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Research Article

Macroplastic pollution in Latin America and the Caribbean: a scientometric review of research trends and gaps

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ABSTRACT. Plastic pollution is a growing environmental concern, with macroplastics posing significant risks to human and animal health. However, despite increasing global attention, there remains a limited understanding of how research on macroplastic pollution has evolved across Latin America in marine and freshwater ecosystems. This study aims to conduct a scientometric review of macroplastic research in Latin America, identifying trends, gaps, and opportunities for future studies. A systematic search was conducted in Web of Science, Scopus, and SciELO databases, using bibliometric tools such as Bibliometrix and VOSviewer to analyze publication trends. Mann-Kendall and Pettitt's tests indicated a significant increase in the number of publications on macroplastic pollution in Latin America since 2013, which may be linked to the rise of global policies aimed at reducing plastic use due to its environmental impact. A total of 206 relevant studies were identified, with Marine Pollution Bulletin being the most prominent journal in this field. Research on macroplastic pollution was primarily conducted in marine coastal beaches (56.6%) and marine islands (12%), while freshwater ecosystems (7.2%) remained underrepresented. Few studies have explored trophic transfer, plastic fragmentation, or macroplastic ingestion by non-marine species. Our findings highlight the need to expand macroplastic research in Latin America, particularly in river and stream systems, which remain critically understudied. Future work in the region should extend sampling beyond beaches into inland and deep-sea environments, integrate hydrological context, incorporate multiple plastic size fractions within unified sampling designs, broaden taxonomic coverage, evaluate policy effectiveness, and strengthen citizen-science initiatives in inland waters to support evidence-based decision-making.

Keywords: plastic pollution; water pollution; science mapping; Bibliometrix; Latin America

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INTRODUCTION

Since the mid-20th century, global plastic production has increased exponentially, reaching 400.3 million tons in 2022, with Central and South America accounting for 4% of the global plastic production (Geyer et al. 2017, Plastics Europe 2023). Although plastics are widely used due to their versatility and low cost, inadequate waste management has raised serious environmental and socio-economic concerns (Macheca et al. 2024). Plastics pose severe environmental threats, primarily due to their low degradation rate and accumulation in terrestrial and aquatic ecosystems (Pilapitiya & Ratnayake 2024, Liu et al. 2025). In the environment, plastic debris undergoes progressive fragmentation from macroplastics (>2.5 cm) to mesoplastics (<2.5 cm) and microplastics (<5 mm) (Arthur et al. 2009, Liro et al. 2023), leading to faunal contamination and direct impacts on biodiversity (Blettler et al. 2019, Altunışık et al. 2025).

Developing countries are experiencing worsening waste management due to rapid urbanization and inefficient waste disposal, factors that contribute to increased plastic deposition in terrestrial and aquatic ecosystems (Ferronato & Torretta 2019, Strokal et al. 2021, MacAfee & Löhr 2024). Although several strategies exist to address plastic pollution, including recycling, microbial degradation, incineration, and the extensive use of biodegradable plastics (Ilyas et al. 2018), these strategies are still poorly adopted in low-income countries, such as those in South and Central America (Husaini et al. 2024). Studies indicate that population density significantly influences the entry of plastics into rivers, which may act as channels for the mobilization of plastic (Rosa et al. 2024), facilitating its deposition and accumulation within the river basins (Rosa et al. 2023) and transporting these pollutants to the oceans (Mai et al. 2023, Funes et al. 2025, Hurley et al. 2025). The transport and retention dynamics of these pollutants in riverine systems can be influenced by factors such as riparian vegetation and fluvial morphological characteristics, which modulate the patterns of plastic debris deposition and dispersion (van Emmerik et al. 2022, Blettler et al. 2023, Gallitelli & Scalici 2024), as well as the impact of extreme events (Clayer et al. 2024).

Although recent reviews have addressed plastic pollution in Latin America, most studies have focused on the presence and impacts of microplastics (Kutralam-Muniasamy et al. 2020, Mesquita et al. 2022, Orona-Návar et al. 2022, Terrazas-López et al. 2024). Reviews on macroplastics in specific countries within Latin America have begun to emerge (Belli et al. 2024, Husaini et al. 2024). Despite their valuable contributions, these studies remain geographically and methodologically constrained, which limits a comprehensive assessment of the magnitude and impacts of this pollutant in Latin America. Also, no comprehensive scientometric studies analyze the main research trends, the most frequently published journals, or the most influential authors in this scientific field. The application of bibliometric tools such as VosViewer and Bibliometrix represents a promising strategy to bridge these gaps, providing a structured overview of academic production and supporting targeted policies and mitigation actions for the region.

Here, we provided a scientometric mapping of macroplastic research in Latin America and the Caribbean (LAC), quantifying temporal trends in publication output and author productivity, identifying core journals, characterizing thematic structure via keyword co-occurrence network with a temporal overlay, and profiling country-level contributions. We also summarized where macroplastics have been investigated across environmental settings and which taxonomic groups have been documented to ingest them. We address four guiding questions: 1) how has publication output evolved, and are there discernible change points? 2) Which journals constitute the core venues in LAC? 3) What thematic clusters organize the field, and how have they shifted over time? 4) Which countries, environments, and taxonomic groups are most represented, and where are the gaps?

MATERIALS AND METHODS

Data collection

Publications on plastic pollution, with an emphasis on macroplastics in Latin America, were retrieved from Web of Science (WoS), Scopus, and SciELO databases. The WoS and Scopus are widely used databases in scientometric analyses and for mapping plastic-pollution research (Li et al. 2018, Gallitelli & Scalici 2022, Li & Li 2024). The SciELO database was included to expand coverage across LAC, given its strong presence in this region. The search was conducted using a comprehensive combination of keywords related to plastic pollution, including the terms: ("macroplastic" OR "macro plastic" OR "macro-plastic*" OR "macrodebris" OR "macro debris" OR "macro-debris" OR "macroplastic contamination" OR "plastic ingestion" OR "macro-litter" OR "macro litter" OR "plastic pollution" OR "plastic trap" OR "plastic litter pollution" OR "plastic waste" OR "plastic litter"

OR "litter sources" OR "litter accumulation" OR "anthropogenic litter" OR "river plastic" OR "fishing plastic*" OR "fishing debris" OR "plastic transport" OR "plastic contamination" OR "macroplastic storage" OR "riverside litter" OR "riverine plastic" OR "plastic debris" OR "plastic fragment*" OR "marine litter" OR "marine debris" OR "marine-debris" OR "anthropogenic material*" OR "anthropogenic debris" OR "plastic monitoring" OR "plastic accumulation zone" OR "urban plastic waste" OR "plastic degradation") AND combined with the names of Latin American countries: ("Argentina" OR "Bolivia" OR "Brazil" OR "Chile" OR "Colombia" OR "Costa Rica" OR "Cuba" OR "Dominican Republic" OR "Ecuador" OR "El Salvador" OR "Guatemala" OR "Haiti" OR "Honduras" OR "Mexico" OR "Nicaragua" OR "Panama" OR "Paraguay" OR "Peru" OR "Uruguay" OR "Venezuela" OR "Bahamas" OR "Barbados" OR "Belize" OR "Dominica" OR "Grenada" OR "Guyana" OR "Jamaica" OR "Saint Lucia" OR "Saint Kitts and Nevis" OR "Saint Vincent and the Grenadines" OR "Suriname" OR "Trinidad and Tobago" OR "Antigua and Barbuda" OR "South America" OR "Central America" OR "Mesoamerica" OR "Meso America" OR "Latin America").

The searches covered the entire publication period available up to December 2024 and were conducted in English, Portuguese, and Spanish. Articles found in more than one database (i.e. duplicate records) were removed using the Bibliometrix 4.1.3 package and the "remove" function (Aria & Cuccurullo 2017), implemented in R 3.4.1 (R Development Core Team 2023).

Articles retrieved using the search strategy were visually inspected to confirm eligibility. Review articles, meta-analyses, and studies that did not align with the research scope were excluded from the analysis. Studies focusing exclusively on microplastics or mesoplastics were also removed. However, articles that analyzed macroplastics in conjunction with other fractions (microplastics, mesoplastics, and megaplastics) were included as they provided relevant quantitative data on macroplastics. This methodological approach ensured a broader and more representative sample of the existing literature. The criteria and stages of study inclusion and exclusion, and the number of articles removed per criterion, are detailed in the PRISMA flow diagram (Fig. 1).

Scientometric analyses

We conducted scientometric analyses with the Bibliometrix 4.1.3 package (Aria & Cuccurullo 2017) in R 3.4.1 (R Development Core Team 2023), using the Biblioshiny web interface for data processing and visualization. We first quantified scientific production and author contributions based on publication output. Author occurrences were computed under a full counting scheme, assigning one count per included article per author, irrespective of authorship position; country attribution followed the first listed affiliation at the time of publication. Scientific productivity was assessed by fitting Lotka's law to the frequency distribution of publications per author (Lotka 1926). We then evaluated journal performance by applying Bradford's law to total article counts and by examining each source's local impact.

We constructed a keyword co-occurrence network in VOSviewer software (van Eck & Waltman 2010) using full counting and a minimum occurrence threshold of four. The overlay visualization "average publication year" (decimal-year mean) was applied to display temporal patterns. In addition, we used VOSviewer's citation analysis to calculate the average number of citations per keyword node in the network.

Finally, we quantified the number of publications per country to identify the leading contributors to research, the primary environmental settings studied, and the interactions between plastic pollution and taxonomic groups. Country-level tallies were computed as records, defined as the number of times a given plastic fraction was reported for a country; multi-country studies contributed one record to each country.

Trends and change-point analysis

The temporal trend in the number of scientific publications by year was initially assessed using the autocorrelation function (ACF) and the Durbin-Watson test (Durbin & Watson 1950). Subsequently, the modified Mann-Kendall test (Mann 1945, Kendall 1975), a widely used non-parametric method for detecting monotonic trends in time series, was applied, incorporating the correction for autocorrelation (Hamed & Rao 1998). Also, Pettitt's test (Pettitt 1979) was employed to identify the annual publication series as either a regime-shift process, when a significant breakpoint was detected ($\alpha = 0.05$, with the corresponding year reported), or a monotonic trajectory. This method compares the distributions of values before and after a potential change point to assess the statistical significance of the change.

All analyses were conducted in the R statistical environment (R Development Core Team 2023) using the Kendall (McLeod 2011), lmtest (Zeileis & Hothorn

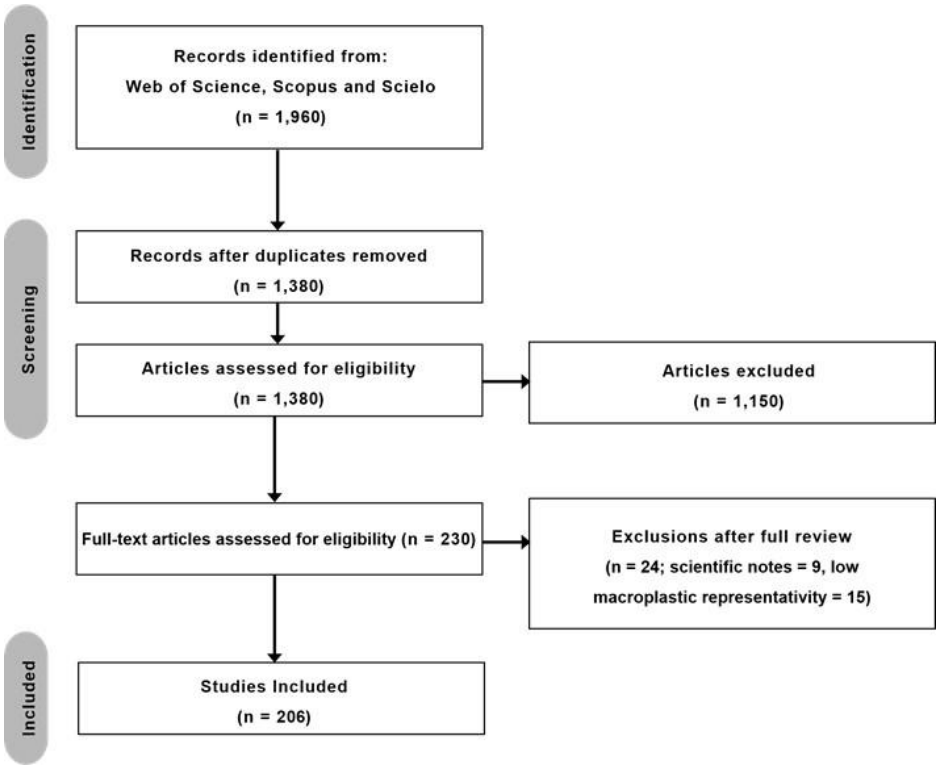

Figure 1. PRISMA flow diagram of the studies' inclusion and exclusion stages to map research trends on macroplastic pollution in Latin America and the Caribbean (up to Dec 2024). Adapted from PRISMA (2020).

2002), trend (Pohlert 2020), ggplot2 (Wickham 2016), and packages.

Categorization by environment and taxonomic group

From each retrieved paper, we extracted the environmental setting (marine coastal beach, marine island, estuarine, freshwater, surface marine water, mangrove, coastal lagoon, deep sea, soil, plastic-embedded sediments/rocks, coastal breakwaters) and the taxonomic group involved in plastic ingestion (Testudines, Birds, Cetacea, Pinnipedia, Carcharhiniformes, Orectolobiformes, Sirenia). Frequencies used full counting (one count per study per category). Bar plots were produced in R using the ggplot2 package. To test uneven representation across environments, we applied a chi-square goodness-of-fit test against a uniform baseline, reporting χ^2, *df*, *P* and Cramér's *V*.

RESULTS

Study classification: distribution by plastic fractions

Our search identified 1,960 studies, of which 221 met the filtering criteria. We identified 83 articles reporting the co-occurrence of macroplastics with different plastic categories. However, 15 of these articles were excluded from the analysis because the term "macroplastics" is mentioned in the study, but its abundance was relatively small. Additionally, nine articles were classified as scientific notes and therefore excluded from the final dataset (Fig. 1). Following these exclusions, 206 articles were selected for the final scientometric analysis, a sample size considered sufficient for generating statistically robust and reliable results in bibliometric studies (Rogers et al. 2020). Among these 206 selected articles, 123 articles (59.7%) exclusively addressed macroplastics, while 41 articles (19.9%) analyzed the co-occurrence of macro- and mesoplastics. Nineteen articles (9.2%) investigated macro-, meso-, and microplastics together, and 12 articles (5.8%) focused solely on the interaction between macro- and microplastics. Only three studies (1.4%) considered all plastic fractions, ranging from microplastics to megaplastics. Additionally, three articles (1.4%) assessed meso-, macro-, and megaplasticity, while another three studies (1.4%) examined the combined presence of macro- and megaplasticity. Finally, only two articles (0.9%)

simultaneously examined nanoplastics, microplastics, mesoplastics, and macroplastics (Fig. S1).

Data were collected from 17 countries in LAC. De Veer et al. (2023) is a multi-country beach-litter study based on citizen science, spanning ~12,000 km of the east Pacific and sampling 130 sandy beaches across nine countries to quantify macrolitter densities and infer dominant sources. Brazil had the highest number of records, with 92 occurrences (42.4%), followed by Chile (34, 15.7%), Argentina (22, 10.1%), and Colombia (22, 10.1%). Conversely, countries such as Honduras, El Salvador, Guatemala, Panama, St. Lucia, and Dominica reported only one record each, accounting for 0.5% (Fig. 2).

Scientific production trends and author contributions

Scientific research on plastic pollution in Latin America began in 1993, with the earliest identified studies documenting the accumulation of marine debris on the coasts of St. Lucia, Dominica, and Panama (Corbin & Singh 1993, Garrity & Levings 1993). The modified Mann-Kendall test indicated a significant increasing trend in the time series (τ = 0.722, Z = 5.4882, $P < 0.001$). Pettitt's test detected a structural change point in the time series in the year 2013 (K = 21, U^* = 230, $P < 0.001$), indicating a statistically significant difference between the periods before and after this point (Fig. 3). Between 1993 and 2008, scientific production remained at low and irregular levels, with some years showing no recorded publications. In 2003, three articles were published, but productivity remained low until 2012, with occasional variations throughout this period. From 2013 onward, a gradual increase in the number of publications was observed, indicating a modest yet continuous growth trend, with a significant peak in 2018, when 17 publications were published. In 2019, the number of articles declined, followed by renewed growth in 2020 and 2021, with 20 and 33 publications, respectively. In recent years, a sharp decline in 2022 was followed by continued growth throughout 2023 and 2024.

Publications on plastic pollution in LAC involved 894 authors, with 82.4% contributing to only a single article. In contrast, a small group of three authors stood out for having produced 19, 16, and 10 articles, respectively (Figs. 4, S2).

Trends, performance, and scientific journal output

A total of 40 journals were identified as publishing studies on plastic pollution in Latin America, with Marine Pollution Bulletin (MPB; 122 articles, 4,766 citations) emerging as the primary source of knowledge dissemination in this field. Environmental Pollution - ENVPOL (12 articles, 315 citations) and Science of the Total Environment - STOTEN (12 articles, 368 citations) contributed significantly to the field, but with a lower output concentration per article than Marine Pollution Bulletin (Fig. 5).

Distribution of macroplastic ingestion across environments and taxonomic groups

Environmental categories were available for 166 of the 206 studies (80.6%); the remaining 40 did not explicitly report an environment or did not focus on the environmental setting and were therefore excluded from the environment-specific analyses. Study environments were highly unevenly distributed relative to a uniform baseline ($\chi^2(10) = 472.8$, $P < 0.001$; Cramér's V = 0.53). Marine coastal beaches dominated the dataset (94/166; 56.6%), followed by marine islands (20/166; 12.0%), freshwater systems (12/166; 7.2%), estuaries (11/166; 6.6%), and surface marine waters (8/166; 4.8%). Soil, mangroves, and coastal lagoons each accounted for 4/166 studies (2.4%), whereas plastic-embedded sediments/rocks, deep-sea settings, and coastal breakwaters each contributed 3/166 studies (1.8%) (Fig. 7).

Scientific production on macroplastic pollution in freshwater environments in LAC is primarily concentrated in South American countries, though it is still in its early stages. Argentina leads with 4 studies, followed by Chile with 3, Brazil and Ecuador with 2 each, and Belize with a single study. In chronological order of publication, Rech et al. (2014) analyzed four rivers in Chile (Elqui, Maipo, Maule, and Bio-Bio), collecting samples along their courses, from headwaters to central reaches and river mouths, and identified plastics as the predominant type of waste. Subsequently, Rech et al. (2015) conducted a follow-up study in the same rivers, incorporating citizen science in the sampling process, which further confirmed the significant presence of plastics. In Argentina, Blettler et al. (2017) investigated the occurrence of macro-, meso-, and microplastics in sediments from Lake Setúbal, located in the Paraná River floodplain. In a subsequent study, Blettler et al. (2019) expanded this research to the Paraná River, examining the deposition of macro-, meso-, and microplastics in its sediments.

In Chile, Honorato-Zimmer et al. (2021) conducted sampling campaigns in 27 rivers between 2013 and 2017, employing a citizen science approach to assess plastic waste accumulation along riverbanks and on the water surface. The authors found that 86% of plastic

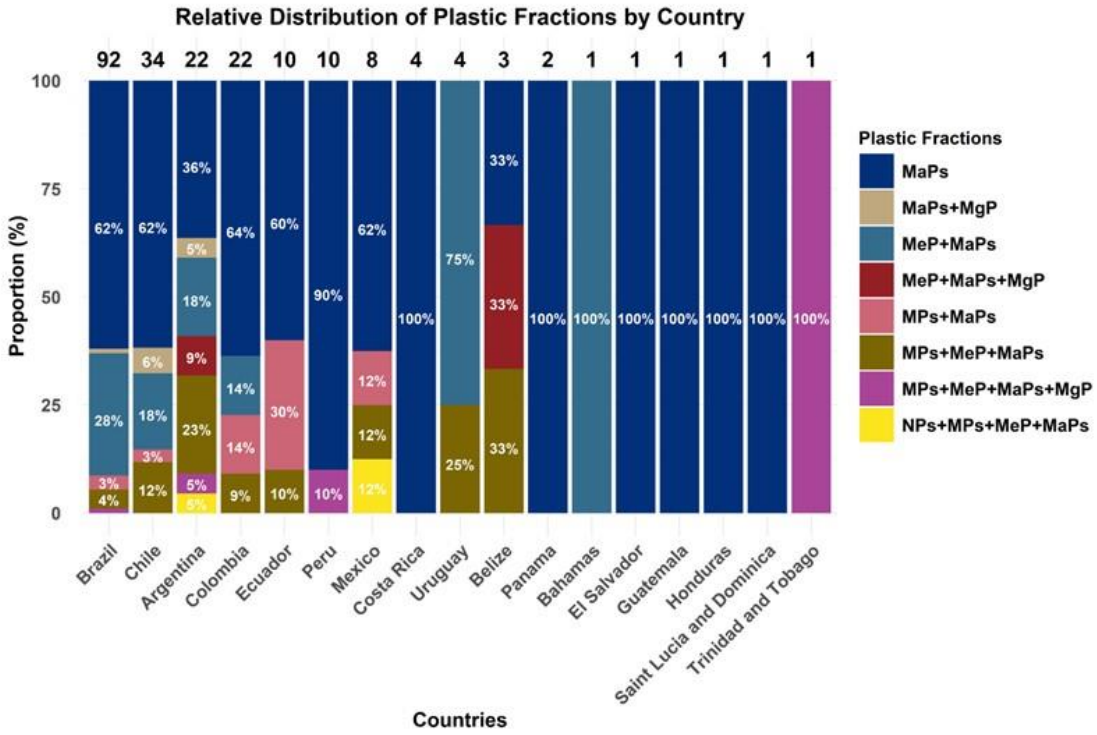

Figure 2. Relative distribution of plastic fractions by country in Latin America and the Caribbean. The colors in the legend indicate the different types of plastic fractions analyzed: MaPs: macroplastic; MeP+MaPs: mesoplastic and macroplastic; MaPs+MgP: macroplastic and Megaplastic; MPs+MaPs: microplastics and macroplastic; MPs+MeP+MaPs: microplastics, mesoplastic, and macroplastic; MPs+MeP+MaPs+MgP: microplastics, mesoplastic, macroplastic, and megaplastic; NPs+MPs+MeP+MaPs: nanoplastics, microplastics, mesoplastic, and macroplastic. Percentages below 3% are not displayed in the graph due to space constraints, but are included in the total distribution.

pollution inputs were attributed to recreational visitors, 66% to residents, and 59% to illegal waste disposal. In Argentina, Garello et al. (2021) investigated meso- and macroplastics on beaches along the Paraná River, identifying 18 different types of plastic debris. Their findings highlighted the influence of the hydrological cycle on the removal and accumulation of plastic waste, whereas wind action had a lesser impact on its distribution. Further north, in the Upper Napo River Basin (Ecuadorian Amazon), Lucas-Solis et al. (2021) collected 200 macroplastic items, with colored plastic bags being the most prevalent type of debris. Similarly, in Argentina, Mitchell et al. (2021) conducted surveys on sandy beaches along the Paraná River, collecting 914 macroplastic items, with an average density of 0.61 items m^{-2}.

In Ecuador, Talbot et al. (2022) analyzed macroplastics in the sediments of the Vinces and Los Tintos rivers, identifying sandbags (33.2%), plastic bags (23.1%), and food packaging (16.7%) as the most prevalent types of debris. In Belize, Silburn et al. (2023) quantified 702 macroplastic items along the banks of the Belize River and in urban drainage channels, providing baseline data for macroplastic pollution in the region. Lastly, two recent studies were conducted in Brazil's Amazon region (Rosa et al. 2023, 2024). These studies analyzed rivers in Belém, state of Pará, in the Amazon, using visual observations to quantify floating macroplastics. The findings demonstrated that the Guamá and Acará rivers, as well as other urbanized water systems, act as conduits for plastic pollution, exporting tons of plastic debris to estuarine environments and ultimately to the ocean.

Estuarine environments and surface marine waters exhibited intermediate study frequencies. In smaller proportions, studies were identified in coastal lagoons, soils, mangroves, and geological formations containing plastics embedded in sediments. The lowest study frequencies were observed in deep-sea areas and artificial coastal structures such as breakwaters. Figure 7 presents the distribution of studies according to the analyzed environmental categories.

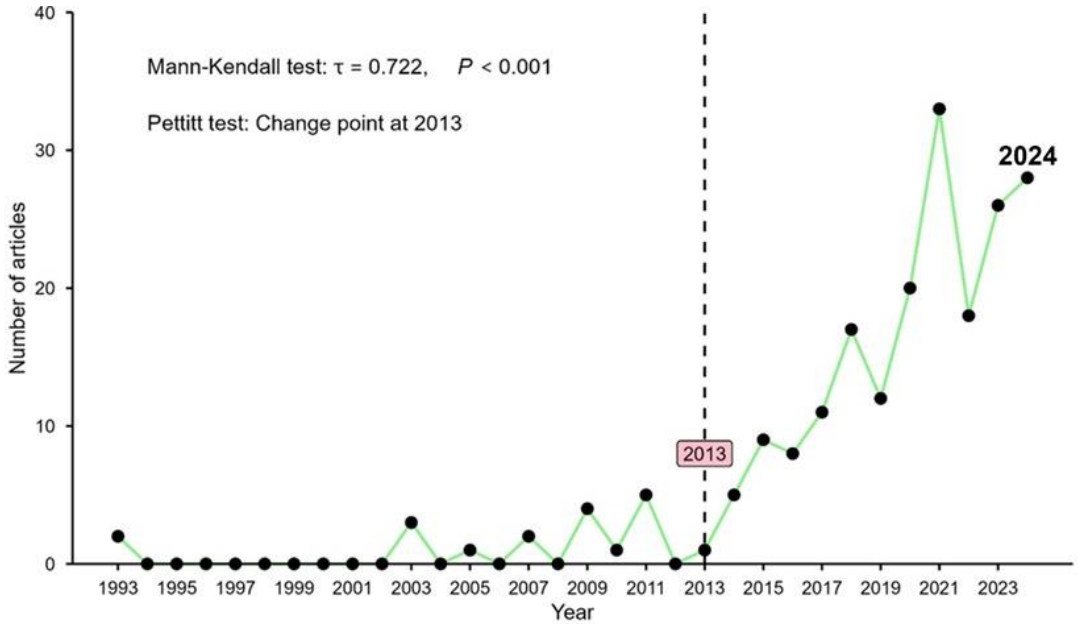

Figure 3. Temporal trend of scientific publications on plastic pollution in Latin America and the Caribbean from 1993 to 2024. The Mann-Kendall test indicates a significant increasing trend (τ = 0.722, P < 0.001). The Pettitt test identifies a structural change in the trend occurring in 2013, marked by a dashed line.

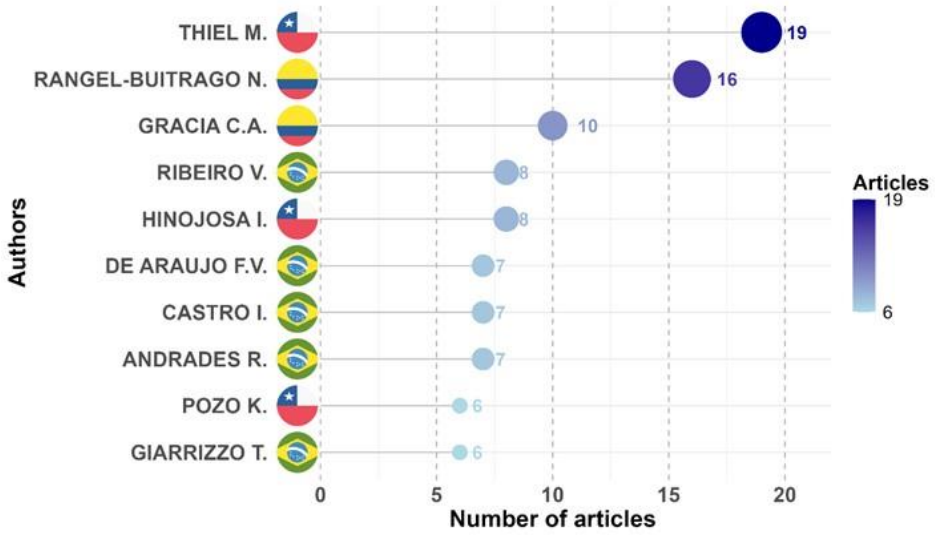

Figure 4. Number of articles per author (full counting: one count per included article per author, irrespective of authorship position). Circle size and color encode article counts; country flags indicate the author's first listed affiliation at the time of publication.

Among the studies on macroplastic ingestion, marine turtles (Testudines - sea turtles) were the most frequently investigated animal group, followed by birds (including seabirds, coastal, terrestrial, and freshwater species) and cetaceans (Cetacea). Other groups, such as pinnipeds (Pinnipedia), sharks (Carcharhiniformes), sirenians (Sirenia), and Orectolobiformes, were analyzed on a smaller scale. Terrestrial turtles (Testudines) had the lowest representation among the included studies (Fig. 8).

Among the analyzed studies, the presence of plastics in seabird nests was documented (5), as was the

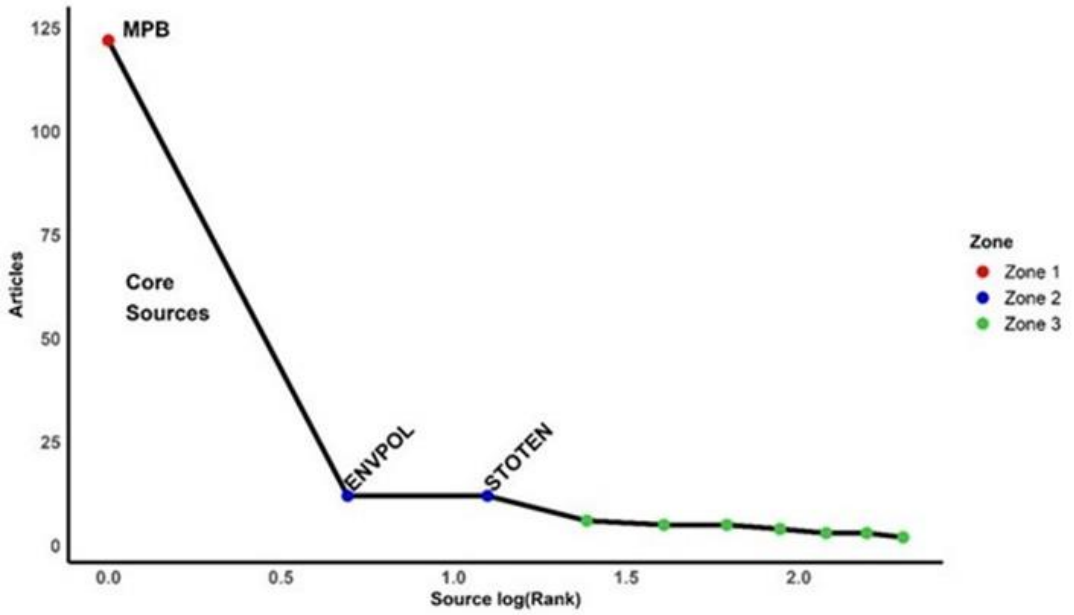

Figure 5. Distribution of scientific output according to Bradford's Law. Zone 1 (red) represents the core journal with the highest number of publications, Marine Pollution Bulletin (MPB). Zone 2 (blue) includes other high-output journals such as Environmental Pollution (ENVPOL) and Science of the Total Environment (STOTEN). Zone 3 (green) comprises the remaining sources with a more scattered distribution of publications.

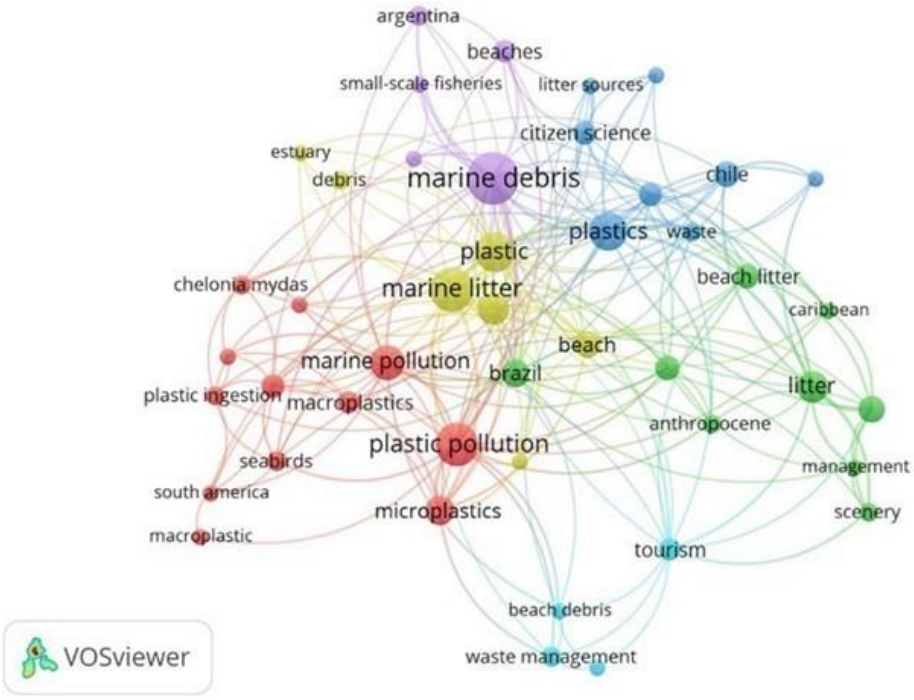

Figure 6. Co-occurrence network of keywords from the analyzed articles, generated in VOSviewer (45 nodes, 222 links, 6 clusters). Nodes represent keywords, and node size reflects term frequency. Connections indicate co-occurrence and colors group related terms (minimum occurrence = 4).

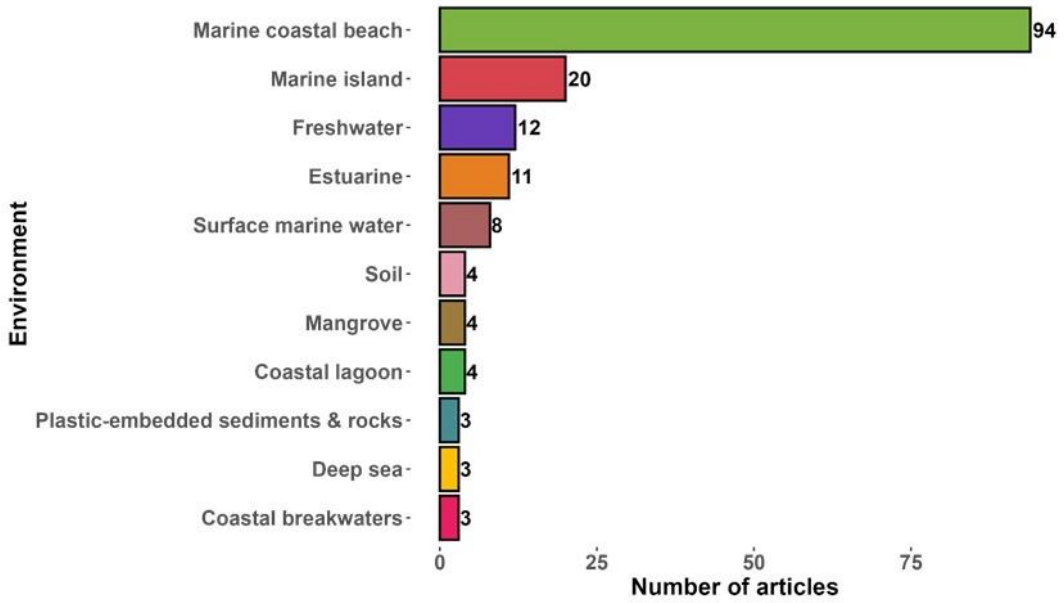

Figure 7. Distribution of studies on plastic pollution across different environments. Marine coastal beaches were the most studied, followed by marine islands and freshwater systems, while deep-sea areas and coastal breakwaters had the fewest studies.

interaction between seabirds and plastic debris (2). Additionally, studies examined plastic ingestion in terrestrial birds (2), ingestion in freshwater birds (2), and investigated the interaction of plastics with freshwater birds (1). Furthermore, seven studies were identified that explored the interaction between invertebrates and plastic items.

Keyword co-occurrence analysis - studies main themes

The final network comprised 45 keywords connected by 222 links (total link strength = 362.0), organized into six clusters (Fig. 6, Table S3). In the dataset analyzed, the central theme was marine pollution, as terms such as marine debris (41 occurrences; 57 connections), marine litter (29; 42), and plastic pollution (28; 42) formed the main interconnected nodes. Plastics (48 connections), plastic debris (14), and microplastics (23) also appeared in the network but sit more peripherally to these core themes. Macroplastics were less frequent overall (7 occurrences; 9 connections). Keyword frequencies also evolved across the overlay window (~2010-2022). Early emphasis was on debris around 2010 (2009.8, representing the mean publication year for studies using that keyword, expressed in decimal-year format), followed by marine pollution around 2020 (2020.11). Marine debris and plastic pollution averaged near 2020 (2019.56) and 2021 (2021.07), and the most recent terms include macroplastics (2021.57, ~2022) and waste management (2021.16, ~2021).

Consistent with these metrics, the thematic clusters are as follows: i) purple (baseline monitoring): a cluster centered on marine debris that links generic debris terms to coastal settings (beaches) and country tags such as Argentina, often coupled with small-scale fisheries, characterizing shoreline surveys and status assessments, ii) red (organism impacts): plastic pollution, marine pollution, macroplastics and microplastics connect to endpoints including plastic ingestion, seabirds and *Chelonia mydas*, indicating exposure pathways and biological effects documented mainly for South America, iii) blue (beach litter and source attribution): plastics, beach, litter sources, citizen science and Chile group together, reflecting programs that quantify macrolitter on beaches and infer provenance, iv) green (management and place): terms such as litter, Anthropocene, Brazil, Caribbean and beach emphasize policy-relevant diagnostics along populated coasts and regional framing of the issue, v) yellow (bridging hub): high-frequency anchors (marine litter, plastic) connect measurement, impact and management strands, acting as the network's integrative core, vi) light blue (tourism and waste): tourism, beach debris and waste management co-occur, pointing to operational and governance responses linked to recreational settings. (Fig. 6, Table S3).

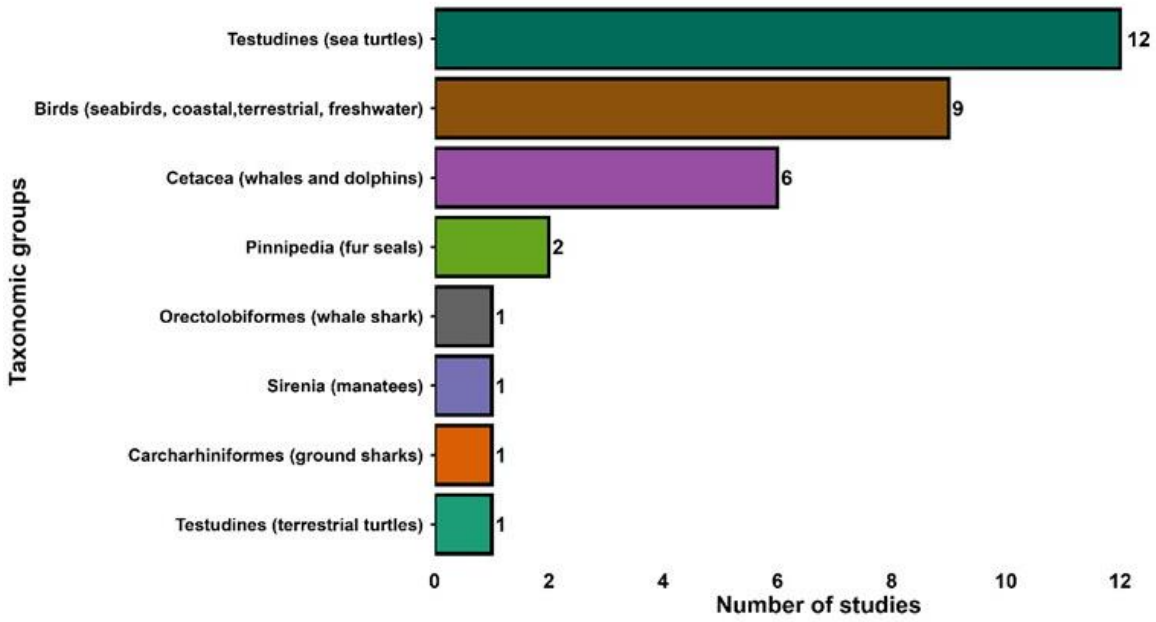

Figure 8. Studies quantifying macroplastic ingestion by taxonomic group in Latin America and the Caribbean (1993-2024; *N* = 33). Sea turtles (12), birds (9), cetaceans (6), fur seals (2), whale shark, manatees, ground sharks, and terrestrial turtles (1 each). Common names are given in parentheses.

The citation analysis revealed that the term "anthropogenic marine debris" had the highest average number of citations per article (133.75), followed by "debris" (87.2) and "marine pollution" (18.77). Additionally, keywords related to ecological impacts, such as plastic ingestion and bioaccumulation, yielded average citation counts of 30.2 and 34.5, respectively.

In the keyword co-occurrence network, country and region-related terms such as Brazil (15 connections; average publication year 2018.41; 42.41 citations per article), Colombia (9 connections; 2019.72; 43.81 citations) and Argentina (5 connections; total link strength = 8; 6 occurrences; average publication year = 2019.17; average citations = 36.17) appear as prominent thematic nodes. Terms referring to broader regions, including the Caribbean (6 connections; 2020.5; 17.25 citations) and South America (7 connections; 2020.25; 33.75 citations), were also represented (Fig. 6).

DISCUSSION

Collectively, our mapping shows a pronounced post-2013 expansion of macroplastic research in LAC (Fig. 3), alongside persistent asymmetries in where and how knowledge is produced. Output is concentrated in a small set of journals (Fig. 5) and a narrow author core (Fig. 4), and stems from only 17 of 33 countries, with Brazil, Chile, Argentina, and Colombia leading. Empirical work remains dominated by beach-centered marine settings, whereas freshwater, estuarine, deep-sea, and engineered shorelines are comparatively understudied, with few empirical analyses to date (Fig. 7). The field's thematic structure is anchored in marine debris/litter and organism-impact nodes, with management and citizen-science strands gaining traction only in recent years (Fig. 6). Ingestion reports focus largely on sea turtles, birds, and cetaceans. In contrast, pinnipeds, sharks, and freshwater taxa have received limited empirical attention (Fig. 8).

Temporal trends and biases in scientific production

The growing number of publications reflects an awareness of the visible and tangible impacts of macroplastics in aquatic ecosystems, and it also exposes a significant gap in the integrative study of plastic pollution across different size classes in the region. Only a small proportion of studies addressed the full spectrum of plastic debris, ranging from microplastics to megaplastics, and an even smaller fraction included nanoplastics in their analyses. This lack of integration reflects a broader structural gap in global research, wherein intermediate-sized plastic fragments remain largely underexplored despite their

fundamental role in the physicochemical degradation continuum from macro- to micro- and nanoplastics (Shi et al. 2023), with the latter reflecting broader scientific limitations in the detection, characterization, and contextualization of nanoplastics within environmental systems, as highlighted by Mitrano et al. (2021). This fragmented approach limits our understanding of the cumulative and potentially synergistic effects of plastic particles of varying sizes within aquatic environments. The scarcity of studies examining multiple plastic size fractions, particularly the smallest and most bioavailable forms, highlights the need for more holistic and interdisciplinary research efforts in Latin America (Fig. 2). Addressing this gap is essential to support regionally relevant risk assessments, inform public policies, and develop effective mitigation strategies adapted to the socio-environmental realities of Latin American countries.

Additionally, scientific production exhibits a notable geographic asymmetry, with 78.3% of studies concentrated in just four countries: Brazil, Chile, Argentina, and Colombia. It should be noted, however, that these four countries alone account for 65% of the total surface and 51.3% of the total population of LAC countries.

The increase in the production of articles from 2013 onwards may be linked to the rise of global policies aimed at reducing plastic use due to its impact on ecosystems. This time-series profile with slow growth up to the early 2010s followed by a marked post-2013 acceleration mirrors global syntheses of plastic-pollution research that document a steep expansion during the 2010s (Kasavan et al. 2021). According to Xanthos & Walker (2017), numerous international regulations restricting the use of plastic bags and microplastics were introduced during this period, leading to increased scientific interest in evaluating their environmental impacts. In 2019, the COVID-19 pandemic led to a sharp increase in plastic production and waste, particularly medical waste (Benson et al. 2021, Shams et al. 2021), further intensifying environmental contamination and exposing gaps in plastic regulation in vulnerable regions such as LAC (Alfonso et al. 2021), which likely contributed to renewed publication growth on the long-term consequences of plastic accumulation as research funding and attention shifted back from COVID-19 (Riccaboni & Verginer 2022). However, LAC still exhibits lower output than Europe and Asia (Kasavan et al. 2021). Authorship was highly skewed, consistent with Lotka's law, with many sporadic contributors and a small core of highly productive researchers (Fig. 4).

The analysis of scientific journals revealed a high concentration of publications in three key sources, corresponding to Bradford's Zones 1 and 2 (Bradford 1934, Xue 2024) (Tables S1-S2). This distribution follows the Bradfordian pattern, in which a limited number of journals account for the majority of publications, reinforcing the unequal distribution of scientific literature. These findings are consistent with previous studies (Aretoulaki et al. 2020, de Deus et al. 2024, Noman et al. 2024).

The predominance of Marine Pollution Bulletin can be attributed to its focus on marine contamination and the environmental impacts of anthropogenic pollutants, which align with the dominant themes of the analyzed publications. This strong concentration of articles in a specialized journal further underscores the emphasis on studies of coastal and oceanic pollution. The keyword co-occurrence analysis further corroborates this thematic focus.

Knowledge gaps and directions for future research

This mapping reveals several overarching gaps. First, environmental coverage: freshwater, estuarine, deep-sea, and artificial coastal structures remain comparatively underrepresented relative to beaches and other nearshore marine settings (Fig. 7). Second, trophic and taxonomic breadth: evidence concentrates on sea turtles, birds, and cetaceans, with limited coverage of pinnipeds, sharks, sirenians, invertebrates, and freshwater taxa (Fig. 8). Finally, geographic representativity: coverage is uneven; eligible records were found for 17 of the 33 LAC countries included in our search string, and several Central American and insular Caribbean nations contributed at most single records or none at all. Figure 2 summarizes country-level profiles.

While coastal areas are well-known accumulation points (Schwarz et al. 2019), growing evidence indicates that rivers can act as temporary reservoirs for macroplastics, with retention modulated by riparian vegetation, hydrodynamics, and channel geomorphology (van Emmerik et al. 2022). This perspective implies that fluvial retention may be underestimated, with consequences for budget estimates of river-to-sea fluxes. Supporting mechanisms have been documented in estuarine and island settings, where vegetated habitats retain more debris than unvegetated areas (Gonçalves et al. 2020, Portz et al. 2022). This finding highlights the likelihood of similar mechanisms occurring in freshwater environments.

Geographically, evidence is concentrated in a small subset of South American producers, with Brazil and Chile as the main hubs and Argentina, Colombia, and

Ecuador showing moderate coverage. Beyond this core, contributions become scattered, with only occasional case studies from parts of the Andean region, Mexico, and Central America. Several insular Caribbean nations, such as The Bahamas, Saint Lucia, Dominica, and Trinidad and Tobago, are represented by isolated single reports. A group of 15 countries yielded no eligible records under our criteria (Bolivia, Cuba, the Dominican Republic, Haiti, Nicaragua, Paraguay, Venezuela, Barbados, Grenada, Guyana, Jamaica, Saint Kitts and Nevis, Saint Vincent and the Grenadines, Suriname, and Antigua and Barbuda). Together, these patterns indicate that large portions of LAC remain lightly sampled or unrepresented, limiting regional inference and hampering coordinated monitoring efforts.

Two process domains are especially sparse across LAC. Macroplastic fragmentation has only incipient documentation in coastal and agricultural environments (Zadjelovic et al. 2023, Corradini et al. 2024). Trophic transfer is supported by a single terrestrial food-web case study (Huerta-Lwanga et al. 2017). Regional coverage is patchy across both topics, limiting inference about ecological fate and risk.

Citizen science remains underused and beach-centric in LAC. Expanding co-designed, quality-controlled protocols to rivers, estuaries, and inland wetlands would broaden spatial coverage and reduce costs while maintaining data verifiability.

Study limitations

This review has several inherent limitations. First, our analyses depend on the coverage of WoS, Scopus, and SciELO, which may exclude locally published or non-indexed studies from smaller institutions in the region. In addition, scientometric outputs are sensitive to search strategies and metadata quality: small changes in search strings or subject categories can substantially alter the composition of the corpus (Zupic & Čater 2015). For example, we did not include the terms "waste management" or "standardization" in our search, as they were not our primary focus. However, these terms are linked to macroplastics research, and their inclusion might have resulted in a different corpus that could eventually become the focus of new research. Moreover, in plastic pollution research, terminology has evolved rapidly and remains only partially standardized, which may affect term frequencies, cluster membership, and the reproducibility of scientometric outputs (Klarin 2024). We've tried to illustrate this with the evolution of co-occurrences over time in the "Keyword co-occurrence analysis - studies main themes" section.

Another limitation concerns citation-based biases, which affect rankings and measures of research influence. Citation counts reflect visibility, accessibility, social dynamics, and disciplinary norms rather than scientific quality (Bornmann & Daniel 2008, Waltman 2016). Older papers have had more time to accumulate citations ("age bias"), review articles tend to dominate citation landscapes, and high-income countries receive disproportionate citation flows (Larivère et al. 2013). These patterns can overshadow emerging research from underrepresented countries such as Caribbean Island Nations and others previously mentioned in the discussion. Such biases can generate misleading signals about influential themes or core literature in plastic pollution research.

Finally, scientometric methods rely heavily on co-occurrence relationships, which may imply conceptual associations that are not necessarily meaningful. The joint appearance of two keywords in the same article does not guarantee substantive thematic linkage; it may simply result from generic methodological descriptions, the structure of review papers, or the small size of subfields (Scharp 2021). Consequently, clusters generated by tools such as Bibliometrix and VOSviewer can oversimplify the conceptual structure of interdisciplinary domains, such as macroplastic sources, their transport, and their impacts on biodiversity, certainly linked to the interpretation of the co-occurrences network by the authors. We tried to overcome this limitation by carefully examining co-occurrences across the selected papers.

Credit author contribution

A.L.G. Camargo: conceptualization, methodology, formal analysis, investigation and writing - original draft; B.R.S. Figueiredo, A.C.M. Silva, and D.S. Caixeta: conceptualization, writing - review and editing; G. Staichak, N.A. Garello, and M.C.M. Blettler: conceptualization, methodology, writing - review and editing; P. Girard: conceptualization, investigation, supervision, writing - review and editing.

Declaration of competing interest

The authors declare no conflicts of interest.

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