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A Machine Learning-based approach for the assessment of eutrophication processes in the Venice Lagoon

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Abstract

Eutrophication is one of the main processes leading to water quality (WQ) deterioration (e.g. proliferation of algae) in environments characterized by stationary water, resulting in cascading effects on the environmental status of natural ecosystems and their capacity to flow services for human wellbeing. Understanding and modeling these processes can be beneficial for both integrated water resources management and sustainability, as required by the Agenda 2030 and the relevant EU acquis (e.g. Water Framework and Marine Strategy Framework Directives).

With the increase in volume, variety, and velocity of spatio-temporal data for environmental applications, and the latest advances in hardware and computer science, Machine Learning methods have started to be widely applied for analyzing eutrophication-related issues, overcoming limitations posed by traditional in-situ measurements. Drawing on these advancements, an Artificial Neural Network-based model, integrating data from monitoring stations, was designed and implemented for the analysis of changes in the Chlorophyll-a (Chl-'a') values used as a proxy indicator of eutrophication processes in the Venice lagoon case study. According to the spatio-temporal resolution of the data available for the testing case, the proposed Multilayer perceptron (MLP) model was trained, validated and tested taking into account 575222 WQ parameters' observations (e.g. Chl-'a', dissolved oxygen, turbidity), monitored across ten stations located in the Venice lagoon, over the 2013-2018 timeframe.

The performance of the designed MLP model in estimating Chl-'a'variations against the input data increased during the learning process with a final ~76% of prediction accuracy during the testing phase, making it ready for the simulation of potential '*what-if*' scenarios (e.g. climate scenarios with increasing water temperatures). Despite constraints posed by input data, the designed MLP model represents a useful tool to identify key drivers of deterioration of natural ecosystems, supporting decision makers in the achievement of environmental and sustainability targets.

Keywords

Machine learning, Eutrophication, Multilayer perceptron, Venice Lagoon