River water temperature forecasting using a deep learning method

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Accurate water temperature forecasting is essential for understanding thermal regimes of rivers in the context of climate change and anthropogenic disturbances, such as dam construction. Machine-learning models proffer an empirically based approach to predicting water temperatures with a high degree of accuracy. This study explores the potential of long short-term neural network (LSTM), a type of deep learning method, to forecast daily river water temperatures and quantify temporal variations in thermal regime induced by changes in climate and by dam construction. The performance of LSTM is compared with that of several other models using daily water-temperature data for nine river gauges around the world. In a detailed analysis, the models are evaluated for the Yichang gauge on the Yangtze River to reconstruct the natural thermal conditions and help to assess daily water temperature variations induced by operation of the Three Gorges Reservoir (TGR). The collective results show that LSTM outperforms other methods for predicting mean daily water temperature in rivers, capturing accurately mean daily variations in thermal regime. The construction of the TGR strongly influenced water temperature variations at Yichang, producing the strongest cooling effect from mid-April to mid-May and the greatest warming effect in late December and early January. These marked effects are most prominent at the highest water levels in the TGR. The enhanced predictive capabilities of the LSTM model provide a powerful tool for water temperature forecasting and ecological management of rivers in the Anthropocene.