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Long-term water quality monitoring in Lake Simcoe based on the empirical method and machine learning

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Abstract: The traditional water quality monitoring methods are time-consuming and laborious, which can only reflect the water quality status of single point scale, and have some problems such as irregular sampling time and limited sample size. Remote sensing technology provides a new idea for water quality monitoring, and the temporal resolution of MODIS is one day, which is suitable for long-term, continuous real-time large-scale monitoring of lakes. In this study, Lake Simcoe (located in Ontario, Canada) was selected as the research area. The long-term spatiotemporal changes of chlorophyll-a, transparency, total phosphorus and dissolved oxygen were analyzed by comparing the empirical method, multiple linear regression, random forest and neural network with MODIS data. Finally, the water quality condition of Lake Simcoe is evaluated. The results show that the overall retrieval results of two machine learning models are better than that of the empirical method. The optimal retrieval accuracy R^2 for four water quality parameters are 0.976, 0.988, 0.943, 0.995, and RMSE are 0.13μg/L, 0.3m, 0.002mg/L and 0.14mg/L, respectively. On the annual scale, the annual mean values of the four water quality parameters during the 10-year period from 2009 to 2018 were 1.37μg/L, 6.9m, 0.0112mg/L and 10.17mg/L, respectively. On the monthly scale, chlorophyll a, total phosphorus and dissolved oxygen first decreased and then increased at the time of year. The higher concentrations of chlorophyll a and total phosphorus in the south and east of Lake Simcoe are related to the input of nutrients from the surrounding residents and farmland.

Key words: water quality monitoring; MODIS; empirical method; machine learning