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A Regional Difference Analysis of Microplastic Pollution in Global Freshwater Bodies Based on a Regression Model

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Abstract: Based on statistical data of the average abundance of microplastics from 37 global freshwater locations up to November 2019, we classified the freshwater bodies according to developments in their local countries and geographic positions. We highlighted the differences and causes of microplastic pollution in the waters of both developed and developing countries and urban and rural areas. The results showed that microplastic pollution was highest in Asia. The pollution in developed countries was significantly lower than in developing countries. The differences in freshwater pollution between urban and rural areas mainly depended on the extent of human activity. The present study found the following phenomena by comprehensively using simple and multiple regression models and a Pearson correlation analysis to solve the impacts of the features, natural factors, and social and economic factors on the distribution of microplastic pollution. The density of microplastics was higher, which promoted the aggregation of microplastics in sediments. Pursuant to that, microplastic pollution was also influenced by the space-time pollution of movable surface sources, such as the soil and air. A population increase and the average gross domestic product (GDP) could also worsen microplastic pollution.

Keywords: microplastic pollution; freshwater bodies; regional difference; regression model

1. Introduction

With the continuous progress and development of society, plastics have permeated every major facet of human life and economy. Large scale production and plastic waste have had great negative impacts on our environment [1]. According to statistical data, the global production and widespread use of plastics led to an accumulation of 348 million tons in 2017. China produced 102.3 million tons of plastic materials, accounting for 29.4% of the world's plastic production. As a result of this, China became the world's largest producer and consumer of plastic materials [2].

In 2004, Thompson et al. from the University of Plymouth published an article in *Science* that first posited that microplastics are small pieces and particles of plastic less than 5 mm in diameter [3]. Microplastics are divided according to their source: primary type and secondary type [4]. Scientific research proved that secondary microplastics have a stronger potential adsorption rate on organics and several heavy metals, like Pb and Hg, compared with primary microplastics. Pollutants will be immediately transferred to aquatic organisms when they ingest food laced with microplastic particles, which is a threat to humans and the environment through the food chain [5–7].

Therefore, microplastics have a strong biotoxicity that leads aquatic organisms to develop symptoms, including mechanical damage, low growth rate, declining reproduction, etc. [8].

Microplastics are widespread in freshwater environments. The severity, location, and terminal treatment of microplastics varies widely by region due to differences in the population, economic development, treatment technology, microplastics composition, and waterbody characteristics [9]. Besides, Lisa et al. investigated the effect of hydrologic and hydraulic factors on the migration of microplastics in waterways. It proved that microplastics concentrations were significantly different in different flow conditions and some obstacles in waterways caused microplastics to accumulate, such as dams [10,11]. However, the current studies on microplastics in waterbodies are mostly experimental determinations of microplastics concentrations and basic chemical properties. Therefore, the purpose of this study was to determine the relevant factors that affect microplastic pollution. In this paper, 37 freshwater bodies were selected globally and samples from the literature were collected from multiple databases, in order to compare the differences in the global distribution of microplastic pollution, trace the source of pollutants in different regions, and study the main effects of the pollution distribution of microplastics.

2. Methods

2.1. Data Sources

Existing data on microplastic abundance and concentration were obtained for 37 freshwater bodies located in 12 countries spanning six continents (except Antarctica) (Table 1). The sample included 1 reservoir, 4 rivers, and 32 lakes. The data on the average abundance and composition of the microplastics in the waterbodies required for the study came from the relevant literature in major Chinese and English databases as of November 2019. The data on the continent and country, country type, population, per capita GDP, secondary industry structure, and urbanization rate came from the *2018 International Statistical Yearbook*. Then, population density was calculated by drainage area and the population of the area. The suburb type was determined according to the number of people and geographical location of the surrounding waterbodies. Among them, the urban waterbodies were closer to the city with a larger population density, while the rural waterbodies were the opposite.

Table 1. Research sample information table.

Serial Number	Name of Waterbody	Type of Waterbody	Continent	Country	Type of Country	Type of Geography	Overall Average Abundance (n/m^3)
1	Lake Winnipeg	Lake	North America	Canada	Developed country	Urban type	0.19 [12]
2	Danube River	River	Europe	Germany	Developed country	Urban type	0.317 [13]
3	Lake Zurich	Lake	Europe	Switzerland	Developed country	Urban type	0.011 [14]
4	Lake Geneva	Lake	Europe	Switzerland	Developed country	Urban type	0.048 [15]
5	Lake Michigan	Lake	North America	America	Developed country	Urban type	0.017 [16]
6	Tamar River	River	Europe	Britain	Developed country	Urban type	0.028 [17]
7	Lake Petit	Lake	Europe	Switzerland	Developed country	Urban type	0.033 [18]
8	Lake Maggiore	Lake	Europe	Italy	Developed country	Urban type	0.039 [19]
9	Lake Iseo	Lake	Europe	Italy	Developed country	Urban type	0.040 [18]
10	Lake Constance	Lake	Europe	Switzerland	Developed country	Urban type	0.061 [19]
11	Lake Neuchatel	Lake	Europe	Switzerland	Developed country	Urban type	0.061 [19]
12	Lake Bolsena	Lake	Europe	Italy	Developed country	Urban type	2.51 [20]
13	Lake Chusi	Lake	Europe	Italy	Developed country	Urban type	3.02 [20]
14	Lake Erie	Lake	North America	America	Developed country	Urban type	0.106 [21]
15	Lake Huron	Lake	North America	America	Developed country	Urban type	3209 [22]
16	Lake Garda	Lake	Europe	Italy	Developed country	Rural type	0.025 [22]
17	Lake St. Clair	Lake	Oceania	Australia	Developed country	Rural type	1.048 [13]

Table 1. *Cont.*

Serial Number	Name of Waterbody	Type of Waterbody	Continent	Country	Type of Country	Type of Geography	Overall Average Abundance (n/m^3)
18	Goiana River	River	South America	Brazil	Developed country	Urban type	0.190 [22]
19	KwaZulu-Natal River	River	Africa	South Africa	Developing country	Urban type	0.487 [23]
20	Lake Hovsgol	Lake	Asia	Mongolia	Developing country	Urban type	0.044 [14]
21	East Lake (Zhejiang)	Lake	Asia	China	Developing country	Urban type	220 [24]
22	Ling Lake	Lake	Asia	China	Developing country	Urban type	350 [24]
23	Dongting Lake	Lake	Asia	China	Developing country	Urban type	633.5 [25]
24	Tai Lake	Lake	Asia	China	Developing country	Urban type	1460 [26]
25	Wu Lake	Lake	Asia	China	Developing country	Urban type	1660 [20]
26	Hong Lake	Lake	Asia	China	Developing country	Urban type	2282.5 [20]
27	South Lake	Lake	Asia	China	Developing country	Urban type	5745 [20]
28	East Lake (Hubei)	Lake	Asia	China	Developing country	Urban type	5914 [20]
29	South Prince Edward Lake	Lake	Asia	China	Developing country	Urban type	6162.5 [20]
30	Tazi Lake	Lake	Asia	China	Developing country	Urban type	6175 [20]
31	Sha Lake	Lake	Asia	China	Developing country	Urban type	6390 [20]
32	Huanzi Lake	Lake	Asia	China	Developing country	Urban type	8550 [20]
33	North Lake	Lake	Asia	China	Developing country	Urban type	8925 [20]
34	Three Gorges Reservoir	Reservoir	Asia	China	Developing country	Rural type	1.600 [27]
35	Easter Island	Lake	South America	Chile	Developing country	Rural type	0.072 [28,39]
36	Siling Co Basin	Lake	Asia	China	Developing country	Rural type	285 [30,31]
37	Lake Ulangsuhai	Lake	Asia	China	Developing country	Rural type	5940 [32]

2.2. Units of Measurement

As an emerging research field, microplastic pollution has attracted the attention of many international researchers in recent years. Due to the different research methods and the lack of internationally unified standards, there have been many forms of measurement units for microplastic abundance. In this paper, n/m^3 was selected as the standard unit. There were 13 different forms of units used to describe the abundance of microplastics in the investigated waterbodies, and the conversion methods are shown in Table 2.

Table 2. Different system unit conversion comparison table for microplastic abundances.

Measure	Original Unit	Conversion Formula	Note
Unit volume	items/L ind/m^3 ind/L pieces/m^3	1 items/L = 10^3 n/m^3 1 ind/m^3 = 1 n/m^3 1 ind/L = 10^3 n/m^3 1 pieces/m^3 = 1 n/m^3	Items, ind, and pieces are equal to abundance units n.
Unit water area	items/m^2 items/km^2 ind/km^2 ind/m^2 particles/m^2 particles/km^2 pieces/m^2	1 items/m^2 = 1 n/m^3 1 items/km^2 = 10^{-6} n/m^3 1 ind/km^2 = 10^{-6} n/m^3 1 ind/m^2 = 1 n/m^3 1 particles/m^2 = 1 n/m^3 1 particles/km^2 = 10^{-6} n/m^3 1 pieces/m^2 = 1 n/m^3	Suppose the water depth per unit area is 1 m,1 km^2 = 10^6 m^2

2.3. Research Methods

Modeling analysis methods are generally applied to trace regional differences in pollution. For example, Meng Lixia et al. used the Theil Index to analyze the differences in the intensity of water pollution emissions in China [33]. Through the application of the Hybrid Single Particle Lagrandian Integrated Trajectory Model (HYSPLIT), potential source contribution factor method (WPSCF), and concentration weighted trajectory analysis (WCWT), Yan Yu et al. analyzed the pollution characteristics and source differences of fine particulate matter (PM2.5) [34]. Based on the Stochastic

Impacts by Regression on Population, Affluence and Technology model (STIRPAT), Wang Naichun et al. analyzed the influencing factors of carbon emissions [35]. In view of the absence of multicollinearity among the selected influencing factors and the scattered research contents related to microplastic pollution (the significances of all variables were higher than 0.05 in the Pearson correlation analysis), we adopted a regression model to analyze the factors that cause differences in the distribution of microplastic pollution.

Through the literature collection and data collation, this paper first describes the distribution map of the average microplastic abundance in freshwater bodies by ArcGIS (a software that can collect, organize, and analyze the geographic information), and compares the differences of microplastic pollution characteristics in developing countries and developed countries, as well as urban and rural freshwater bodies. After collecting all relevant data on the composition and structure of microplastics, water depth, surface area of the water, distance from the city center, region population, population density, per capita GDP, urbanization rate, and secondary industry structure, the primary influencing factors for the distribution of microplastics were identified using a Pearson correlation analysis, univariate or multiple regression models, and other analytical methods.

3. Results and Discussion

3.1. *Difference Analysis of Microplastic Pollution in Global Freshwater Bodies*

Through the collection and collation of the sample data, we obtained the pollution distribution of microplastics in global freshwater bodies (Figure 1). There were relatively more studies on water microplastics in Asia, Europe, and North America. The order of microplastic pollution in freshwater bodies of six continents was: Asia > North America > Africa > Oceania > South America > Europe. China was the country with the most serious microplastic pollution in the world, with the average concentration of microplastics in the water as high as 3793.38 ± 799.68 n/m^3. Among Chinese locations, the average abundance of microplastics in Wuhan Bei Lake was the highest, reaching 8925 n/m^3 [18]. Globally, Switzerland had the lowest level of pollution, with an average concentration of 0.04 ± 0.01 n/m^3. In terms of the concentration of microplastics, the highest was Lake Neuchatel, which was 0.061 n/m^3 [17], and the lowest was Lake Zurich with 0.011 n/m^3 [12].

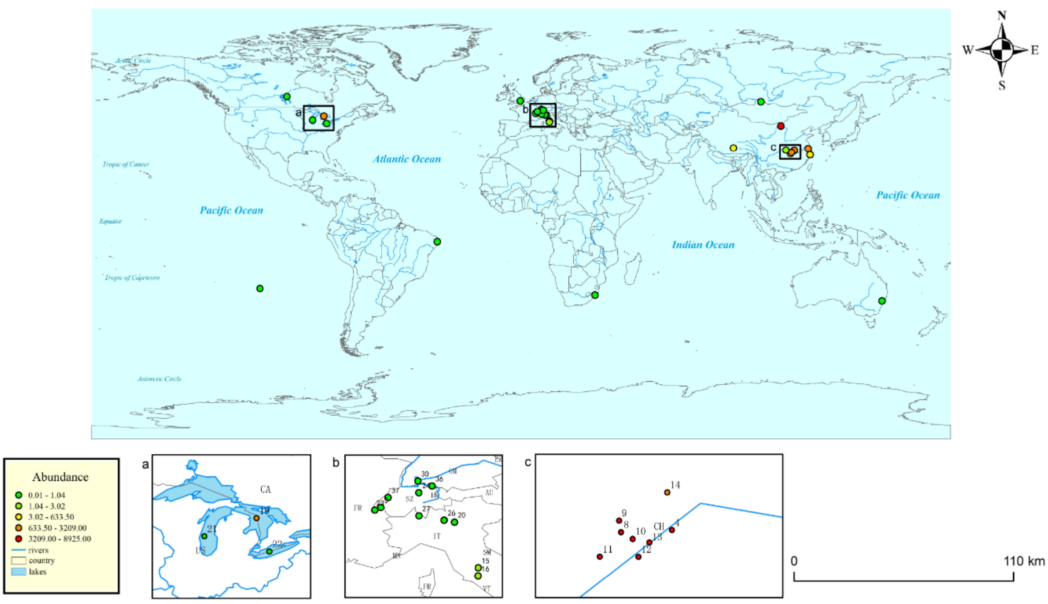


Figure 1. The distribution of microplastics in typical freshwater bodies around the world.

3.1.1. Difference Analysis of Microplastic Pollution in Developed Countries and Developing Countries

Among the selected samples, 17 waterbodies were located in developed countries, including the United States, Switzerland, Canada, Italy, the United Kingdom, and Australia, and 20 waterbodies were located in developing countries, including Mongolia, South Africa, Chile, Brazil, and China (Figure 2). Significant statistical difference (Sig) (2-tailed) = 0.001 was obtained using an independent sample T-test of the two groups, indicating a significant difference. The total average abundance of microplastics in the waterbodies of developed countries was 189.2 ± 188.7 n/m^3, while the total average abundance of microplastics in the waterbodies of developing countries was 3034 ± 725 n/m^3.

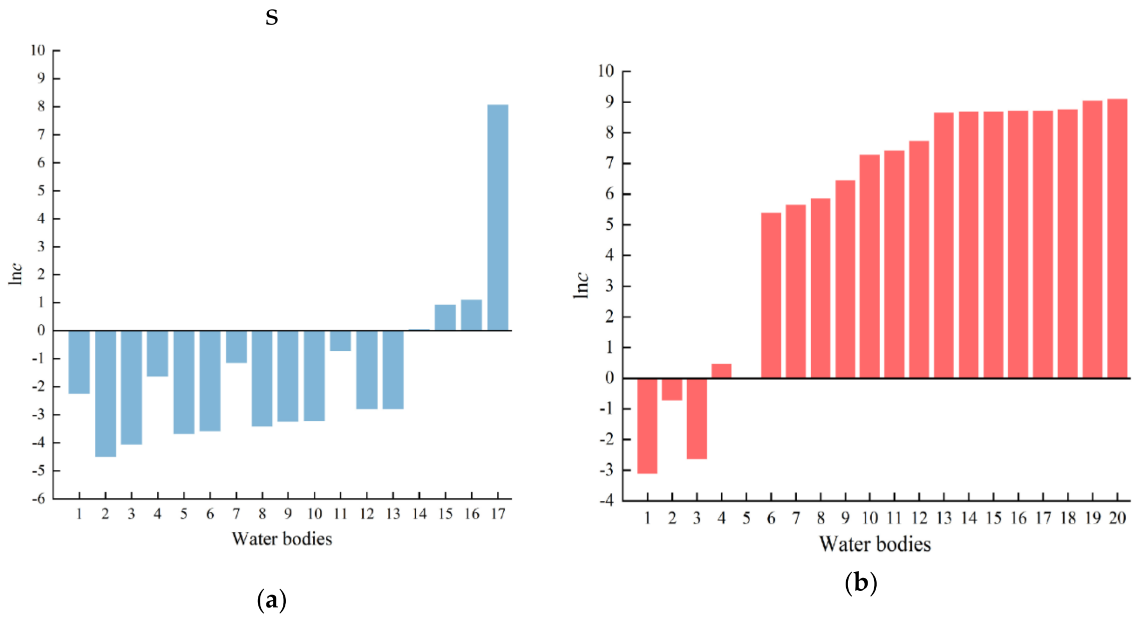


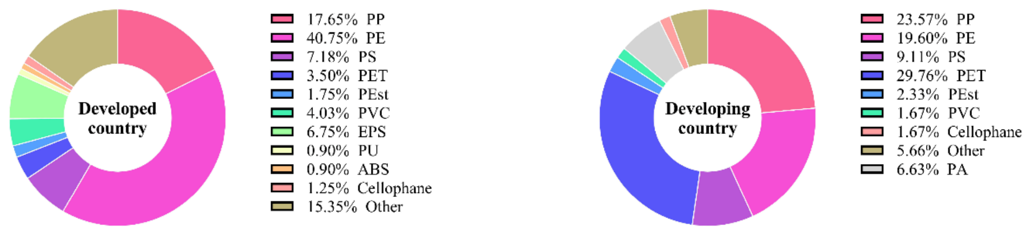
Figure 2. The average content of microplastics in typical freshwater bodies: (**a**) in developed countries; (**b**) in developing countries.

As a developing country, China's waterbodies are polluted by microplastics. In addition to the direct pollution caused by industry and human life, it is also necessary to comprehensively consider the spatial and temporal connections between soil pollution and air pollution. For example, agricultural plastic film is a major source of soil microplastic pollution. The annual growth rate of the area covered by agricultural plastic film in the world was found to be 5.7%. The annual growth rate of the agricultural plastic film coverage area in China from 1991 to 2004 reached as high as 30% [36]. Compared with more than 50% of the global plastic film usage, the plastic film recovery rate in China was less than 2/3 [37]. The residual plastic film can enter waterbodies through the ground rain runoff, resulting in large areas of water with microplastic pollution.

There were differences in the composition of microplastics in the waters between developed and developing countries. We selected 16 samples to determine the settling ratio, main microplastic composition, and proportion (Table 3) in the waterbodies. The main difference identified was that the microplastics in the waters from developing countries had more polyethylene terephthalate (PET). As shown in Figure 3, the proportion of light microplastics, like polypropylene (PP) and polyethylene (PE), in waterbodies from developed counties was higher than those from developing countries. The waterbodies from developed countries demonstrated 6.75% expanded polystyrene (EPS), 0.9% polyurethane (PU), and 0.9% acrylonitrile butadiene styrene plastic (ABS), while none of these were recorded in waterbodies from developing countries.

Table 3. A comparison of the main components of microplastics in the waterbodies of developed and developing countries. Polypropylene (PP), polyethylene (PE), and polyethylene terephthalate (PET).

Type of Country	Number of Samples	Settlement Ratio (%)	Main Composition	Main Ingredient Content (%)		
				PP	PE	PET
Developed country	4	90.72	PP, PE	17.2–19	19–48	-
Developing country	12	99.24	PP, PE, PET	0–29.54	19–63.7	14–40.91



(**a**) (**b**)

Figure 3. Average percentage composition of microplastics: (**a**) in developed countries; (**b**) in developing countries. Polyamide (PA), polyvinyl chloride (PVC), expanded polystyrene (EPS), polyurethane (PU), and acrylonitrile butadiene styrene plastic (ABS).

The types and densities of microplastics were different, which directly influenced the locations of microplastics in waterbodies. High-density microplastics were difficult to contain in waters and later became sediments. As a result, there were microplastic distribution variations between the waterbodies and the sediments from developed and developing countries. This section used a Pearson correlation analysis to screen out the major effects (Table 4) on the concentration distribution of microplastics. These compositions, including PET, polyamide (PA), polyvinyl chloride (PVC), PU, ABS, and EPS, had correlations with the concentration distribution of microplastics. In addition, the correlation pecking order for these compositions was PET > PA > PVC = PU = ABS = EPS. The PET contents had the most significant statistical difference (Sig = 0.005) for the concentration distribution of microplastics, and the PET density was as high as 1.38 g/m^3, which could explain the phenomenon that the settling ratio of microplastics in waters from developing countries was higher than that from developed countries.

Table 4. The correlation analysis results of each microplastic component content and microplastic concentration.

	PP	PE	PS	PET	PEst	PVC	PA	EPS	PU	Cellophane	ABS
Pearson correlation	0.333	−0.340	−0.112	0.661 **	−0.295	−0.625 **	0.596 **	−0.522 *	−0.522 *	−0.295	−0.522 *
Sig	0.207	0.198	0.681	0.005	0.267	0.010	0.015	0.038	0.038	0.267	0.038

** indicates significant correlation at the 0.01 level; * indicates significant correlation at the 0.05 level.

3.1.2. Difference Analysis of Microplastic Pollution in Urban and Rural Freshwater Bodies

As shown in Figure 4, there were 31 urban waterbodies in the global sample, and the total average value of microplastic abundance was 1861 ± 520 n/m^3. The total number of rural waterbodies was six, and the total average value of microplastic abundance was 1038 ± 981 n/m^3. Sig (2-tailed) = 0.519 was obtained by an independent sample T-test of the two samples, with no significant difference. Considering the differences of environmental governance between developed countries and developing countries, it was of little significance to explore the differences in suburban waterbodies on a global scale. Therefore, the scope of discussion was limited to developed countries and developing countries (Table 5).

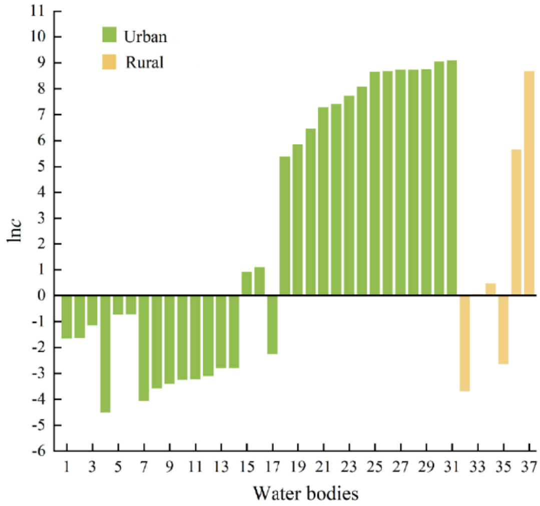


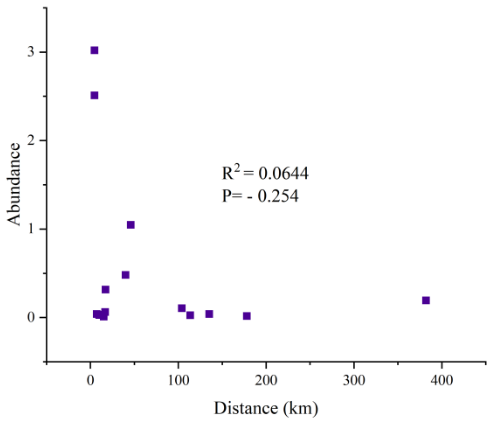
Figure 4. The average content of microplastics in freshwater bodies in urban and rural areas of the world.

Table 5. Comparison table of the microplastic concentration in urban and rural waterbodies.

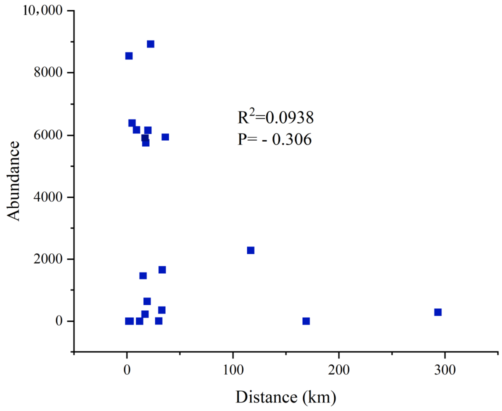
Type of Waterbody	Type of Country	Number of Samples	Average Distance from City Center (km)	Average Abundance Range of Microplastics (n/m^3)
Urban type	Developed country	15	76.21	0.011–3209
	Developing country	16	31.37	0.044–8925
Rural type	Developed country	2	79.85	0.025–1.05
	Developing country	4	92.98	0.072–5940

The main difference between urban and rural freshwater bodies is the surrounding population and building density. The rural waterbodies are usually far away from cities with low populations and building density. There may be a correlation between the distance between each waterbody and the city center and the distribution of microplastic pollution. Based on the classification in Table 5, this section explores the above correlations. The determination coefficient R^2 of the linear regression model was close to 0 (Figure 5), indicating that the distance was not the main effect affecting the concentration of microplastics in freshwater bodies. Due to the independence between the waterbodies (even urban waterbodies), developed countries can reduce the microplastics content in their waterbodies through efficient sewage treatment processes, for instance, Lake Zurich in Switzerland, where the average abundance of microplastics in waterbodies was only 0.11 n/m^3 [14].

On the contrary, for developing countries, even if it is a rural waterbody, if the sewage treatment system is not mature enough to treat the sewage discharged by the surrounding factories, it will cause water pollution more serious than some urban lakes, such as Lake Ulansuhai in China, where the concentration of microplastics in seawater was as high as 5940 n/m^3 [29]. In addition, some of the rural lakes in scenic spots, such as the Three Gorges Reservoir, are frequented by tourists all year round and inevitably influenced by human activities, which can also aggravate the degree of pollution.



(**a**)



(**b**)

Figure 5. A scatter diagram of distance correlation between the concentration of microplastics in the waterbodies and the distance from the city center: (**a**) in developed countries; (**b**) in developing countries.

3.2. Research on the Influencing Factors of Global Microplastic Pollution Distribution

3.2.1. Natural Factors: Water Depth and Water Area

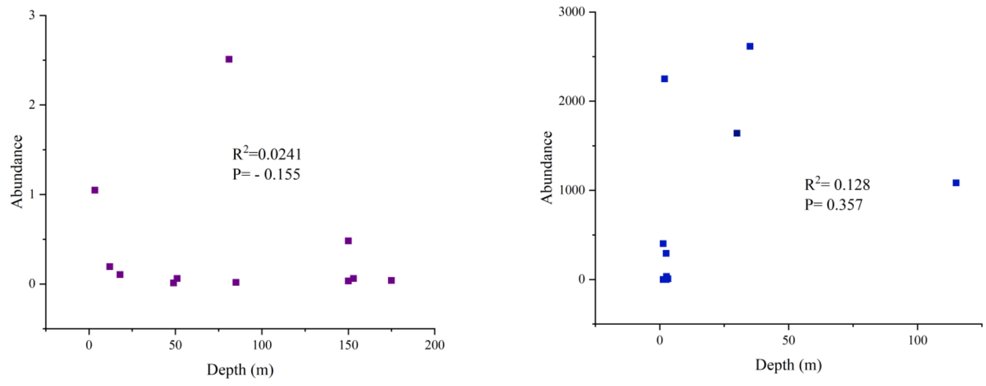
Water depth and water area are two significant limnological and morphological variables, which are closely related to the water storage capacity and heat capacity of waterbodies. There are differences in the hydrodynamic processes of waterbodies at different water depths. The different flow field distribution and wind and wave characteristics lead to the different self-purification capacities of waterbodies [38]. Therefore, the difference in the average water depth and water area may become factors that affect the concentration of microplastics in waterbodies. We selected the basic information of 28 freshwater bodies and extracted the relevant data of the average water depth and water area of each waterbody. The selected freshwater bodies were located in Europe, Asia, and North America (Table 6). The average depth of the waterbodies was of the order of Europe > North America > Asia, while the order of the degree of microplastic pollution was exactly the opposite. No obvious correlation law was found between the water area and the water microplastic concentration. Based on this, we explored the influence of the average water depth and water area differences on the water microplastic concentration, and then screened out the main effect. As shown in Table 7, Sig = 0.009 was obtained by the regression model of the average water depth and the water microplastic concentration, indicating that there was a weak correlation. In order to control the interaction of country development level with other variables, we fit the linear model of developed and developing countries, respectively. After fitting, the R^2 and *p*-value for developed countries were 0.024 and −0.155 and for the developing countries were 0.128 and 0.357, which revealed that the x-value parameter did not support this model (Figure 6). According to the above analysis, when the water depth was large, although the distribution of the water flow field was different, the self-purification capacity did not change significantly. Especially for developed countries, the concentration of microplastics was lower than for developing countries, so the effect was not obvious.

Table 6. The statistical average water depths and water areas of the waterbody samples.

Continent	Number of Samples	Average Water Depth (m)	Water Area (m^2)
Europe	9	115.57	306.6
Asia	15	18	731.5
North America	4	43.75	7238.3

Table 7. The results of the binary regression analysis with the average water depth and water area as independent variables.

Model	Unstandardized Coefficient		Standardized Coefficient	t	Significance
	B	Standard Error	Beta		
Constant	3069.931	653.170		4.700	0.000
Average water depth (m)	−24.252	8.454	−0.531	−2.869	0.009
Water area (m^2)			−0.106	0.564	0.579



(**a**) (**b**)

Figure 6. A scatter diagram of the correlation analysis between the microplastic concentration and average water depth in global freshwater bodies: (**a**) in developed countries; (**b**) in developing countries.

3.2.2. Social Factors: Population, Population Density, GDP per Capita, Urbanization Level, and Secondary Industry Contribution Rate

Social factors symbolize a country's level of economic development and industrialization, and may have an indirect effect on microplastic pollution [39]. Developed countries had a small population, a high level of urbanization and GDP per capita, and the contribution rate of secondary industry was slightly lower than that of developing countries (Table 8). Compared with developing countries, developed countries were generally less polluted by microplastics. In this section, the multiple regression analysis method was used to solve the regression equations, with population, population density, GDP per capita, urbanization level, and secondary industry contribution rate as independent variables, to explore the effects of the above five factors on microplastic pollution. The test result of residual independence was Durbin–Watson (DW) = 2.74, indicating that there was no obvious autocorrelation in the residual sequence. Based on the P-P diagram (Figure 7), the distribution of residual disability was relatively concentrated, and the histogram was in line with the characteristics of normal distribution, indicating that the regression equation model was suitable to explain the variation law of microplastic pollution with population, population density, GDP per capita, urbanization level, and the contribution rate of secondary industry.

Table 8. Comparison of the economic development and industrial structure between developed countries and developing countries.

	Developing Country	Developed Country
Number of waterbodies	20	17
Number of countries involved	5	7
Average population (ten thousand people)	33,279.66	8552.86
Average population density (n/km^2)	47.82	156.42
GDP per capita (ten thousand yuan)	60.10	356.72
Average secondary industry contribution rate (%)	22.67	19.67
Average urbanization rate (%)	63.90	80.72

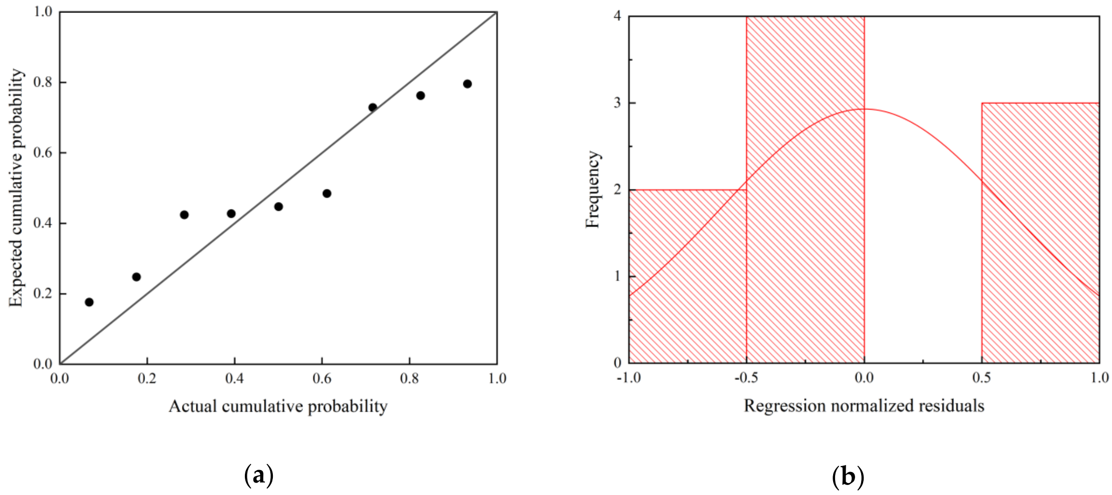


Figure 7. Regression normalized residual: (**a**) normal P-P diagram; (**b**) histogram.

Based on the analysis results of further research, the fitted equation Sig = 0.002 was obtained, from which the regression equation was judged to be highly significant. The regression equation model indicated that the determination coefficient R^2 = 0.993, indicating that the fitting effect was excellent. The Sig values of the two independent variables of the population scale and per capita GDP were 0.001 and 0.033, respectively (Table 9), which passed the test at the significance level of 5%, while the other three factors failed the significance test. According to the coefficients obtained from the non-standardized coefficient B in the table, the regression equation can be obtained as:

$$y = 0.029x_1 + 1.403x_2 - 0.076x_3 - 10.279x_4 - 0.303x_5 + 310.453 \quad (1)$$

where x_1 is the population (ten thousand people), x_2 is the GDP per capita (ten thousand yuan), x_3 is the contribution rate of the secondary industry (%), x_4 is the urbanization rate (%), and x_5 is the population density.

Table 9. The regression equation independent variable coefficients.

Model	Unstandardized Coefficient		Standardized Coefficient	t	Distinctiveness
	B	Standard Error	Beta		
onstant	310.453	611.812		0.507	0.647
Population (ten thousand people)	0.029	0.002	0.983	15.493	0.001
GDP per capita (ten thousand yuan)	1.403	0.516	0.160	2.718	0.033
Secondary industry contribution rate (%)	−0.076	4.095	−0.001	-0.019	0.986
Urbanization rate (%)	−10.279	7.700	−0.110	−1.335	0.274
Population density (n/km^2)	−0.303	0.683	−0.026	−0.443	0.688
Dependent variable: average abundance of microplastics in waterbodies (n/m^3).					

From the signs of the indicators, the coefficient of population number and per capita GDP of the independent variables were positive, indicating that population factors and human living standards were positive for microplastic pollution. With the increase of population and the improvement of living standards, the demand for plastic products increases, and economic development accelerates, leading to the increase in the degree of microplastic pollution. There was no correlation between the population density, the contribution rate of the secondary industry, and the urbanization rate to the concentration of microplastics. Therefore, it was of little significance to discuss them separately. Only their combined effect with other indicators should be considered.

4. Conclusions

After the above comparative analysis, the conclusions are as follows:

- The degree of microplastic pollution in the freshwater bodies of the six continents in the world were ranked as follows: Asia > North America > Africa > Oceania > South America > Europe. China was the most seriously polluted and Switzerland was the least polluted. The pollution levels in developed countries were significantly lower than those in developing countries.
- The average density of microplastics in the water environments of developed countries was lower than that of developing countries. Therefore, microplastics in the water environment of developed countries did not easily sink, and were mostly stored in waterbodies. In developing countries, microplastics were mostly found in sediments. The geographical location and the size of the waterbodies had no significant influence on the distribution of microplastic pollution, so they were not the primary factors affecting the distribution of microplastic pollution.
- The regional differences in the distribution of microplastic pollution may depend on factors such as the population, GDP per capita, national economic production level, the receiving waterbody of sewage, and the city pollution treatment technology. Among them, the population and the GDP per capita were directly proportional to the concentration of microplastics. When the waterbody was used as the receiving waterbody of sewage, it depended on the maturity of the urban sewage treatment technology.

The above conclusions are based on the previous research. The research on microplastics is still not fully mature. The majority of the research objects are large urban waterbodies. There is no uniform measurement method for microplastic content internationally; therefore, it is inevitable that there may be errors when comparing the experimental results. In addition, hydrology was the key element missing from this study, which would require another systematic analysis and be difficult to present in the limited space. In this case, taking the regional differences of microplastic pollution distribution as the starting point, we attempted to use the existing research results to further analyze the fundamental factors affecting microplastic pollution, which has significance as a reference for the formulation of governance strategies.

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