Assessing Inland Lake Water Quality and Its Response to Climate and Anthropogenic Factors by AI Based Remote Sensing

Jinhui Huang[1], Hongwei Guo[1], Xiaotong Zhu[1]

[1]Nankai University

This study aimed to assess the water quality of Lake Simcoe, Canada, and understand how it is affected by climate and anthropogenic factors. Despite the long-term use of remote sensing in inland water quality monitoring, accurately estimating water quality parameters (WQPs) remains a complex challenge. The study proposed the use of enhanced multimodal deep learning (EMDL) models to retrieve six WQPs, namely Chlorophyll-a, total phosphorous, total nitrogen, Secchi disk depth, dissolved organic carbon, and dissolved oxygen, from the remote sensing reflectance (Rrs) data derived from Landsat and Sentinel-2 images, synchronized water quality measurements, water surface temperature, and climate data.

The performance of the EMDL models was compared with other machine learning, deep learning, and empirical models, and it was found that the EMDL models produced satisfactory results with a Slope close to 1 (0.84-0.95), normalized mean absolute error $\leqslant$ 20.17%, and Bias $\leqslant$14.68%. Using the EMDL models, the spatial distributions and long-term variations of the WQPs in Lake Simcoe from 1980 to 2019 were reconstructed. The study also discussed the impacts of 12 potential natural and anthropogenic factors on the water quality of the entire Lake Simcoe and its two estuaries.

The study found that the EMDL models had the potential to reconstruct the spatial patterns and time-series dynamics of water quality, effectively detect the gradients of spatial patterns, and identify the factors affecting water quality in Lake Simcoe. This research provides a novel approach to support environmental management and identify the affecting factors for the Lake Simcoe watershed, which can be used to improve the understanding of inland water quality monitoring and management in other regions.

Keywords

Deep learning, Remote sensing, Water quality, Climate Change, anthropogenic factors