

Water Stratification is Key to the Formation of Algal Bloom in the Backwater Areas of the Three Gorges Reservoir, China

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The Three Gorges Dam has backed up water to varying *depths* in the catchment tributaries after impoundment which has resulted in slow flow and an accumulation of nutrients in the backwater areas. Since 2003, the reservoir started to store water, and algal blooms developed immediately in the tributaries ranging from short time periods to several months in a year. In order to determine the relationship between the water environment and algal bloom development, a high frequency sampling study at a fixed site was carried out from April to December 2013 in Gaoyang Lake, the backwater area in Pengxi River, the largest river in the north bank of Yangtze River in the Three Gorges Reservoir catchment.

A clear thermal stratification was observed in the spring, summer and autumn vertical profiles of the water column, but not in winter during the deep water phase where isothermal mixing was occurring (Fig. 1). The mixing layer depth during stratification (Z_{mix}) changed from 3.8 m to 10 m depth (Fig. 2). The annual water euphotic layer depth (Z_{eu}) ranged from 1.35 m to 9.45 m, but was maintained at 3 m from May to September. In the stratified water, especially during in the middle of April when the algal bloom was predominant, peaks of Chla in surface water occurred shortly after the maxima of Z_{eu}/Z_{mix} in the water column (Fig. 3), demonstrating that in highly eutrophic waters like that in Gaoyang Lake, stratification and high ratio of Z_{eu}/Z_{mix} strongly attributed to the development and persistence of algal blooms.

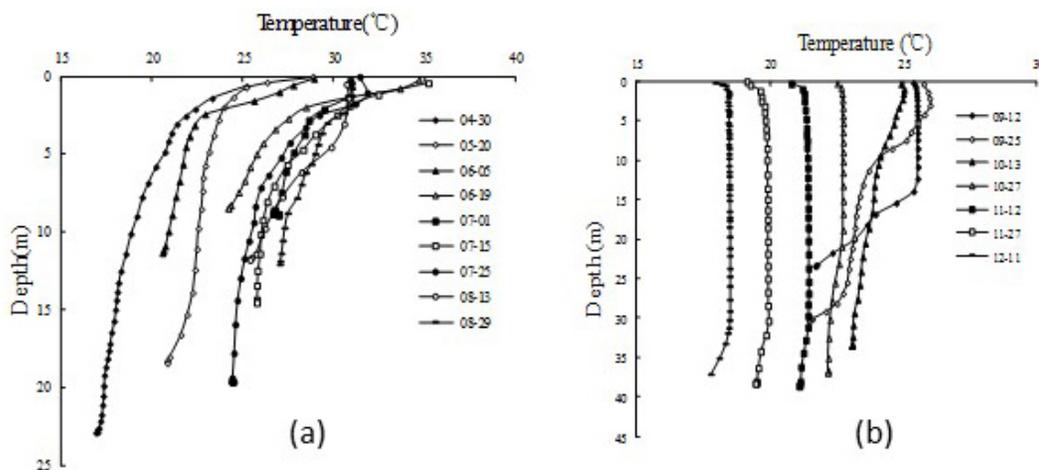


Figure 1. The temperature curves in vertical distribution in Gaoyang Lake. (a): Low water level; (b): High water level.

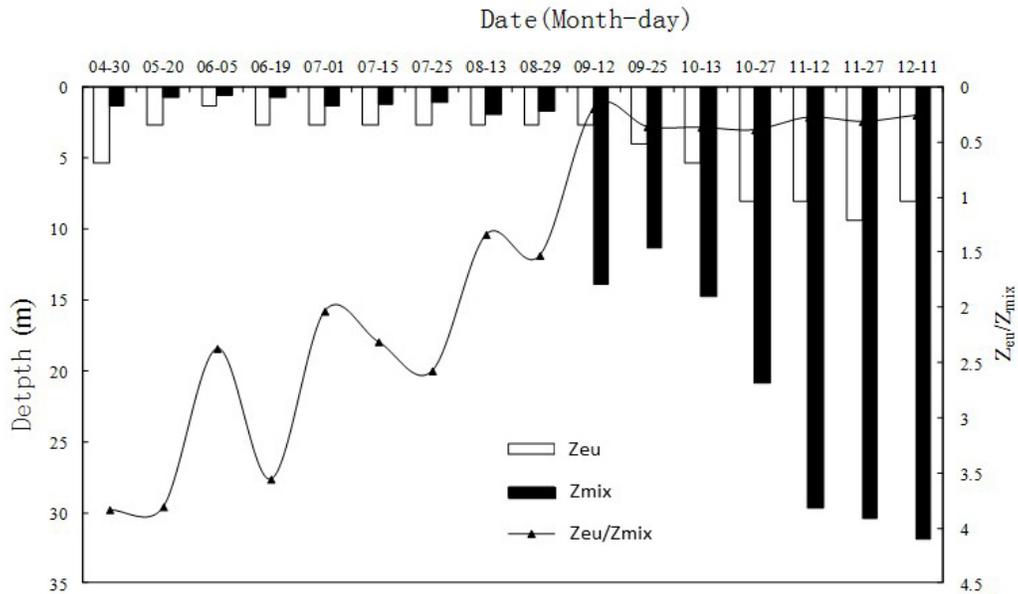


Figure 2. Variation of Zeu, Zmix and Zeu/Zmix in Gaoyang Lake.

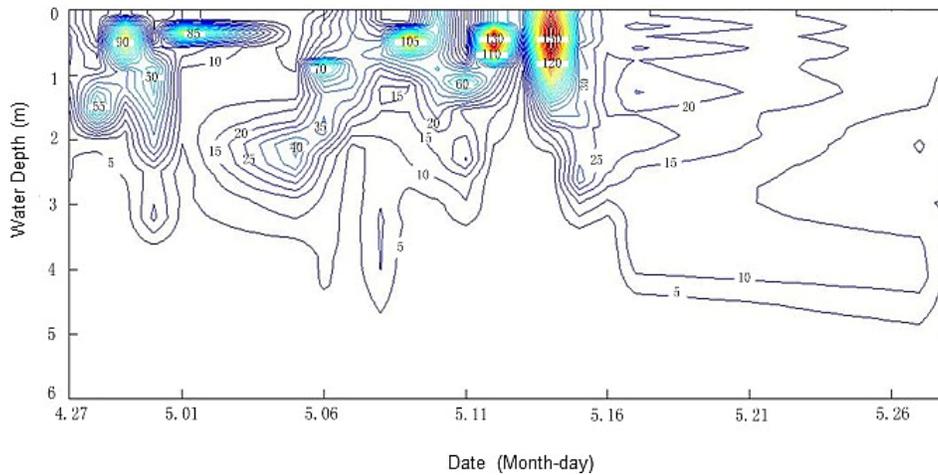


Figure 3. The spatial and temporal isoclines map of concentration of chlorophyll ($\mu\text{g/L}$) on permanent backwater area of the Pengxi River.

In late spring, during the algal bloom, the algal community was composed of 9 genera of 4 divisions, while the average cell abundance in surface water was 2284×10^4 cell/L, mainly composed of *Cyanophyta* and *Chlorella* groups, and the dominant genera were *Microcystis*, *Pandorina* and *Eudorina*. However, in the winter when the waters of Gaoyang lake were not stratified, the dominant genera were *Cyclotella* and *Synedra*, and algal density was much lower with a maximum biomass of 14×10^4 cell/L and the average cell abundance in different depths of the water column layers was similar. Gaoyang Lake water stratification affects the growth and distribution of algal community.

REFERENCES

- Jiang JG & Shen YF. 2007. Development of the microbial communities in Lake Donghu in relation to water quality. *Environmental Monitoring and Assessment*, 127(1-3): 227-236.
- Lan Wang, Qinghua Cai, Yaoyang Xu, Linghui Kong, Lu Tan, Min Zhang. 2011. Weekly dynamics of phytoplankton functional groups under high water level fluctuations in a subtropical reservoir-bay. *Aquatic Ecology*, 45(2):197-212.
- Syuhei Ban, Wataru Makino, Hiroyuki Sakano, Hiroyuki Haruna, Hiroshi Ueda. 2012. Annual variation in biomass and the community structure of crustacean zooplankton over 5 years in Lake Toya, Japan. *Limnology*, 14(1):59-70.
- Yang J, Yu XQ, Liu LM, Zhang WJ, & Guo PY. 2012. Algae community and trophic state of subtropical reservoirs in southeast Fujian, China. *Environmental Science and Pollution Research*, 19(5): 1432-1442.
- Zhang Lei, Xia Zhiqiang, Zhou Wei, Hamilton BP, Haffner GD. 2015. Spatial distribution of nutrient and phytoplankton and the causes for their differences of the Three Gorges Reservoir in spring season. *Research and Environmental Sciences*. 28(7): 55-63.
- Zhang Lei, Yu Jianjun, Fu Li, Zhou Chuan, Haffner GD. 2015. Temporal and spatial variation of nutrients and chlorophyll A, and their relationship in Pengxi River backwater area, Three Gorges Reservoir. *Environmental Sciences*. 36(6):151-159.