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PREDICTION OF WASTEWATER PARAMETERS USING ANN MODEL

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Abstract: Water quality modelling is required for proper water quality conservation and management. The limitation of fresh water sources suggests the need for water quality protection because it influences millions of people's lives. The need for increased accuracy in modelling water quality has motivated researchers to develop innovative models. Artificial neural networks (ANN) can identify the complex nonlinear relationships between input and output data. Biochemical Oxygen Demand (BOD) is an essential parameter for usage conditions of surface waters. The measurement of the wastewater BOD5 level requires five days, and using a prediction model to estimate BOD5 saves time and enables the adaptation of a modernized automated system. This study investigates the application of artificial neural networks (ANNs) in predicting the entering BOD5 concentration and the performance of WWTPs. The WWTP performance is defined in terms of the COD, BOD, and TSS concentrations in the effluent. Sensitivity analysis was performed to sort out the best-performing ANN network structure and configuration. The results showed that the ANN model created to predict the BOD concentration performed the best among the three outputs. The optimal performing neural network model that was obtained (three inputs – one output), indicated that the influent temperature and conductivity significantly affect the WWTP performance as inputs in all models.

Keywords: *Artificial Neural Network, wastewater, prediction, biochemical oxygen demand, chemical oxygen demand, total suspended solids*

I. INTRODUCTION

Wastewater is a major environmental issue that requires efficient treatment before discharge to the environment. Treatment of wastewater requires an understanding of the composition and concentration of pollutants present in the wastewater. The biochemical oxygen demand (BOD), chemical oxygen demand (COD), and total suspended solids (TSS) are essential parameters that are used to assess the quality of wastewater. Accurate prediction of these parameters is important for efficient and effective treatment of wastewater. Artificial Neural Networks (ANNs) have been shown to be effective in predicting various environmental parameters, including wastewater parameters. In this study, we propose an ANN model for the prediction of BOD, COD, and TSS in wastewater. Due to rapid urbanization, there has been an increase in wastewater flow rate, which leads to difficult modeling through a linear regression model, quality of effluent is an essential factor for environmental & health concerns. For this reason, it is necessary to have a relatively accurate prediction of future BOD.

Wastewater treatment is a technique used to dispose of contaminants from wastewater and convert it into an effluent that may be returned to the water cycle. once returned to the water cycle, the effluent creates a suitable impact at the environment or is reused for numerous functions (referred to as water reclamation). The treatment manner takes place in a wastewater treatment plant. the primary reason of wastewater treatment is for the dealt with wastewater in order to be disposed or reused properly. but earlier than it's far treated, the alternatives for disposal or reuse need to be considered so the proper treatment system is used on the wastewater. Biochemical oxygen demand (BOD) is an impactful parameter in the planning and management of WWTPs. BOD is an approximate measure of the quantity of biochemically degradable organic matter found in a water sample. performing the BOD test involves the stages of preparation and analysis that require responsibility. This test takes about 5 days. The value of the analysis will increase if the experiments conducted as part of the test emerge as too lengthy and the measurements involve problems, subsequently an almost accurate prediction of BOD is simply important, while it could be done using mathematical regressions and iteration that is again troublesome, ANN can provide an accurate prediction in seconds.

Understanding Relationship between Waste water parameters: -

Wastewater parameters are the used to decide effect waste water towards water pollution and its degree. pollutants are described as any alteration of the physical, chemical and organic properties of water, that's later known as as wastewater. these waters, typically generated as a end result of human activities, it must be cleaned after use to prevent pollution of lakes, groundwater, rivers and oceans. All of these pollutants are chemical compounds or unwanted

materials that contaminate the air,soil and water. each day, in all wastewater treatment plants, heaps of people carry out analyses on wastewater parameters. these are signs of water pollution and are used to make sure that wastewater meets ordinary region wise local standards.

COD (mg/l)	BOD (mg/l)	TSS (mg/l)	PH
<500	<250	<200	5-8

Fig. no. 1: - Waste water parameters & their limiting values

In general terms, the greater the pollution, the higher the BOD. It provides a rough measure and some reference values for certain water types are as follows:

- Pure: 2 – 20 mg/L
- Slightly polluted: 20 – 100 mg/L
- Moderately polluted: 100 – 500 mg/L
- Highly polluted: 500 – 3,000 mg/L
- Extremely polluted: 3,000 – 15,000 mg/L

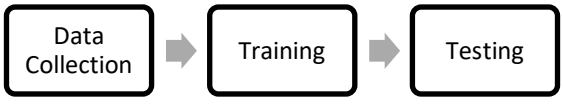
The primary distinction among BOD and COD is that COD measures all organic material, whilst BOD only measures organic material which is or may be biologically degraded. consequently, for a given water sample, the COD is always more than the BOD, and the second result (COD), as the complete chemical oxidation of the sample, may be considered to consist of the first. There exists a specific correlation among the COD and BOD under certain conditions and by determining the COD, the statistics approximately the BOD of the wastewater can be derived, however it is highly waste dependent. these parameters have advantages and downsides, and the choice usually depends on many factors along with, the reproducibility of the determinations, time period required, location of the test. COD effects are typically higher than BOD values, and the ratio among them will range depending at the characteristics of the wastewater.

Prediction of Waste water parameters using ANN: -

ANN is an efficient tool for modelling and forecasting. ANN is a machine that is designed to model the way in which the brain performs a particular task or function of interest. It resembles the brain in two aspects that knowledge is acquired by the network from its environment through a learning process and inter neuron connection strengths, known as synaptic weights are used to store the acquired knowledge. The application of artificial neural network consists of two phases; training and testing. The procedure used to perform the learning process is called a learning algorithm, the function of which is to modify the synaptic weights of the network in an orderly fashion to attain a desired design objective. The main objective of this study is to predict one of the most important parameters, BOD, with the help of some easily measured physical and chemical variables of the WWTP using neural network. A further aim is to evaluate the results obtained and to apply sensitivity analysis to them, in order to determine which input variable(s) played a significant role in the prediction of output.

II. METHODOLOGY

We have sorted down our methodology to 3 easy steps here i.e.:



1. Data Collection
2. Training of data in neural network &
3. Testing model for accuracy

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1. Data collection: We collected BOD data from different water bodies, including rivers, lakes, and reservoirs, from various sources such as USGS Water Data and EPA Water Quality Monitoring Data.

The data used in the model training and testing is acquired from the Dr. Naidu waste water treatment plant which is situated besides AISSMS College of Engineering in Pune. We have officially with all legal procedures have collected this data with the permission of municipal Corporation of Pune. We have collected total 1 year of data which was recorded on daily basis, it consists

of waste water parameters such as COD, BOD, PH, TSS and Flow of both inlet and outlet. Following fig no.2 Shows a screenshot of the waste water parameters record collected from the treatment plant. This data is then compiled into the required format and a human analysis is
done by us. And then the data is divided in 70-30 parts, where 70% data will be used for training the neural network and 30 % data would be used for testing the model created.

DATE	INLET	INLET				OUTLET					REMARKS
	FLOW	PH	TSS	COD	BOD	PH	TSS	COD	BOD	FAECAL COLIFORM	
	MLD	-	mg/l	mg/l	mg/l	-	mg/l	mg/l	mg/l	mg/l	
2-Aug	114.37	7.590	93	198	66	7.430	14	45	14	60	
3-Aug	114.36	7.710	97	199	64	7.800	6	25	6	50	
4-Aug	113.42	7.600	89	192	61	7.430	8	38	13	60	
5-Aug	110.67	7.650	96	186	63	7.400	7	25	8	60	
6-Aug	110.34	7.640	95	186	66	7.440	9	25	13	80	
7-Aug	104.044	7.660	97	198	70	7.450	8	32	7	90	
9-Aug	91.325	7.370	104	192	79	7.450	6	25	7	60	
10-Aug	78.72	7.680	98	194	72	7.520	7	24	6	30	
11-Aug	60.11	7.880	98	202	65	7.740	6	26	6	90	
12-Aug	62.66	7.550	98	194	70	7.410	6	25	7	60	
13-Aug	94.45	7.720	95	210	99	7.370	8	26	8	60	
14-Aug	111.72	7.240	97	188	70	7.470	13	13	7	50	
16-Aug	107.7	7.460	98	180	62	7.150	12	30	13	40	
17-Aug	110.45	7.440	95	198	65	7.190	11	26	11	40	
18-Aug	110.19	7.600	98	188	70	7.230	14	45	11	60	
19-Aug	107.991	7.800	94	185	68	7.740	5	18	5	40	
20-Aug	109.1	7.410	98	186	69	7.200	13	25	9	40	
21-Aug	95.336	7.550	96	196	70	7.270	13	33	13	70	
23-Aug	78.11	7.500	98	188	64	7.180	13	36	10	130	
24-Aug	99.548	7.540	106	192	70	7.180	12	32	8	60	
25-Aug	107.706	7.590	104	180	63	7.210	14	42	14	110	
26-Aug	107.963	7.440	97	211	73	7.270	14	32	11	90	

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Fig no 2: Lab data collected from the waste water treatment plant

2. Data preprocessing: We preprocessed the collected data, including data cleaning, normalization, and feature selection, to ensure the accuracy and quality of the data used for training the neural network.

3. Neural Network architecture: We chose appropriate neural network architecture for our model, considering the size of the dataset, input variables, and desired output. We used the MATLAB NN tool to design and train the neural network model.

With the help of nntool the data acquired will be feeded to the workspace in form of the variable.

(I)- represents the input data which are PH, COD, TSS
(T)- represents the target data which the BOD

After importing the data unto the workspace target data and input data is allotted and then allowed to train with respect to the different functions. We need to do trial and error check with different function to get an accuracy of regression value on near about.

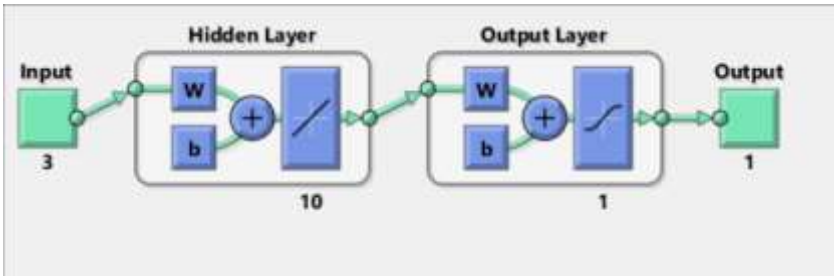


Fig no 3: Test neural network created (3 input -1 output)

4. Training and validation: We trained the neural network using the cleaned and normalized data. We used techniques such as k-fold cross-validation to estimate the performance of the model and fine-tune the network parameters.

The trained model is then tested with the remaining 30% of the data which will eventually help it to train itself and give more accurate results. The model will be tested and trained till an accuracy of regression value will be almost to 1 i.e., R=1.

5. Model evaluation: We evaluated the performance of the BOD prediction model using commonly used metrics such as RMSE, MAE, and R-squared. We compared the results of our model with other existing BOD prediction models to assess its effectiveness.

6. Deployment: The final step is the deployment of the developed model for practical applications, such as water quality management, monitoring, and decision-making.

Utilization of MATLAB Software: -

MATLAB is a programming platform designed especially for engineers and scientists to examine and design systems and products that transform our world. The heart of MATLAB is the MATLAB language, a matrix-primarily based language permitting the maximum natural expression of computational arithmetic.

Neural Network Tool Box (nntool): -

Neural network tool box is an utility plugin in MATLAB which can be located and released by way of typing “nntool” in command window in workspace. It permits a user to create, train, test and simulate the neural network, most of the work of our task is going to revolve around this utility tool box.

III. PERFORMANCE EVALUATION

The trained model is then tested with the remaining 30% of the data which will eventually help it to train itself and give more accurate results. The model is tested and trained till an accuracy of regression value will be almost to 1 i.e., R=1 it is now giving accuracy of 80%, we have plotted graphs for a network which was somewhat accurate. Following are graphs that we acquired by training 70% of the data to the test model: -

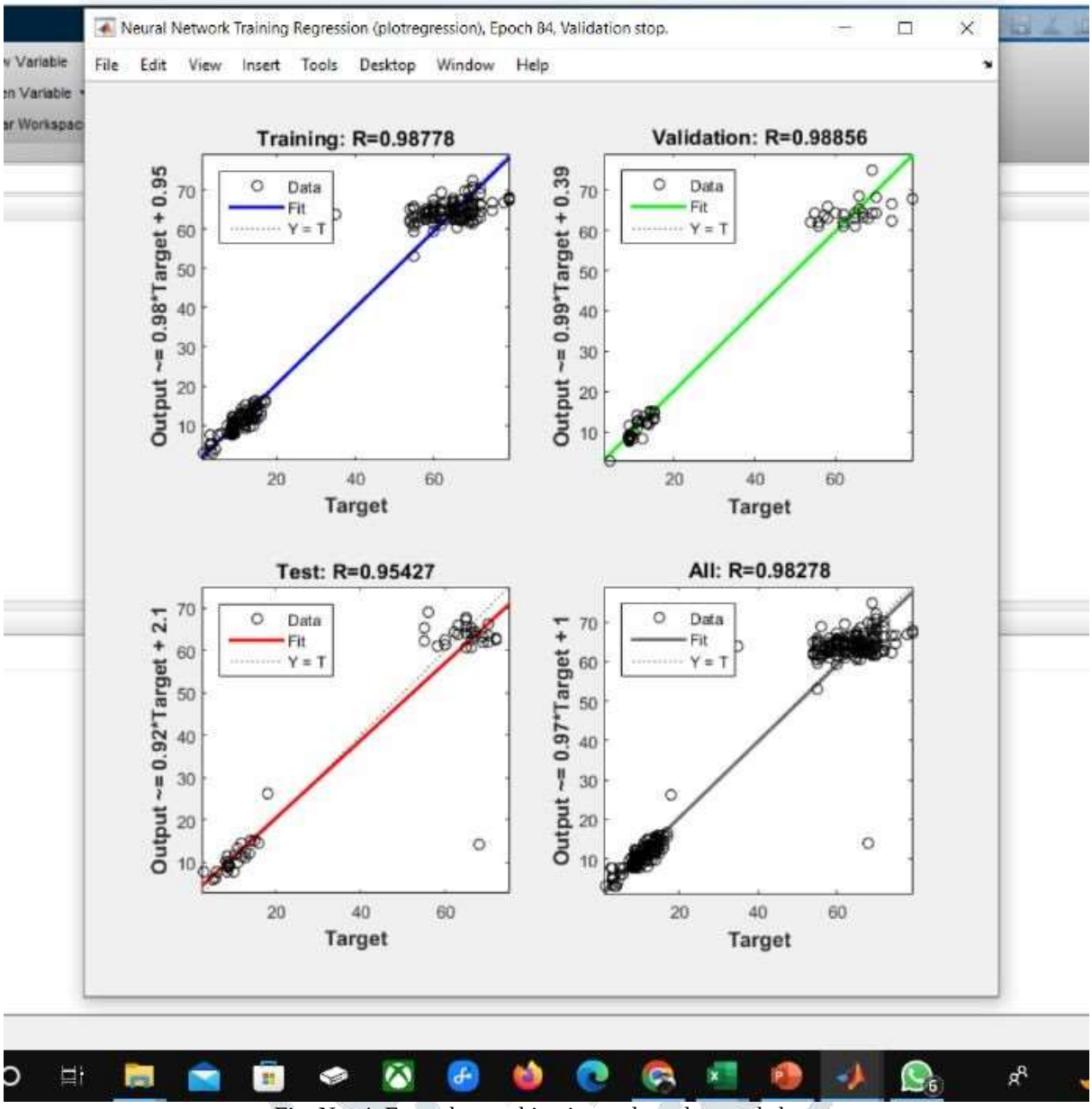
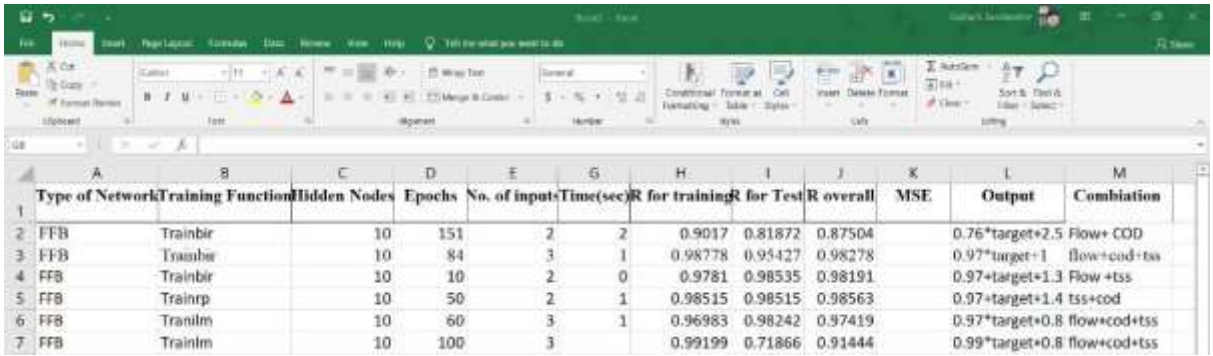


Fig. No. 4: From the combination and results excel sheet

These are the graphs that are obtained after testing the data and simulation of these model gives data up to 80% accuracy.

Selecting the appropriate training functions and combinations of transfer function: -
There are various transfer functions and training functions in MATLAB nntool such as trainbr, trainlm, purelin, trainsg, mse, No of neurons, Epochs, max fails, etc. Mixing and matching and doing trail and error with different combination of data is carried out on an excel sheet, plus different combination of inputs and target are also carried out for example: 1. Flow+COD, 2. Flow+TSS, 3. COD + TSS, 4. COD + TSS+ Flow all for a prediction of target value of BOD.

We have created an excel sheet consisting all the trial and error and different combination of input and target data. Out of all we have found that 3 input- 1 output model gives the most accurate results



	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Type of Network	Training Function	Hidden Nodes	Epochs	No. of inputs	Time(sec)	R for training	R for Test	R overall	MSE	Output	Combiation	
2	FFB	Trainbr	10	151	2	2	0.9017	0.81872	0.87504		0.76*target+2.5	Flow+ COD	
3	FFB	Trainbr	10	84	3	1	0.98778	0.95427	0.98278		0.97*target+1	flow+cod+tss	
4	FFB	Trainbr	10	10	2	0	0.9781	0.98535	0.98191		0.97+target+1.3	Flow +tss	
5	FFB	Trainrp	10	50	2	1	0.98515	0.98515	0.98563		0.97+target+1.4	tss+cod	
6	FFB	Trainlm	10	60	3	1	0.96983	0.98242	0.97419		0.97*target+0.8	flow+cod+tss	
7	FFB	Trainlm	10	100	3		0.99199	0.71866	0.91444		0.99*target+0.8	flow+cod+tss	

Fig. No.5: - Combinations sheet

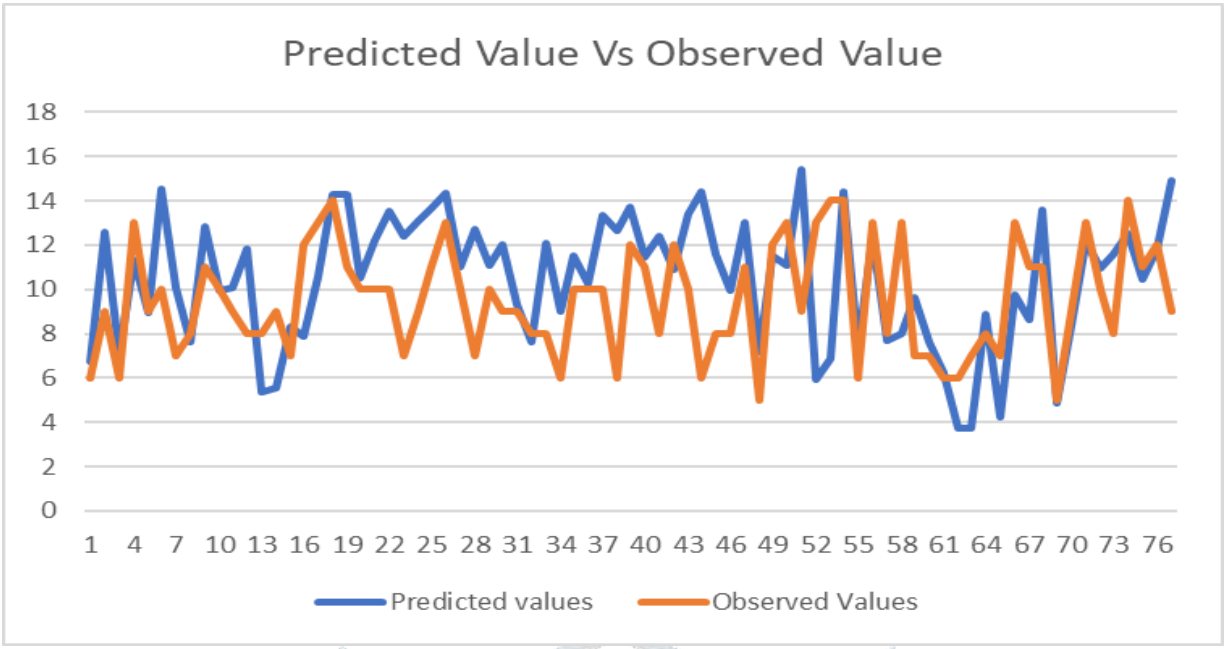


Fig No. 6:- Predicted values vs the Observed values

Above plot in fig no. 6 illustrates the difference in predicted values by the model and the original values. As there are no sudden ascend or descend in the graph and values are nearly similar to predicted values, after a thorough analysis we found that accuracy of model is 80%

IV. CONCLUSION

BOD measurements require five days, but COD measurements only take a few hours. This project gives the perspective and the usefulness of an artificial neural network (ANN) model in prognosticate a water quality indicator, namely BOD, COD, TSS used for greywater. The model's performance was assessed using mean squared error statistics (MSE).The findings lead to the ANN model with the smallest number of inputs such as pH, temperature (T), total suspended particles, total solids, and chemical oxygen demand could accurately predict BOD in greywater. The ANN model predicts efficiency of approximately 70% of the data by now. The model gives a accuracy of 80% by comparing expecting values and predicted value of the 30% test data that is used for testing.

REFERENCES

[1]. L. Håkanson, Water pollution : Methods and criteria to rank, model and remediate chemical threats to aquatic ecosystem. Backhuys Publishers, Leiden, 1999
[2]. E. Dogan, B. Sengorur, and R. Koklu, “Modeling biological oxygen demand of the Melen River in Turkey using an artificial neural network technique,” Journal of Environmental Management, pp. 1229-1235, 2009.
[3]. Artificial neural network modeling approach for the prediction of five-day biological oxygen demand and wastewater treatment plant performance-Abdalrahman Alsulaili and Abdelrahman Refaie issue - 2018
[4]. BOD modelling using artificial neural network- Roshni R1 , Elizabeth C Kuruvila- IJARIIE-ISSN(O)-2395-4396 Vol-2 Issue-4 2017
[5]. https://in.mathworks.com/discovery/neural-network.html
[6]. Prediction of Chemical Oxygen Demand In Dondang River Using Artificial Neural Network- International Journal of Information and Education Technology, Vol. 2, No. 3, June 2012- Anita Talib and Mawar Idati Amat.