Characteristics and driving factors for algal growth and water quality in two major water source reservoirs in the Yangtze River Estuary

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Objectives

Qingcaosha reservoir (QCS) and Chenhang reservoir (CH), located on the Yangtze River Estuary, are two major sources of drinking water for Shanghai, benefiting more than 11 million people. Profiting from the achievements of the Yangtze River protection and restoration during the "13th Five-Year Plan" period, the intake-water quality of the two reservoirs has been improved. However, despite the almost identical intake-water quality of the two reservoirs, QCS is at risk of eutrophication caused by algal overgrowth. In view of the importance of water supply security, this study investigated the water quality characteristics of the two reservoirs as well as the driving factor of algal proliferation in QCS based on hydrological and water quality monitoring data of the two reservoirs from 2020 to 2021.

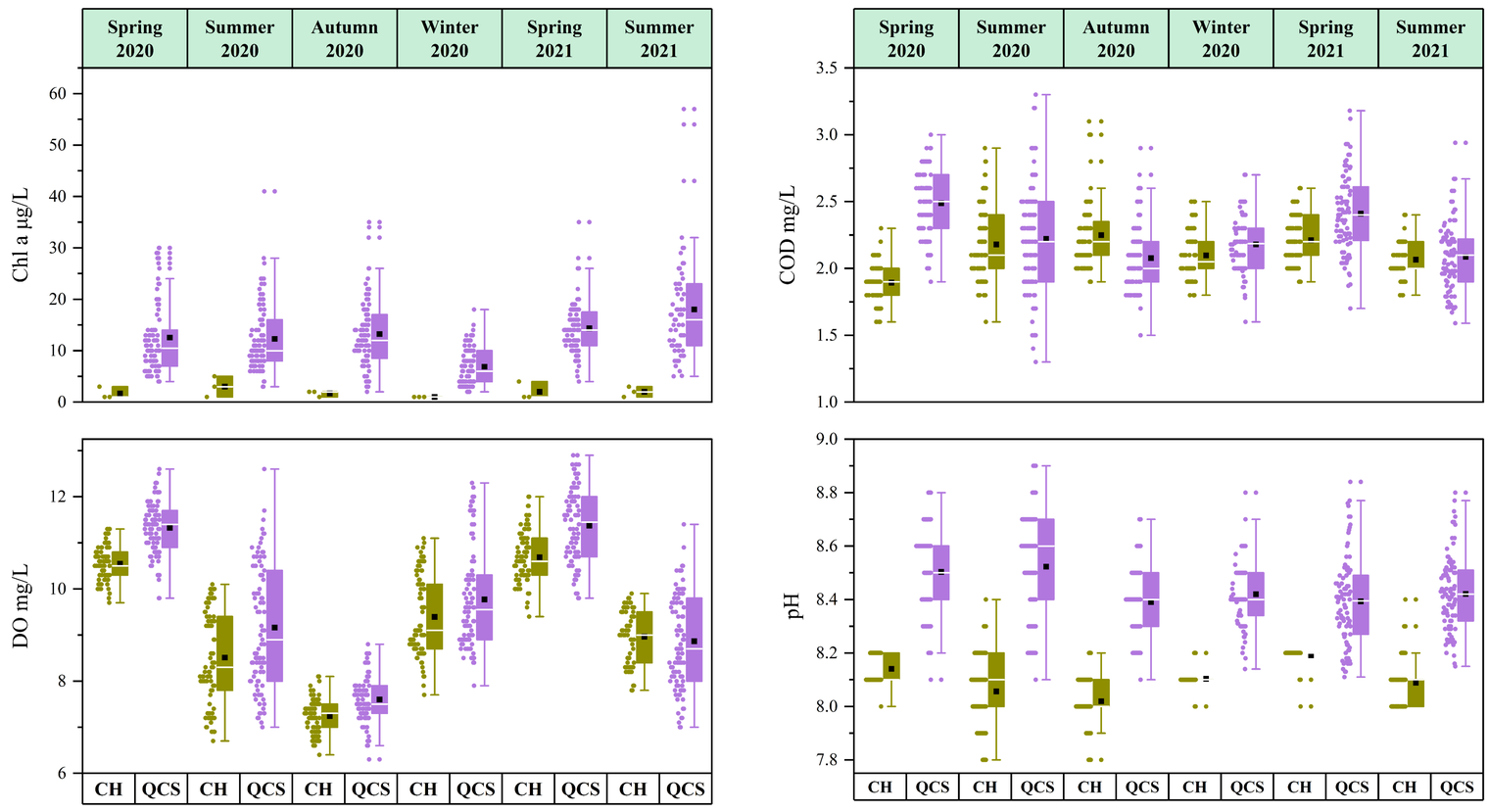

Fig. 1 Water qualities of QCS and CH from 2020 to 2021

Methods

The hydrological and water quality of QCS and CH datasets from 2020 to 2021 reservoir were provided by the reservoir management department, which included water surface elevation, water temperature, flow rate, total nitrogen (TN), total phosphorus (TP), ammonia nitrogen (NH3-N), chemical oxygen demand (COD), dissolved oxygen (DO), pH, turbidity and chlorophyll a concentration (Chl a).

Results

The results showed that the Chl a concentration in QCS was 5-20 times higher than that in CH. Moreover, water quality indicators associated with phytoplankton production, such as COD, DO and pH, also exhibited higher concentration levels in QCS, suggesting that the principal factors leading to water quality differences between the two reservoirs were related to algal activities. In addition, the results of correlation analysis showed that NH3-N and TP were not significantly correlated with Chl a concentration, while low surface elevation were the major factors contributing to the elevation in Chl a concentration. Accordingly, the characteristic pattern of algal overgrowth observed primarily during salty tides in spring could be explained as follows: Prolonged hydraulic residence time and weak hydrodynamic conditions during the salty tide resulted in decreased turbidity and improved light availability for algae, which stimulated the abnormal algal proliferation progress. By contrast, the Chl a concentration in CH was considerably lower, which was due to the significantly shorter hydraulic residence time and smaller reservoir capacity scale.

Conclusions

Variations in environmental factors caused by hydrological conditions were the driving factors for the abnormal algal proliferation in QCS, which in turn triggers the distinction in water quality between the QCS and CH. These results would provide scientific references for water quality management in the research area.

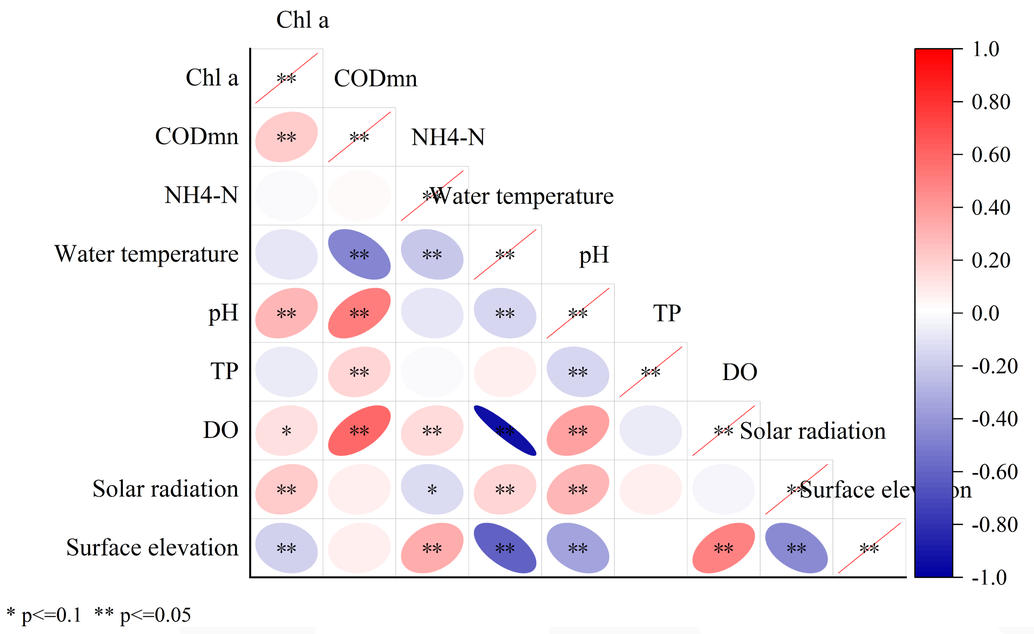

Fig. 2 Correlation significance of Chl a concentration with environmental factors