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# FACTORS INFLUENCING THERMAL STRUCTURE IN A TRIBUTARY BAY OF THREE GORGES RESERVOIR*

YU Zhen-zhen, WANG Ling-ling
College of Water Conservancy and Hydropower Engineering, Hohai University, Nanjing 210098, China,
E-mail: yuzhenzhen8@126.com

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**Abstract:** To better understand the factors influencing the thermal structure of tributaries in the Three Gorges Reservoir (TGR), a well validated three-dimensional hydrodynamic and water temperature model was proposed to simulate the water temperature distribution in the Xiangxi Bay, a representative tributary of TGR. The numerical results show that water temperature stratification seasonally occurred in the Xiangxi Bay, with stable vertical temperature profiles. It is found from the numerical experiments that three key factors are responsible for the formation of water temperature structure: (1) very often, the locations of thermocline are mainly determined by wind speeds, and the higher the wind speed is, the deeper the thermocline is located beneath the water surface, which could be expressed by a fitted exponential function, (2) the thermal structure is affected by static stability of water column, and the thermocline becomes closer to the water surface and its thickness increases with the increase of temperature, (3) due to the effect of the thermal density inflow, the water temperature of the hypolimnion tends to be uniform, however, even under the condition of larger inflow discharge, the influence of the inflow on the epilimnion and the thermocline is not significant.

**Key words:** water temperature stratification, numerical simulation, density current, influencing factors, wind force, static stability of water, inflow discharge, Three Gorges Reservoir (TGR)

## Introduction

Thermal stratification is one of the most important environmental issues for deep waters, due to its strong effects on physical, chemical, and biological processes. Often in summer, surface water temperature is much higher than that at bottom, consequently, water densities become stacked vertically, forming the upper epilimnion, the bottom hypolimnion, and the metalimnion (thermocline) between them. Note that the thermocline can be regarded as a transition layer with a sharp temperature gradient. Vertical stratification causes weak mixing, which in fact prevents the surface water from supplying substances to the bottom layer. Therefore, nutrients and Dissolved Oxygen (DO) are often confined only in the epilimnion layer, causing a series of water quality problems such as hypoxia[1,2]. In particular, water temperature stratification may speed up the eutrophication and create favorable conditions for algal blooms[3], which may pose a significant adverse impact on the ecosystems in water. On the other hand, large-scale waters are frequently disturbed by human society. Hence, it is of great interest and significance to study the spatial and temporal characteristics of water temperature in human-made water bodies, such as the Three Gorges Reservoir (TGR).

The TGR is the largest reservoir in China and around the world, with a normal pool level of 175 m and a total reservoir storage capacity of $3.93\times10^{10}$ m$^3$. After the impoundment of TGR, there is a significant increase of water level in some tributaries due to the effect of backwater, leading to a decrease of flow speed therein. It is observed that seasonal stratification has occurred almost every year, especially in tributary waters of which the hydrodynamic characteristics are fundamentally similar to that in deep lakes[4]. Both monitoring data and numerical simulation indicated that, water temperature stratification has occurred in

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**Biography:** YU Zhen-zhen (1982-), Female. Ph. D. Candidate
**Corresponding author:** WANG Ling-ling,
E-mail: wanglingling@hhu.edu.cn