MODELLING BIOCHEMICAL OXYGEN DEMAND (BOD_5) USING ARTIFICIAL NEURAL NETWORK BASED APPROACH: CASE STUDY OF SIDI MAROUANE WASTEWATER TREATMENT PLANT (WWTP) AT BENI HAROUN DAM RESERVOIR

Salim HEDDAM*[1], Hilal LAMDA [2], Samir FILALI [3]

[*1]Maître de conférences (MCA), Faculté des Science, Département des Sciences Agronomiques, Section Hydraulique Agricole, Université 20 Août 1955, Route EL HADAIK, BP 26, SKIKDA, Algérie.
E-mail: heddamsalim@yahoo.fr. TEL: 06 61 74 51 22.

[2,3] Etudiant Ingénieur d'Etat, Faculté des Science, Département des Sciences Agronomiques, Section Hydraulique Agricole, Université 20 Août 1955, Route EL HADAIK, BP 26, SKIKDA, Algérie. hilalhilalo@hotmail.com.

ABSTRACT. In this study, *Multi-Layer Perceptron Neural Networks (*MLPNN) and multiple linear regression (MLR) models were employed to predict the effluent Biochemical Oxygen Demand (BOD_5) from a wastewater treatment plant (WWTP) of Sidi Marouane WWTP at Beni Haroun Dam Reservoir, Algeria. The two models are built using many variables, namely temperature of water (TE), conductivity (EC), water pH, suspended solids (SS), chemical oxygen demand (COD) and Biochemical oxygen demand (BOD_5). The two models are presented and compared. The performances of the models are evaluated using root-mean square errors (RMSE), mean absolute error (MAE) and correlation coefficient (CC) statistics. The low RMSE and high CC values were obtained with MLPNN based approach. The usefulness, robustness and capabilities of the MLPNN model in this study are demonstrated and can be used as a powerful tool to improve WWTP planning and management.

Key words: Modelling, BOD_5, MLPNN, water quality

1. Introduction

Traditionally biochemical oxygen demand (BOD) is used as indicator of environmental pollution caused by biodegradable organic substances and has been widely *used* as water quality index. In this study, we investigated the capabilities of an artificial neural network model, called *Multi-Layer Perceptron Neural Networks* (MLPNN) for predicting the effluent biochemical oxygen demand (BOD_5) from the wastewater treatment plant (WWTP) of Sidi Merouane at Beni Haroun Dam Reservoir, Algeria. In this context, we have employed 691 measured data at daily time step to build the model and to evaluate its reliability. The results obtained with MLPNN models are compared with multiple linear regressions (MLR). This study demonstrates that MLPNN investigated herein outperforms MLR technique for BOD_5 modelling.

2. Wastewater Treatment Plant (WWTP) and raw water data

The wastewater treatment plant (WWTP) is located in a rural region of Sidi Marouane town at about 12 kilometers northeast of the Mila province, East of Algeria country. The plant treats wastewater from about 137,000 person equivalents living in the area of the dam reservoir Beni Haroun, and the plant has an average daily flow of 20,657m³/d. The surface area of this WWTP covers about 13 hectares. The treatment scheme is of a conventional activated sludge type and includes coarse and fine screens, Grit and Grease removal, primary sedimentation tanks, activated sludge aeration tanks, and secondary sedimentation tanks, final clarification and chlorination facilities. The effluent quality data from (1 august 2009) to (31 July 2011) were used in this investigation. Among the available dataset, six variables of the effluent wastewater of the Sidi Marouane WWTP were selected, namely, biochemical oxygen demand (BOD), chemical oxygen demand (COD), suspended solids (SS), *electrical conductivity* (*EC*), temperature (TE) and pH, are considered for the evaluation of developed models.

3. Results and Discussion

To assess the fitting and predictive accuracy of the models, the data sets were mathematically evaluated by calculating the following evaluation criteria: coefficient of correlation (*CC*), root mean squared error (*RMSE*) and mean absolute error (*MAE*).

Table 1 Performances of the MLPNN and MLR models in different phases

Models	MLR						MLPNN					
	Training			Validation			Training			Validation		
	CC	RMSE	MAE	CC	RMSE	MAE	CC	RMSE	MAE	CC	RMSE	MAE
M1	0.858	2.950	2.153	0.894	2.682	2.128	0.873	2.793	2.040	0.894	2.653	2.041
M2	0.868	2.853	2.143	0.896	2.661	2.126	0.900	2.504	1.765	0.920	2.319	1.799
M3	0.868	2.851	2.131	0.897	2.651	2.125	0.905	2.444	1.736	0.898	2.621	2.078
M4	0.869	2.843	2.133	0.896	2.658	2.136	0.914	2.331	1.661	0.903	2.566	1.956
M5	0.869	2.843	2.128	0.897	2.647	2.122	0.918	2.269	1.639	0.910	2.456	1.837

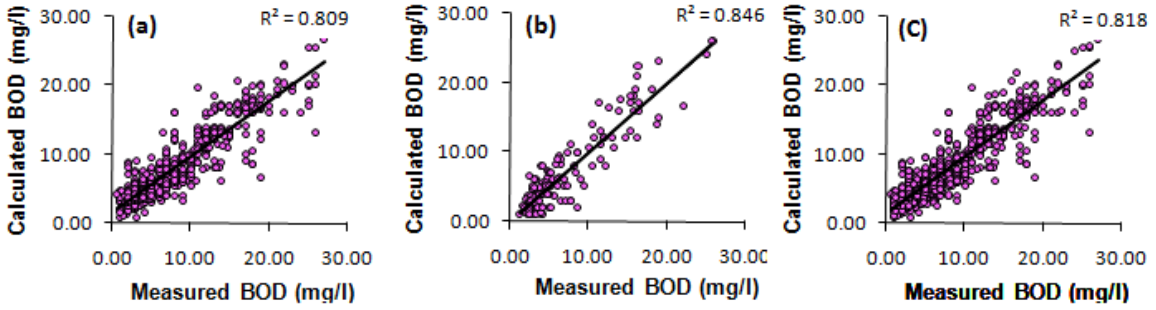

Fig.1. Results obtained with MLPNN model for biochemical oxygen demand (BOD_5): Scatter plots and Comparison of observed and calculated series of BOD_5in the (a) Training, (b) Validation sets and (c) All data.

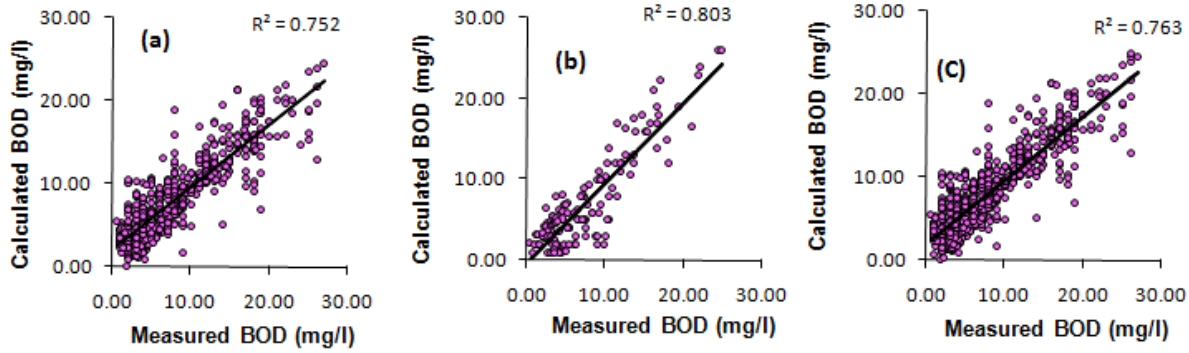

Fig.2. Results obtained with MLR model for biochemical oxygen demand (BOD_5): Scatter plots and Comparison of observed and calculated series of BOD_5 in the (a) Training, (b) Validation sets and (c) All data.

4. CONCLUSION

Two methods, MLR and MLPNN, were used to construct linear and nonlinear models for BOD_5 prediction on the basis of measured five water quality variables, and a model with high statistical quality and low prediction errors was obtained. Satisfactory results were obtained with the proposed methods. Additionally, the nonlinear MLPNN model produced better results with good predictive ability than MLR linear model.