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Modelling eutrophication processes in the Venice Lagoon: a multi-hazard approach exploiting machine learning capabilities.

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Abstract

Eutrophication is a worldwide environmental problem affecting the health of close and semi-close water bodies as lagoons, lakes, and estuaries. The ecological and environmental state of water ecosystems is increasingly threatened by cultural eutrophication, i.e the excessive plant growth resulting from nutrient enrichment due to human activities (e.g. urban and agricultural waste and runoff), a process further exacerbated by simultaneous changes in water temperature, and turbidity. A multi-hazard approach is then required to understand and model spatio-temporal changes in water quality, accounting for the complex interactions among natural and human-made pressures.

To this aim, a multivariate machine learning-based Long short-term memory (LSTM) algorithm integrating ecological, chemical, and physical data, was applied in this study to model Chl-a concentration, used as a proxy indicator of eutrophication processes in the Venice Lagoon case study. Specifically, half-hourly water quality (e.g. OD, salinity, and turbidity) and hydro-meteorological data (e.g. precipitation and river flow) for the 2008-2019 timeframe were used to train, validate and test the LSTM models developed for each of the 7 monitored lagoon water bodies.

Results from the case study showed as the LSTM model successfully captured Chl-a trends under a multi-hazard perspective accounting for changes in multiple concurrent parameters. In particular, models developed for water bodies with few missing data showed very good performances (best RMSE=0.774) with also high capability to capture Chl-a extreme low and high values.

The proposed Machine Learning-based multi-hazard model represents a valuable approach to strengthen eutrophication modelling and management, which could be a significant advantage for the design of effective strategies aimed at preventing transitional ecosystems' deterioration. Moreover, the designed model is a promising tool, ready for *'what-if'* scenario analysis accounting for changes in climate conditions and urban development.

Keywords

eutrophication, climate change, machine learning, multi-hazard