The Fine Spatial Scales of Hydrology in Dammed Tributaries Determining the Algal Blooms' Potential

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Abstract

Harmful algal bloom (HABs) in reservoir tributaries is a global concern. However, the mechanisms regulating the size of HABs along the length of tributaries remain unclear. In this study, we hypothesized that the variation in water column stability is a critical driver of when and where HABs develop in reservoir tributaries. To test the hypothesis, we conducted a sampling campaign from April 17th to May 20th, 2021 in 4 km apart transects (S1, S2, and S3 from upstream to downstream of the river) along Pengxi River, TGR. The results revealed that each transect experienced unique hydrological conditions that modified water column stability, hence affected the strength of algal bloom. Transect S3 characterized by thermal stratification and pronounced backwater influence, experienced the prolonged formation of unique surface density layers (SDLs) compared to S1 and S2. This environment fostered the development of HABs. On May 6th, when Chl-α peaked at S3, the Chl-α content varied significantly among transects, with S3 recording 96.28% and 81.80% higher than those of S1 and S2, respectively. Dinophyta dominated the algal blooms at all three transects. As the air temperature increased, thermal stratification was strengthened, leading to more prominent SDL formation, particularly at S3 (May 2nd to May 17th). Water mixing influenced DTP distribution, with no significant difference between the bottom and surface layers. The SDL formation decreased surface DTP at S2. While at S3, backwater increased bottom DTP, contrarily SDL decreased surface DTP. PCA analysis revealed varied responses of HABs communities to water quality and distinct associations among transects. In conclusion, the backwater effect on the Pengxi River significantly influenced hydrodynamics and nutrient availability, affecting algal bloom potential at fine spatial scales. To effectively mitigate blooms, it's vital to account for how hydrological variations can alter water column stability to promote the development of HABs.

Keywords

Algal Blooms, Hydrodynamics, Nutrients, Tributary Backwater, Transects, Three Gorges Reservoir