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The current situation of water pollutants and pollution source in Poyang Lake: A review

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Abstract. As the largest freshwater lake and the largest connecting lake in the Yangtze River basin, Poyang Lake stores abundant water resources, and undertakes multiple ecological functions. The water pollution of Poyang Lake is related to the ecological environment of the middle and lower reaches of the Yangtze River, and also affects the regional economic and social development. After sorting out and summarising other literatures, we analysed the main pollutants in Poyang Lake. The discharge of some industrial waste and frequent human activities are the main reasons for the increase of total phosphorus nitrogen, heavy metal pollutants and microplastic pollutants in Poyang Lake.

Keywords: Poyang Lake, water pollution source, heavy metal pollution, total phosphorus and nitrogen index, microplastics.

1. Introduction

Lakes are the main carrier of water resources and a crucial link in the ecosystem. Lakes with abundant resources play a huge role in maintaining the ecological balance and regulating the climate in the surrounding environments [1]. As the largest freshwater lake and connecting lake in the Yangtze River basin, Poyang Lake collects incoming water from the Ganjiang River, Fuhe River, Xinjiang River, Raohe River and Xiushui River [2]. Poyang Lake stores abundant water resources, and undertakes multiple ecological functions such as flood control, water storage, climate regulation and pollution degradation. The lakeside wetlands and beaches around Poyang Lake also have vital ecological value [3]. Therefore, the water pollution of Poyang Lake is related to the ecological environment of the middle and lower reaches of the Yangtze River, and also affects the regional economic and social development.

2. The current contaminated situation at Poyang Lake

As a major freshwater lake resource, the residents around Poyang Lake are committed to developing the agricultural economy, thus a large amount of chemical fertilizers and pesticides are applied to agricultural areas. As the water source of farmland is the same as that of Poyang Lake, a water cycle relationship is formed between the surrounding farmland and Poyang Lake. A large amount of chemical fertilizers and pesticides, such as ammonium sulfide and ammonium nitrogen, which are acidic and

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irritating compounds, have deteriorated the water quality of Poyang Lake. Industrial wastewater is also one of the main causes of water pollution in Poyang Lake. As Poyang Lake is a freshwater resource, any substances containing heavy metals or strong acids and alkalinity will directly destroy the freshwater resources of the lake. Due to the great hazards of industrial wastewater, it was reported in [4] 2010 that Jiangxi Province would strictly control the increase of major pollutants while continuing to promote emission reduction by engineering and structure and strengthening management and emission reduction, and would build more than ten sewage treatment plants in industrial parks around Poyang Lake to ensure the completion of emission reduction tasks. With time, the area around Poyang Lake has increased numerous residents, and the domestic wastewater discharge of residents has also increased. According to report [5], the organic matter contained in this domestic sewage will affect the river quality and cause river water eutrophication. The increase of total phosphorus and total nitrogen content in water will affect the survival of aquatic organisms directly or indirectly.

3. Literature analysis

Under the long-term interference of the above-mentioned human factors, the ecological environment of Poyang Lake is continuously changing. In recent years, scholars have conducted relevant studies on the water environment of Poyang Lake. Scholars including Jiawei Liu, pointed out that man-made industrial and agricultural activities in the Poyang Lake basin are the main source of heavy metal pollution [1]. Sheng Wentao et al. [2] studied the dynamic changes of total phosphorus in five rivers entering Poyang Lake. Tang Guohua et al. [6] analyzed and studied the characteristics of total phosphorus transfer, diffusion and reduction in the lake area. Li Zheng [7] et al. evaluated the potential ecological risk of heavy metals in surface sediments by comparing and analyzing the interannual variation of heavy metal content. Other scholars have also studied various aspects of Poyang Lake, such as the pollution of total nitrogen and phosphorus, the change in the concentration of corresponding pollutants, the main pollution sources, and the evaluation methods of eutrophication. They have concluded that the main factor of Poyang Lake eutrophication is the increase of nitrogen and phosphorus, which has a good reference and guidance for the water pollution control of Poyang Lake.

The above studies have provided some understanding of the concentration and form of major pollutants in Poyang Lake and related drainage basins, but there are still some limitations. For example, there needs to be the more specific elaboration of the pollution classification of related industries and agriculture. Regarding research indicators, less attention is paid to the distribution of phosphorus forms. Lack of attribution analysis of hydrology and phosphorus from a discussion point of view. Therefore, this paper will perform a detailed classification from the perspective of pollutants and pollution sources.

Heavy metal pollution belongs to inorganic matter pollution, which seriously endangers water environment safety and biological safety. According to the data, the heavy metal pollution in Poyang Lake mainly includes Cu, Cd, Pb, As, Zn, Cr, etc. Under the evaluation system of the potential ecological risk index method, from 1993 to 2021, the annual average order of heavy metals was: Cu (75.13)> Cd (32.97)> Pb (18.93)> As (10.28)> Zn (2.71)> Cr (1.43), and the average of heavy metal comprehensive pollution index was 129.67, showing a moderate pollution level. From the perspective of the change trend, from 1993 to 2011, RI decreased significantly, and the risk level changed from strong to slight; in 2011, it gradually recovered and increased slowly; in 2020, the risk level changed from slight to medium; in 2021, the risk level decreased from medium to slight. The maximum that occurred in 1993 was 322.27 and the minimum in 2011 was 44.00. In 1993, the ecological risk level of heavy metals reached strong, especially the single ecological risk of Cu, which was caused by a large number of copper mining in the basin at that time. The heavy metal content of water bodies and sediments in the basin gradually increased [7]. Man-made industrial and agricultural activities in the Poyang Lake basin are the main source of heavy metal pollution. From the main pollution factors of PC1 and PC2 from 2011 to 2015, the main sources of pollutants are mainly concentrated in industrial production and chemical plant emissions. Secondly, it is related to the discharge of domestic sewage. It can be seen that human life around Poyang Lake is frequent, the production activities are intensive, and the pollution load of the water body is large [1].

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In recent years, the rapid development of industry and agriculture and the increase in domestic sewage discharge has led to water pollution and water quality deterioration in more rivers entering the lake. Water environment problems are becoming increasingly serious. As Poyang Lake surrounds Jiujiang city, Nanchang City, Shangrao City, and five surrounding rivers, nitrogen and phosphorus detection is also crucial for nitrogen and phosphorus pollution in Poyang Lake. Total phosphorus and total nitrogen belong to organic pollutants. Nitrogen and phosphorus pollutants will make the lake water appear eutrophication, directly lead to water pollution, or form sediments, and produce secondary pollution through mineralization and deposition [8].

The average concentration of TN and TP in the water of the five incoming rivers has exceeded the critical concentration of eutrophication: TN is 0.2 mg/L and TP is 0.02 mg/L [2]. This indicates that the concentration of nitrogen and phosphorus in the lake river water can meet the endogenous conditions required for the growth of algae. Once the temperature and external light conditions in the water reach the necessary conditions for the growth of algae, the eutrophic water will make the algae grow and reproduce rapidly, which will lead to the deterioration of the quality of the lake water and the decline of the overall quality of the water environment and aggravate the eutrophication of the lake [9]. Combined with the hydrological conditions of the five rivers entering the lake, the concentration difference of the wet season during the dry season and the artificial factors of the surrounding cities, we sorted out the approximate pollution sources of total phosphorus and nitrogen: the first point is the natural source, including land nitrogen and atmospheric settlement. The second point is man-made sources. Including the discharge of nitrogen fertilizers, phosphorus fertilizers and other organic matter in fertilizer production in the manufacturing industry, the loss of nitrogen caused by the long-term use of nitrogen fertilizers in agricultural production, the discharge of nitrogen-rich and phosphorus-rich wastewater in aquaculture, nitrogen-containing salts and phosphorus-containing inorganic substances For example, the Chaoyang Phosphate Mine in Shangrao City directly discharges the polluting wastewater generated during the phosphate operation into the Xinjiang River, one of the lakes and rivers. In addition to the two main sources of pollution, the hydrological conditions of rivers entering the lake are also an important factor affecting the concentration of nitrogen and phosphorus in water bodies. The construction of different water conservancy facilities will also affect the change of total nitrogen and phosphorus concentration [10]. The specific analysis and treatment of these pollution sources will effectively improve the water conditions of rivers entering the lake, provide a theoretical basis for the formulation of relevant policies, and also provide experience in the treatment of rivers and lakes in other countries and regions.

4. Field investigation and discussion

We pay attention to the main influencing factors, but we always ignore some invisible factors. Through investigation, we found many submerged plants at the bottom of Poyang Lake, which can absorb nitrogen and phosphorus very well. With the slow arrival of global warming, human factors and the influence of environmental humidity, the total area of submerged plants has significantly been reduced. In the mathematical relationship, if the total pollution index remains unchanged and the degradation conversion index decreases, the final pollutant index will increase indirectly. Therefore, we investigated some environmental information, weather conditions, water, and plants in Poyang Lake Ecological Park, and finally discussed some external factors that can indirectly increase the pollution index.

In addition, the analysis of pollutants and pollution sources in this paper is all under the normal climatic conditions of Poyang Lake Basin. When it is used as a reference model, some differences in temperature, humidity and other conditions may lead to different results from the results in this paper. There is no specific research method for the analysis of pollutants and pollution sources in lake basins under different climatic conditions.

5. Conclusion

Some research data and reports show that the increase in total phosphorus and total nitrogen index is the main culprit affecting freshwater resources. Some phosphorus-related nitrogen manufacturing

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enterprises produce wastewater in manufacturing, which can affect the total phosphorus nitrogen index, and some inorganic heavy metal pollutants produced by heavy industrial plants will seriously pollute the freshwater resources of Poyang Lake. The consequences will be unimaginable if humans ingest a large amount of heavy metal water. Heavy metal inorganic substances will eventually flow to human beings under the enrichment of the food chain in Poyang Lake Basin, and will cause irreversible damage to human health. In addition, because heavy metals are too small, the diffusion rate in water environment and soil is extremely fast, and it is very easy to accumulate and difficult to remove [11]. There are also some suspended solids similar to microplastics. If ingested by aquatic animals, it will affect the quality of aquaculture output [12].

Phosphorus-nitrogen-related enterprises should strictly control the wastewater discharge standards to ensure that they can be discharged into rivers after passing the tertiary treatment of the wastewater treatment plant. Moreover, Poyang Lake is a freshwater resource, and the treatment method of wastewater should be more rigorous. Secondly, in an appropriate environment, it is not recommended to continue adding new heavy industrial plants. Existing heavy industrial plants should have wastewater treatment methods with higher requirements than nitrogen-related and phosphorus-related enterprises. Regularly dispatch environmental protection personnel to fully salvage suspended objects on the surface of the waters to prevent water pollution and aquatic plants caused by the long floating time of suspended materials.

Authors' contributions

Bingzhen Xu completed the main content of the thesis and the structure layout
YuHao Zhang found a lot of relevant information literature and academic content provided
Yue He Undertook the thesis theme improvement, structure refinement and paper logical sequence

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