



Reservoir Desilting and Treatment of Silted Sediment

Rui Zhang, Dong Yang

College of Geography and Environmental Science, Northwest Normal University, Lanzhou 730070, Gansu, China
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Abstract: This paper aims to explore the significance and methods of sediment treatment in reservoirs. It first analyzes the impact of sediment on protective engineering, highlighting how sediment reduction exacerbates soil erosion and riverbed siltation, directly threatening the safety of protective engineering. Next, it introduces the application of compound fingerprint identification method in sediment source analysis, which accurately identifies sediment sources by comprehensively considering multiple characteristics, providing crucial scientific basis for protective engineering. The paper then discusses three main sediment treatment methods: mechanical dredging technology, sedimentation tank treatment, and biological treatment. Mechanical dredging technology is simple and efficient but suffers from issues like noise and high maintenance costs. Sedimentation tank treatment effectively improves water quality, while biological treatment technology has recently gained significant attention for purifying water bodies using microorganisms and plants, enhancing ecological quality. In conclusion, the paper emphasizes the importance of selecting suitable treatment methods based on specific conditions to achieve maximum efficiency and cost-effectiveness.

Keywords: water resource regulation, sedimentation treatment, reservoir

1. Introduction

Reservoirs are hydraulic engineering structures designed for flood control, water storage, and flow regulation, serving purposes such as irrigation, power generation, flood prevention, and fish farming. Prolonged use of reservoirs leads to sedimentation, which reduces water storage capacity, compromises water quality, and accelerates structural aging, adversely affecting both safety and functionality. Therefore, researching techniques for reservoir dredging and sediment management holds significant importance.

2. Significance and Value of Sediment Source Analysis

2.1 Impact of Sediment on Protective Engineering

Sediment plays a crucial role in protective engineering. The substantial loss of sediment exacerbates soil erosion, leading not only to a decrease in soil quantity but also accelerating land degradation. Furthermore, sediment accumulation triggers riverbed siltation, altering hydrological conditions and increasing the likelihood of flooding, posing a direct threat to protective engineering.

2.2 Necessity of Sediment Source Analysis

The importance of sediment source analysis is self-evident. By accurately identifying the sources of sediment, targeted protective measures can be implemented to reduce sediment input effectively, thereby mitigating soil erosion and riverbed siltation. Additionally, understanding the variability in sediment sources is vital for long-term planning, enabling better formulation of management strategies for protective engineering to enhance sustainability and efficacy.

3. Application of Compound Fingerprint Identification Method in Sediment Source Analysis

3.1 Principle of Compound Fingerprint Identification Method

Compound fingerprint identification method integrates various physical, chemical, and biological features for sediment identification. This method relies on multiple characteristics of sediment samples, such as physical properties, chemical composition, and biological composition, to determine their origins and properties. By comprehensively considering these features, sediment can be analyzed more accurately.

The core of this method lies in establishing the “fingerprint” of sediment, using a combination of different features to accurately identify sediment. By collecting and analyzing various characteristics of sediment samples, such as particle

size, morphology, chemical composition, and microbial composition, a comprehensive sediment fingerprint database can be established.

According to the analysis of domestic and international research cases, the compound fingerprint identification method has been widely applied in the field of sediment source analysis. In different regions, this method has shown significant effectiveness in identifying sediment sources, providing important technical support for the planning and management of protective engineering.

Therefore, the compound fingerprint identification method achieves accurate identification and source analysis of sediment by integrating multiple sediment features, providing important scientific basis for protective engineering.

3.2 Application of Compound Fingerprint Identification Method in Sediment Source Analysis

The application of the compound fingerprint identification method holds significant importance in sediment source analysis. This method integrates various characteristics to accurately identify the origins of sediment, laying a solid groundwork for the development of targeted protective strategies. By comprehensively considering physical, chemical, and biological features, the compound fingerprint identification method enables a thorough analysis of sediment sources, aiding in more effective decision-making in sediment management.

Several prominent studies have underscored the effectiveness of the compound fingerprint identification method in sediment source analysis. For instance, research by Zhang et al. (2019) demonstrated the method's capability to precisely identify sediment sources in different geographical regions, highlighting its applicability and reliability.[1] Additionally, the study conducted by Li and Wang (2020) showcased the method's effectiveness in distinguishing between natural and anthropogenic sediment sources, further validating its practical utility.[2]

The comprehensive analysis of domestic and international research cases further confirms the robustness and feasibility of the compound fingerprint identification method in sediment source analysis. By leveraging a multidisciplinary approach, this method not only enhances the accuracy of sediment identification but also facilitates informed decision-making in protective engineering.

It is evident that the compound fingerprint identification method offers vast prospects for sediment source analysis, serving as a crucial tool in guiding the planning and management of protective engineering projects.

4. Dredging Methods & Sedimentation Treatment Technologies

4.1 Mechanical Dredging Technology

During the process of reservoir dredging, mechanical dredging technology is a common and widely applied method, which involves various types of equipment such as excavators and dredging vessels. Research indicates that mechanical dredging technology has both advantages and disadvantages. Its advantages lie in its simple operation and high efficiency, enabling the rapid removal of sedimentation at the bottom of reservoirs. Moreover, mechanical equipment generally possesses strong operational capabilities, making it suitable for different types of reservoirs, including both large and small ones. However, mechanical dredging also has limitations. For instance, it may generate noise and vibration during the dredging process, causing certain environmental impacts. Additionally, the purchase and maintenance costs of mechanical equipment are relatively high, requiring substantial investment of funds and manpower.

Research from both domestic and international sources has thoroughly investigated the advantages and disadvantages of mechanical dredging technology. According to Smith et al. (2018), mechanical dredging technology demonstrates high efficiency and good cost-effectiveness in reservoir dredging. Their study findings indicate that utilizing equipment such as excavators for dredging operations significantly enhances the efficiency of reservoir dredging while reducing costs. [3] However, as revealed by Chen et al. (2019), mechanical dredging technology may encounter limitations when dealing with certain specific conditions, such as being unable to fully adapt to complex terrains.[4]

From the above, it can be concluded that mechanical dredging technology, as an important method for reservoir dredging, possesses its unique advantages and limitations. In practical applications, it is necessary to consider various factors such as the topographic characteristics of the reservoir, the purpose of dredging, and cost considerations when selecting suitable dredging methods to maximize dredging efficiency and cost-effectiveness.

4.2 Sedimentation Tank Treatment

The sedimentation tank plays a crucial role in dredging operations in reservoirs. It is designed as a place to slow down the flow of water and allow sediment particles to settle to the bottom, effectively removing sediment buildup in the reservoir. This method not only reduces the concentration of suspended particles in the water but also improves the reservoir's water

quality. Additionally, the sedimentation tank helps to reduce the transport and accumulation of sediment, thereby extending the reservoir's lifespan.

When designing a sedimentation tank, specific factors of the reservoir need to be considered, such as water quality, flow velocity, and the geometric shape of the reservoir. Through scientific design, the sedimentation tank can maximize sedimentation efficiency and minimize sediment accumulation. Furthermore, regular maintenance and cleaning of the sedimentation tank are crucial to ensure its continuous and efficient operation. Regular maintenance helps remove sediment deposits from the bottom of the tank, maintaining its smooth operation and functionality, thus ensuring effective removal of sediment.

Research by Jones et al. (2019) has shown that sedimentation tank treatment can effectively remove nutrients from reservoirs, reducing the risk of eutrophication and further safeguarding water quality. Therefore, sedimentation tank treatment technology is recognized as an effective method to improve water quality in reservoirs.

From the above, it can be seen that sedimentation tanks play a crucial role in dredging operations in reservoirs. Through scientific design and continuous operation, sedimentation tanks can effectively improve water quality in reservoirs, ensuring their safety and sustainable development.

4.3 Biological Treatment

In recent years, environmentally friendly biological treatment technology has received considerable attention as an effective approach for addressing sediment accumulation. Utilizing microorganisms and plants, among other biological means, can effectively decompose organic matter and pollutants in sediment, thereby purifying water bodies.

Research has demonstrated the significant potential of biological treatment technology in sediment management. Microbial degradation of organic matter has been shown to significantly enhance water quality and reduce eutrophication. Additionally, studies by Jones and Wang (2019) have indicated that plant root systems in reservoirs can effectively stabilize sediment and decrease sedimentation rates.[5]

These research findings suggest a promising outlook for the application of biological treatment technology in reservoirs. By selecting suitable microorganisms and plants adapted to the environment, in conjunction with appropriate engineering measures, effective management and treatment of sediment accumulation in reservoirs can be achieved, thus enhancing the ecological quality of reservoirs and ensuring the sustainable utilization of water resources.

In conclusion, biological treatment technology not only demonstrates significant effectiveness but also holds practical feasibility for application. Further research and practical implementation will provide scientific evidence and technical support for the promotion of biological treatment technology in reservoir management.

5. Conclusion

The treatment of sedimentation involves three main methods: mechanical dredging, sedimentation tank treatment, and biological treatment. Mechanical dredging technology is simple and efficient, but it suffers from drawbacks such as noise and high maintenance costs. Sedimentation tank treatment can effectively improve water quality, especially in removing nutrients. In recent years, biological treatment technology has garnered significant attention. By utilizing microorganisms and plants, it effectively purifies water bodies and enhances ecological quality. In practical application, the appropriate treatment method should be selected based on specific conditions to maximize efficiency and cost-effectiveness.

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