Enhancement of nitrogen prediction accuracy through a new hybrid model using ant colony optimization and an Elman neural network

ABSTRACT

Advanced human activities, including modern agricultural practices, are responsible for alteration of natural concentration of nitrogen compounds in rivers. Future prediction of nitrogen compound concentrations (especially nitrate-nitrogen and ammonia-nitrogen) are important for countries where household water is obtained from rivers after treatment. Increased concentrations of nitrogen compounds result in the suspension of household water supplies. Artificial Neural Networks (ANNs) have already been deployed for the prediction of nitrogen compounds in various countries. But standalone ANN have several limitations. However, the limitations of ANNs can be resolved using hybrid models. This study proposes a new ACO-ENN hybrid model developed by integrating Ant Colony Optimization (ACO) with an Elman Neural Network (ENN). The developed ACO-ENN hybrid model was used to improve the prediction results of nitrate-nitrogen and ammonia-nitrogen prediction models. The results of new hybrid models were compared with multilayer ANN models and standalone ENN models. There was a significant improvement in the mean square errors (MSE) (0.196→0.049→0.012, i.e. ANN→ENN→Hybrid), mean absolute errors (MAE) (0.271→0.094→0.069) and Nash–Sutcliffe efficiencies (NSE) (0.7255→0.9321→0.984). The hybrid model had outstanding performance compared with the ANN and ENN models. Hence, the prediction accuracy of nitrate-nitrogen and ammonia-nitrogen has been improved using new ACO-ENN hybrid model.

Keyword: Nitrate-nitrogen; Ammonia-nitrogen; Ant colony optimization; Elman neural network; New ACO-ENN hybrid model