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Prediction of Singapore Seawater Quality Variables with Artificial Neural Networks

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In recent years, there has been a growing tendency to use data-driven techniques such as Artificial Neural Networks (ANN) to complement physics-based models. The ANN is being used increasingly to simulate and forecast quantitative characteristics of water bodies. The true power and advantage of neural networks lie in their ability to represent both linear and non-linear relationships and in their ability to learn these relationships directly from the data being modeled. A neural network is a powerful data modeling tool that is able to capture and represent complex input/output relationships. The use of ANN is particularly an option when, for examples, the physical world is not fully defined, model's uncertainties (model coefficients, boundary conditions, input parameters etc), and/or high cost involved in large scale water quality monitoring. ANN requires, however, a good number of representative data for training the network. In the present study, the development and application of data driven methods are performed for quick assessment and forecast of the Singapore seawater quality variables at different locations within a domain of interest. The variables of interest are salinity, temperature and dissolved oxygen. The measurements from Singapore coastal waters were used to train, test, and validate the trained neural networks. The model was built to predict the values of the variables at time t, at a location of interest, based on the same variables at other locations in the domain of interest. A time lag up to $2\Delta t$, for each station, appeared to suffice to yield good simulation results. A test set was used in the study to prevent model overfitting during the training period. To validate the performance of the trained ANN, an unseen data set from a station in the region, not considered in the training, was applied. The results show a great potential of ANN in simulating water quality variables. Their simulation accuracy, measured in the Nash–Sutcliffe coefficient of efficiency R^2, ranged from 0.8-0.9. A potential application of a trained ANN model is to provide its simulated values at desired locations where no measured data are available and yet required for an eutrophication model. Further study is being conducted to apply ANN to forecast seawater quality variables at different forecast horizons.

Keywords: Data driven technique, neural network, seawater quality, forecasting.