In spite of numerous investigations into water cooling effects, there are still limitations in comprehending this phenomenon. Primarily, previous studies have employed linear equations to analyze the relationships between water cooling and influencing factors. However, owing to the complexity and irregularity of urban characteristics, the impacts of influencing factors on urban climate are often non-linear (Li et al., 2020). Hence, more accurate methods are required to analyze the non-linear effects of geographical features to gain a comprehensive understanding of water cooling effects. Additionally, morphological characteristics differ between rivers and lakes. A significant proportion of lakes exhibit polygonal or circular shapes and are dispersedly located within a city, while rivers follow a narrow and linear layout, predominantly traversing or flowing around urban areas. Consequently, the cooling effects of rivers on the surrounding areas differ from those of lakes or ponds. In the northeastern Chinese cities of Changchun and Jilin City, river cooling effects have been identified to be stronger than those of lakes and green spaces (Xue et al., 2019).

Despite numerous studies on water cooling effects, the understanding of this phenomenon still faces certain limitations. Firstly, previous researches on water cooling focused on ponds, lakes, and wetlands (Cheval et al., 2020; Xue et al., 2019; Yao et al., 2023). Rivers, as crucial water bodies in urban settings, have received comparatively less attention. Flowing through or around urban areas, rivers influence the climate characteristics of their surrounding areas. Hence, there is a need for more in-depth exploration of river cooling effects.

Additionally, the practical significance of studying water cooling lies in understanding the effects of environmental factors on cooling, enabling targeted measures to alleviate the negative impacts of extreme heat. However, existing relevant studies primarily pay attention to normal summer days, and the understanding of water cooling on extremely hot days is insufficient. As differences in characteristics of urban climate have been found between normal summer days and extremely hot days. Specifically, higher urban heat island intensities were observed during heatwave days compared to normal summer days, particularly in metropolitan areas of China (Ramamurthy et al., 2017; Gao et al., 2019). Therefore, it is essential to pay more attention to water cooling on extremely hot days, which has crucial practical implications for heat mitigation in urban areas.