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A Study of marine plastic pollution abatement: A bibliometric analysis on status and development trend

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Abstract: *Marine plastic pollution, including microplastics is now becoming a serious problem around the world. It presents for marine species and environment. It presents a a serious threat to all marine life and human, while also influencing the climate. In this paper, a bibliometric analysis on marine plastic pollution is conducted by R to reveal the research progress and future trend from a qualitative and visual perceptive. The result showed that countries pay increasing attention to the research of marine garbage, especially microplastics, covering multiple scales of macro and micro. In the future, the research on marine plastic debris may focus on the monitoring of marine plastic and the treatment of microplastics.*

Keywords: *Marine plastic pollution, Microplastic, Bibliometric analysis*

1. Introduction

Recent years, plastic has become widely used in daily life for all. Marine plastic pollution is currently the most abundant type of debris, plastic waste make up 85% of all marine pollution. The main source of marine plastic is land based, including stormwater runoff littering and inadequate waste disposal. At least 14 million plastic end up buried in the deep-ocean every year. It is estimated that about 75 to 199 million tons of plastic have accumulated in the ocean by 2015[1]. UNEP estimates that plastic pollution in the sea and other water bodies continues to increase sharply and may more than double by 2030[2] and the plastic in the ocean may outweigh all fish by 2050.

Marine plastic pollution may affect the service value of marine ecosystem and marine species[3]. The most visible impact of plastic debris is entanglement ingestion and suffocation of marine species including turtles, fish, whales and seabirds. Plastic debris may also transport invasive species therefore threatening marine ecosystem and biodiversity. In addition, because of its small size, marine microplastics pose a greater threat to human body by enter through inhalation or absorb via the skin, and then accumulate in organs including the placenta[4].

Efforts should be done around the world to address marine plastic pollution. The reduction of Marine plastic pollution requires changes in the whole society, including promoting recycling, reducing the consumption and production of low-recyclable products, and improving the efficiency of waste treatment[5] . In March 2022, United Nations member states agreed establish an Intergovernmental Negotiating Committee and reach a legally binding instrument by 2024 to manage the entire life of plastics, including design, production, consumption and disposal[6]. It could be seen that the elimination of marine plastic pollution has gained the attention of all countries. This paper would present the quantitative results obtained from bibliometrics and then provide suggestions for marine plastic pollution management in the future.

2. Methodology

2.1 Data sources

The literature data was derived from the Scopus database. The Scopus database is an influential indexing and abstract database that includes 14,000 Science, Technology & Medicine (STM) and social science journal articles from more than 4000 publishers and also the references present in those articles which would be feasible for this study. In addition, there is no significant difference of the bibliometric

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analysis results between Scopus and Web of Science in similar areas[7].

After the extraction process of literature for 15 years, a total of 2180 publications would be considered for subsequent analysis. Topics of these publications are selected using keywords "marine plastic pollution" and "marine debris" from 2007-01-01 to 2022-12-31 for 15 years. These peer-reviewed publications here are regarded as marine plastic pollution study used for this study.

2.2 Bibliometric analysis

Bibliometrics is defined as a model application of mathematics and statistical methods to books and other media of communication. Compared with classical review approach which become impractical for increasing amount of publications, Bibliometrics methods could be a quite realistic way to analysis publications from scientific and technology databases. For scholars, Bibliometric analysis methods could be useful to model a large number of unstructured data of publications in a rigorous way, and therefore revealing and mapping the accumulated scientific knowledge and evolutionary nuances of established fields. The Bibliometric analysis method could clearly quantify the characteristics of literature through mathematical and statistical methods, and draw valuable qualitative conclusions from statistical data. In addition, with the help of computer graphics and image processing technology, quantitative results obtained from literature measurement could be converted into accessible graphics or images[8].

2.3 Analysis tools

For analyzing and visualizing of the results, "Bibliometrix" "ggplot2" and "treemap" packages of R 4.2.1 are chosen for as our research tool for analysis and visualization of this paper. R is an open source language and environment that used for statistical computing and graphics. "Bibliometrix" package of R could be used for a whole-process quantitative research in scientometrics and bibliometrics that includes all the main bibliometric methods for co-citation, coupling, scientific collaboration analysis and co-word analysis, as well as visual display of bibliometric analysis results[9].

3. Publication analysis

How to eliminate marine plastic pollution is a multifaceted topic in both the natural and social sciences with Increasing attention of global scholars. It is analyzed from the following aspects including keyword, publication trends, country analysis, affiliation analysis and evolution trend.

3.1 Keywords analysis

Keywords of an article could provide useful information including field, topic and research issue for readers. The keywords of selected publications includes different aspects and sub-field, and high frequency keywords appeared are marine debris (562 times), microplastics (493 times), plastic pollution (248 times) and marine litter (217 times) respectively, which is showed by a tree map of the keywords in Fig. 1.

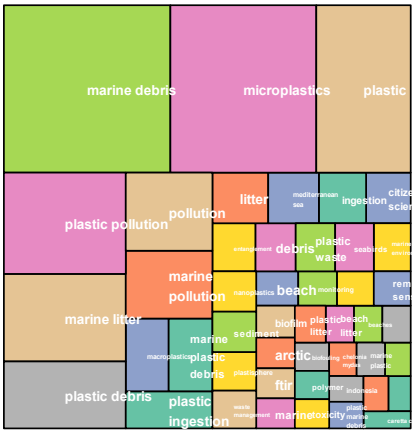

Figure 1: Tree map of keywords

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Through keyword analysis, it could be found that the research on marine plastic pollution management mainly includes marine plastics, micro plastics and corresponding large plastics. From different scales, the study area includes the Mediterranean Sea, the South Pole, etc., as shown in Figure 2.

Figure 2: Word cloud of publications

3.2 Publication trends analysis

The numbers and trends of papers published each year on marine plastic pollution are shown in Fig 3, which could be an indicator of how attention of scholars changed as time goes on. It can be seen from Fig 3 that before 2014, there were few articles about marine plastic debris. Less publications indicate less concern about marine plastic pollution at that time.

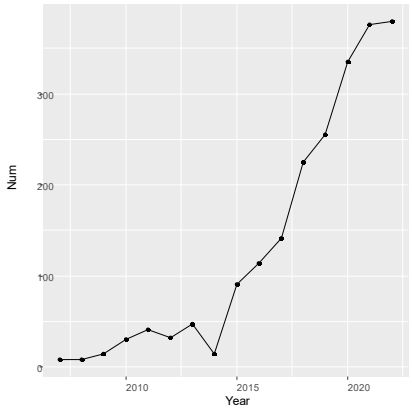

Figure 3: Publication trends from 2007 to 2022

In a report released by the United Nations Environment Programme in 2014, microplastics was first officially regarded as one of the top 10 emerging environmental issues in the world, and special attention was given to the problems of marine plastics and microplastics at the first, second and third United Nations Environment Conferences. Since then, marine plastic pollution has attracted worldwide attention, and related research has developed rapidly[10]. In 2015, American scholar Jenna Jambeck published a research paper in *Science*, and calculated the emissions of marine plastic debris based on models and assumptions, which has a wide global impact.

Many countries have also begun to pay attention to the treatment of plastic pollution. In 2016, China included marine microplastics into the scope of routine monitoring of the marine environment for the first time. In 2017, the monitoring activities of marine microplastics were also carried out in the oceans and polar regions for the first time. Under this opportunity, marine plastic pollution has attracted more attention from scholars. In recent years, many papers have been published in such fields as the impact of marine garbage, especially microplastics, on marine environment and biology.

3.3 Country analysis

Table 1 shows the top 10 countries in terms of papers published from 2007 to 2022 (The top 10 countries accounted for 51.3% of the total publications). The USA has the highest number of papers with 201 times, followed by the Italy and China with 139 times and 133 times respectively. The top 10 countries are mainly the United States, China, Brazil, the United Kingdom, which have a large population and a large amount of plastic debris and other marine countries such as Australia and Indonesia.

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It could be found that more countries need to pay attention to plastic pollution, because the problem of marine plastic is caused by land-based pollution. Considering the mobility of the ocean, it is not enough to focus only on these countries mentioned above to eliminate marine plastic pollution globally, other countries that dump solid plastic waste and discharge waste water with micro-plastic into the sea should pay attention to plastic management.

Table 1: The top 10 Countries' Scientific Production

Country	Articles	Freq
USA	201	9.2%
ITALY	139	6.4%
CHINA	133	6.1%
BRAZIL	128	5.9%
UNITED KINGDOM	117	5.4%
AUSTRALIA	100	4.6%
SPAIN	93	4.3%
INDONESIA	73	3.3%
CANADA	68	3.1%
FRANCE	66	3.0%

3.4 Source of publications

The 2180 papers retrieved are published in 494 journals. Fig 4 shows the top 10 journals in the field of marine plastic pollution in terms of the publications.

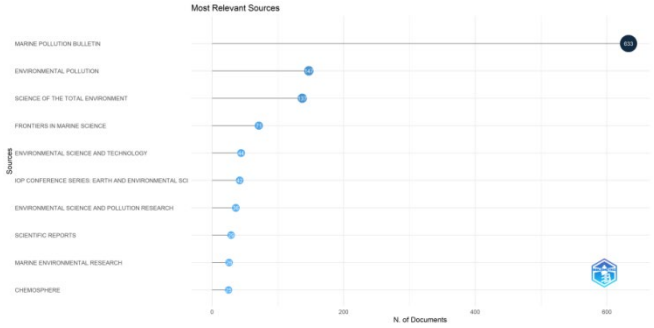

Figure 4: Most relevant publications sources

This indicates the mainstream journals that focused on marine plastic pollution. The most published journal is *Marine Pollution Bulletin* (29%), followed by *Environment Pollution* (6.7%), *Science of the Total Environment* (6.28%) and *Frontiers in Marine Science* (3.25%) respectively. Plastic pollution control is not only a scientific problem, but also a management problem. However, the current academic publications are mostly concentrated in natural science journals, and the research on management policy and legal system is still insufficient.

In terms of citations, the number of citations of the scientific papers published by Jack mentioned above is the largest (5600 times), followed by Barnes' publication on the global distribution of microplastics (3233 times) and Cole's publication on the review of microplastics impacts (2938 times) which is shown in Fig 5.

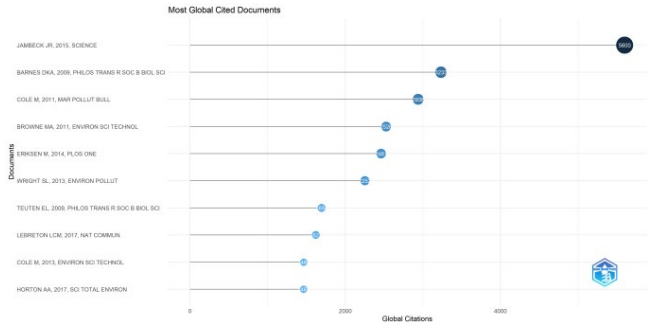

Figure 5: Most cited journals

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3.5 Analysis of thematic evolution trends

Although the topic of all publications is marine plastic pollution, the research focus of scholars in different years is also different. Through the trend analysis of words in all abstracts of publications, it can be found that, with the passage of time, the research on the regulation and effect of marine plastic debris, and marine micro-plastics began to increase significantly (shown in Fig 6). Since 2020, researchers also began to pay attention to the marine plastic pollution caused by the COVID -19 epidemic like the medical waste.

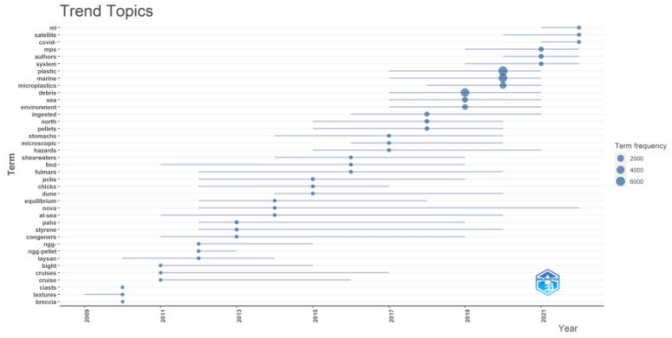

Figure 6: Thematic evolution trends

4. Conclusion and prospect

4.1 Conclusion

A wide range of researches have been conducted for the past 15 years to eliminate marine plastic pollution for global marine environment. The research content covers the composition, chemical composition, cumulative emissions, main sources, damage to human body and ecological environment, technical means for monitoring the pollution of deep-sea plastics, and the relationship between pollution and COVID-19.

In this paper, by analyzing the publications on marine plastic pollution from 2007 to 2022 using R package “Bibliometrix”, the academic achievements and research progress are quantitatively and visually discussed.

The research publications on marine plastic pollution exhibit increased flourishing and would be more thriving in the future. Attention to marine plastic pollution is closely related to international attention to plastic and micro plastic pollution, The appeal of international organizations such as the United Nations and IUCN and the research results of well-known scholars have played a very good role in promoting.

The understanding of marine plastics of scholars continues deepen. At first, it mainly discussed the chemical composition and harm of marine garbage, and then added the mechanism of how plastic pollution caused damage to marine organisms. The research of micro-plastics has also become a hot topic. In addition, after the outbreak of the epidemic, the research on plastic pollution also focused on COVID 19 pandemic. Future research would be conducted from a wider scope.

4.2 Prospect

Furthermore, the issue of marine plastics and microplastics has been put forward for no longer than 20 years, which is still an issue for in-depth research and development for all scholars. In the future, the research on marine garbage needs economic, social, scientific, technological and legal perspectives with participation of all stakeholders.

Considering environment externality of marine plastic pollution, the problem of marine plastic treatment is not only a scientific and technical problem, but also requires efforts at the policy level, including the establishment of a strict garbage classification and recycling system and plastic waste discharge system, while strengthening the supervision of rivers into the sea to reduce land-based pollution. In addition, it is also necessary to pay attention to the participation of stakeholders and call on the public to reduce the use of plastic products. In the future, we need to strengthen research in these areas.

At last, because of the limited data sources and the lack of knowledge of marine chemistry and

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materials, there might be some insufficiently in-depth and specific aspects in this study, further research would be carried out by further enriching data of publications in this career.

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