Analysis of Effluent Outfall Problems and Their Classification and Regulation Countermeasures

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Abstract Effluent outfalls are an important exit for pollutants discharged from the source flowing into environmental water bodies, as well as an important guarantee for the ecological environment of natural water bodies. In response to main problems of large and diverse effluent outfalls, as well as their monitoring analysis, tracing and regulation in China, classification and regulation countermeasures were proposed based on the characteristics of effluent outfalls. It is suggested that a comprehensive management and control system should be built by improving the management and control system, upgrading monitoring techniques and strengthening social supervision and public education, so as to provide a scientific basis for the supervision and management of effluent outfalls in China and help promote the improvement of water quality and the sustainable development and utilization of water resources.

Key words Effluent outfalls; Monitoring and analysis; Classification and regulation; Environmental management

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Effluent outfalls are an important factor causing environmental water pollution. The amount of wastewater generated by industrial development and urbanization has been increasing year by year, and wastewater enters natural water bodies such as rivers, lakes, and oceans through sewage pipes. China's effluent outfalls have the characteristics of large quantity and diverse types, mainly including industrial outfalls, urban sewage treatment plant outfalls, agricultural outfalls, and temporary outfalls, and wastewater is discharged into natural water bodies such as rivers, lakes, ditches, reservoirs, dams, and coastal water bodies through drainage ditches, pipelines and other facilities and equipment, which will inevitably affect the balance of water ecosystems. Currently, due to factors such as sewage treatment capacity and pollution control, untreated wastewater is discharged directly into the Haihe River, causing pollution to the natural water ecological environment, which is detrimental to public health and safety production. In 2022, *Implementation Opinions of the General Office of the State Council on Strengthening the Supervision and Management of Effluent Outfalls for Rivers and Seas* required the investigation, tracing, classification, regulation, and supervision of effluent outfalls. Various regions across the country are actively responding and carrying out various types of effluent outfall regulation, and establishing regional effluent outfall layout planning systems for carrying out planned supervision and management and ensuring water environment safety[1-2]. By the end of 2025, the basic goal is to complete the regulation of effluent outfalls in major river basins, tributaries, important lakes, and sea areas in China. The key to preventing water pollution is to investigate and trace the source, and to reasonably control the problem of effluent outfalls.

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Upon reviewing domestic and foreign literature and materials, it has been found that there is still no established comprehensive system and technical specifications for the layout planning and control of effluent outfalls both domestically and internationally. Developed countries in Europe and America have carried out relevant work in the management of effluent outfalls for rivers[3]. In terms of pollution source control, developed countries in Europe and America mainly establish and improve relevant policies and regulations, and take measures such as limiting the amount of pollution emissions from pollution sources. The United States has established a comprehensive management structure for some river basins, addressing water pollution issues from various aspects such as controlling the total amount of pollutants entering rivers and improving water environment quality[4]. However, the tracing of effluent outfalls for rivers in China has not yet formed a working mechanism and systematic management model. The current work is mainly reflected in the national pollution source census and the treatment of black and odorous water bodies. Overall, foreign research on the impact of effluent outfalls for rivers on water quality and aquatic ecology has expanded from conventional pollutants to comprehensive ecological impacts. Due to differences in management and governance perspectives, the tracing and control work of effluent outfalls in China is still in the early stage of understanding the situation and tracing the source, and comprehensive control and legal regulations urgently need to be strengthened. Promoting nationwide management of effluent outfalls is a guarantee for promoting water ecological environment security.

Analysis on the Current Situation of Effluent Outfalls in China

In recent years, the discharge of sewage and wastewater brought by economic development and urbanization has caused a lot of pressure on natural water bodies. There are many types of effluent outfalls in China, which are characterized by large

volume, large regional distribution and diverse discharge methods overall. The supervisory monitoring and daily inspection of effluent outfalls and laws and regulations are not perfect, so it is difficult to conduct regulation, and there are problems such as unclear sewage sources and difficult tracing. According to the monitoring data of effluent outfalls in the Guangzhou section of Pearl River Basin, it is found that main factors exceeding the standards are COD, total nitrogen, ammonia nitrogen and total phosphorus, and one of the reasons is that sewage basically enters effluent outfalls where ammonia nitrogen, permanganate index and total phosphorus exceed the standards[5].

Main problems existing in effluent outfalls were summarized combining with investigation. ① Some sewage is directly discharged into water bodies, and the supporting pipe network is not perfect. Some enterprises have sewage overflow around them, and the water quality index is not clear, which causes water quality problems easily. Some effluent outfalls have no signs around them, and the responsible subjects are not clear. ② The monitoring capacity of effluent outfalls is insufficient, and it is difficult to determine the source of wastewater currently. At present, the investigation of effluent outfalls in China is mainly based on manual field investigation, which is time-consuming and laborious. Compared with a large number of effluent outfalls, the efficiency needs to be improved. Therefore, it is necessary to combine drone aerial photography, satellite remote sensing and other technical means, and continuously improve the level of detection techniques, in order to more effectively conduct preliminary tracing analysis of on-site investigation results[6]. ③ The control of effluent outfalls is not perfect, and it is necessary to improve the registration of the inspection system and establish a regulatory system, in order to clarify responsibilities and provide guarantees for carrying out effluent outfall regulation work.

Classification and Regulation Measures for Effluent Outfalls

There is no unified model for the management of effluent outfalls, and it is necessary to classify and regulate them according to their types and pollution sources. Research has shown that the classification and regulation of pollutants directly discharged into the Bohai Sea has achieved certain results. In the past decade, the total amount of wastewater discharged into the Bohai Sea has increased, but the concentration of pollutants has been well controlled[7]. Responsible parties of relevant effluent outfalls must conscientiously formulate and implement regulation plans in accordance with relevant government regulations. The supervision of industrial enterprise effluent outfalls and over-standard rainwater discharge outlets mixed with industrial wastewater should be strengthened, as well as over-standard rainwater discharge outlets and emergency water treatment facility effluent outfalls. The sources of municipal rainwater and flood discharge outlets that experience mixed flow of rainwater and sewage, exceeding water quality standards, and violating regulations should be traced and regulated.

This paper explored regulation strategies for several main types of industrial effluent outfalls, agricultural, rural, and urban effluent outfalls, as well as effluent outfalls of sewage treatment plants. ① Industrial effluent outfalls: In order to control pollutants from the source into the natural environment, it is necessary to find out enterprise investigation devices, sewage discharge time, destination, pollutant types and monitoring data, and implement the most stringent sewage discharge control measures. Rainwater and sewage diversion renovation should be conducted, and whether the sewage pipe network and rainfall pipelines are independently laid and intact in each enterprise's factory building should be checked. It is necessary to strengthen the independent inspection and management of daily environmental standards of pollutant discharge enterprises, so as to effectively prevent the pollutants discharged by enterprises from exceeding the standards due to running, dripping and leaking, and strictly control wastewater pollution discharge by enterprises. Enterprises should implement clean production audit, and strengthen clean production incentives, and compulsory clean production audit shall be carried out for enterprises that use high-concentration toxic and harmful pollution raw materials for chemical production and operation or discharge high-concentration toxic and harmful substances in production operations. It is necessary to urge manufacturing enterprises to actively improve the utilization rate of resources and energy, minimize waste, minimize pollution from the initial source, and realize the transformation from pollution control at the end to pollution control at the source and in the whole process. ② Agricultural, rural and urban effluent outfalls: Sewage interception and treatment measures should be taken to direct discharge outlets for various types of urban domestic sewage and production and operation wastewater within the coverage ranges of sewage pipe network systems in established towns as soon as possible, and they should be included in centralized sewage pipe networks in established towns and synchronously discharged into sewage centralized treatment facilities to achieve unified collection and centralized treatment of pollutants. For rural domestic sewage outfalls that cannot be normally connected to centralized sewage pipe networks in towns, the construction of rural domestic sewage treatment facilities should be gradually planned and implemented as soon as possible, and on-site management, inspection and maintenance should be strengthened according to regulations. ③ Effluent outfalls of centralized sewage treatment facilities: The comprehensive coverage of centralized sewage pipeline network systems should be completed based on the scale and quality of sewage discharged within established towns to achieve full coverage of rainwater and sewage diversion, sewage collection and treatment, and meet the needs of development. If there are various direct effluent outfalls for domestic and production wastewater within the coverage areas of centralized sewage pipe networks in established towns, in principle, immediate measures should be taken to intercept and collect sewage and discharge it into sewage pipe networks nearby and into

centralized sewage treatment facilities, thereby achieving systematic collection and centralized treatment.

Construction of Comprehensive Control Systems for Effluent Outfalls

In response to the current situation of effluent outfalls in China, it is necessary to improve the management system, clarify standards, and enhance monitoring capabilities to strengthen the comprehensive control system of effluent outfalls and promote the comprehensive regulation work of effluent outfalls.

Improving the management system of effluent outfalls

The consent, registration, and approval procedures for the establishment of effluent outfalls have not been effectively implemented, and the inspection, monitoring, tracing and regulation work of effluent outfalls into rivers should be continuously and orderly carried out. Starting from strengthening local supervision, effective supervision can be carried out on illegal behaviors such as excessive emissions from effluent outfalls into rivers[8], and responsible parties can supervise corresponding tracing and regulation in accordance with the law. According to the principle of "one river, one policy", relevant departments need to increase regulatory efforts for the overall remediation of main rivers discharged into the sea, especially for the regulation of the source, establish a long-term management mechanism, and strictly control the discharge of land-based pollutants. It is necessary to strengthen cross-city water pollution prevention and control. According to the source tracing data of effluent outfalls, most of the outfalls meet discharge standards, but some outfalls are still seriously polluted, mainly concentrated in the outfalls of enterprises in cross-city basins. Therefore, from the overall consideration of basins, we should strengthen the joint efforts of all cities to control water pollution, strengthen the sustainable development of water quality, and formulate relevant regulations on water quality guarantee in cross-city basins. We should further strengthen the inspection and supervision of key coastal enterprises involving sewage discharge, investigate the discharge of pollutants into the sea by industries and enterprises, clarify the discharge permit system for industries and enterprises, and strictly implement the up-to-standard discharge plan and the pollutant discharge standards. Also, it is necessary to accelerate the interception and management of industrial wastewater, and access it to sewage treatment plants for unified treatment.

Improving the monitoring system of effluent outfalls, strengthening intelligent supervision and establishing archives of sewage discharge

In view of different water quality, we should speed up the research and development and use of supporting products for rapid water quality inspection of effluent outfalls[9] to comprehensively improve the monitoring capacity of effluent outfalls. Through improving on-line monitoring systems for enterprise production wastewater quality and increasing the monitoring efficiency, automatically tracking and monitoring of water quality can be realized, facilitating finding the illegal discharge of polluted wastewater by enterprises in real time, and directly playing an effective role in supervision and detection. Following up on-line monitoring of industrial sewage depth, it is suggested to add specific pollutant monitoring sensors in combination with its process. The data will be automatically reported to the pollution source online monitoring and alarm platform of corresponding environmental protection department in real time, and the thresholds for exceeding standards will be set to give an alarm to all monitoring indicators that have exceeded standards, so as to effectively and timely supervise the work. If the setting conditions of effluent outfalls do not meet relevant standards, and it is not convenient to collect samples and perform measurement and monitoring, supervision and inspection, or concealed pipes are used to discharge without leaving an observation window, the responsible subjects should rebuild the effluent outfalls into rivers according to the requirements of relevant standards, so as to facilitate sample collection, measurement and monitoring, supervision and inspection.

Strengthening the social supervision system

It is necessary to do a good job in water environment-related pollution prevention and control training, and provide free and convenient consultation for the public. In response to environmental law enforcement actions and major water pollution incidents, we sincerely invite the whole people to participate and relevant organizations to investigate. The whole people can participate in the environmental supervision mechanism and supervise environmental law enforcement and media exposure through internet collection and offline collection. Signs for sewage outlets into rivers should be established, and the management of classification and marking of sewage outlets for rivers should be conducted. The up-to-standard discharge of wastewater from industrial enterprises should be strictly implemented, and signs should be set at each discharge outlet. The signboards should be placed in prominent positions near discharge outlets for rivers or sampling points, have clear, unified, coordinated and beautiful contents, and can be stored for a long time. They can be produced, distributed and updated by municipal ecological environment bureaus, which are also responsible for the maintenance and management of the signboards.

Strengthening education and publicity

Water environmental protection can be incorporated into the education system to improve people's understanding of social and economic sustainable development, give full play to the public opinion-oriented role of the Internet, and enhance public awareness of environmental protection. Efforts should be made to promote regional cooperation and exchange. For the protection of marine ecological environment, newspapers, radio, television, the internet and public places should be fully utilized to carry out multi-level and multi-form marine environmental warning education[10], and civil environmental protection organizations and volunteers should be supported to carry out the work. Led by government regulatory departments, relevant publicity, themed cultural performances and distribution of promotional materials can be organized, forming a

construction atmosphere that environmental protection is everyone's responsibility.

Conclusions

Effluent outfalls are a bridge connecting land and water, and they are important point sources for land-based pollutants entering natural water bodies. We should do a good job in land and water planning, and complete investigation, tracing, classification and regulation, and only when the supervision and management of effluent outfalls are in place can we promote the continuous improvement of the ecological environment quality of water bodies in basins.

References

[1] LIU XD, LIU SY, HUANG YX, *et al.* Regional effluent outfalls into surface water bodies distribution planning: A case study of Huizhou City [J]. Environmental Protection, 2023. (in Chinese).

[2] TANG C. Study on the current situation and countermeasures of effluent outfalls for rivers in Qinhuangdao City [J]. Technology Wind, 2023 (24): 168 – 170. (in Chinese).

[3] SUN N, XIE P, LIU Y, *et al.* The enlightenment to China from the management of sewage outlets into river in Europe and America[J]. Environmental Protection, 2021, 49(24): 25 – 28. (in Chinese).

[4] JIANG HH, LIU JM, ZHANG R, *et al.* The United States' management experience of sewage outlets on rivers and the related recommendations for China: Taking Massachusetts and Texas as example[J]. World Environment, 2021(6): 78 – 81. (in Chinese). (in Chinese).

[5] TANG JY, YU XY, LIU JT, *et al.* Classified distribution characteristics, supervision, and man-agement measures for sewage outfalls into the sea in Guangdong Province[J]. Marine Sciences, 2021, 45(3): 51 – 58. (in Chinese).

[6] HUANG YH, XIONG B, YANG HJ, *et al.* Review on the progress of remote sensing investigation of the outfalls into rivers[J]. Remote Sensing Technology and Application, 2022, 37(1): 24 – 33. (in Chinese).

[7] ZHANG P, YAN JS, ZHAO B, *et al.* Study on emission characteristics and management countermeasures of pollution sources directly discharged into Bohai Sea[J]. Marine Environmental Science, 2021, 40(6): 814 – 822. (in Chinese).

[8] NIU N. Thoughts and suggestions on strengthening the supervision and management of local effluent outfalls for rivers [J]. China Water Resources, 2018(9): 25 – 26. (in Chinese).

[9] BAI YP, XIE HJ, LIANG J, *et al.* Innovative pratice of marine outlet regulation and supervision: Taking Huizhou Daya Bay Zone as an example [J]. Environmental and Development, 2022. (in Chinese).

[10] HU P, YAN SQ, SHI P, *et al.* The situation and protection suggestions of marine ecological environment in Guangdong Province[J]. Ocean Development and Management, 2020, 37(6): 115 – 120. (in Chinese).

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[5] WANG QW, CHENG CL, QIN X, *et al.* Progress in bioactivity and structure-activity relationship of *Sargassum fusiforme* polysaccharides [J]. Guangdong Chemical Industry, 2021, 48(9): 164 – 165. (in Chinese).

[6] FU HY, ZHOU DP, LIU J, *et al.* Extraction, physicochemical properties and application of *Sargassum fusiforme* polysaccharides[J]. Guangxi Journal of Light Industry, 2021, 37(3): 7 – 9. (in Chinese).

[7] HU SQ, ZHENG EP, ZHAO TX, *et al.* Preparation and stability evaluation of *Sargassum fusiforme* polyphenols microcapsules [J]. Modern Food, 2022, 28(15): 156 – 160. (in Chinese).

[8] CAI SB, LI MQ, YI JJ. Optimization of extraction process for phlorotannins from *Hizikia fusiformis* by response surface methodology[J]. Journal of Dalian Dalian Polytechnic University, 2020, 39(5): 334 – 338. (in Chinese).

[9] DAI SC. Purification and antioxidant activity of polyphenols from *Sargassum fusiforme*[D]. Wenzhou: Wenzhou University, 2018. (in Chinese).

[10] LI YX. Purification and antitumor activity of crude polyphenols from *Sargassum fusiforme*[D]. Dalian: Dalian Ocean University, 2016. (in Chinese).

[11] ZHANG JL, ZHONG YG, WAN JQ, *et al.* Optimization of ultrasonic-assisted extraction of inorganic arsenic in *Sargassum fusiforme* (Harv.) by response surface methodology[J]. Food Science, 2013, 34(10): 67 – 71. (in Chinese).

[12] CAO Y, DUAN JA, GUO JM, *et al.* Analysis and evaluation of inorganic elements in *Sargassum pallidum* and *Sargassum fusiforme* from different habitats[J]. Science & Technology Review, 2014, 32(15): 15 – 24. (in Chinese).

[13] LI JJ, ZHAO MY, XIA QL, *et al.* Analysis of super critical CO_2 extract from *Sargassum fusiforme* and its application in cigarette[J]. Tobacco Science & Technology, 2008(8): 41 – 43. (in Chinese).

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