comprehensive research system that includes cause analysis, monitoring, and various governance methods. The technical means involved have also increased. The existing research review summarizes various governance methods such as physical, chemical, and biological ones, and also introduces some emerging technologies, such as nanotechnology, electrocoagulation technology, and ultrasonic technology. The focus of the research is mainly on finding a reasonable balance among the governance effect, economic cost, and environmental impact. The related review also points out that there is currently no single method that can solve all problems or achieve long-term and thorough control of algal blooms. In recent years, with the development of satellite remote sensing, underwater automatic sensors, molecular detection technology, and data models, people's ability to monitor and warn of algal blooms has significantly improved, enabling earlier detection and response to algal blooms in marine and freshwater environments. At the same time, the issue of algal bloom governance has gradually been linked to broader issues such as social development, ecological protection, and policy management. By integrating the results of various studies, it can be seen that although significant progress has been made in scientific understanding and technical reserves, there are still certain deficiencies in long-term governance effects, governance capabilities, and cross-departmental cooperation.

In recent comprehensive studies, "prevention first and comprehensive management" has been regarded as an important approach for controlling algal blooms in the future. For instance, measures such as reducing the discharge of nutrients like nitrogen and phosphorus, improving wastewater treatment and agricultural management methods, and restoring natural water flow have always been considered as important foundations for solving algal bloom problems and key means to reduce the risk of large-scale and long-term algal blooms. However, single governance methods are often limited by factors such as water body size, cost, or ecological impact. Therefore, some studies suggest combining physical, chemical and biological methods, such as using algivorous microorganisms, regulating the food chain structure, or promoting flocculation through nanomaterials, to form more targeted comprehensive management plans. Such plans can not only reduce the risk of algal blooms in the short term but also contribute to the long-term restoration of the water body ecosystem. Moreover, effective prevention also requires the establishment of a complete monitoring network, the formation of unified and standardized monitoring methods, and the establishment of a risk communication mechanism that can promptly convey scientific information to managers and the public, thereby increasing public participation. These practices also indicate that algal bloom control requires interdisciplinary and holistic management from the watershed to the estuary.

In the future, the management of cyanobacterial blooms will rely more on technological upgrades and the optimization of management methods. The new generation of control systems will closely integrate monitoring and management work, integrate various observational data, model algorithms and intelligent tools, build an intelligent monitoring and governance network, and make management more predictive. The current key technical directions are to develop environmental-friendly nanomaterials, promote microbial and ecological restoration methods, and use underwater and hyperspectral observation equipment. Various regions are also improving their management systems, integrating the management of cyanobacterial blooms with major policies such as climate change and public health, and enhancing the adaptability and sustainability of aquatic ecosystems.

Acknowledgments

The authors extend sincere thanks to two anonymous peer reviewers for their feedback on the manuscript.

Conflict of Interest Disclosure

The authors would like to thank the colleagues at the Aquatic Biology Research Center, Cuixi Academy of Biotechnology, for their assistance and support during the preparation of this study. The authors also sincerely appreciate the valuable comments and suggestions provided by the anonymous reviewers, which helped improve the quality and clarity of the manuscript.

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