^{-1} in the EZ, 338 particles kg^{-1} in the CZ, and 218 particles kg^{-1} in the WZ. Polymer composition differed among regions and compartments. CR dominated sediments in the EZ and CZ, whereas PVA dominated in the WZ. In surface waters, PVA was the predominant polymer across all three zones. The pronounced spatial differences suggest that regional anthropogenic activities and environmental conditions strongly influence MP distribution along the Nigerian coast.

Yahaya *et al.* [108] examined MPs at three sites along the Badagry Lagoon: Ibeshe, Amuwo Odofin, and Ojo. Sediment concentrations ranged from 283 - 315 particles kg^{-1}, compared with 108 - 199 particles L^{-1} in surface waters. Fibers represented 52% - 90% of MPs in both compartments, followed by fragments and films. Identified polymers included PP, PE, PA, and PS. Fiber dominance indicates persistent inputs from land-based and potentially wastewater-related sources.

6.3. Central Africa

Cameroon

Ndumbe *et al.* [109] investigated plastic contamination across five beaches along the 50.6-km Limbe-Idenau coastline in southwestern Cameroon. Plastic abundance varied strongly among locations and seasons, ranging from 3.13 items m^{-2} at Seme Beach to 163.88 ± 17.15 items m^{-2} at Limbe Down Beach. The highest contamination occurred at Limbe Down Beach during August, coinciding with the rainy season. Intense rainfall, flooding, and surface runoff likely facilitated the transport of land-based plastic waste to the coast.

Fragments were the predominant microplastic category, reaching 37.27 ± 10.05 items m^{-2}, while pellets reached 0.33 ± 0.02 g m^{-2}. The predominance of fragments suggests substantial contributions from weathering and fragmentation of larger plastic items, whereas pellets may reflect industrial or commercial sources. The strong seasonal variability highlights the importance of rainfall and hydrological processes as transport mechanisms in tropical coastal environments.

6.4. Southern Africa

South Africa

South Africa has one of the most extensive bodies of evidence for coastal plastic contamination in Africa. Early surveys by Ryan and Moloney [48] showed that densities of plastic debris had increased significantly between surveys of 50 beaches conducted in 1984 and 1989. Packaging and fishing equipment constituted the majority of the debris. Ryan *et al.* [110] subsequently examined mesodebris (approximately 2 - 25 mm) on 82 beaches in 1994, 2005, and 2015. Plastics represented 99% of items by number and 95% by mass. Industrial pellets were the most abundant items, whereas rigid plastic fragments contributed most of the mass. Mesodebris abundance was associated with urban-industrial centres, while correlations with population density were weak and no relationship with local runoff was detected. The decline in pellet size within creasing distance from urban centres further supports the importance of local land-based sources.

Chitaka and von Blottnitz [111] documented substantial plastic accumulation along five beaches in the Cape Town area, with accumulation rates ranging from 36 to 2961 particles day^{-1} per 100 m of beach. Plastic represented 94.5% - 98.9% of collected particles. Lamprecht [112] reported approximately 30,900 MP m^{-3} of sediment at Milnerton Beach in Table Bay, further demonstrating substantial contamination of South African beach sediments.

Nel and Froneman [113] investigated approximately 480 km of southeastern coastline, sampling 21 beaches in sheltered bays and exposed coastal areas. Sediment concentrations ranged from 688.9 ± 348.2 to 3308 ± 1449 particles m^{-2}, while water-column concentrations ranged from 257.9 ± 53.36 to 1215 ± 276.7 particles m^{-3}. More than 90% of recovered MPs were microfibers. Contrary to expectations, sheltered bays did not consistently exhibit higher concentrations than exposed beaches, indicating that local sources, hydrodynamic transport, beach morphology, and sediment retention collectively determine MP distribution.

Vetrimurugan *et al.* [114] surveyed nine tourist beaches along the KwaZulu-Natal coast. The highest concentration occurred in Durban-area sediments, reaching 506 MPs per 30 g sediment. Microfibers predominated, reinforcing their importance in South African coastal sediments and identifying the highly urbanized Durban region as a potential MP hotspot.

Boshoff *et al.* [115] examined plastic contamination at two locations within the Knysna Estuary. The Ashmead Channel is influenced by an industrial area, the Bongani River, stormwater draining much of the central business district, and effluent from the Knysna wastewater-treatment plant. Brenton-on-Lake is less developed and subject to lower anthropogenic pressure. The authors found MP concentrations of 1.7 ± 1.6 MP m^{-3} to 2.5 ± 1.4 MP m^{-3} in the areas sampled. In these areas, Boshoff *et al.* [116] subsequently compared MP accumulation in sediments associated with *Zosteracapensis* meadows and adjacent unvegetated sediments over approximately 5 km. Total MP abundance did not differ significantly between vegetated and unvegetated sediments, although fiber abundance differed

significantly between locations. These findings demonstrate that MP abundance and composition can vary considerably over very short spatial scales according to catchment characteristics and local pollution pressure.

De Villiers [117] investigated microfiber pollution at 175 sites spanning more than 2700 km of coastline during 2016-2017. Mean concentrations were 87 ± 84 fibers dm^{-3} in 2016 and 80 ± 102 fibers dm^{-3} in 2017, with individual sites ranging from 4 - 772 and 0 - 797 fibers dm^{-3}, respectively. The highest concentrations occurred along the eastern coastline, particularly between Port Edward and Durban, where mean concentrations were approximately 160 fibers dm^{-3} compared with 28 - 43 fibers dm^{-3} in northern KwaZulu-Natal. The spatial gradient coincided with population density, riverine inputs, and wastewater infrastructure. The highest concentration in 2017 occurred at Merebank, near a major coastal wastewater-treatment discharge point. These associations support an important contribution from land-based sources.

The Port of Durban represents a particularly important MP hotspot because of the combined influence of urbanization, port activity, wastewater inputs, and local hydrodynamics. Naidoo *et al.* [118] reported a mean water-column concentration of 7.03 ± 11.93 particles m^{-3}, increasing to 15.82 ± 18.54 particles m^{-3} in the Bayhead Canal. Sediment concentrations averaged 159.9 ± 271.2 particles per 500 mL and reached 745.4 ± 129.7 particles per 500 mL in the Bayhead Canal. Concentrations declined away from central Durban, suggesting a strong influence of localized urban sources.

Preston-Whyte *et al.* [119] documented substantial spatial heterogeneity throughout the harbour. Water-column concentrations increased with decreasing particle size, reaching 82 particles m^{-3} for 200 - 300 μm particles, compared with 45 particles m^{-3} for 300 - 500 μm particles and 22.5 particles m^{-3} for 500 μm - 5 mm particles at the most contaminated sites. Sediment concentrations ranged from 2400 ± 529 to 111,933 ± 29,189 particles kg^{-1} dry sediment, with particularly high abundances at localized depositional sites. These patterns emphasize the importance of sediment characteristics and harbour hydrodynamics in controlling MP retention.

Methodological differences also strongly affect comparisons among studies. Nel *et al.* [120], for example, reported 1200 ± 133.2 particles m^{-3} after filtering 100 L through a 63 μm mesh, whereas Preston-Whyte *et al.* [119] reported 99.14 ± 36.29 particles m^{-3}. Differences in mesh size and particle-size range scan substantially alter measured abundance because smaller meshes capture a greater proportion of fine particles. Comparisons among studies should therefore account for sampling volume, mesh size, particle-size range, extraction procedures, and reporting units.

Naidoo and Glassom [121] examined coastal plastic debris along the KwaZulu-Natal coastline using 43 manta-trawl samples collected over one year. Mean surface plastic abundance was 4.01 ± 3.28 particles 100 m^{-2}. Concentrations were significantly higher during winter (5.54 ± 3.26 particles 100 m^{-2}) than summer (2.96

± 2.94 particles 100 m^{-2}), with the highest concentrations occurring south of Durban.

Increasing attention has also been given to chemical additives associated with environmental MPs. Vilakati *et al.* [122] examined MPs from seven sites along the Atlantic coastline of Cape Town. PE was detected at six sites (87.5%), while PET and PVC occurred at five sites (71.4%). Other polymers included PS, PA-12, PAA, and EVA. Py-GC-TOF-MS identified six additives, predominantly fatty acid esters, and nine plasticizers derived from alcohols, carboxylic esters, and carboxylic acids.

Along the Indian Ocean coast, MP contamination has also been documented in mangrove-associated waters and sediments in KwaZulu-Natal [123]. Concentrations varied substantially among sites. In the St Lucia Estuary, concentrations were 1.19 ± 1.12 MP m^{-3} in water and 18.5 ± 34.4 MP per 500 g sediment. At uMgeni, concentrations reached 4.09 MP m^{-3} and 143.3 MP per 500 g sediment, while Durban Harbour and Isipingo Estuary exhibited similarly strong spatial variability. Mangrove waters showed higher MP concentrations during the wet season (1.31 - 9.42 MP m^{-3}) than during the dry season (0.33 - 2.23 MP m^{-3}), whereas sediment concentrations were higher during the dry season. This inverse relationship may reflect enhanced deposition during periods of reduced river discharge.

Ryan [124] emphasized the importance of South Africa as a contributor to global marine plastic pollution. Thus, in 2010 it was assumed that South Africa contributed 0.09 - 0.25 million metrictons of plastic debris to the marine environment [14]. Although offshore activities and long-distance transport contribute to marine plastic inputs, the composition and distribution of coastal debris indicate that local land-based sources are also highly important. Burial in beach sediments and retention in backshore vegetation can temporarily remove plastics from the active coastal environment, while beach cleaning removes larger debris. Conversely, sea-level rise and increasing extreme storms may remobilize previously buried plastics.

Oceanographic processes can subsequently transport plastics released from South African coastlines into both the South Atlantic and Indian Oceans. Floating macroplastics are particularly concentrated near urban centres, whereas offshore plastics tend to consist of larger and more buoyant items. Biofouling can increase particle density and promote sinking, while biological interactions may also influence the abundance of small floating particles. The seabed therefore represents a potentially important long-term sink, although existing observations account for only a small proportion of the plastic predicted to enter the marine environment. This discrepancy highlights substantial uncertainty regarding the transport, accumulation, burial, and degradation of marine plastics and reinforces the need for source-reduction measures.

6.5. East Africa

6.5.1. Mozambique

Evidence for MP and plastic-debris contamination along Mozambique's coastline remains comparatively limited. Karlsson [125] investigated plastic debris accu-

mulation at beaches in Maputo Bay, including two sites on Inhaca Island and one at Catembe. Debris abundance was in the range of 40 - 205 and 0 - 47 particles per 100 m transect at the Marine Station and Saco sites on Inhaca Island, respectively, compared with 980 - 37,575 particles per 100 m at Catembe. The substantially greater abundance at Catembe likely reflects its closer association with the densely populated Maputo metropolitan area, although oceanographic transport and shoreline characteristics may also contribute.

Browne *et al.* [126] previously reported 21 - 30 MPs per 250 mL of beach sediment at Pemba, Mozambique. Barnes also investigated macro- and mesoplastic contamination (>1 cm^2) on Quirimbas and Inhaca Islands [127].

6.5.2. Tanzania

Nchimbi *et al.* [128] documented widespread MP contamination in Tanzanian coastal sediments, with significantly higher concentrations in beach sediments (864.15 ± 275.10 MPs kg^{-1} dry sediment) than in seabed sediments (79.9 ± 21.5 MPs kg^{-1}). Concentrations were also higher around Dar es Salaam than Zanzibar, with the Tegeta estuary representing the most contaminated Dar es Salaam site. Elevated abundances were associated within adequate waste management, riverine transport, urbanization, and shoreline activities. Fibers and fragments predominated, while polythene and polyester were the principal polymers.

Mayoma *et al.* [129] similarlyfound substantial spatial variability across 18 coastal sites. The highest abundance occurred at Mtoni Kijichi Creek, an industrial port in Dar es Salaam, where 2972 ± 238 particles kg^{-1} dry sediment were recorded. Other sites ranged from 15 to 214 particles kg^{-1}. Fragments and fibers were detected at all sites, while PP and PE were the predominant polymers.

Balasubramaniam and Phillott [130] detected 3 - 7 MPs per 25 g sediment at Tebeke Beach, with a mean of 4.6 MPs per 25 g. Although geographically limited, this observation further confirms MP occurrence along the Tanzanian coast and highlights spatial variability associated with anthropogenic inputs, sediment characteristics, and hydrodynamics.

6.5.3. Kenya

Kerubo *et al.* [131] compared MP contamination in surface waters of urbanized Tudor and Port-Reitz creeks in Mombasa with Mida Creek near Watamu, a comparatively less urbanized system within a Marine National Reserve. MPs were detected at all sites, including Mida Creek. Mean concentrations were 3365.1 ± 431.2 and 2539.3 ± 223.5 particles m^{-3} during the two sampling periods. Fibers predominated. The occurrence of MPs within Mida Creek demonstrates that protected and comparatively remote coastal environments remain exposed to plastic pollution through local settlements, tourism, fishing, and regional transport.

Kerubo *et al.* [132] subsequently examined sediments from the same systems. Mean MP concentration was 1.61 ± 0.14 particles g^{-1} dry weight, with significant spatial variability. Tudor Creek exhibited significantly greater contamination than Mida and Port-Reitz, although high concentrations were also recorded at Mik-

indani, Dabaso, and Mayonda. Fibers predominated, and LDPE, HDPE, and PP were identified. The results demonstrate the combined influence of urban sources and regional transport.

Kosore *et al.* [133] further demonstrated the importance of riverine and catchment-scale inputs by investigating six coastal centres: Lamu, Kipini, Malindi, Mombasa, Gazi, and Vanga. Concentrations ranged from 0.02 ± 0.00 to 3.22 ± 2.04 MP m^{-3}, with an overall mean of 0.58 ± 1.29 MP m^{-3}. The highest concentration occurred at Malindi, potentially reflecting its connection to the Sabaki River and its heavily impacted catchment. Sampling shortly after the October-November short-rain period may also have contributed to elevated concentrations through enhanced runoff, flooding, and river discharge.

As already mentioned above, mangrove forests represent another important environment for MP retention. Okuku *et al.* [134] examined debris accumulation across landward, middle, and seaward zones of seven Kenyan mangrove forests. The landward zone primarily retained land-derived debris, whereas the seaward zone preferentially trapped marine-derived litter. The middle zone exhibited the highest debris density (0.162 ± 0.150 items m^{-2}), compared with 0.066 ± 0.049 items m^{-2} in the landward zone and 0.036 ± 0.028 items m^{-2} in the seaward zone. These findings demonstrate that mangroves function as spatially structured retention systems in which vegetation, tidal exchange, hydrodynamics, and litter-transport direction determine where plastic accumulates.

Taken together, Kenyan studies demonstrate widespread MP contamination across surface waters, sediments, estuaries, and mangrove environments, extending from highly urbanized systems to comparatively protected areas. The prominence of fibers suggests important contributions from wastewater, domestic activities, fishing, and other land-based sources, while rainfall, river discharge, sediment characteristics, and mangrove zonation modify their distribution. The occurrence of MPs in protected coastal environments indicates that marine protected areas cannot be isolated from regional plastic pollution and that mitigation must address sources throughout connected catchments.

KeChi Okafor *et al.* [135] examined microfibers in surface waters along the Kenyan and Tanzanian coasts. Of 2403 microfibers recovered from 37 sites, 55% were natural, 8% regenerated cellulosic, and 37% synthetic. Natural microfibers were more abundant than synthetic microfibers at 33 of the 37 sites, demonstrating the importance of distinguishing synthetic microplastics from other fiber types during environmental assessments.

Weideman *et al.* [136] investigated meso-, microplastics, and microfibers off Mozambique and Tanzania during October-November 2017 when aboard the research vessel S.A. Agulhas II. Net and bulk-water samples were collected at 60 stations, including 44 off Mozambique and 16 off Tanzania. Synthetic microfibers were several orders of magnitude more abundant numerically than net-collected litter (45 ± 50 fibers m^{-2} versus 0.009 ± 0.020 items m^{-2}), although net-collected litter contributed more by mass (0.044 ± 0.195 mg m^{-2} versus 0.01 ± 0.01 mg m^{-2}).

Meso-litter, micro-litter, and microfibers were widespread along northern Mozambique and southern Tanzania. Litter loads were generally higher along the Tanzanian coast, potentially reflecting higher population density. Greater proportions of films and polystyrene off Tanzania were consistent with predominantly local sources. Litter size decreased with increasing distance from shore, while higher densities near river mouths and greater litter mass close to shore suggested an important contribution from land-based sources.

However, the absence of increased offshore litter concentrations near major coastal cities, including Dar es Salaam and Beira, complicates a simple land-source interpretation. One possible explanation is rapid retention of land-derived debris on nearby beaches through tidal processes and long shore drift. Alternatively, small particles may accumulate along salinity fronts where rivers discharge into the sea. Further synoptic investigations of river systems are required to distinguish among these mechanisms.

6.5.4. Sudan

Ibrahim *et al.* [137] investigated the composition, distribution, and abundance of beach litter on selected beaches within the Dungonab Bay and Mukkawar Island National Park (DMNP), a World Heritage Site located along the Sudanese Red Sea coast. The southern boundary of the DMNP lies approximately 125 km north of Port Sudan Harbour. The protected area covers approximately 2800 km^2, including around 800 km^2 of coastal land and 2000 km^2 of marine waters. Dungonab Bay is a shallow-water basin that is partially enclosed by the long, narrow Dungonab Peninsula. The bay extends approximately 31 km from north to south and is about 13 km wide at its southern end, covering an area of approximately 284.5 km^2. Mukkawar Island is an uninhabited rocky island located approximately 30 km offshore from the Dungonab Peninsula.

The DMNP is situated in a remote and sparsely populated rural area, with approximately 2000 inhabitants distributed among several small villages. Artisanal fishing represents the principal economic activity, supplemented by other small-scale activities such as shellfish collection and animal husbandry. Despite the relatively low population density and limited development in the region, Ibrahim *et al.* [137] recorded considerable quantities of beach litter. A total of 24 beach-litter surveys were conducted along approximately 600 m of coastline, corresponding to an area of around 7700 m^2. In total, 3037 litter items were collected, corresponding to an overall mean abundance of 126.72 ± 76.86 items per 100 m of shoreline, or approximately 0.4 items m^{-2}.

Plastic was the dominant litter category, accounting for 1738 items, or 57.23% of all collected debris. The mean density of plastic litter was 72.52 items per 100 m, equivalent to approximately 0.23 items m^{-2}. However, substantial spatial variation was observed among the sampled beaches. Plastic densities ranged from 11.5 ± 13.9 items per 100 m on a beach used for oyster cleaning to as high as 140 ± 89.11 items per 100 m at Mohammed Gol Jetty, which includes a semi-rural beach. These differences suggest that local human activities and patterns of beach use

may influence the accumulation of plastic debris even within this relatively remote coastal environment.

Temporal variation was also evident in the accumulation of beach litter. The litter flux ranged from 16.43 to 21.9 items per 100 m per day during the study period, with an overall mean of 18.82 ± 2.8 items per 100 m per day. Overall, the findings demonstrate that plastic constitutes the dominant component of beach litter in the DMNP and that significant plastic accumulation can occur even in sparsely populated and relatively undeveloped coastal areas. The observed spatial and temporal variability further highlights the influence of local activities, coastal dynamics, and potentially marine sources on the distribution and accumulation of beach litter along the Sudanese Red Sea coast.

During the dry season 2024, Salah *et al.* [138] investigated microplastic (MP) contamination at four coastal sites near Port Sudan, comprising two semi-enclosed bays (Flamingo Bay and Al Khaleej Bay) and two open-coast sites (Flamingo Coast and Al Kilo Coast). This sampling design enabled a direct comparison between semi-enclosed and exposed coastal environments. Water and sediment samples were collected from 19 stations in total: four in Flamingo Bay, five at Flamingo Coast, six in Al Khaleej Bay, and four at Al Kilo Coast, yielding 57 water and 57 sediment samples.

Mean MP abundances were substantially higher in the semi-enclosed bays than along the open coast, reaching 154.84 ± 4.44 items m^{-3} in seawater and 171.79 ± 2.66 items kg^{-1} in sediments in the bays, compared with 91.85 ± 1.51 items m^{-3} and 61.15 ± 1.64 items kg^{-1}, respectively, at open-coast sites. Fibers were the predominant MP morphology, accounting for 51.84% of particles in seawater and 45.80% in sediments, while PE and PVC were the dominant polymer types. A distinct spatial gradient in MP abundance was observed in surface water, following the order Flamingo Bay > Al Khaleej Bay > Al Kilo Coast > Flamingo Coast. In contrast, sediment samples showed a higher MP concentration in Al Khaleej Bay than in Flamingo Bay.

Diversity and correlation analyses indicated that the semi-enclosed bays receive more complex MP inputs and are strongly influenced by local anthropogenic pressures and site-specific hydrodynamic conditions. In contrast, MPs at the open-coast sites appeared to be influenced more strongly by long-range transport, salinity, and water depth. Ecological risk was also greater in the bays, where elevated risk levels were associated with the presence of potentially hazardous polymers and stronger direct anthropogenic inputs. Overall, the study demonstrates that coastal geomorphology and hydrodynamic setting strongly influence MP accumulation, with semi-enclosed bays acting as important hotspots for both MP contamination and associated ecological risk.

6.6. Western Indian Ocean Islands

6.6.1. Mayotte

Mulochau *et al.* [139] investigated marine litter accumulation across 22 stations

on fringing reefs within the Marine Natural Park of Mayotte. Litter densities ranged from 0 to 50 items per 500 m^2, with similar mean abundances in winter (3.9 ± 1.3 items per 500 m^2) and summer (3.8 ± 1.1 items per 500 m^2). Plastic represented 92% of litter, approximately 66% of which consisted of fishing gear. The predominance of fishing-related debris is particularly concerning because entanglement and attachment to coral colonies can cause physical damage and potentially impair coral growth and recovery. Approximately half of coral colonies containing litter exhibited visible impacts.

6.6.2. Seychelles and the Western Indian Ocean

Evidence from remote Seychelles islands demonstrates that geographical isolation does not prevent marine plastic accumulation. On Cousine Island [140], 9119 litter items were recorded across 40 surveys, corresponding to an overall accumulation rate of 0.0082 items m^{-1} d^{-1}. This increased significantly over time, reaching 0.0255 items m^{-1} d^{-1} in 2019. More than 80% of collected litter was wholly or partly plastic, with polystyrene fragments and pieces representing the most frequent category. The increasing deposition rate indicates that remote islandscanact as sinks for plastics transported by regional ocean circulation.

Alphonse Island [71] similarly accumulated substantial marine debris. A 2013 survey of a 1-km windward beach recovered 4743 items weighing approximately 142 kg. Small plastic fragments represented 25.89% of the total. Prevailing winds, currents, and wave action likely facilitate long-range transport to the island. Marine debris on remote western Indian Ocean islands has also been linked to sources in Indonesia, India, and Sri Lanka [68], emphasizing the transboundary nature of plastic pollution.

A particularly striking example is Aldabra Atoll. During a large-scale clean-up in March 2019, approximately 25 tonnes of plastic were removed at a cost of US$224,537. Remaining plastic waste was estimated at approximately 513 tonnes (95% CI: 212 - 814 tonnes), representing one of the largest reported accumulations of plastic litter on a single island. Fishing-related debris accounted for 83% of the total mass, followed by flip-flops (7%), fragments (4%), packaging (3%), other litter (2%), and consumer items (1%) [141]. Complete removal was estimated to require approximately US$4.68 million and 18,000 person-hours. These findings demonstrate both the scale of plastic accumulation on remote islands and the substantial logistical and financial burden associated with remediation. Clean-up therefore needs to complement, rather than replace, measures aimed at preventing plastic leakage at source.

6.6.3. Mauritius

MP contamination has also been reported from beaches and mangrove systems in Mauritius. Beach sediments at Troud'Eau Douce and La Cambuse, together with measurements from beaches across the western, northern, southern, southeastern, and eastern coasts, demonstrate considerable spatial variability [142] [143]. Reported concentrations ranged from relatively low values at Baie du Cap and Bel

Ombre to substantially higher concentrations at Flat Island, La Cambuse, and Pointe D'Esny. At La Cambuse, for example, concentrations reached 89.2 MP m^{-2} in the upper layer, 67.8 MP m^{-2} in the beach-surface layer, and 39.3 MP m^{-2} in the lower sampled layer.

Mangrove forests provide additional evidence of plastic retention. At Mahebourg and Ferney, plastic represented 42.9% and 43.7% of anthropogenic litter, respectively, with plastic abundances of 0.20 ± 0.11 and 0.10 ± 0.09 particles m^{-2} [144]. These observations reinforce the role of mangrove environments as important retention zones for anthropogenic plastic debris.

6.7. Summary of the Results

Collectively, the available evidence demonstrates that plastic and MP contamination is widespread across African coastal environments, spanning the Mediterranean and Red Sea coasts of North Africa, the Atlantic and Gulf of Guinea coasts of West and Central Africa, the Indian Ocean coast of East and Southern Africa, and remote islands of the western Indian Ocean. MPs and larger plastic debris have been documented in surface waters, beach and seabed sediments, lagoons, estuaries, rivers, harbours, mangroves, coral reefs, and remote island shorelines.

Despite substantial differences in reported concentrations, several consistent patterns emerge. Fibers and fragments are among the most frequently dominant particle morphologies, while PE and PP commonly represent the principal polymers. However, polymer composition can vary considerably among regions and environmental compartments, emphasizing the diversity of plastic sources and the importance of local material use.

Anthropogenic activity is a recurring driver of contamination. Urbanization, industrial activity, wastewater discharge, fishing, tourism, port operations, and inadequate solid-waste management are repeatedly associated with elevated plastic concentrations. Rivers, streams, stormwater, and wastewater provide important pathways through which land-derived plastics reach coastal environments. Conversely, fine-grained sediments, beaches, lagoons, estuaries, mangroves, harbours, and semi-enclosed bays frequently function as accumulation zones.

At the same time, MP abundance cannot be interpreted solely as a measure of local emissions. Hydrodynamic connectivity is a central control on the distribution and fate of plastic debris. Tidal circulation, surface currents, waves, wind, river discharge, seasonal rainfall, and sediment dynamics can transport particles away from their sources or concentrate them in particular depositional environments. This is evident in the seasonal redistribution of MPs in Algeria, rainfall-driven transport in Cameroon, riverine transport in Kenya, and the accumulation of marine-derived debris on remote Seychelles islands.

The evidence from mangrove systems is particularly important because these ecosystems can act as both sinks and temporary reservoirs. Their complex root structures, tidal channels, and spatial zonation can retain debris originating from both land and marine environments. However, retention is not necessarily per-

manent, and changes in hydrodynamics, storms, river discharge, and sediment dynamics may remobilize previously deposited material.

The South African literature additionally highlights the importance of methodological standardization. Reported concentration scan differ by orders of magnitude depending on mesh size, sampled volume, particle-size range, extraction procedure, polymer-identification method, and reporting units. The contrasting estimates from the Port of Durban illustrate why numerical comparisons among studies should be made cautiously unless methodological characteristics are comparable.

Finally, recent evidence from the Port of Durban suggests that stormwater drains may represent an important pathway for MP delivery to the harbour and may contribute more MPs than riverine sources [119]. This observation reinforces the broader conclusion that coastal plastic pollution is governed by interconnected drainage, wastewater, riverine, and coastal transport pathways rather than by individual point sources alone.

Plastic pollution in the African marine environment affects not only marine organisms but also industries that depend on them, particularly the fishing industry. In this context, a report by the FAO's EAF-Nansen Programme examined the prevalence of plastic debris in the catches of seine fishers across four West African countries—Côte d'Ivoire, Ghana, Togo, and Benin. The study found that plastic debris accounted for between 1.1% and 15.7% of the total catch by weight (**Table 5**) [145].

Table 5. Plastic debris found in the catch of artisanal fishers in four countries along the Gulf of Guinea.

Country	Number of fishing units surveyed	Average weight of catch (kg)	Average weight of litter as "by-catch" (kg)	Proportion of waste by weight (%)	Proportion of plastic by number of items (%)	Proportion of plastic litter by weight (%)
Côte d'Ivoire (Ivory Coast)	17	388	13	3.4	97	32
Ghana	23	185	8	4.3	99	84
Togo	17	198	38	19.2	99	82
Benin	18	315	33	10.5	99	22

Overall, the African coastal literature indicates that MP contamination is widespread, spatially heterogeneous, and strongly controlled by the interaction between anthropogenic sources and environmental transport processes. The occurrence of MPs even in protected, sparsely populated, and remote environments demonstrates the regional and transboundary nature of the problem. Effective mitigation therefore requires a combination of source reduction, improved solid-waste and wastewater management, control of riverine and stormwater inputs, responsible fisheries and port practices, and targeted monitoring of major accu-

mulation environments. At the same time, greater harmonization of sampling and analytical methods is essential to enable robust comparisons of MP abundance and trends across African coastal ecosystems.

Acknowledgements

The author thanks the library of UAEU for making available its electronic resources.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

References

[1] Carpenter, E.J. and Smith, K.L. (1972) Plastics on the Sargasso Sea Surface. *Science*, **175**, 1240-1241. https://doi.org/10.1126/science.175.4027.1240

[2] Thompson, R.C., Olsen, Y., Mitchell, R.P., Davis, A., Rowland, S.J., John, A.W.G., *et al.* (2004) Lost at Sea: Where Is All the Plastic? *Science*, **304**, 838-838. https://doi.org/10.1126/science.1094559

[3] Cliff, G., Dudley, S.F.J., Ryan, P.G. and Singleton, N. (2002) Large Sharks and Plastic Debris in Kwazulu-Natal, South Africa. *Marine and Freshwater Research*, **53**, 575-581. https://doi.org/10.1071/mf01146

[4] Furness, B.L. (1983) Plastic Particles in Three Procellariiform Seabirds from the Benguela Current, South Africa. *Marine Pollution Bulletin*, **14**, 307-308. https://doi.org/10.1016/0025-326x(83)90541-6

[5] Ryan, P.G. (1987) The Incidence and Characteristics of Plastic Particles Ingested by Seabirds. *Marine Environmental Research*, **23**, 175-206. https://doi.org/10.1016/0141-1136(87)90028-6

[6] Brožová, K., Heviánková, S., Halfar, J., Čabanová, K. and Valigůrová, A. (2025) Plastic Degradation in Aquatic Environments: A Review of Challenges and the Need for Standardized Experimental Approaches. *Frontiers in Environmental Science*, **13**, Article 1677793. https://doi.org/10.3389/fenvs.2025.1677793

[7] Sharma, D., Dhanker, R., Bhawna, Tomar, A., Raza, S. and Sharma, A. (2024) Fishing Gears and Nets as a Source of Microplastic. In: Shahnawaz, M., Adetunji, C.O., Dar, M.A., and Zhu, D., Eds., *Microplastic Pollution*, Springer, 127-140. https://doi.org/10.1007/978-981-99-8357-5_8

[8] Kum, G., Berglund, O. and Hollander, J. (2025) Lost in Definition: Unravelling Microplastics from Marine Coatings through Bibliometrics Science Mapping in Thematic Analysis and Systematic Narrative Literature Review. *Environmental Sciences Europe*, **37**, Article No. 38. https://doi.org/10.1186/s12302-025-01070-4

[9] Tamburri, M.N., Soon, Z.Y., Scianni, C., Øpstad, C.L., Oxtoby, N.S., Doran, S., *et al.* (2022) Understanding the Potential Release of Microplastics from Coatings Used on Commercial Ships. *Frontiers in Marine Science*, **9**, Article 1074654. https://doi.org/10.3389/fmars.2022.1074654

[10] Mehdinia, A., Dehbandi, R., Hamzehpour, A. and Rahnama, R. (2020) Identification of Microplastics in the Sediments of Southern Coasts of the Caspian Sea, North of Iran. *Environmental Pollution*, **258**, Article ID: 113738. https://doi.org/10.1016/j.envpol.2019.113738

[11] de Melo Nobre, F.S., Santos, A.A. and Nilin, J. (2021) What Remains on the Beach after Tourists Leave? The Case of Abaís Beach (Sergipe, Brazil). *Marine Pollution*

Bulletin, **171**, Article ID: 112700. https://doi.org/10.1016/j.marpolbul.2021.112700

[12] Mejjad, N., Rossi, A. and Pavel, A.B. (2022) The Coastal Tourism Industry in the Mediterranean: A Critical Review of the Socio-Economic and Environmental Pressures & Impacts. *Tourism Management Perspectives*, **44**, Article ID: 101007. https://doi.org/10.1016/j.tmp.2022.101007

[13] Strokal, M., Vriend, P., Bak, M.P., Kroeze, C., van Wijnen, J. and van Emmerik, T. (2023) River Export of Macro- and Microplastics to Seas by Sources Worldwide. *Nature Communications*, **14**, Article No. 4842. https://doi.org/10.1038/s41467-023-40501-9

[14] Jambeck, J.R., Geyer, R., Wilcox, C., Siegler, T.R., Perryman, M., Andrady, A., *et al.* (2015) Plastic Waste Inputs from Land into the Ocean. *Science*, **347**, 768-771. https://doi.org/10.1126/science.1260352

[15] Lebreton, L.C.M., van der Zwet, J., Damsteeg, J., Slat, B., Andrady, A. and Reisser, J. (2017) River Plastic Emissions to the World's Oceans. *Nature Communications*, **8**, Article No. 15611. https://doi.org/10.1038/ncomms15611

[16] Meijer, L.J.J., van Emmerik, T., van der Ent, R., Schmidt, C. and Lebreton, L. (2021) More than 1000 Rivers Account for 80% of Global Riverine Plastic Emissions into the Ocean. *Science Advances*, **7**, eaaz5803. https://doi.org/10.1126/sciadv.aaz5803

[17] Kushwaha, M., Shankar, S., Goel, D., Singh, S., Rahul, J., Rachna, K., *et al.* (2024) Microplastics Pollution in the Marine Environment: A Review of Sources, Impacts and Mitigation. *Marine Pollution Bulletin*, **209**, Article ID: 117109. https://doi.org/10.1016/j.marpolbul.2024.117109

[18] Cho, Y., Loh, A., Shim, W.J., Han, G.M., Ha, S.Y. and Hong, S.H. (2026) Atmospheric Deposition as a Pathway for Microplastic Transport to the Marine Environment: Temporal Variation and Environmental Factors. *Marine Pollution Bulletin*, **225**, Article ID: 119189. https://doi.org/10.1016/j.marpolbul.2025.119189

[19] Ryan, A.C., Allen, D., Allen, S., Maselli, V., LeBlanc, A., Kelleher, L., *et al.* (2023) Transport and Deposition of Ocean-Sourced Microplastic Particles by a North Atlantic Hurricane. *Communications Earth & Environment*, **4**, Article No. 442. https://doi.org/10.1038/s43247-023-01115-7

[20] Mukherjee, A., S, S.K., Singh, R., D, S., Ahn, Y. and Ray, S.S. (2025) Tracing the Footprint of Microplastics: Transport Mechanism, Degradation, and Remediation in Marine Environment. *Water, Air, & Soil Pollution*, **236**, Article No. 134. https://doi.org/10.1007/s11270-025-07751-3

[21] Li, J., Shan, E., Zhao, J., Teng, J. and Wang, Q. (2023) The Factors Influencing the Vertical Transport of Microplastics in Marine Environment: A Review. *Science of the Total Environment*, **870**, Article ID: 161893. https://doi.org/10.1016/j.scitotenv.2023.161893

[22] Zhang, Y., An, X., An, L., Tian, Y., Yao, J., Fu, H., *et al.* (2026) Marine Sediments Serving as a Primary Sink for Microplastics? *Journal of Hazardous Materials Advances*, **23**, Article ID: 101241. https://doi.org/10.1016/j.hazadv.2026.101241

[23] Allison, E.H., Perry, A.L., Badjeck, M., Neil Adger, W., Brown, K., Conway, D., *et al.* (2009) Vulnerability of National Economies to the Impacts of Climate Change on Fisheries. *Fish and Fisheries*, **10**, 173-196. https://doi.org/10.1111/j.1467-2979.2008.00310.x

[24] Golden, C.D., Allison, E.H., Cheung, W.W.L., Dey, M.M., Halpern, B.S., McCauley, D.J., *et al.* (2016) Nutrition: Fall in Fish Catch Threatens Human Health. *Nature*, **534**, 317-320. https://doi.org/10.1038/534317a

[25] African Natural Resources Centre (ANRC) (2022) The Future of Marine Fisheries in

the African Blue Economy. African Development Bank. https://www.afdb.org/sites/default/files/documents/publications/afdb_the_future_of_marine_fisheries_in_the_african_blue_economy_-_final_for_publication.pdf?utm_source=chatgpt.com

[26] FAO Regional Office for Africa (2024) FAO Report: Global Fisheries and Aquaculture Production Reaches a New Record High, Untapped Potential Remains in Africa. https://www.fao.org/africa/news-stories/news-detail/fao-report--global-fisheries-and-aquaculture-production-reaches-a-new-record-high--untapped-potential-remains-in-africa/?utm_source=chatgpt.com

[27] Wootton, N., Reis-Santos, P., Van Eck, R.A., Duke, I. and Gillanders, B.M. (2026) Microplastic Impacts on Seafood: A Global Synthesis of Experimental Findings. *Fish and Fisheries*, **27**, 591-606. https://doi.org/10.1111/faf.70071

[28] Lundebye, A., Lusher, A.L. and Bank, M.S. (2021) Marine Microplastics and Seafood: Implications for Food Security. In: Bank, M.S., Ed., *EMicroplastic in the Environment*: *Pattern and Process*, Springer, 131-153. https://doi.org/10.1007/978-3-030-78627-4_5

[29] Gune, R. and Martin, A. (2025) Microplastics in Our Diet: A Review of Food Source Contamination. *Food Control*, **178**, Article ID: 111486. https://doi.org/10.1016/j.foodcont.2025.111486

[30] Ragusa, A., Matta, M., Cristiano, L., Matassa, R., Battaglione, E., Svelato, A., *et al.* (2022) Deeply in Plasticenta: Presence of Microplastics in the Intracellular Compartment of Human Placentas. *International Journal of Environmental Research and Public Health*, **19**, Article 11593. https://doi.org/10.3390/ijerph191811593

[31] Dong, C., Xu, H., Lin, Y., Zhang, B., Yu, Z., Xie, Y., *et al.* (2024) Microplastics Detected in Three Types of Female Reproductive Organs Using Micro-Raman Spectroscopy. *Ecotoxicology and Environmental Safety*, **285**, Article ID: 117099. https://doi.org/10.1016/j.ecoenv.2024.117099

[32] Iannuzzi, G.L., D'Alto, M., Bosso, G., Montella, A.P., D'Oria, V., Pellegrino, L., *et al.* (2025) Microplastics, Nanoplastics and Heart Contamination: The Hidden Threat. *Journal of Clinical Medicine*, **14**, Article 7618. https://doi.org/10.3390/jcm14217618

[33] Nihart, A.J., Garcia, M.A., El Hayek, E., Liu, R., Olewine, M., Kingston, J.D., *et al.* (2025) Bioaccumulation of Microplastics in Decedent Human Brains. *Nature Medicine*, **31**, 1114-1119. https://doi.org/10.1038/s41591-024-03453-1

[34] Li, R., Lin, F., Zhao, X., Wang, J., Teng, M., Li, C., *et al.* (2026) Microplastics and Nanoplastics in Brain Tumours and the Healthy Human Brain. *Nature Health*, **1**, 633-646. https://doi.org/10.1038/s44360-026-00091-4

[35] Sychowski, G., Romanowicz, H., Cieślik-Wolski, B., Wojciechowska-Durczyńska, K. and Smolarz, B. (2025) Microplastics Exposure Impact on Lung Cancer—Literature Review. *Cancers*, **17**, Article 3616. https://doi.org/10.3390/cancers17223616

[36] V. L. Leonard, S., Liddle, C.R., Atherall, C.A., Chapman, E., Watkins, M., D. J. Calaminus, S., *et al.* (2024) Microplastics in Human Blood: Polymer Types, Concentrations and Characterisation Using μFTIR. *Environment International*, **188**, Article ID: 108751. https://doi.org/10.1016/j.envint.2024.108751

[37] Ali, N., Katsouli, J., Marczylo, E.L., Gant, T.W., Wright, S. and Bernardino de la Serna, J. (2024) The Potential Impacts of Micro-and-Nano Plastics on Various Organ Systems in Humans. *eBioMedicine*, **99**, Article ID: 104901. https://doi.org/10.1016/j.ebiom.2023.104901

[38] Cheng, Y., Yang, Y., Bai, L. and Cui, J. (2024) Microplastics: An Often-Overlooked Issue in the Transition from Chronic Inflammation to Cancer. *Journal of Transla-*

tional Medicine, **22**, Article No. 959. https://doi.org/10.1186/s12967-024-05731-5

[39] Vanetti, C., Broggiato, M., Pezzana, S., Clerici, M. and Fenizia, C. (2025) Effects of Microplastics on the Immune System: How Much Should We Worry? *Immunology Letters*, **272**, Article ID: 106976. https://doi.org/10.1016/j.imlet.2025.106976

[40] Prattichizzo, F., Ceriello, A., Pellegrini, V., La Grotta, R., Graciotti, L., Olivieri, F., *et al*. (2024) Micro-Nanoplastics and Cardiovascular Diseases: Evidence and Perspectives. *European Heart Journal*, **45**, 4099-4110. https://doi.org/10.1093/eurheartj/ehae552

[41] Bardawil, C.E., Dobbins, J., Lankford, S., Soloff, A.C. and Dhupar, R. (2026) Micro- and Nanoplastics and Pulmonary Health: The Current State of Research. *Microplastics*, **5**, Article 29. https://doi.org/10.3390/microplastics5010029

[42] Lu, L., Wan, Z., Luo, T., Fu, Z. and Jin, Y. (2018) Polystyrene Microplastics Induce Gut Microbiota Dysbiosis and Hepatic Lipid Metabolism Disorder in Mice. *Science of the Total Environment*, **631**, 449-458. https://doi.org/10.1016/j.scitotenv.2018.03.051

[43] (2026) Plastic Pollution by Country 2026. World Population Review. https://worldpopulationreview.com/country-rankings/plastic-pollution-by-country

[44] Wang, J., Bucci, K., Helm, P.A., Hoellein, T., Hoffman, M.J., Rooney, R., *et al*. (2022) Runoff and Discharge Pathways of Microplastics into Freshwater Ecosystems: A Systematic Review and Meta-Analysis. *FACETS*, **7**, 1473-1492. https://doi.org/10.1139/facets-2022-0140

[45] Wang, C., O'Connor, D., Wang, L., Wu, W., Luo, J. and Hou, D. (2022) Microplastics in Urban Runoff: Global Occurrence and Fate. *Water Research*, **225**, Article ID: 119129. https://doi.org/10.1016/j.watres.2022.119129

[46] Ryan, P.G. and Jackson, S. (1987) The Lifespan of Ingested Plastic Particles in Seabirds and Their Effect on Digestive Efficiency. *Marine Pollution Bulletin*, **18**, 217-219. https://doi.org/10.1016/0025-326x(87)90461-9

[47] Ryan, P.G. (1988) The Characteristics and Distribution of Plastic Particles at the Sea-Surface off the Southwestern Cape Province, South Africa. *Marine Environmental Research*, **25**, 249-273. https://doi.org/10.1016/0141-1136(88)90015-3

[48] Ryan, P.G. and Moloney, C.L. (1990) Plastic and Other Artefacts on South African Beaches: Temporal Trends in Abundance and Composition. *South African Journal of Science*, **86**, 450-452.

[49] Ryan, P.G. (2015) A Brief History of Marine Litter Research. In: Bergmann, M., Gutow, L. and Klages, M., Eds., *Marine Anthropogenic Litter*, Springer, 1-25. https://doi.org/10.1007/978-3-319-16510-3_1

[50] Verster, C., Minnaar, K. and Bouwman, H. (2017) Marine and Freshwater Microplastic Research in South Africa. *Integrated Environmental Assessment and Management*, **13**, 533-535. https://doi.org/10.1002/ieam.1900

[51] Mokgalaka-Fleischmann, N.S., Melato, F.A., Netshiongolwe, K., Izevbekhai, O.U., Lepule, S.P., Motsepe, K., *et al*. (2024) Microplastic Occurrence and Fate in the South African Environment: A Review. *Environmental Systems Research*, **13**, Article No. 59. https://doi.org/10.1186/s40068-024-00389-w

[52] Pereao, O., Opeolu, B. and Fatoki, O. (2020) Microplastics in Aquatic Environment: Characterization, Ecotoxicological Effect, Implications for Ecosystems and Developments in South Africa. *Environmental Science and Pollution Research*, **27**, 22271-22291. https://doi.org/10.1007/s11356-020-08688-2

[53] Mvovo, I. (2021) A Comprehensive Review on Micro-Plastic Pollution in African

Aquatic Systems. *Environmental Advances*, **5**, Article ID: 100107. https://doi.org/10.1016/j.envadv.2021.100107

[54] Aragaw, T.A. (2021) Microplastic Pollution in African Countries' Water Systems: A Review on Findings, Applied Methods, Characteristics, Impacts, and Managements. *SN Applied Sciences*, **3**, Article No. 629. https://doi.org/10.1007/s42452-021-04619-z

[55] Moto, E., Hossein, M., Bakari, R., Mateso, A.S., Selemani, J.R., Nkrumah, S., *et al.* (2024) Ecological Consequences of Microplastic Pollution in Sub-Saharan Africa Aquatic Ecosystems: An Implication to Environmental Health. *HydroResearch*, **7**, 39-54. https://doi.org/10.1016/j.hydres.2023.11.003

[56] Nyaga, M.P., Shabaka, S., Oh, S., Osman, D.M., Yuan, W., Zhang, W., *et al.* (2024) Microplastics in Aquatic Ecosystems of Africa: A Comprehensive Review and Meta-Analysis. *Environmental Research*, **248**, Article ID: 118307. https://doi.org/10.1016/j.envres.2024.118307

[57] Asori, M., Dogbey, E., Ampofo, S.T. and Odei, J. (2023) Microplastic Pollution in Africa: An Overview of Abundance in Aquatic Organisms, Freshwater and Marine Water Environments and Analytical Methods for Reporting. *Management of Environmental Quality*: *An International Journal*, **35**, 634-652. https://doi.org/10.1108/meq-06-2023-0170

[58] Thiemann, T. (2025) A Review on Microplastics in Offshore and Nearshore Waters. *Journal of Water Resource and Protection*, **17**, 159-195. https://doi.org/10.4236/jwarp.2025.173009

[59] https://citypopulation.de/en/world/agglomerations/

[60] Millot, C. and Taupier-Letage, I. (2005) Circulation in the Mediterranean Sea. In: Saliot, A., Ed., *The Mediterranean Sea*, Springer, 29-66. https://doi.org/10.1007/b107143

[61] Akpoti, K., Velpuri, N.M., Mizukami, N., Kagone, S., Leh, M., Mekonnen, K., *et al.* (2024) Advancing Water Security in Africa with New High-Resolution Discharge Data. *Scientific Data*, **11**, Article No. 1195. https://doi.org/10.1038/s41597-024-04034-0

[62] Andersen, R., Harsaae, A.L., Kellner, A., Smyth, A., Westermann, T.A.R., Green, M., *et al.* (2024) Abundance, Distribution and Characteristics of Microplastics in the North and South Atlantic Ocean. *Marine Pollution Bulletin*, **209**, Article ID: 117217. https://doi.org/10.1016/j.marpolbul.2024.117217

[63] Awosika, L., Folorunsho, R. and Imovbore, V. (2013) Morphodynamics and Features of Littoral Cell Circulation Observed from Sequential Aerial Photographs and Davies Drifter along a Section of the Strand Coast East of the Niger Delta, Nigeria. *Journal of Oceanography and Marine Science*, **4**, 12-18. https://doi.org/10.5897/joms09.011

[64] Popoola, S.O., Oyatola, O.O., Hamzat, A.B., Adegbite, A.A., Shelle, R.O.D., Ayoola, N.O., *et al.* (2026) Microplastic Distributions, Bioaccumulation, and Ecological Risk in Brackish and Freshwater Creeks off the Gulf of Guinea. *Estuarine*, *Coastal and Shelf Science*, **340**, Article ID: 110029. https://doi.org/10.1016/j.ecss.2026.110029

[65] Obiefuna, J., Adeaga, O., Omojola, A., Atagbaza, A. and Okolie, C. (2021) Flood Risks to Urban Development on a Coastal Barrier Landscape of Lekki Peninsula in Lagos, Nigeria. *Scientific African*, **12**, e00787. https://doi.org/10.1016/j.sciaf.2021.e00787

[66] van der Lingen, C. and Huggett, J. (2003) The Role of Ichthyoplankton Surveys in Recruitment Research and Management of South African Anchovy and Sardine. *Proceedings of the* 26*th Annual Larval Fish Conference*, Os, 22-26 July 2003, 303-343.

[67] Collins, C. and Hermes, J.C. (2019) Modelling the Accumulation and Transport of Floating Marine Micro-Plastics around South Africa. *Marine Pollution Bulletin*, **139**,

46-58. https://doi.org/10.1016/j.marpolbul.2018.12.028

[68] Ryan, P.G. (2014) Litter Survey Detects the South Atlantic 'Garbage Patch'. *Marine Pollution Bulletin*, **79**, 220-224. https://doi.org/10.1016/j.marpolbul.2013.12.010

[69] Chassignet, E.P., Xu, X. and Zavala-Romero, O. (2021) Tracking Marine Litter with a Global Ocean Model: Where Does It Go? Where Does It Come from? *Frontiers in Marine Science*, **8**, Article 667591. https://doi.org/10.3389/fmars.2021.667591

[70] Vogt-Vincent, N.S., Burt, A.J., Kaplan, D.M., Mitarai, S., Turnbull, L.A. and Johnson, H.L. (2023) Sources of Marine Debris for Seychelles and Other Remote Islands in the Western Indian Ocean. *Marine Pollution Bulletin*, **187**, Article ID: 114497. https://doi.org/10.1016/j.marpolbul.2022.114497

[71] Duhec, A.V., Jeanne, R.F., Maximenko, N. and Hafner, J. (2015) Composition and Potential Origin of Marine Debris Stranded in the Western Indian Ocean on Remote Alphonse Island, Seychelles. *Marine Pollution Bulletin*, **96**, 76-86. https://doi.org/10.1016/j.marpolbul.2015.05.042

[72] Pu, S., Bushnaq, H., Munro, C., Gibert, Y., Sharma, R., Mishra, V., *et al.* (2024) Perspectives on Transport Pathways of Microplastics across the Middle East and North Africa (MENA) Region. *npj Clean Water*, **7**, Article No. 114. https://doi.org/10.1038/s41545-024-00410-w

[73] Barbariol, F., Davison, S., Falcieri, F.M., Ferretti, R., Ricchi, A., Sclavo, M., *et al.* (2021) Wind Waves in the Mediterranean Sea: An ERA5 Reanalysis Wind-Based Climatology. *Frontiers in Marine Science*, **8**, Article 760614. https://doi.org/10.3389/fmars.2021.760614

[74] Sayed, A.E.H., Hamed, M., Badrey, A.E.A., Ismail, R.F., Osman, Y.A.A., Osman, A.G.M., *et al.* (2021) Microplastic Distribution, Abundance, and Composition in the Sediments, Water, and Fishes of the Red and Mediterranean Seas, Egypt. *Marine Pollution Bulletin*, **173**, Article ID: 112966. https://doi.org/10.1016/j.marpolbul.2021.112966

[75] Kanhai, L.D.K., Officer, R., Lyashevska, O., Thompson, R.C. and O'Connor, I. (2017) Microplastic Abundance, Distribution and Composition along a Latitudinal Gradient in the Atlantic Ocean. *Marine Pollution Bulletin*, **115**, 307-314. https://doi.org/10.1016/j.marpolbul.2016.12.025

[76] Suaria, G., Cappa, P., Perold, V., Aliani, S. and Ryan, P.G. (2023) Abundance and Composition of Small Floating Plastics in the Eastern and Southern Sectors of the Atlantic Ocean. *Marine Pollution Bulletin*, **193**, Article ID: 115109. https://doi.org/10.1016/j.marpolbul.2023.115109

[77] Hildebrandt, L., El Gareb, F., Zimmermann, T., Klein, O., Kerstan, A., Emeis, K., *et al.* (2022) Spatial Distribution of Microplastics in the Tropical Indian Ocean Based on Laser Direct Infrared Imaging and Microwave-Assisted Matrix Digestion. *Environmental Pollution*, **307**, Article ID: 119547. https://doi.org/10.1016/j.envpol.2022.119547

[78] Al Hashmi, A.H., Thankamony, R., Al Hammadi, H.A., Thiemann, T. and Siddiqui, A. (2026) First Expedition Jaywun Research Vessel: Assessment of Microplastics from International Waters, Spain to Abu Dhabi, U.A.E. *Frontiers in Marine Science*, **13**, Article 1856396. https://doi.org/10.3389/fmars.2026.1856396

[79] Shabaka, S.H., Ghobashy, M. and Marey, R.S. (2019) Identification of Marine Microplastics in Eastern Harbor, Mediterranean Coast of Egypt, Using Differential Scanning Calorimetry. *Marine Pollution Bulletin*, **142**, 494-503. https://doi.org/10.1016/j.marpolbul.2019.03.062

[80] Kateesh, M., A. Temraz, T., Khattab, R.A., El-Sherbiny, M.M. and Ali, I. (2026) Anal-

ysis of Microplastic Contamination in Water, Sediment, and Fish on the Northeastern Coast of Libya. *Analytica*, **7**, Article 58. https://doi.org/10.3390/analytica7030058

[81] Abidli, S., Antunes, J.C., Ferreira, J.L., Lahbib, Y., Sobral, P. and Trigui El Menif, N. (2018) Microplastics in Sediments from the Littoral Zone of the North Tunisian Coast (Mediterranean Sea). *Estuarine, Coastal and Shelf Science*, **205**, 1-9. https://doi.org/10.1016/j.ecss.2018.03.006

[82] Abidli, S., Toumi, H., Lahbib, Y. and Trigui El Menif, N. (2017) The First Evaluation of Microplastics in Sediments from the Complex Lagoon-Channel of Bizerte (Northern Tunisia). *Water, Air, & Soil Pollution*, **228**, Article No. 262. https://doi.org/10.1007/s11270-017-3439-9

[83] Missawi, O., Bousserrhine, N., Belbekhouche, S., Zitouni, N., Alphonse, V., Boughattas, I., *et al.* (2020) Abundance and Distribution of Small Microplastics (≤ 3μm) in Sediments and Seaworms from the Southern Mediterranean Coasts and Characterisation of Their Potential Harmful Effects. *Environmental Pollution*, **263**, Article ID: 114634. https://doi.org/10.1016/j.envpol.2020.114634

[84] Toumi, H., Abidli, S. and Bejaoui, M. (2019) Microplastics in Freshwater Environment: The First Evaluation in Sediments from Seven Water Streams Surrounding the Lagoon of Bizerte (Northern Tunisia). *Environmental Science and Pollution Research*, **26**, 14673-14682. https://doi.org/10.1007/s11356-019-04695-0

[85] Chouchene, K., da Costa, J.P., Wali, A., Girão, A.V., Hentati, O., Duarte, A.C., *et al.* (2019) Microplastic Pollution in the Sediments of Sidi Mansour Harbor in Southeast Tunisia. *Marine Pollution Bulletin*, **146**, 92-99. https://doi.org/10.1016/j.marpolbul.2019.06.004

[86] Setiti, S., Hamdi, B., Chernai, S., Houma Bachari, F., Bachouche, S., Ghezali, Y., *et al.* (2021) Seasonal Variation of Microplastics Density in Algerian Surface Waters (South-Western Mediterranean Sea). *Mediterranean Marine Science*, **22**, 317-326. https://doi.org/10.12681/mms.24899

[87] Taïbi, N., Bentaallah, M.E.A., Alomar, C., Compa, M. and Deudero, S. (2021) Micro- and Macro-Plastics in Beach Sediment of the Algerian Western Coast: First Data on Distribution, Characterization, and Source. *Marine Pollution Bulletin*, **165**, Article ID: 112168. https://doi.org/10.1016/j.marpolbul.2021.112168

[88] Tata, T., Belabed, B.E., Bououdina, M. and Bellucci, S. (2020) Occurrence and Characterization of Surface Sediment Microplastics and Litter from North African Coasts of Mediterranean Sea: Preliminary Research and First Evidence. *Science of the Total Environment*, **713**, Article ID: 136664. https://doi.org/10.1016/j.scitotenv.2020.136664

[89] Bouadil, O., Benomar, M., El Ouarghi, H., Aboulhassan, M.A. and Benbrahim, S. (2024) Identification and Quantification of Microplastics in Surface Water of a Southwestern Mediterranean Bay (Al Hoceima, Morocco). *Waste Management Bulletin*, **2**, 142-151. https://doi.org/10.1016/j.wmb.2024.01.003

[90] Abelouah, M.R., Ben-Haddad, M., Alla, A.A. and Rangel-Buitrago, N. (2021) Marine Litter in the Central Atlantic Coast of Morocco. *Ocean & Coastal Management*, **214**, Article ID: 105940. https://doi.org/10.1016/j.ocecoaman.2021.105940

[91] Ben-Haddad, M., Abelouah, M.R., Hajji, S., Rangel-Buitrago, N., Hamadi, F. and Alla, A.A. (2022) Microplastics Pollution in Sediments of Moroccan Urban Beaches: The Taghazout Coast as a Case Study. *Marine Pollution Bulletin*, **180**, Article ID: 113765. https://doi.org/10.1016/j.marpolbul.2022.113765

[92] Abelouah, M.R., Ben-Haddad, M., Rangel-Buitrago, N., Hajji, S., El Alem, N. and Ait Alla, A. (2022) Microplastics Pollution along the Central Atlantic Coastline of Mo-

rocco. *Marine Pollution Bulletin*, **174**, Article ID: 113190.
https://doi.org/10.1016/j.marpolbul.2021.113190

[93] Haddout, S., Gimiliani, G.T., Priya, K.L., Hoguane, A.M., Casila, J.C.C. and Ljubenkov, I. (2021) Microplastics in Surface Waters and Sediments in the Sebou Estuary and Atlantic Coast, Morocco. *Analytical Letters*, **55**, 256-268.
https://doi.org/10.1080/00032719.2021.1924767

[94] Lourenço, P.M., Serra-Gonçalves, C., Ferreira, J.L., Catry, T. and Granadeiro, J.P. (2017) Plastic and Other Microfibers in Sediments, Macroinvertebrates and Shorebirds from Three Intertidal Wetlands of Southern Europe and West Africa. *Environmental Pollution*, **231**, 123-133. https://doi.org/10.1016/j.envpol.2017.07.103

[95] Sonko, A., Brehmer, P., Constantin de Magny, G., Pennec, G.L., Ba, B.S., Diankha, O., *et al.* (2023) Pollution Assessment around a Big City in West Africa Reveals High Concentrations of Microplastics and Microbiologic Contamination. *Regional Studies in Marine Science*, **59**, Article ID: 102755.
https://doi.org/10.1016/j.rsma.2022.102755

[96] Tavares, D.C., Moura, J.F., Ceesay, A. and Merico, A. (2020) Density and Composition of Surface and Buried Plastic Debris in Beaches of Senegal. *Science of the Total Environment*, **737**, Article ID: 139633.
https://doi.org/10.1016/j.scitotenv.2020.139633

[97] Hosoda, J., Ofosu-Anim, J., Sabi, E.B., Akita, L.G., Onwona-Agyeman, S., Yamashita, R., *et al.* (2014) Monitoring of Organic Micropollutants in Ghana by Combination of Pellet Watch with Sediment Analysis: E-Waste as a Source of PCBs. *Marine Pollution Bulletin*, **86**, 575-581. https://doi.org/10.1016/j.marpolbul.2014.06.008

[98] Nuamah, F., Tulashie, S.K. and Debrah, J.S. (2022) Assessing Contamination of Microplastics in the Ghanaian Coastal Sea Using a Self-Constructed LADI Trawl. *Marine Pollution Bulletin*, **182**, Article ID: 114006.
https://doi.org/10.1016/j.marpolbul.2022.114006

[99] Nuamah, F., Tulashie, S.K., Debrah, J.S. and Pèlèbè, R.O.E. (2023) Microplastics in the Gulf of Guinea: An Analysis of Concentrations and Distribution in Sediments, Gills, and Guts of Fish Collected off the Coast of Ghana. *Environmental Research*, **234**, Article ID: 116567. https://doi.org/10.1016/j.envres.2023.116567

[100] Faseyi, C.A., Miyittah, M.K., Yafetto, L., Sowunmi, A.A. and Lutterodt, G. (2022) Pollution Fingerprinting of Two Southwestern Estuaries in Ghana. *Heliyon*, **8**, e10337.
https://doi.org/10.1016/j.heliyon.2022.e10337

[101] Chico-Ortiz, N., Mahu, E., Crane, R., Gordon, C. and Marchant, R. (2020) Microplastics in Ghanaian Coastal Lagoon Sediments: Their Occurrence and Spatial Distribution. *Regional Studies in Marine Science*, **40**, Article ID: 101509.
https://doi.org/10.1016/j.rsma.2020.101509

[102] Aziade, K.C.M., Bodjona, B.M., Alonso-Hernandez, C.M., Tchegueni, S., Metian, M., Hazou, E., Mora, J., Bernard, N. and Tchangbedji, G. (2026) Assessment of Micro-Plastic Particles (0.3-5 mm) in the Sand of Togo's Beaches. *Journal of Chemical, Biological and Physical Sciences*, **16**, 463-475.

[103] Fred-Ahmadu, O.H., Ayejuyo, O.O. and Benson, N.U. (2020) Microplastics Distribution and Characterization in Epipsammic Sediments of Tropical Atlantic Ocean, Nigeria. *Regional Studies in Marine Science*, **38**, Article ID: 101365.
https://doi.org/10.1016/j.rsma.2020.101365

[104] Olarinmoye, O.M., Stock, F., Scherf, N., Whenu, O., Asenime, C. and Ganzallo, S. (2020) Microplastic Presence in Sediment and Water of a Lagoon Bordering the Urban Agglomeration of Lagos, Southwest Nigeria. *Geosciences*, **10**, Article 494.

https://doi.org/10.3390/geosciences10120494

[105] Akinhanmi, F.O., Ayanda, O.I. and Dedeke, G.A. (2023) Occurrence and Characteristics of Microplastics in the Surface Water and Sediment of Lagos Lagoon, Nigeria. In: Isibor, P.O., Akinduti, P., Oranusi, S.U. and Popoola, J.O., Eds., *Biotechnological Approaches to Sustainable Development Goals*, Springer, 103-118. https://doi.org/10.1007/978-3-031-33370-5_7

[106] Dada, O.A. and Bello, J.O. (2023) Microplastics in Carnivorous Fish Species, Water and Sediments of a Coastal Urban Lagoon in Nigeria. *Environmental Science and Pollution Research*, **30**, 55948-55957. https://doi.org/10.1007/s11356-023-26410-w

[107] Yakub, A.S., Bassey, B.O., Bello, A.I., Bello, B.O., Olapoju, O.A., Agwu, O.A., *et al.* (2024) Eco-Toxic Risk Assessment of Microplastics in Water and Sediment across Nigeria Offshore, Gulf of Guinea. *Environmental Monitoring and Assessment*, **196**, Article No. 906. https://doi.org/10.1007/s10661-024-13021-2

[108] Yahaya, T., Abdulazeez, A., Oladele, E.O., Williams, E.F., Obadiah, C.D., Umar, J. and Salisu, N. (2022) Microplastics Abundance, Characteristics, and Risk in Badagry Lagoon in Lagos State, Nigeria. *Pollution*, **8**, 1325-1337. https://doi.org/10.22059/poll.2022.342499.1462

[109] Ndumbe, E.E., Manga, V.E., Foba, J.T. and Yengong, F.L. (2023) Quantitative Analysis of the Sized Ranged Plastic Debris on Beach Shoreline along the Limbe Coastline, Cameroon. *Journal of Environmental Protection*, **14**, 441-469. https://doi.org/10.4236/jep.2023.146026

[110] Ryan, P.G., Perold, V., Osborne, A. and Moloney, C.L. (2018) Consistent Patterns of Debris on South African Beaches Indicate That Industrial Pellets and Other Mesoplastic Items Mostly Derive from Local Sources. *Environmental Pollution*, **238**, 1008-1016. https://doi.org/10.1016/j.envpol.2018.02.017

[111] Chitaka, T.Y. and von Blottnitz, H. (2019) Accumulation and Characteristics of Plastic Debris along Five Beaches in Cape Town. *Marine Pollution Bulletin*, **138**, 451-457. https://doi.org/10.1016/j.marpolbul.2018.11.065

[112] Lamprecht, A. (2013) The Abundance, Distribution and Accumulation of Plastic Debris in Table Bay, Cape Town, South Africa. Master's Thesis, University of Cape Town, 1-52.

[113] Nel, H.A. and Froneman, P.W. (2015) A Quantitative Analysis of Microplastic Pollution along the South-Eastern Coastline of South Africa. *Marine Pollution Bulletin*, **101**, 274-279. https://doi.org/10.1016/j.marpolbul.2015.09.043

[114] Vetrimurugan, E., Jonathan, M.P., Sarkar, S.K., Rodríguez-González, F., Roy, P.D., Velumani, S., *et al.* (2020) Occurrence, Distribution and Provenance of Micro Plastics: A Large Scale Quantitative Analysis of Beach Sediments from Southeastern Coast of South Africa. *Science of the Total Environment*, **746**, Article ID: 141103. https://doi.org/10.1016/j.scitotenv.2020.141103

[115] Boshoff, B.J., Hull, K.L. and von der Heyden, S. (2025) The Interaction between Seagrass Meadow Density and Microplastic Retention in Four Cool-Temperate Estuaries. *Marine Pollution Bulletin*, **212**, Article ID: 117502. https://doi.org/10.1016/j.marpolbul.2024.117502

[116] Boshoff, B.J., Robinson, T.B. and von der Heyden, S. (2023) The Role of Seagrass Meadows in the Accumulation of Microplastics: Insights from a South African Estuary. *Marine Pollution Bulletin*, **186**, Article ID: 114403. https://doi.org/10.1016/j.marpolbul.2022.114403

[117] de Villiers, S. (2018) Quantification of Microfibre Levels in South Africa's Beach Sediments, and Evaluation of Spatial and Temporal Variability from 2016 to 2017. *Ma-*

rine Pollution Bulletin, **135**, 481-489.
https://doi.org/10.1016/j.marpolbul.2018.07.058

[118] Naidoo, T., Glassom, D. and Smit, A.J. (2015) Plastic Pollution in Five Urban Estuaries of Kwazulu-Natal, South Africa. *Marine Pollution Bulletin*, **101**, 473-480. https://doi.org/10.1016/j.marpolbul.2015.09.044

[119] Preston-Whyte, F., Silburn, B., Meakins, B., Bakir, A., Pillay, K., Worship, M., *et al.* (2021) Meso- and Microplastics Monitoring in Harbour Environments: A Case Study for the Port of Durban, South Africa. *Marine Pollution Bulletin*, **163**, Article ID: 111948. https://doi.org/10.1016/j.marpolbul.2020.111948

[120] Nel, H.A., Hean, J.W., Noundou, X.S. and Froneman, P.W. (2017) Do Microplastic Loads Reflect the Population Demographics along the Southern African Coastline? *Marine Pollution Bulletin*, **115**, 115-119. https://doi.org/10.1016/j.marpolbul.2016.11.056

[121] Naidoo, T. and Glassom, D. (2019) Decreased Growth and Survival in Small Juvenile Fish, after Chronic Exposure to Environmentally Relevant Concentrations of Microplastic. *Marine Pollution Bulletin*, **145**, 254-259. https://doi.org/10.1016/j.marpolbul.2019.02.037

[122] Vilakati, B., Sivasankar, V., Mamba, B.B., Omine, K. and Msagati, T.A.M. (2020) Characterization of Plastic Micro Particles in the Atlantic Ocean Seashore of Cape Town, South Africa and Mass Spectrometry Analysis of Pyrolyzate Products. *Environmental Pollution*, **265**, Article ID: 114859. https://doi.org/10.1016/j.envpol.2020.114859

[123] Govender, J., Naidoo, T., Rajkaran, A., Cebekhulu, S., Bhugeloo, A. and Sershen, S. (2020) Towards Characterising Microplastic Abundance, Typology and Retention in Mangrove-Dominated Estuaries. *Water*, **12**, Article 2802. https://doi.org/10.3390/w12102802

[124] Ryan, P.G. (2020) The Transport and Fate of Marine Plastics in South Africa and Adjacent Oceans. *South African Journal of Science*, **116**, Article No. 7677. https://doi.org/10.17159/sajs.2020/7677

[125] Karlsson, M. (2015) Identifying the Presence of Microplastics in Maputo Bay- Quantifying Microplastic Debris in a Field Setting. Bachelor Thesis, University of Gothenburg, 26 p. https://doi.org/10.13140/RG.2.2.30149.96482

[126] Browne, M.A., Crump, P., Niven, S.J., Teuten, E., Tonkin, A., Galloway, T., *et al.* (2011) Accumulation of Microplastic on Shorelines Woldwide: Sources and Sinks. *Environmental Science & Technology*, **45**, 9175-9179. https://doi.org/10.1021/es201811s

[127] Barnes, D.K.A. (2004) Natural and Plastic Flotsam Stranding in the Indian Ocean. In: Davenport, J. and Davenport, J.L., Eds., *The Effects of Human Transport on Ecosystems*: *Cars and Planes*, *Boats and Trains*, The Royal Irish Academy, 193-205.

[128] Nchimbi, A.A., Shilla, D.A., Kosore, C.M., Shilla, D.J., Shashoua, Y. and Khan, F.R. (2022) Microplastics in Marine Beach and Seabed Sediments along the Coasts of Dar Es Salaam and Zanzibar in Tanzania. *Marine Pollution Bulletin*, **185**, Article ID: 114305. https://doi.org/10.1016/j.marpolbul.2022.114305

[129] Mayoma, B.S., Nkini, G., Rubekie, A.P. and Limbu, S.M. (2026) First Evidence of Anthropogenic Activity Contribution to Spatial Abundance and Characteristics of Microplastics in Selected Urban Shores of Lake Tanganyika. *Soil and Sediment Contamination*: *An International Journal*. https://doi.org/10.1080/15320383.2026.2650569

[130] Balasubramanian, M. and Phillott, A.D. (2016) Preliminary Observations of Micro-

Plastics from Beaches in the Indian Ocean. *Indian Ocean Turtle Newsletter*, **23**, 13-16. https://www.iotn.org/wp-content/uploads/2017/05/23-05-PRELIMINARY-OBSERVATIONS-OF-MICROPLASTICS-FROM-BEACHES-IN-THE-INDIAN-OCEAN.pdf

[131] Kerubo, J.O., Muthumbi, A.W., Onyari, J.M., Kimani, E.N. and Robertson-Andersson, D. (2021) Microplastic Pollution in the Surface Waters of Creeks along the Kenyan Coast, Western Indian Ocean (WIO). *Western Indian Ocean Journal of Marine Science*, **19**, 75-88. https://doi.org/10.4314/wiojms.v19i2.6

[132] Kerubo, J.O., Onyari, J.M., Muthumbi, A.W.N., Andersson, D.R. and Kimani, E.N. (2021) Microplastic Polymers in Surface Waters and Sediments in the Creeks along the Kenya Coast, Western Indian Ocean (WIO). *European Journal of Sustainable Development Research*, **6**, em0177. https://doi.org/10.21601/ejosdr/11433

[133] Kosore, C.M., Ojwang, L., Maghanga, J., Kamau, J., Shilla, D., Everaert, G., *et al.* (2022) Microplastics in Kenya's Marine Nearshore Surface Waters: Current Status. *Marine Pollution Bulletin*, **179**, Article ID: 113710. https://doi.org/10.1016/j.marpolbul.2022.113710

[134] Okuku, E.O., Kombo, M., Mwalugha, C., Owato, G., Otieno, K., Mbuche, M., *et al.* (2023) Are Tropical Mangroves a Sink for Litter Leaking from Land- and Sea-Based Sources? Evidence from Selected Kenyan Mangroves. *Marine Pollution Bulletin*, **187**, Article ID: 114590. https://doi.org/10.1016/j.marpolbul.2023.114590

[135] KeChi-Okafor, C., Khan, F.R., Al-Naimi, U., Béguerie, V., Bowen, L., Gallidabino, M.D., *et al.* (2023) Prevalence and Characterisation of Microfibres along the Kenyan and Tanzanian Coast. *Frontiers in Ecology and Evolution*, **11**, Article 1020919. https://doi.org/10.3389/fevo.2023.1020919

[136] Weideman, E.A., Perold, V., Donnarumma, V., Suaria, G. and Ryan, P.G. (2023) Proximity to Coast and Major Rivers Influence the Density of Floating Microplastics and Other Litter in East African Coastal Waters. *Marine Pollution Bulletin*, **188**, Article ID: 114644. https://doi.org/10.1016/j.marpolbul.2023.114644

[137] Ibrahim, E.A.A., Rahim Osman, N.A. and Eisa, O.A.M. (2020) Status of the Beach Litter in the UNESCO World Heritage Site of Dungonab and Mukkawar Island Marine National Park in Sudan, Red Sea. *International Journal of Ecology*, **2020**, Article ID: 6904745. https://doi.org/10.1155/2020/6904745

[138] Salah, M., Li, N., Liu, X., Zhong, B., Rehman, A., Mei, X., *et al.* (2026) Elevated Microplastic Pollution in Bays Compared to Open Coastlines: Initial Assessment from Port Sudan, Sudan's Red Sea. *Regional Studies in Marine Science*, **101**, Article ID: 105297. https://doi.org/10.1016/j.rsma.2026.105297

[139] Mulochau, T., Lelabousse, C. and Séré, M. (2020) Estimations of Densities of Marine Litter on the Fringing Reefs of Mayotte (France—South Western Indian Ocean)—Impacts on Coral Communities. *Marine Pollution Bulletin*, **160**, Article ID: 111643. https://doi.org/10.1016/j.marpolbul.2020.111643

[140] Dunlop, S.W., Dunlop, B.J. and Brown, M. (2020) Plastic Pollution in Paradise: Daily Accumulation Rates of Marine Litter on Cousine Island, Seychelles. *Marine Pollution Bulletin*, **151**, Article ID: 110803. https://doi.org/10.1016/j.marpolbul.2019.110803

[141] Burt, A.J., Raguain, J., Sanchez, C., Brice, J., Fleischer-Dogley, F., Goldberg, R., *et al.* (2020) The Costs of Removing the Unsanctioned Import of Marine Plastic Litter to Small Island States. *Scientific Reports*, **10**, Article No. 14458. https://doi.org/10.1038/s41598-020-71444-6

[142] Boodhoo, K., Ramessur, R.T., Namah, O. and Bhandu, P.L. (2022) A Quantitative

and Qualitative Assessment of Microplastics Collected at Two Public Beaches along the East and South-East Coast of Mauritius. *Environmental Monitoring and Assessment*, **194**, Article No. 640. https://doi.org/10.1007/s10661-022-10269-4

[143] Mattan-Moorgawa, S., Chockalingum, J. and Appadoo, C. (2021) A First Assessment of Marine Meso-Litter and Microplastics on Beaches: Where Does Mauritius Stand? *Marine Pollution Bulletin*, **173**, Article ID: 112941. https://doi.org/10.1016/j.marpolbul.2021.112941

[144] Seeruttun, L.D., Raghbor, P. and Appadoo, C. (2021) First Assessment of Anthropogenic Marine Debris in Mangrove Forests of Mauritius, a Small Oceanic Island. *Marine Pollution Bulletin*, **164**, Article ID: 112019. https://doi.org/10.1016/j.marpolbul.2021.112019

[145] Sohou, Z. and Abrokwah, S. (2025) The Impact of Marine Litter on the Beach Seine Fishery of Four Countries in the Gulf of Guinea: Benin, Côte d'Ivoire, Ghana and Togo—A Preliminary Investigation of the Social and Economic Impacts of Marine Litter on Fishing Communities [L'impact des déchets marins sur la pêche à la senne de plage de quatre pays dans le Golfe de Guinée: Bénin, Côte d'Ivoire, Ghana et Togo. Une étude préliminaire des impacts sociaux et économiques des déchetsmarins sur les communautés de pêcheurs]. FAO EAF-Nansen Programme, Report/FAO Programme EAF-Nansen, Rapport No./n° 76. https://doi.org/10.4060/cd5392b

[146] De Villiers, S. (2019) Short Communication: Microfibre Pollution Hotspots in River Sediments Adjacent to South Africa's Coastline. *Water SA*, **45**. https://doi.org/10.4314/wsa.v45i1.11

[147] Ferguson, L., Awe, A. and Sparks, C. (2024) Microplastic Concentrations and Risk Assessment in Water, Sediment and Invertebrates from Simon's Town, South Africa. *Heliyon*, **10**, e28514. https://doi.org/10.1016/j.heliyon.2024.e28514

[148] Sparks, C., Viljoen, N., Hill, D., Lassen, J. and Awe, A. (2023) Characteristics and Risk Assessment of Microplastics in Water and Mussels Sampled from Cape Town Harbour and Two Oceans Aquarium, South Africa. *Bulletin of Environmental Contamination and Toxicology*, **110**, Article No. 104. https://doi.org/10.1007/s00128-023-03737-1

[149] Mofokeng, R.P. and Glassom, D. (2025) Assessment of Microplastic and Heavy Metal Contamination in Durban Harbour Sediments: Ecological Implications for Grandidierella Lignorum. *Microplastics*, **4**, Article 74. https://doi.org/10.3390/microplastics4040074

[150] Wakkaf, T., El Zrelli, R., Kedzierski, M., Balti, R., Shaiek, M., Mansour, L., *et al.* (2020) Characterization of Microplastics in the Surface Waters of an Urban Lagoon (Bizerte Lagoon, Southern Mediterranean Sea): Composition, Density, Distribution, and Influence of Environmental Factors. *Marine Pollution Bulletin*, **160**, Article ID: 111625. https://doi.org/10.1016/j.marpolbul.2020.111625

[151] Latcheman, D.D.S., Richards, H., Madikizela, L.M., Ndungu, K., Newman, B.K. and Chimuka, L. (2024) Occurrenc, Spatial Distribution, and Source Apportionment of Microplastics in Durban Bay, South Africa. *Regional Studies in Marine Science*, **73**, Article ID: 103496. https://doi.org/10.1016/j.rsma.2024.103496

[152] Naidoo, T. (2015) Plastic Pollution in Five Urban Estuaries of KwaZulu-Natal, South Africa. Master's Thesis, University of KwaZulu-Natal, 1-69.

Abbreviations

ABS (acrylonitrile-butadiene-styrene co-polymer), BS (beach slope), CP (cellophane), CR (polychloroprene),ER (epoxide resin), GCRMN (Global Coral Reef Monitoring Network), HD (high density), HDPE (high density polythene), LD (low density), LDPE (low density polythene), LLDPE (linear low density polythene), MD (microdebris, oftentimes seen as larger than microplastics), MDPE (medium density polythene), ML (microliter, oftentimes seen as larger than microplastics), MP (microplastics), Mt (million tonnes),N/A (not available), NC (not clearly disclosed), NL (nylon), NP (nanoplastics), P (particles), PA (polyamide), PAA (polyacrylic acid), PCB (polychlorinated biphenyls), PDMS (polydimethylsiloxane), PE (polythene, polyethylene), PEH (polyethylene/hexene-1-copolymer), PES (polyester), PET (polyethylene terephthalate), PEVA (polythene vinylacetate), PP (polypropylene), PS (polystyrene), PTFE (polytetafluoroethylene), PU (polyurethane), PVC (polyvinyl chloride), Py-GC-TOF-MS (Pyrolysis coupled with gas chromatography and time-of-flight mass spectrometry), SAN (styrene-acrylonitrile co-polymer), SEB (ethylene-butylene-styrene), SL (strandline), T (transect), VL (vegetation line), WWTP (wastewater treatment plant).

Supplementary Tables

Table S1. MP contamination in sediments of creeks, river catchments, and estuaries.

Country	Location	MP concentration	Sampling technique	Separation technique Density gradation separation technique	Digestion	Major polymer types	Co-investigation of living organisms (+/−)	Reference
Tunisia	Menzel Bourguiba	461.25 ± 29.74 MP/kgdw	0.25 m × 0.25 m quadrats	NaCl Filtered through Whatman® GF/C filters, ~1 µm pore size		PE, PP, PS	(−)	Abidli *et al.*, 2018 [81]
RSA	River catchments along the South Africa's coastline	0 - 567 fibers/dm^3	up to 5 cm depth	NaCl, filtered through 40 µmsieve	(−)	mostly microfibers	(−)	de Villiers, 2019 [146]
	Knysna esturay	4 fibers/dm^3						
	Swartkops, Eastern Cape	60 fibers/dm^3						
	Mkomaas, Kwa-Zulu Natal	208 fibers/dm^3						
Kenya	Dabaso, Mida	1.5 ± 0.087 MPs/gdw	3.6 cm Hand corer (up to 10 cm)	NaCl	10% KOH	Overall: HDPE (38.3%), PP (34.6%), LDPE (27.1%), MDPE (17.1%)	(−)	Kerubo *et al.*, 2022 [132]
	Kirepwe, Mida	0 .981 ± 0.150 MPs/gdw						
	Mayonda, Mida	1.53 ± 0.066 MPs/gdw						
	Makupa, Port Reitz	1.43 ± 0.220 MPs/gdw						
	Mikindani, Tudor	2.18 ± 0.225 MPs/gdw						
	Nyali, Tudor	1.26 ± 0.210 MPs/gdw						

Table S2. MP contamination in surface waters off the East African coast.

Country	Location	MP concentration	Sampling technique	Isolation of MPs	Digestion	Polymer type	Co-investigation of living organisms (+/−)	References
RSA	Olifants estuary	1.9 ± 1.5 MP/m^3	LADI (Low-tech Aquatic Debris Instrument, with a mouth area of 0.50 m and a mesh size of 250 µm)				(+) interaction of MPs with *Zostera capensis* meadows	Boshoff *et al.*, 2025 [115]
	BergRiverestuary	2.2 ± 0.4 MP/m^3						
	Knysnaestuary	2.5 ± 1.4 MP/m^3						
	Swartkopsestuary	1.7 ± 1.6 MP/m^3						
Ghana	Sekondi, Bay of Guinea	1.33 ± 1.02 P/m^3	LADI trawl	NaI (4.4 M), then filtered through GF/C Whatman, 1.2 µm pore size	10% KOH		PP (47%), PE (37%) and PS (16%).	Nuamah *et al.*, 2022 [98]
	Cape Coast, Bay of Guinea	1.14 ± 0.63 P/m^3						
	Tema, Bay of Guinea	2.79 ± 2.79 P/m^3						
	Denu, Bay of Guinea	2.36 ± 1.95 P/m^3						
	Bay of Guinea, Ghana	1.9 ± 1.7 P/m^3						
Tanzania/Mozambique	60 stations: 44 off Mocambique and 16 off Tanzania	8500 ± 19,700 P/km^2	Coastal transect; 200 µm neuston-net sampling plus bulk-water sampling for fiber	25 µm filters for bulk-water microfiber samples				Weideman *et al.*, 2023 [136]

Continued

Kenya	Off Kilifi beach	215,484 marine litter/km^2						Okuku *et al.*, 2020 [134] (no specific emphasis on microplastics)
	Off Kuruwitu beach	41,144 ML/km^2						
	Off Malindi beach	15,958 ML/km^2						
	Off Watamu beach	17,112 ML/km^2						
	Off Gazi beach	35,466 ML/km^2						
	Off Shimoni beach	30,971 ML/km^2						
	Off Tradewinds beach	8426 ML/km^2						
	Off Vanga beach	1060 ML/km^2						
Kenya/ Tanzania	37 sites (overall)	1.33 - 58.67 fibers/L; mean 10.73 ± 1.99 fibers/L (it was only sampled for microfibers)						
Lamu County, Kenya	2 sites	27.59 fibers/L	6 L surface water/site; bespoke filtration device with a 50 µm nylon filter incorporated into the sampling device				Polyester (27%), nylon (8%), acrylic, PE, and PP also identified	KeChi-Okafor *et al.*, 2023 [135]
Tana River County, Kenya	3 sites	7.50 fibers/L						
Kilifi County, Kenya	13 sites	12.33 fibers/L						
Kwale County, Kenya	6 sites	7.72 fibers/L						
Zanzibar Archipelago, Tanzania	13 sites	8.67 fibers/L						
Kenya	Creeks along the Kenyan coast	2897.7 ± 232 MPs/m^3	250 and 500 µm size neuston net and metal bucket (for smaller MPs)	Filtered through cellulose nitrate mem brane (millipore HA of 0.8 µm)	10% KOH			Kerubo *et al.*, 2020 [131]
Sudan	Flamingo bay	164.75 ± 4.58 P/m^3	5L stainless steel container	Filtration through a 0.5-µm membrane		Fenton oxidation	PVC > PET > PE > PA	Salah *et al.*, 2026 [138]
	Al Khaleej bay	144.94 ± 4.30 P/m^3						
	Flamingo coast	29.8 ± 0.69 P/m^3						
	Al Kilo coast	133.91 ± 2.33 P/m^3						

Table S3. MP contamination in sediments on the Atlantic and Indian coasts of Africa.

Country	Location	MP concentration	Sampling technique	Isolation technique	Digestion	Co-investigation of living organisms	Type of polymer	Reference
Mauritania	Baied'Aouatif, Bancd'Arguin	5.5 ± 6.73 MP/mL	3 × 3 cm quadrat, with a depth of 1 cm using a spatula and with a sampling corer (10 cm diameter × 15 cm depth)	Wet sieved through a 63 µm mesh		(+)		Lourenço *et al.*, 2017 [94]
	EbelkAznaya, Bancd'Arguin	3.1 ± 2.01 MP/mL						
Guinea	Escadinhas, Bubaque Island, Bijagos	6.7 ± 2.40 MP/mL	3 × 3 cm quadrat, with a depth of 1 cm using a spatula	Wet sieved through a 63 µm mesh		(+)		Lourenço *et al.*, 2017 [94]
	Bijante, Bubaque Island, Bijagos	0.7 ± 0.65 MP/mL						
Ghana	Sekondi, Bay of Guinea	0.078 ± 0.020 MP/gdw	Ekman grab sampler	NaI (4.4M), then filtered through glass microfiber filter (GF/C, (1.2 µm pore size)	10% KOH	(+)		Nuamah *et al.*, 2023 [99]
	Denu, Bay of Guinea	0.217 ± 0.012 MP/gdw						
	Bay of Guinea	0.144 ± 0.061 MP/gdw						
Ghana	Pra estuary	14.22 ± 4.99 fibers/10gdw 24.44 ± 13.21 sheets/10gdw 38.00 ± 25.47 fragments/10gdw 4.22 ± 4.84 beads/10gdw	Ekman grab sampler	$ZnCl_2$, filtered through Whatman glass-fiber paper (1.6 µm pore size)	H_2O_2	(−)	nd	Faseyi *et al.*, 2022 [100]
	Ankobra estuary	13.00 ± 7.56 fibers/10gdw 20.60 ± 12.59 sheets/10gdw 8.70 ± 11.22 fragments/10gdw 3.30 ± 4.14 beads/10gdw						
Ghana	Mukwei La goon	11.22 ± 2.69 MP/10cm^3	Cores were 30 cm deep and 8 cm in diameter	NaCl, then filtered through a micropore filter and black microporous membranes (Whatman Cyclopore Track Etched Membrane 47 mm - 0.2 µm).	H_2O_2, then filtered through a sieve with a mesh size of 10 µm	(−)		Chico-Ortiz *et al.*, 2020 [101]
	Kpeshie Lagoon	16.39 ± 3.26 MP/10cm^3						
	Kpeshie Lagoon (mangrove forest)	25.94 ± 3.13 MP/10cm^3						
Nigeria	Agbowa, lagoonal system, Lagos	310 P/kgdw (≥100 µm)	Van Veen graber at 80 cm depth	$KHCO_2$ (potassium formate) filtration through Whatman filter (0.2 µm)	H_2O_2	(−)	PP > PE > PS ≈ PES > PA	Olarinmoye *et al.*, 2020 [104]
	Liverpool, lagoonal system, Lagos	345 P/kgdw (≥100 µm)						
	Ojo, lagoonal system, Lagos	410 P/kgdw (≥100 µm)						

Continued

	Makoko, lagoonal system, Lagos	2319 P/kgdw (≥100 µm)				
	Lagoon system, Lagos	310 - 2319 P/kgdw (≥100 µm)				
RSA	Olifants estuary	23.5 ± 24.9 MP/kgdw	plastic corer (internal diameter of 10 cm)	$ZnCl_2$, filtered through 100 µm nylon mesh filter	interaction of MPs with *Zostera capensis* meadows	Boshoff *et al.*, 2025 [116]
	BergRiverestuary	25.6 ± 30.3 MP/kgdw				
	Knysnaestuary	23.2 ± 29.1 MP/kgdw				
	Knysnaestuary	91 ± 85 MP/kgdw (22% fibers)				
	Swartkopsestuary	30.1 ± 22.1 MP/kgdw				
RSA	uMgeni estuary	41.7 ± 23.0 P/500mL		NaCl, then filtration through 1000, 500, 250, 100 and 20 µmfilters		Naidoo *et al.*, 2015 [118]
	Isipingo estuary	47.6 ± 22.8 P/500mL				
	Mdloti estuary	19.9 ± 16.2 P/500mL				
	iLovu estuary	13.7 ± 5.6 P/500mL				
Sudan	Flamingo bay	152.25 ± 1.44 P/kgdw	Peterson grab collector	$ZnCl_2$ solution, then filtration through a 5 µm nitrocellulose membrane, then digestion	Fenton oxidation, then filtration through a 0.45 µm nitrocellulose filter	PE > PVC > PET > PA Salah *et al.*, 2026 [138]
	Al Khaleej bay	191.33 ± 3.89 P/kgdw				
	Flamingo coast	43.4 ± 0.75 P/kgdw				
	Al Kilo coast	78.91 ± 2.52 P/kgdw				

Table S4. MP concentrations in surfacewaters of harborareas.

Country	Name of harbor	Notes on MP size/form	MP concentration	Digestion	Sampling technique	Type of polymers observed	Co-investigation of living organisms	Reference
Egypt	Eastern harbor (beach)	0.5 mm to 5 mm	24.2 MP/L		Bulk water sample of 15L		(−)	Shabaka *et al.*, 2019 [79]
RSA	Durban harbor		1200 ± 133.2 MP/m^3		*In situ* filtration through a 63 µm mesh filter			Nel *et al.*, 2017 [120]
RSA	Durban harbor		7.03 ± 11.93 P/m^3 15.82 ± 18.54 P/m^3 (Bayhead Canal)		Conical 300 µm mesh zooplankton net with a mouth diameter of 30 cm		(−)	Naidoo *et al.*, 2015 [118]
RSA	Durban harbor	200 µm - 5 mm (mesoplastics were also quantified	41.50 - 143.5 MP/m^3 Mean: 93.07 ± 36.78 MP/m^3		KC Denmark plankton pump	PP > PE > PET ≈ PS (mesoplastics) PE > PET > PS (microplastics)	(−)	Preston-Whyte *et al.*, 2021 [119]
RSA	Richards Bay harbor	(63 - 5000 µm)	413.3 ± 77.53 P/m^3		10L bucket, *In situ* filtration through a 63 µm mesh filter			Nel *et al.*, 2017 [120]
RSA	Simon's Town Marina		0.37 ± 0.06MP/L (370 MP/m^3)			PA6 > PET > PAA > synthetic rubber	(+)	Ferguson *et al.*, 2024 [147]
RSA	Cape Town harbor	Fragments and fibers	12.08 ± 1.3 MPs/L (12.08 × 10^3 MP/m^3)		1 L pre-cleaned glass bottles	PE, PAN, PP, PET, PMMA	(+) mussel *Mytilus galloprovincialis*	Sparks *et al.*, 2023 [148]

Table S5. MP concentrations in sediments in harborareas.

Country	Location	MP concentration	MP type	Sampling technique	Isolation Technique	Digestion	Plastic type	Co-investigation of living organisms	Reference
Tunisia	Sidi Mansour harbor (harbor bottom), Sfax	252 - 5332 MP/m^2 from 5 - 10 cm top sediment	Fragments > granules/pellets, fibers/lines > foams	Scuba diver handling a box-corer (0.25 × 0.25 m^2				(−)	Chouchene *et al.*, 2019 [85]
RSA	Simon's Town Marina	38 ± 2.00 MP/kg		0.25 m × 0.25 m quadrat, at 5 cm depth			PA6 > PET > PAA > synthetic rubber	(+)	Ferguson *et al.*, 2024 [147]
RSA	Durban harbor (Bayhead area)	159.9 ± 271.2 P/500 mL (3.20×10^5 MP/m^3)			NaCl Filtration through 1000, 500, 250, 100 and 20 µm filters			(−)	Naidoo *et al.*, 2015 [118]
RSA	Durban harbor	0.2 - 2.5 MP/g		Utilizing a sediment Microplastics Isolation (SMI) Unit	NaCl Filtration on to 20 µm membrane		PE, PP, PET	(amphipod's survival tested under conditions of Durban harbor)	Mofokeng and Glassom, 2025 [149]
RSA	Durban harbor	2400 - 45,867 MP/kgdw with one outlier: 111,933 ± 29,189 P/kgdw; mean: 17,131 ± 14,374 P/kgdw	200 µm - 5 mm (no mesoplastics were found)	0.025 m^2 handheld Van Veen grab	NaCl Filtration through cellulose nitrate filter with a 0.2 µm pore size	30% KOH: NaClO solution	PE > CP > PP > PS	(−)	Preston-Whyte *et al.*, 2021 [119]

Table S6. MP contamination of surfacewaters of lagoons and bays.

Country	Location	MP concentration	MP size	Sampling technique	Isolation of MPs	Digestion	Polymer types observed	Co-investigation of living organisms	Reference
Tunisia	Bizerte lagoon	453.0 ± 335.2 MP/m^3	≥300 µm	Surface water directly punped through cylindrical stainless-steel filter with a mesh size of 300 µm	NaI, then filtration through filter of 10 µm pore size		PE, PP are main Overall: PE > PP > PET > CP > NL > PS	(−)	Wakkaf *et al.*, 2020 [150]
Tunisia	Bizerte lagoon channel complex	3000 - 18,000 P/kgdw	Mostly fibers					(−)	Abidli *et al.*, 2017 [82]
Algeria	Bou-Ismail bay	0.86 ± 0.35 MP/m^3	Fibers (32%), fragments (27%), films (16%), foams (13%), granules (12%).	Manta trawl (330 µm)			PE > PP > PS	(−)	Setiti *et al.*, 2021 [86]
Nigeria	Lagos lagoon	3906 particles/kg						(−)	Akinhanmi *et al.*, 2023 [105]
Nigeria	Makoko, lagoonal system, Lagos	204 P/L	≥100 µm	Jar			PP > PES > PE	(−)	Olarinmoye *et al.*, 2020 [104]

Continued

	Agbowa, lagoonal system, Lagos	139 P/L	≥100 µm						
	Liverpool, lagoonal system, Lagos	303 P/L	≥100 µm						
	Ojo, lagoonal system, Lagos	184 P/L	≥100 µm						
	Lagoon system, Lagos	139 - 303 P/L	≥100 µm						
RSA	Durban bay	4.27 - 80.72 MP/m^3		conical plankton net (50 µm mesh size, 0.5 m opening size, 1 m length)			PE > PES > PP > PS > PA	(−)	Latcheman *et al.*, 2024 [151]
RSA	Durban bay	0.447 MP/g 0.039 - 1.76 MP/g		van Veen grab	NaI Filtered through Whatman® glass microfiber filters, Grade GF/A (1.6 µm pore size)	(−)	PE > PP > PES > PS > PA	(−)	Latcheman *et al.*, 2024 [151]

Table S7. MP contamination of surfacewaters off the South African coast.

Country	Location	MP type	Sampling technique	MP concentration	Co-investigation of living organisms	Reference
RSA	Off the southwestern Cape Province	foamed plastics, fragments and pellets	900 µm mesh Neuston net (1224 trawls @ 190 m^2 sea surface each)	3640 P/km^2 (both meso-and microplastics)	(−)	Ryan, 1988 [47]
RSA	Off the coast of KwaZulu-Natal			0.2 - 48.7 P/m^3	(+)	Naidoo, 2015 [152]
RSA	Off the coast of KwaZulu-Natal	fragments, films and fibers	333 µm mesh Manta net (data from 43 trawl samples)	4.01 ± 3.28 P/100m^2 5.54 ± 3.26 P/100m^2 (winter) 2.96 ± 2.94 P/100m^2 (summer)	(−)	Naidoo and Glassom, 2019 [121]
	Off Amanzimtoti, KwaZulu-Natal	mostly fragments	333 µm mesh Manta net	9.54 P/100m^2 (summer)		
	off Isipingo, KwaZulu-Natal	mostly fragments	333 µm mesh Manta net	12.2 P/100 m^2 (winter)		
RSA	Oyster Bay	mostly fibers	Water was filtered through a WP-2 type net with 80 µm mesh size using a 155 mm hoop diameter for 10 m filtering 188.692 L water for each sampling event	1215 ± 276.7 MP/m^3	(−)	Nel and Froneman, 2015 [113]
	Skuitbaai	mostly fibers		927.4 ± 114.5 MP/m^3		
	Sedgefield	mostly fibers		858.5 ± 241.0 MP/m^3		
	Danabaai	mostly fibers		257.9 ± 53.36 MP/m^3		

Table S8. MP contamination in coastal and sea sediments.

Country	Location	MP type	MP concentration	Sampling technique	Isolation technique	Polymer type	Co-investigation of living organisms	Reference
Tunisia	coast of Carthage	Mostly fibers and fragments	141.20 ± 25.98 P/kgdw	0.25 m × 0.25 m quadrats	NaCl, filtered through Whatman® GF/C filters, ~1 µm pore size	PE, PP, PS	(−)	Abidli *et al.*, 2018 [81]
RSA	Oyster Bay	mostly fibers	2636 ± 612.2 MP/m^2	Top 5 cm of beach sediment.	NaCl, then filtered through 63 µmsieve	nc	(−)	Nel and Froneman, 2015 [113]
	Skuitbaai	mostly fibers	2411 ± 297.7 MP/m^2					
	Sedgefield	mostly fibers	3308 ± 1449 MP/m^2					
	Aston Bay	mostly fibers	688.9 ± 348.2 MP/m^2					
Tanzania	Bububu, Zanzibar (sea sediment)	mostly fibers	210 ± 15 MP/kgdw	stainless steel Ekman grab (400 cm^2)	NaCl, then filtered through a 0.7 µm Whatman GF/C glass fiber filter		(−)	Nchimbi *et al.*, 2020 [128]
	Fumba, Zanzibar (sea sediment)	mostly fibers	208.33 ± 15.2 MP/kgdw					
	Pwani mchangani, Zanzibar (sea sediment)	mostly fibers	188.30 ± 9.4 MP/kgdw					
	Nungwi, Zanzibar (sea sediment)	mostly fibers	155.27 ± 3.8 MP/kgdw					
	Kunduchi, Dar es Salam (sea sediment)	mostly fibers	55.09 ± 9.86 MP/kgdw					

Table S9. MP contamination of beach sediments.

Country	Location	MP concentration	Size	Sampling technique	Isolation technique	Polymer type	Co-investigation of living organisms (+/−)	Reference
Egypt	Eastern harbor (beach)	242 MP/kgdw 0.5 mm to 5 mm) 33 - 108 transparent MPs/100 gdw 107 to 174 colored MPs/ 100gdw (<0.5 mm)		0.25 m × 0.25 m quadrat, at 5 cm depth		PET, ABS, PP, PS, PEVA, PTFE, LDPE, LLDPE, HDPE, nylon identified. main: PET and PP	(−)	Shabaka *et al.*, 2019 [79]
Algeria	Chapuis beach, Annaba	182.66 ± 27.32 P/kgdw*	≥32 µm	0.25 m × 0.25 m quadrat, up to 3 cm depth, glass bijoux jar as miniature borer	NaCl, 0.47 µm pore diameter (Whatman 969)	PE > PP > PS ≈ Cellulose acetate	(−)	Tata *et al.*, 2020 [88]
	Joannonville beach, Annaba	649.33 ± 184.02 P/kgdw*				PE > PS		
	Sidi Salem, Annaba	586.33 ± 25.16 P/kgdw*				PE > PP ≈ PS		
	Cap Rosa beach	201.66 ± 16.07 P/kgdw*				PET > PE > PP > PS		
Algeria	Sidi Mansour beach	18.46 ± 15.62 P/kgdw*	≥1 mm	0.5 m × 0.5 m quadrat	Dry sieving @ 1 mm		(−)	Taibi *et al.*, 2021 [87]
	Sablettes beach	66.00 ± 107.28 P/kgdw*						
	Sakhra beach	14.93 ± 18.79 P/kgdw*						

Continued

	Benabdelmalek R. beach	34.29 ± 36.69 P/kgdw*						
	Hadjadj beach	12.80 ± 11.75 P/kgdw*						
	Petit Port beach (W)	11.20 ± 10.29 P/kgdw*						
	Petit Port beach (E)	66.40 ± 44.95 P/kgdw*						
	Sidi Abdelkader beach	7.60 ± 18.80 P/kgdw*						
	Bahara beach	17.60 ± 17.40 P/kgdw*						
Tunisia	Beaches on the Gulf of Tunis	40 - 50 P/kgdw (500 µm - 1 mm) 223 - 268 P/kgdw (3 µm - 500 µm) 67 - 127 P/kgdw (1.2 - 3 µm)	≥1.2 µm	stainless-steel shovel (1 kg samples from the topmost 20 cm sediment)	$ZnCl_2$, then filtration through Whatman 3 and 1.2 µm cellulose nitrate filters	PE > PP, additionally LDPE, HDPE, PA, PEVA	(+)	Missawi *et al.*, 2020 [83]
	Beaches on the Gulf of Hammamet	10 - 20 P/kgdw (500 µm - 1 mm) 78 - 172 P/kgdw (3 µm - 500 µm) 51 - 151 P/kgdw (1.2 - 3 µm)						
	Beaches on the Gulf of Gabes	15 - 110 P/kgdw (500 µm - 1 mm) 60 - 326 P/kgdw (3 µm - 500 µm) 46 - 170 P/kgd (1.2 - 3 µm)						
Togo	Palm beach	32 ± 50 P/m^2 9 ± 13 P/kg	0.3 - 5 mm	stainless-steel spatula (surface layer until 1 cm depth was collected)	NaCl, then sieved through 250 µm metal sieve	PE (48%), PP (34%), PS (14%), PET (3%), PMMA (1%)	(−)	Aziade *et al.*, 2026 [102]
	Onomo beach	16 ± 20 P/m^2 2 ± 3 P/m^3						
	Baguida beach	35 ± 40 P/m^2 6 ± 6 P/kg						
	Avépozo beach	61 ± 51 P/m^2 10 ± 9 P/Kg						
	Agbodrafo beach	45 ± 31 P/m^2 7 ± 5 P/kg						
	Aného beach	58 ± 68 P/m^2 11 ± 13 P/kg						
Nigeria	Badagry beach	3.6 ± 3.5 MPs/kg	1 - 5 mm	quadrat (0.5 × 0.5 × 0.2 m) stainless steel spoon		PE/PP > PS	(−)	Fred-Ahmadu *et al.*, 2020 [103]
	Oniru beach	173.0 ± 21.3 MPs/kg				PE > PP > PS		
	Elegushi beach	119.6 ± 38.5 MPs/kg				PS > PE > PP		
	Atican beach	22.8 ± 9.3 MPs/kg				PS > PE > PP		
	Eleko beach	23.4 ± 9.2 MPs/kg				PE > PP > PS		
	Badagry, Oniru, Elegushi, Atican and Eleko beach	3424 P/m^2				PE > PS > PP		
Cameroon	5 beaches along Limbe coastline	78 P/m^2		2 × 2 m quadrat size measured by ruler		N/A	(−)	Ndumbe *et al.*, 2023 [109]

Continued

Mocambique	Maputo, Marine Station, Inhaca Island Catembe Saco, Inhaca Island	40 - 205 P/100m transect 980 - 37,575 P/100m transect 0 - 47 P/100m transect		2 × 2 m quadrat top 2 cm layer	NaCl, then filtration through Whatman GF/C filter (1.2 µm)	PS	(+)	Karlsson, 2015 [125]
Mocambique	Pemba	21 - 30 MP/250mL					(−)	Browne *et al.*, 2011 [126]
RSA	52 beaches (Austral winter 1984) 52 beaches (Austral winter 1989)	491 MP/m beach (0.5 m-wide transect) 679 MP/m beach (0.5m-wide transect)	2 - 20 mm*	2 mm sieve		PE/PP pellets (80%) > fragments > PS PE/PP pellets (68%) > fragments > PS	(−) (−)	Ryan and Moloney, 1990 [48]
RSA	175 sampling sites at sandy beaches Feb/ March 2017 175 sampling sites at sandy beaches May/ June 2016	80 ± 102 fibers/dm^3 87 ± 84 fibers/dm^3		metal spoon to a depth of 5 cm within a 10 cm × 5 cm mini-quadrant	NaCl, then decanted through a 40 µm sieve	nc	(−) (−)	de Villiers, 2018 [117]
RSA	Milnerton beach, Table Bay	30,900 MP/m^3		Sampling to a depth of 30 cm			(−)	Lamprecht (2013) [112]
RSA	Beach near Durban harbour Isipingo beach iLovu beach Mdloti beach uMgenibeach	38.6 ± 20.9 P/500mL 46.0 ± 23.0 P/500mL 20.4 ± 10.0 P/500mL 20.0 ± 7.5 P/500mL 38.5 ± 12.3P/500mL		Corer with 50 mm internal diameter, up to 10 cm depth	NaCl, filtration through 1000, 500, 250, 100 and 20 µm filters	PE, PP, PS, PES, PU	(−)	Naidoo *et al.*, 2015 [118]
Tanzania	Tegeta estuary (beach) Ocean Road beach, Dar es Salamr Kundunchi beach, Dar es Salam Bububu beach, Zanzibar Kizimkazi, Zanzibar (beach)	1578.4 ± 38.23 MP/kgdw 643.98 ± 77.13 MP/kgdw 1176.88 ± 28.62 MP/kgdw 507.24 ± 36.93 MP/kgdw 166.44 MP/kgdw		3 × 3 m quadrat stainless steel shovel (top 5 - 10 cm)	NaCl, then filtered through a 0.7 µm Whatman GF/C glass fiber filter	PE > PS ≈ SAN > PVC PE > PS PE > PS ≈ PVC	(−)	Nchimbi *et al.*, 2020 [128]
Tanzania	Mission Cross Beach, Pwani, Zanzibar Mtoni Kijichi Creek beach, Dar es Salam	589 ± 99 MP/kgdw 2972 ± 238 MP/kgdw				PE, PP	(+)	Mayoma *et al.*, 2020 [129]
Tanzania	Temeke, Dar es Salam	4.6 P [fibers]/25g sediment	microfibers	20 × 20 cm quadrat (1 m seaward of high tide line)	NaCl, filtered through 1.2 µm GF/C Whatman filter paper	NC	(−)	Balasubramanian and Phillott, 2016 [130]

*The authors have provided data for this size fraction (2 - 20 mm), which includes both micro- and mesoplastic particles.