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Artificial neural network modelling for the prediction of WWTP effluent ortho-phosphates concentration

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Abstract: *This paper presents a neural network model to predict the effluent ortho-phosphates concentration in the Cluj-Napoca wastewater treatment plant. The model may be further used for monitoring (i.e., none or faulty hard sensors) and process control purposes*.
Key words: wastewater treatment, data driven model, artificial neural networks, phosphorus.

Introduction: As an important indicator for the eutrophication of rivers, the accurate prediction of ortho-phosphates concentration is crucial for the Wastewater Treatment Plant (WWTP) control strategy.[1] Artificial neural networks (ANNs) take into account the high time correlation between WWTP data and their nonlinear mapping ability.[2] Therefore, ANNs are widely used to characterize the complexity of WWTPs.

Experimental and Modelling: The data used for the ANN model development and independent testing was collected from the Cluj-Napoca WWTP (maximum capacity of 111,000 m^3/day) over a period of 15 days, at a frequency of 10 s. It was then reduced to 10 minutes intervals by averaging every 60 points. Normalized values were randomly divided into 3 sets: 80% for training, 10% for testing and 10% for validation. The ANN architecture was developed using the trial and error methodology, until a satisfactory result was achieved.

Results and discussions: The ANN model has an architecture of 2 hidden layers (15 and 10 neurons; logistic sigmoid function) and an input delay of 46 previous moments (7.66 hours). Its performance assessment, using multiple indicators, reveals very good results on the testing data: the coefficient of determination (R^2: 0.921), the root mean squared error (RMSE: 0.0045) and the mean absolute percentage error (MAPE: 2.0722).**Error! Reference source not found.**The analysis of ANN predictions against WWTP measurements revealed excellent model behavior in following the process dynamics (Fig. 1) and a symmetrical distribution of model outputs along the targets line (Y = T in Fig. 2). This indicates no bias tendency or systematic errors in any direction. Simulation results validate

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the precision and accuracy of the ANN model as a soft sensor and support its further use as a process monitoring support tool.

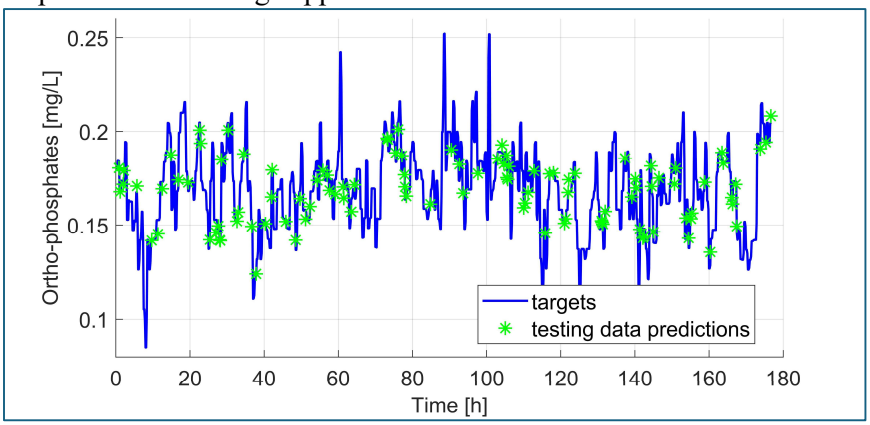

Fig. 1 Model results against measurements for the testing data: ortho-phosphates dynamics.

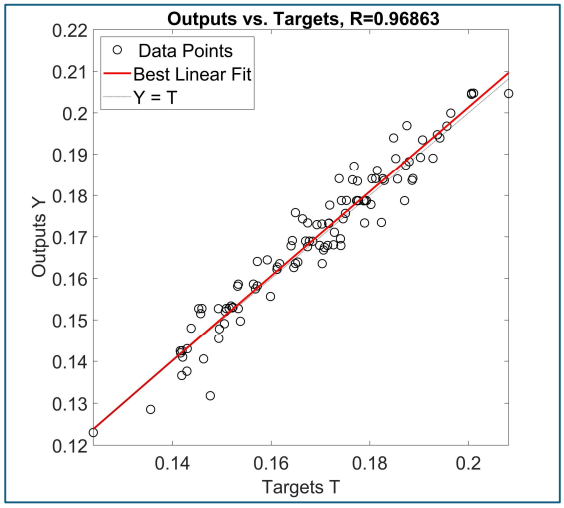

Fig. 2 Model results against measurements visualized for the test data: ANN regression plot.

Conclusions: An accurate ANN model for ortho-phosphates concentration in the effluent has been developed and verified against field data from the Cluj-Napoca WWTP.

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