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Bibliometric Analysis and Research Trends on Microplastic Pollution in the Soil and Terrestrial Ecosystems

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Environmental pollution from microplastics (MPs), an anthropogenically mediated menace to the biosphere, is a global concern. This research conducted a bibliometric analysis of MPs in soil and terrestrial ecosystems using R software and biblioshiny to analyze descriptive statistics, author contributions, documents, and conceptual structures. The Scopus database was selected, and various keywords optimized the search. An analysis of research trends divided the timeline into three periods: period I (2012–2018), period II (2019–2021), and period III (2022). Results showed Wang J. as the author with the highest h-index, while Science of the Total Environment had an h-index of 43. In period I, research focused on MPs and plastic pollution, raising questions about their impacts on terrestrial ecosystems. Research found that MPs negatively affected soil organisms by decreasing growth rates and causing weight loss. In period II, research diversified, exploring interactions between MPs and heavy metals, bioaccumulation, phytotoxicity, soil pollution, and gut microbiota. Research revealed that MPs could influence heavy metal uptake by plants and affect bacterial community structures in soil. In period III, research emphasized oxidative stress, a common ecotoxicity response in plants and animals. MPs induced oxidative stress, leading to reactive oxygen species (ROS) buildup. Polyethylene MPs were more toxic to plant seedlings than polystyrene and polypropylene, causing significant oxidative stress. Similarly, oxidative stress impacts on soil organisms were highlighted when exposed to MPs and pesticides. Research in this area is expected to continue growing, aiding in delineating distinct research paths, particularly focusing on oxidative stress, bioaccumulation, and heavy metals.

Keywords: bibliometric analysis, bibliometrix, microplastics, soil, terrestrial ecosystem.

Introduction

Plastics have emerged as the predominant materials of the modern era, and their worldwide production has dramatically increased to accommodate the burgeoning demand for these highly versatile substances (Bakir et al., 2012). Their widespread popularity stems from their ease of use, durability, and cost-effectiveness (Wijesekara et al., 2018). However, the pervasive utilization of plastics across various sectors of society has led to substantial plastic waste in natural environments (Rillig, 2012). It is estimated that approximately 60–80% of anthropogenic waste in aquatic and terrestrial ecosystems is plastic (Derraik, 2002).

Microplastics (MPs) are plastic particles ≤ 5 mm (Blettler et al., 2017), encompassing various shapes including fragments, films, fibers, foams, pellets, as well as polymerpolymer components like polyethylene (PE), polypropylene (PP), polyvinyl chloride (PVC), and polystyrene (PS) (Qiu et al., 2022).

There is a worldwide consensus on the importance of studying microplastic pollution in aquatic environments; however, most marine microplastic pollution originates from land, with approximately 0.013 to 0.034 Mt of plastics being transferred to marine ecosystems annually (Haward, 2018). In addition, since the annual release of plastics in the soil is 4 to 23 times greater than in the oceans (Nizzetto et al., 2016), the research focus has shifted from primarily studying MPs in water systems to increasingly investigating their presence and impacts in soil systems over the last decade (Sun et al., 2022). The presence of small plastic debris in the ocean was first highlighted in the 1970s (Carpenter and Smith, 1972), and since then, microplastic pollution has been extensively studied in aquatic environments, mainly in the sea. However, recognizing the greater magnitude of plastic pollution in terrestrial environments has prompted a shift in research efforts toward understanding and addressing this emerging issue in soil ecosystems.

The terrestrial ecosystem is characterized as a complex system encompassing soils, vegetation, other biotic components, and the intricate ecological, biogeochemical, and hydrological processes operating within these elements (Reynolds, 2013). MPs accumulation in the terrestrial ecosystem can occur via primary sources, involving the direct introduction of micrometer-sized particles from various industrial activities (Horton et al., 2017), or secondarily through the physical, chemical, and biological fragmentation of larger plastic debris, referred to as macroplastics (de Souza Machado et al., 2019).

MPs can impact ecosystems adjacent to marine environments, like beaches (Mesquita et al., 2022), even on rocks (De-la-Torre et al., 2022). These particles may adopt a form known as "pyroplastics", characterized by a single neutral color derived from melted plastic that was subjected to prolonged environmental conditions (Turner et al., 2019). Moreover, MPs, which can be transported over long distances (Evangeliou et al., 2020; Allen et al., 2021), including through atmospheric deposition (Ryan et al., 2023) and riverine transport, have the potential to extend their presence to various ecosystems beyond marine environments, thus posing threats to terrestrial ecosystems as well.

In terrestrial ecosystems, MPs can have negative effects on plants (Chang et al., 2022), since they can absorb heavy metals and increase phytotoxicity (Kumar et al., 2022), inhibiting root growth, aerial growth of the plant, photosynthetically active radiation, and net photosynthesis (Zhao et al., 2023). Furthermore, MPs can affect soil properties including pH, soil bulk density, soil water capacity (de Souza Machado et al., 2018; Dissanayake et al., 2022), soil enzyme activity (Yu et al., 2020; Liang et al., 2021; Pinto-Poblete et al., 2022), and soil organic matter, since MPs can contain inert carbon with long-term stability, which can alter the content of soil organic carbon (SOC) and influence the carbon cycle in many ways, including increasing the content of carbon dioxide, affecting the microbial process (Rillig et al., 2021; Yang et al., 2022). Likewise, MPs influence the nitrogen cycle (Shen et al., 2022), and a possible cause is that according to their type of polymer, and concentration, they act as organic substrates and release certain additives influencing nitrogen-fixing bacterial communities in the soil (Seeley et al., 2020). MPs can enter the soil surface, or enter the deep layers through tillage, so they can be ingested by animals, including annelids (Amorim and Scott-Fordsmand, 2021), and nematodes like *Caenorhabditis elegans* (Höss et al., 2022; Qu et al., 2022). Animals like earthworms, including *Eisenia fetida*, can also ingest and egest MPs, often serving as indicators in ecotoxicological research worldwide (Gao et al., 2022; Li et al., 2022; Huang et al., 2013).

Understanding the origins, applications and impacts of MPs in soil is crucial. Bibliometric analysis is a published record mapping tool, and it has been widely recognized as an alternative method for evaluating academic topics (Zhao et al., 2018). It helps to identify current research trends, provides insights into specific and general aspects over time, and contributes to the development of significant areas (Virú-Vásquez et al., 2022). It utilizes statistical analysis and quantitative research publications to present quantified data in evaluating research trends (Mao et al., 2018; Mallawaarachchi et al., 2020). While several bibliometric and review studies have examined plastic pollution in marine ecosystems (Wu et al., 2021; Papadimitriu and Allinson, 2022), similar studies in terrestrial ecosystems remain limited. Thus, this research aims to summarize the current accessible information on MPs and evaluate their various applications in soil and terrestrial ecosystems. The objectives of this research are to address the questions:

- What is the annual trend of production of documents related to MPs in terrestrial ecosystems?
- What are the most relevant authors, institutions and sources, impact, and production over the years?
- What is the conceptual structure, the most relevant words, and the Spectroscopy of the Year of Reference Publication (SYRP)?
- What are the hotspots and difficulties that are suggested to increase the current research on terrestrial MPs?

Methods

The bibliometric analysis of the research followed the procedures described by Zupic and Čater (2015), comprising the steps below:

a) Study design. Research questions were defined, and the appropriate bibliometric methods were chosen (Aria and Cuccurullo, 2017). The Scopus database was selected for this research. The keywords used to generate the dataset were as follows: (KEY (microplastic OR microplastics OR nanoplastic OR nanoplastics) AND KEY (terrestrial AND ecosystem OR terrestrial AND system OR soil OR plant OR inland OR earthworm OR mosses OR nematode OR land OR fungi OR agroecosystem)) AND PUBYEAR < 2023.

b) Data analysis. This study utilized the bibliometrix R-package (Aria and Cuccurullo, 2017) for bibliometric analysis. Additionally, biblioshiny, a shiny app providing a web interface for bibliometrix was employed (Secinaro et al., 2020). All articles downloaded in CSV format were processed both qualitatively and quantitatively.

c) Data visualization. It was conducted to analyze the bibliometric data from all 239 articles obtained. This analysis included an overview of information including annual scientific production. It also involved an analysis of author impact metrics, including the h-index, which means a set of papers that have an h-index if those papers have at least h citations (Hirsch, 2005); the g-index, which means that a set of papers has a g-index, if they have at least g^2 citations (Egghe, 2013); the m-index, which means a relation between the h-index and the number of years since the first publication (by the author); author production over time, based on citations per year and totals. Furthermore, the Lotka Law was included. This law is intended to measure the productivity of authors by explaining the relationship between the number of authors and articles (Lotka, 1926). The Lotka law of scientific productivity is a bibliometric example of such empirical observations: the number of authors against the number of contributions made by the authors was plotted on a logarithmic scale (Kawamura et al., 2000) and mathematically it is represented as follows in Equation (1):

$$A_N = A_1 / N^C \quad (1)$$

Where: A_N it is the number of authors publishing N papers; A_1 it is the number of authors publishing one paper; C it is a parameter to estimate depending on the data and N: 1, 2, 3, ... n (Simont, 1955; Bookstein, 1977).

In the section of sources, the analysis included sources impact, based on some index, total citations, and the Bradford Law. The Bradford law is a pattern first described by Bradford (1934), and it estimates the exponentially diminishing returns of searching for references in science journals. According to Bradford law, if if journals within a specific field are sorted by the number of articles they publish, they can be divided into three groups, each comprising approximately one-third of the total articles in that field. This relationship is mathematically expressed in Equation (2):

$$k = (e^{\gamma} Y_m)^{\frac{1}{p}} \quad (2)$$

Where: γ is 0.578; Y_m is equal to the maximum productivity of the first magazine; P is the number of groups (Andrés, 2009).

For documents, the most cited documents and the Spectroscopy of the Year of Reference Publication (SYRP) were shown. SYRP is a bibliometric method used to analyze the historical origins of research fields or researchers by examining cited references and the referenced publication years of a publication set (Thor et al., 2018). Additionally, a word cloud illustrates the distribution of keywords in terms of percentage. The conceptual structure was presented through the conceptual structure map-method, the thematic map, and thematic evolution. The conceptual structure map-method groups research topics into different research clusters. The thematic map included four zones: i) niche themes, ii) motor themes, iii) emerging or declining themes, and iv) basic themes. Moreover, factorial analysis was presented using the method of multiple correspondence analysis (MCA). Finally, thematic evolution and the difficulties associated with hotspots were analyzed across three periods.

Results and Discussion

Overview

According to *Table 1*, a total of 239 documents were found using the specified keywords. The research spanned from 2012 to 2022 involving 60 sources that contributed to these topics, with an annual growth rate of 54.4% (*Fig. 1*) (r = 0.75). There were 1008 authors, with an international co-authorship of 34.31%. Among

Fig. 1. *Annual scientific production*

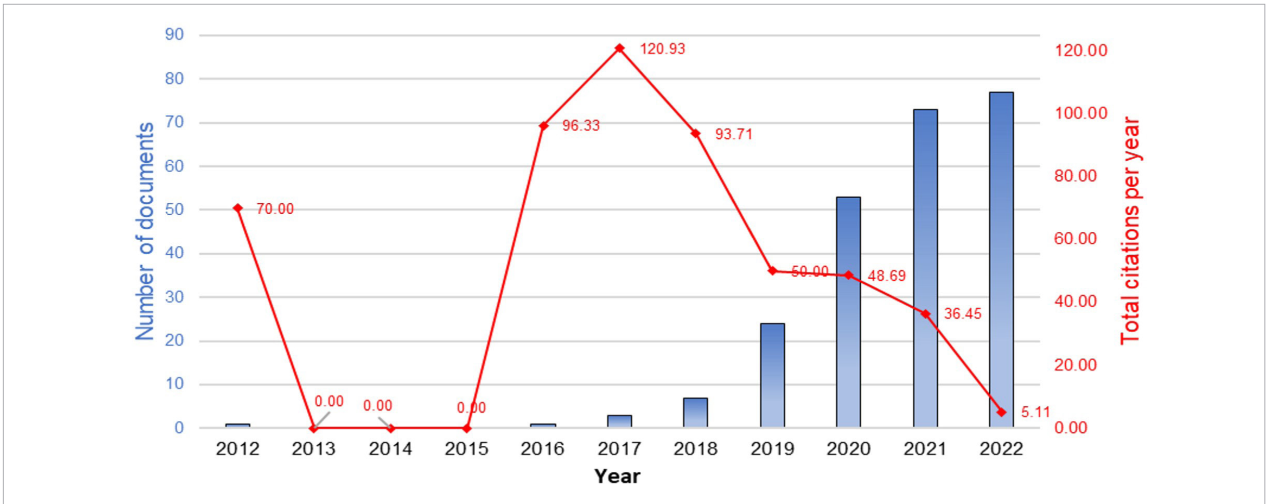


Table 1. *Overview about scientific production*

Description	Results
Timespan	2012:2022
Documents	239
Sources	60
Annual growth rate %	54.4
Average citations per document	73.44
References	15 115
Documents content	
Author's keywords (DE)	668
Authors	
Authors	1008
Authors of single-authored docs	6
Single-authored docs	6
Co-authors per doc	5.89
International co-authorships %	34.31
Document types	
Article	163
Book chapter	2
Conference paper	3
Editorial	1
Review	67
Short survey	3

these, 6 authors were responsible for single-authored documents. The documents included 668 unique author keywords (DE). In terms of document types, there were 163 articles, 2 book chapters, 3 conference papers, 1 editorial, 67 reviews, and 3 short surveys.

Analysis of authors

Fig. 2 shows Wang J. as the author with the most published documents as both main author and co-author. In 2020, Wang J. published a total of 7 articles, generating 217 citations. During this period, his research focused on the effect of MPs on *Eisenia foetida* (Wang et al., 2019; Cheng et al., 2020; Zhou et al., 2020; Li et al., 2021). A continuous trajectory of authors was observed starting from 2016; however, Geissen V. and Yu Y. did not publish any articles in 2022. Wang X. ranked second, while Geissen V., despite publishing few articles (only in 2016 and 2018), garnered a total of 561 and 578 citations, respectively.

Another way to assess the impact of authors is by evaluating their h, g, and m indices, as shown in *Fig. 3*. These different methods of author impact indices are generally proportional to the productivity of the respective authors. *Fig. 3* illustrates the impact of 10 authors using these indices. Wang J. ranks first with an h-index of 15, a g-index of 17, an m-index of 3.75, and a total of 1277 total citations (TC). Geissen V. ranks second, with an h-index of 9, a g-index of 10, an m-index of 1.29, and a total citation count of 1804, which is much higher than that of all the other authors.

The application of the Lotka Law is shown in *Fig. 4*, illustrating the number of articles contributed by each author. Authors contributed between 1 and 21 papers. It is shown that a large number of authors contributed a small number of articles, while a small group contributed a large number of articles. Specifically, 821 authors (81%) contributed at least 1 article, 98 authors (9.7%) contributed at least 2 articles, and only 1 author (0.1%) contributed at least 21 articles.

Analysis of sources

Another way to measure impact is through the analysis of sources, which determines the position of certain sources in specific aspects of science, including research on MPs in terrestrial environments. *Fig. 5* shows the sources with their respective h-index, g-index, and total citations (TC). Science of the Total Environment leads the list with an h-index of 43, a g-index of 75, an m-index of 6.14, and a TC of 7200. According to the Bradford Law, relevant journals can be divided into three groups, with each group contributing approximately one-third of all articles in a specific research area (Kilicoglu and Mehmetcik, 2021). As shown in *Fig. 6*, Science of the Total Environment and Environmental Pollution were the most relevant journals in this field.

Fig. 2. *Top author´s production over time*

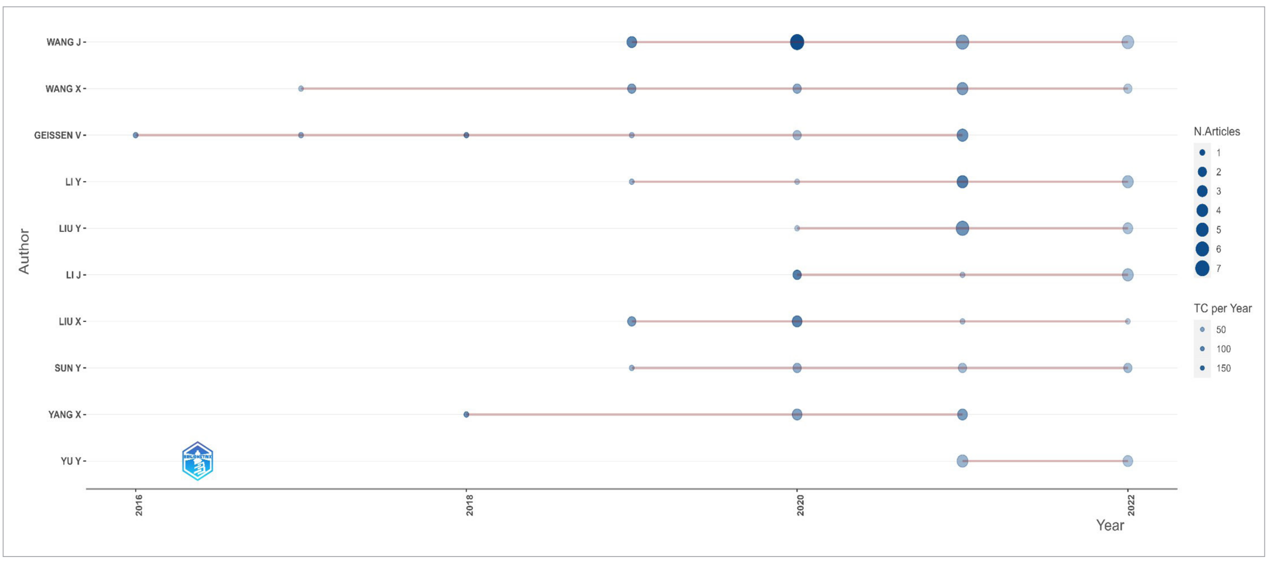


Fig. 3. *Author impact*

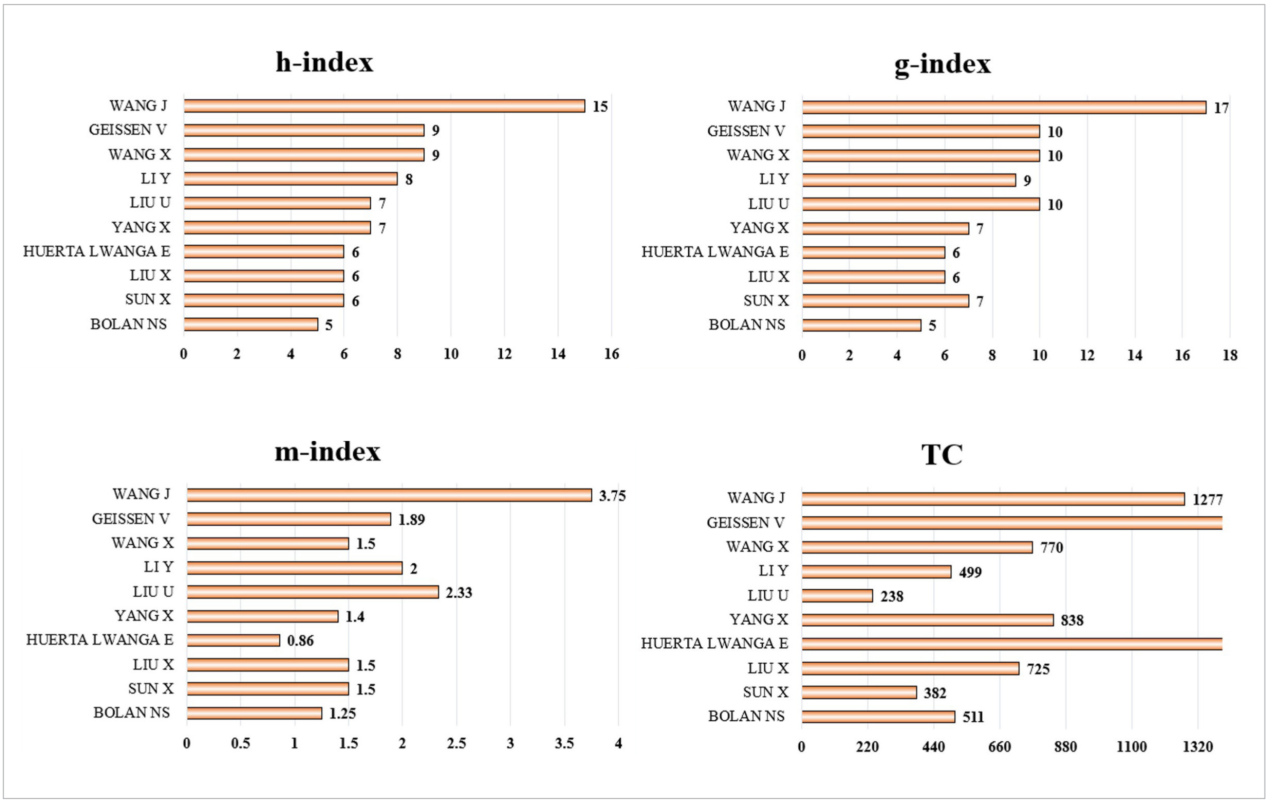


Fig. 4. *Author productivity through the Lotka Law*

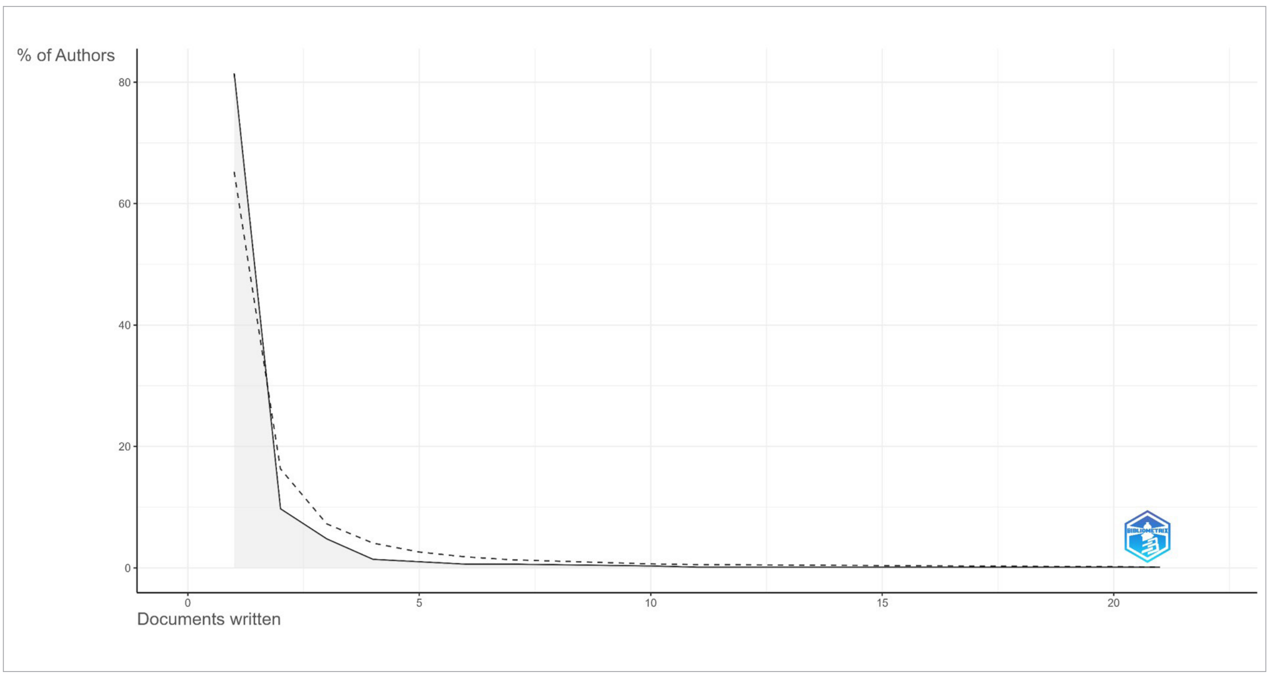


Fig. 5. *Sources impact*

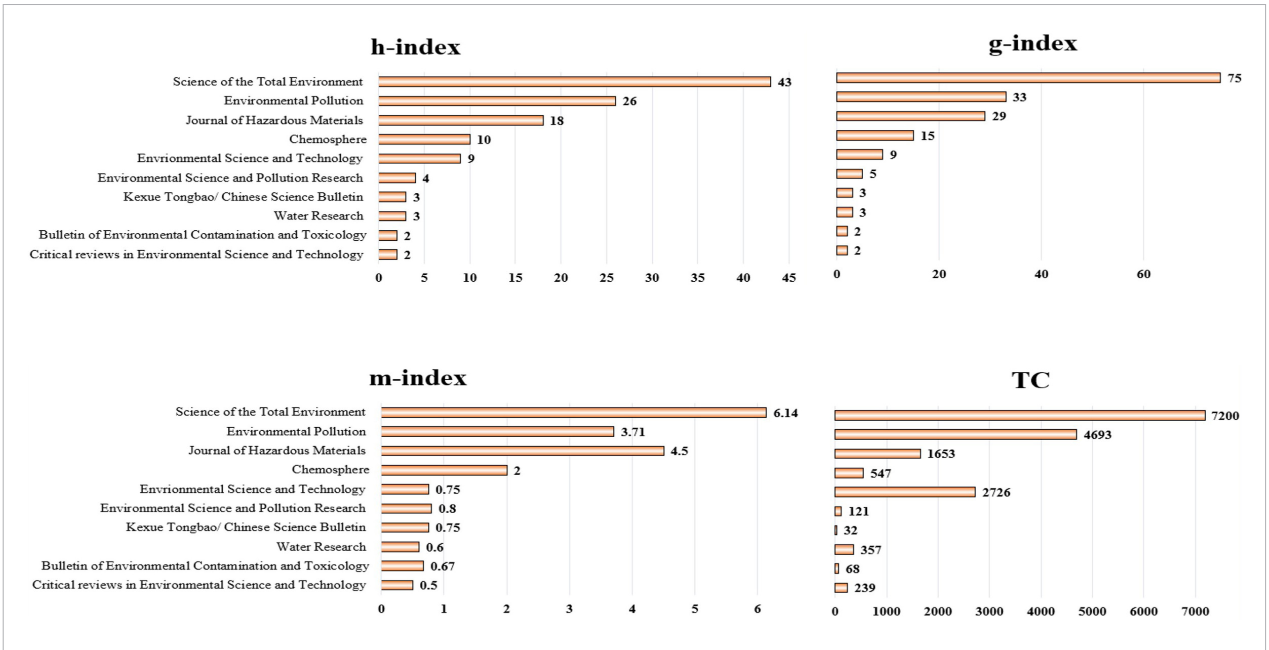
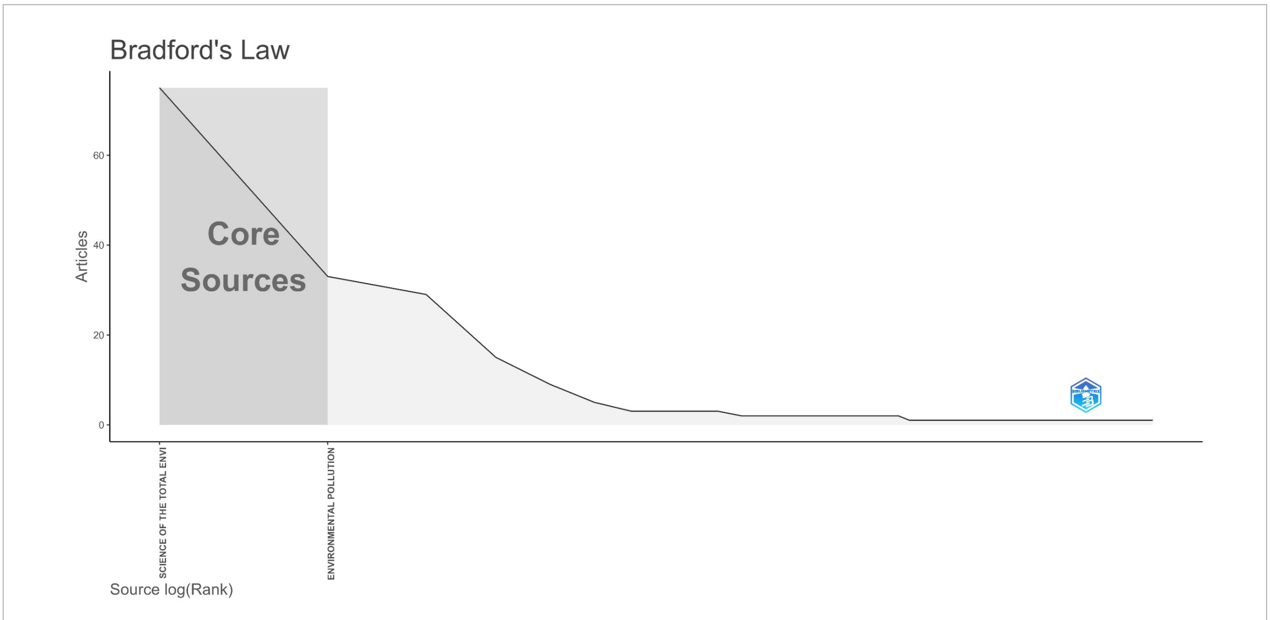


Fig. 6. *The Bradford law*



Analysis of documents

In bibliometric analysis, consulting and analyzing the most cited documents is practical, as illustrated in *Table 2*, which lists the title, sources, keywords, type, and total citations (TC). The article by Horton et al. (2017) ranks first with the highest TC. This review article examines the literature, behavior, and fate of MPs in freshwater and terrestrial environments, focusing on issues including nanotechnology, agriculture, and waste management. Another review article by Ng et al. (2018) evaluated the mechanisms and dynamic behavior of plastic particles in agroecosystems, considering

Table 2. *Most cited documents*

Rank	Tittle	Source	Keywords	Type	TC	Reference
1	Microplastics in freshwater and terrestrial environments: Evaluating the current understanding to identify the knowledge gaps and future research priorities	Science of the Total Environment	Plastic pollution; nanoplastics; litter; rivers; soil; hazard	Review	1352	Horton et al. (2017)
2	Microplastic in Terrestrial Ecosystems and the Soil?	Environmental Science and Technology	Not found	Viewpoint	700	Rillig (2012)
3	Microplastics in the Terrestrial Ecosystem: Implications for *Lumbricus terrestris* (Oligochaeta, Lumbricidae)	Environmental Science and Technology	Not found	Research Article	578	Huerta Lwanga et al. (2016)
4	An overview of microplastic and nanoplastic pollution in agroecosystems	Science of the Total Environment	Soils; plan response; ecotoxicology; soil food web; plastic degradation	Review	561	Ng et al. (2018)
5	Microplastic and mesoplastic pollution in farmland soils in suburbs of Shanghai, China	Environmental Pollution	Microplastics, mesoplastics, soils, farmland, terrestrial ecosystem	Research Article	505	Liu et al. (2018)
6	Microplastics Can Change Soil Properties and Affect Plant Performance	Environmental Science and Technology	Not found	Research Article	498	de Souza Machado et al. (2019)
7	Microplastics research—from sink to source	Science	Not found	Perspective	493	Rochman (2018)
8	Current research trends on plastic pollution and ecological impacts on the soil ecosystem: A review	Environmental Pollution	Plastic pollution; microplastic; soil pollution; plastic waste; terrestrial ecosystem	Review	488	Chae and An (2018)
9	Microplastics in soils: Analytical methods, pollution characteristics and ecological risks	TrAC Trends in Analytical Chemistry	Microplastics; soil; analytical methods; pollution characteristics; ecological risks; terrestrial ecosystem	Review	410	He et al. (2018)
10	Evaluating scenarios toward zero plastic pollution	Science	Not found	Research Article	383	Lau et al. (2020)

the responses of soil organisms and plants. Similarly, Chae and An (2018) discussed plastic contamination in the soil environment and investigated the effects of plastic waste on the soil ecosystem, highlighting studies on microplastic contamination using earthworms and suggesting a need for research on invertebrates and insects. Research articles included Huerta Lwanga et al. (2016), who analyzed the survival of the earthworm *Lumbricus terrestris* exposed to MPs; Liu et al. (2018) evaluated MPs and mesoplastics in farmland soil; and de Souza Machado et al. (2019) assessed the development of *Allium fistulosum* in microplastic-contaminated areas and analyzed soil-plant interactions, including soil microbial communities and plant traits.

The Reference Publication Year Spectroscopy (RPYS) technique, proposed by Marx et al. (2014), analyzes cited references (CR) and referenced publication years of a publication set (Leydesdorff et al., 2016), facilitating the identification of seminal documents within the collection (Marx et al., 2014). *Fig. 7* illustrates the number of cited references (NCRs) per year with a black line, indicating the total documents cited in the collection annually, with years featuring multiple documents cited potentially representing historical roots of the field (Ciavolino et al., 2022). The historical root emerges from 1922 (n = 1), signifying the beginning of theoretical support for research in MPs and terrestrial ecosystems. Limited investigations are evident until 1979, when NCRs began to increase (n = 17), peaking in 2018 (n = 2972). The red line represents the deviation of the 5-year median at the current moment "t" compared to the previous four years (t–1; t–2; t–3; t–4), aiding in identifying publication peaks and comparing each year's publication with significantly more cited documents (Ciavolino et al., 2022). *Fig. 8* displays the word cloud of the analyzed keywords.

Fig. 7. *Reference publication year spectroscopy*

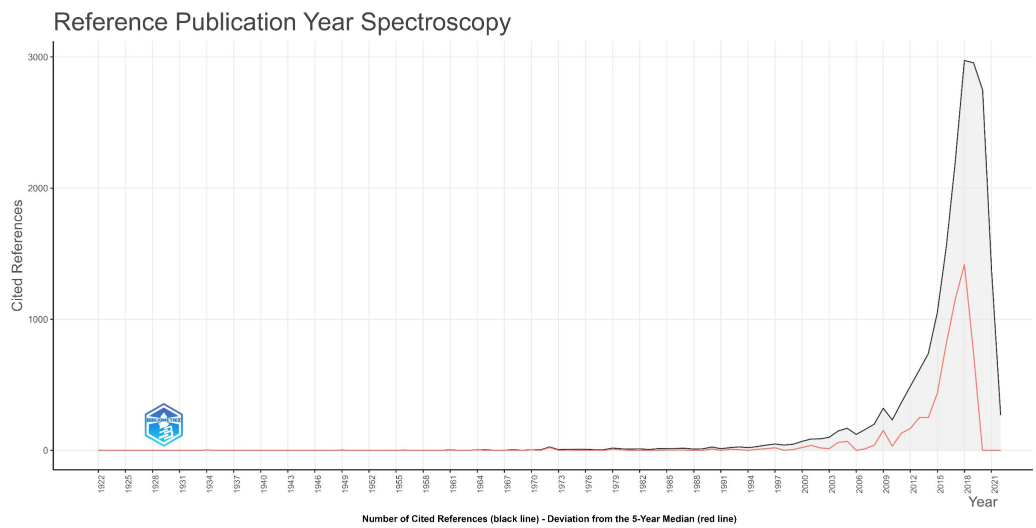


Fig. 8. *Wordcloud*

Analysis of conceptual structure

Multiple correspondence analysis (MCA) is a widely used technique for analyzing categorical data, aiming to condense large sets of variables into smaller components summarizing the information of data (Mori et al., 2016). *Fig. 9* illustrates four clusters represented by different colors. The red cluster predominantly included words related to fields of application like agriculture, terrestrial environments, and soils. The green cluster contained words like “plastic” and “litter”, referring to a broader aspect. The purple cluster was oriented towards sorption mechanisms, transport, and ecological risks. The blue cluster focused on earthworms, toxicity, ingestion, and oxidative stress.

Fig. 10 shows the thematic map, which categorizes the keywords of authors into four sections, effectively emphasizing the relevance of the research field. These sections include: i) motor themes, ii) basic themes, iii) emerging or declining themes, and iv) very specialized/niche themes. Niche themes encompass terms like “toxicity”, “animals”, “earthworm”, and “oxidative stress”. In the green cluster, terms like “risk assessment”, “polystyrene”, and “soil pollutants” represent motor issues, indicating well-developed and significant topics with high centrality and density. Basic topics, like “microplastic”, “plastic”, and “soils”, are found in the lower right quadrant, representing general terms. The lower left quadrant comprises emerging or declining topics, including “environmental monitoring”, “polypropylenes”, and “agriculture”. Additionally, emerging issues like “machine learning” are discussed elsewhere but not presented in this thematic map. For instance, Yu and Hu (2022) suggest machine learning as a potential solution for assessing ecological risks of MPs based on big data, emphasizing the urgent need for universal microplastic collection standards and testing methods. Another notable topic in this section is microplastic contamination in e-waste dismantling areas, with studies conducted in China highlighting the lack of protocols or methodologies to evaluate MPs in these areas (Chai et al., 2020; Zhan et al., 2022).

Fig. 9. *Conceptual structure map-method*

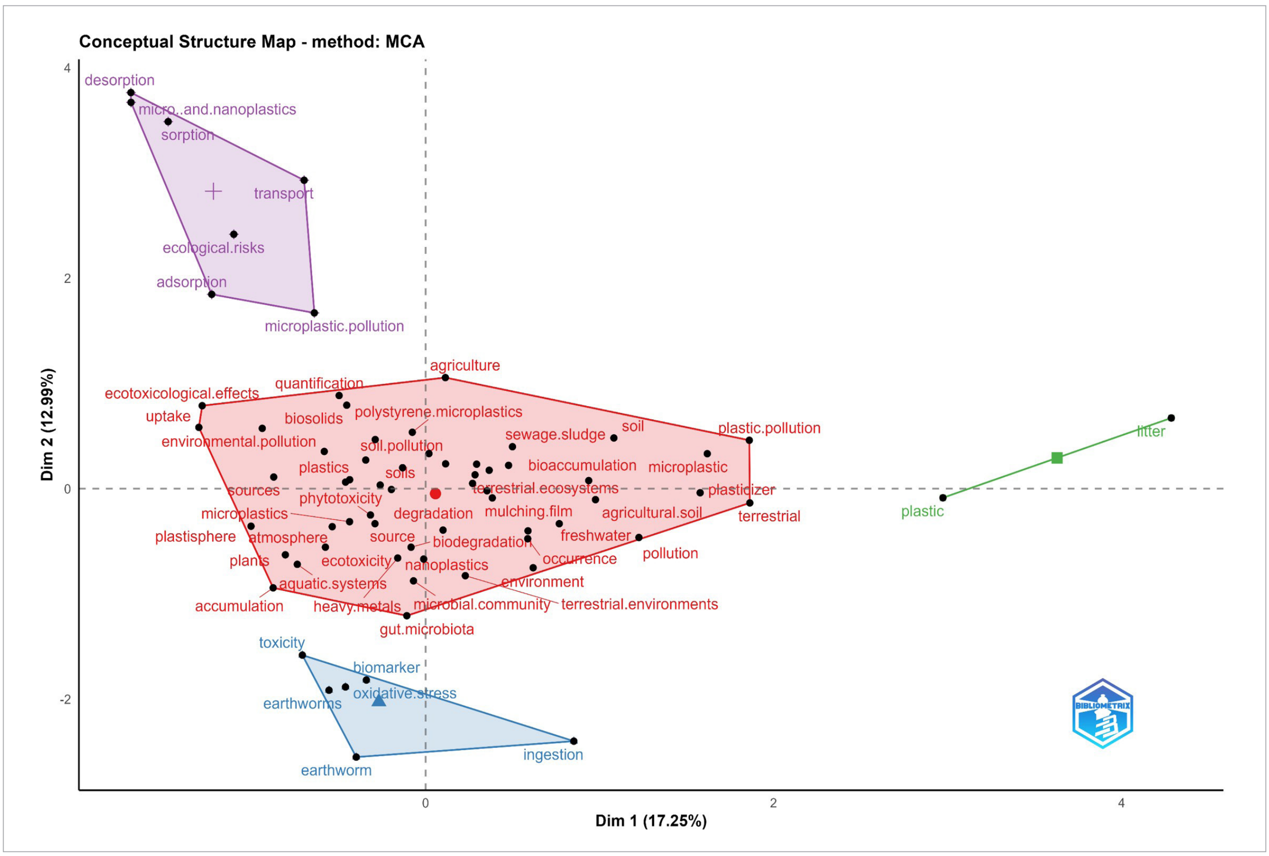
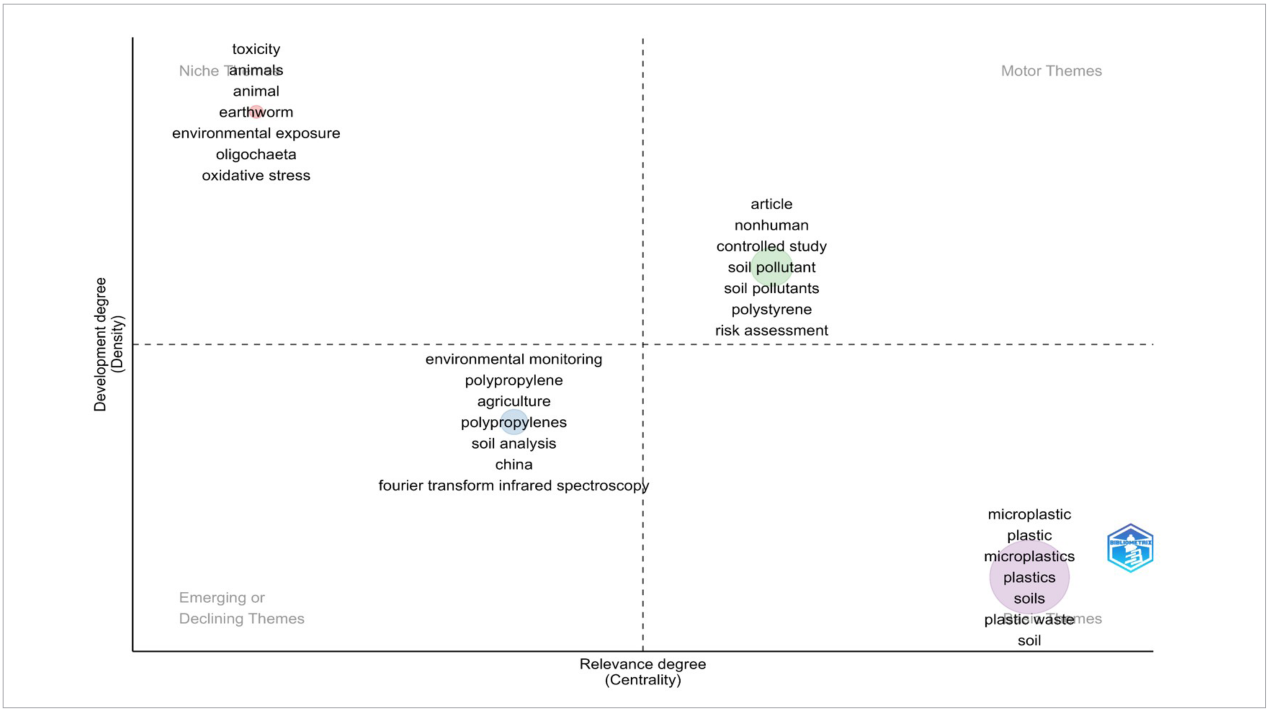


Fig. 10. *Thematic map*



Thematic evolution and research trends

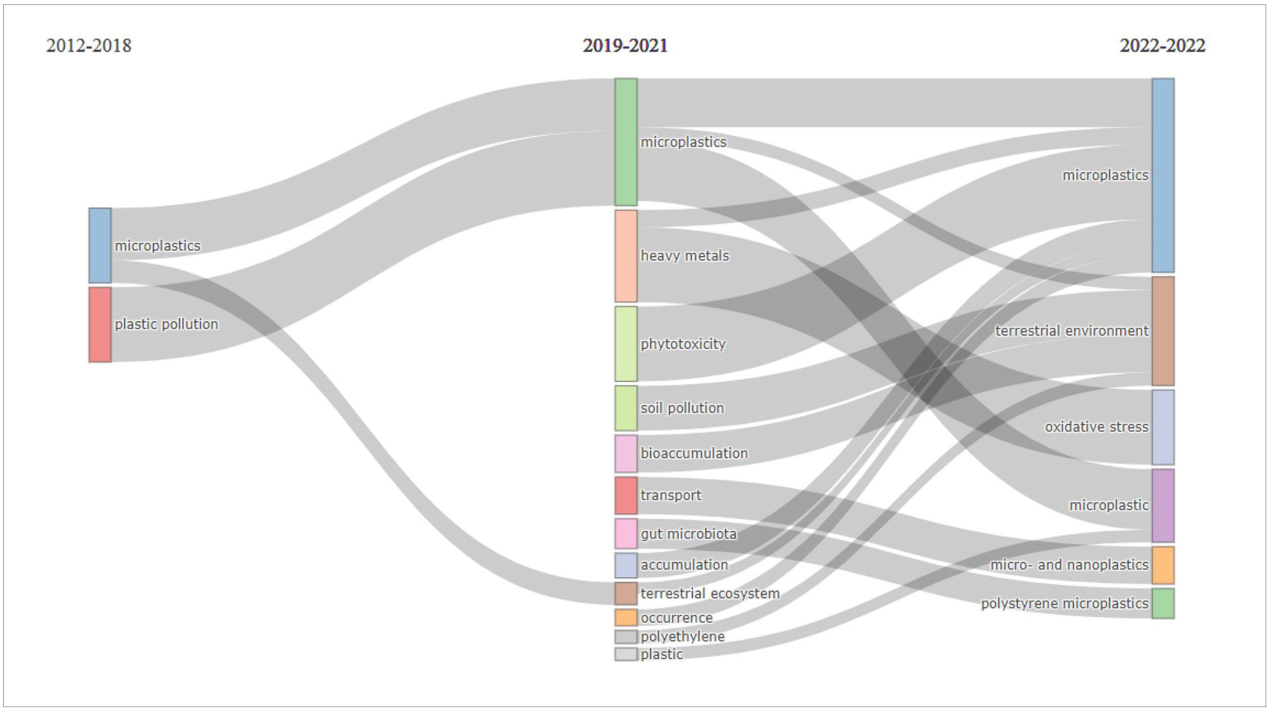
In the thematic evolution section (*Fig. 11*), some articles are analyzed in three periods that comprise period I (2012–2018), period II (2019–2021), and period III (2022).

In the first period, general words are shown, like "microplastics", and "plastic pollution". Topics were addressed, raising questions about how MPs might impact the terrestrial ecosystem or living organisms, and highlighting the growing concern that policymakers should heed (Rillig, 2012). Additionally, the effect of MP on *Lumbricus terrestris* was studied, concluding that MPs have an impact by decreasing the growth rate and causing consequent weight loss (Huerta Lwanga et al., 2016).

For period II, there has been a significant increase in research on various topics related to MPs, like heavy metals, bioaccumulation, phytotoxicity, soil pollution, transport, gut microbiota, accumulation, terrestrial ecosystem, occurrence, PE, and plastic. Regarding heavy metals, the focus was mainly on the interaction between MPs and heavy metals. Heavy metals (Cd, Pb, Hg and Mn) are often inherent to MPs and can impact terrestrial ecosystems (Zhou et al., 2019). Nevertheless, this is not always the case, as Corradini et al. (2021) determine, there is no association between the increase in MPs and the presence of heavy metals. On the other hand, studies have shown that MPs can influence the uptake of heavy metals by plants (Dong et al., 2021a). For instance, Dong et al. (2021b) have demonstrated that MPs could enter carrots since arsenic increases the negatively charged regions of polystyrene MPs and causes deformation of the cell walls. Another study shows that PET particles can act as carriers, transporting heavy metals to the rhizosphere zone of growing wheat (Abbasi et al., 2020).

Regarding bioaccumulation, particularly in agricultural settings, examples include the bioaccumulation of MPs in corn (Urbina et al., 2020) and *Arabidopsis thaliana* (Sun et al., 2020). MPs can interact with organic contaminants, specifically polycyclic aromatic hydrocarbons (PAHs), exhibiting a strong tendency to accumulate in contaminated soils. This is evidenced in the study by Černá et al. (2021). On the other hand, the impacts of MPs on terrestrial systems, particularly on vascular plants such as *Lepidium sativum*, have shown short-term adverse effects on germination and root growth, suggesting that MPs can physically block pores in seed capsules and accumulate in root hairs (Bosker et al., 2019). It has also been demonstrated that nanoplastics

Fig. 11. *Thematic evolution*



can accumulate in terrestrial plants depending on their surface charge, affecting seedling growth and development, with implications for both ecological sustainability and agricultural security (Sun et al., 2020). However, despite these findings, research on the accumulation of MPs in terrestrial ecosystems, especially in agroecosystems, and their impacts on components remains limited. This underscores a significant knowledge gap regarding subsequent risks to human health and agricultural productivity.

Regarding the gut microbiota, which is intricately linked to the health, metabolism, and immune system of the host, as well as to soil decomposition processes (Cheng et al., 2021), there is limited knowledge about the effects of MPs on ambient microbial communities (Wang et al., 2020). Nonetheless, Wang et al. (2020) have demonstrated that the effects of polyethylene MPs significantly altered the structure of the bacterial community and led to an increasingly divergent succession of the bacterial community in the soil.

For period III, some of the topics covered were MPs, terrestrial environment, oxidative stress, microplastic, micro, nanoplastics and polystyrene MPs. The most significant research focused on oxidative stress, which is the most common form of ecotoxicity induced by pollutants in both plants (Morales y Munné-Bosch, 2016) and animals (Browne et al., 2013). Oxidative stress leads to the buildup of reactive oxygen species (ROS), like H_2O_2 and -OH (Bhattacharjee, 2005). Terrestrial plants can take up MPs via the roots or leaves and translocate them to other parts (Wang et al., 2022). In addition, Shi et al. (2022) have conducted research on the toxicity of polystyrene (PS), polyethylene (PE), and polypropylene (PP) MPs at various concentrations (0, 10, 100, 500, and 1000 mg/L) on tomato plants (*Lycopersicon esculentum L.*). Their research determined that PE exhibited greater toxicity to seedling growth than PS and PP. They confirmed that MPs could induce oxidative stress in plants, with PP showing relatively lower toxicity to antioxidant enzymes compared to PS and PE. In animals, MPs have been found to damage various tissue components, inhibiting enzyme activities, and promoting lipid peroxidation effects (Köktürk et al., 2023). Mishra et al. (2022) have evaluated the effects of PVC and PP, both alone and in combination with the pesticide monocrotophos, in soil on tissue protein, lipid peroxidation, and the activities of lactate dehydrogenase and catalase in the epigeic earthworm *Eudrillus eugeniae*. Their findings reveal an increase in oxidative stress and consequent damage to the animal.

Conclusions

There is a relatively growing annual production trend, although the number of articles in general is increasing, with a value of r = 0.75. The most impactful author, based on the h-index, was Wang J., followed by Geissen V. Among institutions, Beijing led with a total of 42 articles. The journal *Science of the Total Environment* had an h-index of 43. It should be noted that the citation rates for the first articles were higher since they consolidated the current bases regarding contamination by MPs in the soil. Although there is increasing research in this field of application, the growth is slow. Based on the SYRP, the historical root arises from the year 1922. Even though the research of MPs in the terrestrial ecosystem is relatively new, the conceptual bases have strengthened and provided theoretical support for many years. Regarding research trends and hotspots, thematic evolution analysis highlights a growing research emphasis on MPs impacts on terrestrial ecosystems in the last decade. Early research flagged concerns regarding soil organism effects and advocated for policy interventions. Subsequent research unveiled multiple adverse mechanisms of MPs in terrestrial environments: interactions with heavy metals, bioaccumulation in plants and animals, phytotoxicity, changes to soil microbial communities, and induction of oxidative stress, leading to tissue, enzyme, and cellular damage. MPs also inhibited enzyme activities, promoted lipid peroxidation, and increased oxidative stress in animals, particularly alongside pesticides. However, research on MPs accumulation and impacts in terrestrial ecosystems, especially in agroecosystems, remains limited. Addressing this gap is critical for ecological sustainability, agricultural productivity, food security, and organism health, necessitating further investigations and effective mitigation measures against MPs release and accumulation in terrestrial.

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