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Surface Water Quality Assessment and Prediction Modelling of Kathajodi River

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Abstract:

Water quality index (WQI), a technique of rating water quality, is an effective tool to access quality and ensure sustainable safe use of water for drinking. The main objective of the present study is to access the surface water quality of Kathajodi river for knowing the suitability of drinking purpose by calculating the WQI. Samples were collected from selected locations during different seasons (winter, summer, rainy) over a period of 3 years (2011, 2012, 2013). Water quality assessment was carried out for the parameters like pH, total dissolved solids, total suspended solids, Alkalinity, Biological Oxygen Demand(BOD), Dissolved Oxygen(DO), Chloride, Nitrate, Alkalinity, Total Hardness, Calcium, Magnesium. The main objective is to develop a model to assess and predict the water quality changes of Kathajodi River Basin Odisha, India using neural networks and compared with the statistical methods. The result shows the proposed ANN prediction model has a great potential to simulate and predict the strongly correlated parameters like TSS (Total Suspended Solids), TDS(Total Dissolved Solids), Alkalinity, BOD(Biological Oxygen Demand)with Mean Square Error (MSE) : TSS_{MSE} = 1.78 ; TDS_{MSE} = 0; $Alkalinity_{MSE}$ = 3.77 and BOD_{MSE} = 8E-03.The Neural Network model has been compared with Linear Regression model to find out the best modelling approach for the study area. And it is concluded that the neural network model is superior to Linear Regression Model.

Keywords: Water Quality Index(WQI), ANN, Excel, Physico-Chemical Parameters, Correlation and Regression Analysis.

I. INTRODUCTION

Water is a transparent and nearly colorless chemical substances that are the main constituent of earth's streams, lakes, and oceans and the fluids of most living organisms. Water comprises 70% of the earth's surface, making it one of the most valuable natural resources. On earth, 96.5% of the planet's crust water is found in seas and oceans, 1.7% in groundwater, 1.7% in glaciers and the ice caps of Antarctica and Greenland a small fraction, in other large water bodies and 0.001% in the air as vapor, clouds, and precipitation. Only 2.5% of this water is freshwater, and 98.8% of that water is in ice and groundwater. Less than 0.3% of all fresh waters are in rivers, lakes, and the atmosphere, and an even smaller amount of the earth's freshwater (0.003%) is contained within biological bodies and manufactured products. It is a fundamental element to all forms of life for various functions such as drinking, cleaning, as a reproductive medium and as habitat for aquatic organisms and for irrigation purposes. It is also essential as a transport mechanism and for metabolic processes of most living organisms.

India experiences an average precipitation of 1,170 millimeters (46 in) per year, or about 4000 cubic kilometers (960cu mi) of rains annually or about 1720 cubic meters (6100cuft). Of fresh water per person every year. Some 80% of its area experiencing rains of 750 millimeters (30 in) or more a year. However, this rain not uniform in time or geography. India is a country with vast geographic, biological and climatic diversity. India's surface water flows through 14 major river basins. In addition to major rivers, there are 44 medium and 55minor river basins. These rivers are fast flowing and are mostly monsoon fed.

In the last decades, there has been a tremendous increase in the demand for fresh water due to the rapid growth of population and the accelerated pace of industrialization. However surface water resources in the country are in much greater volume when compared to the groundwater resources. Water resources are steadily declining because of the increase in population, industrial growth, pollution by various human, agricultural growth and industrial wastes and unexpected climatic change.

II. LITERATURE REVIEW

Gopal Krishna, Surjeet Singh calculated water quality index of 27 samples from Rajkot district, Gujurat by assessing seven parameters viz PH ,Total Dissolved Solids , Fluorides, Chlorides , Sulphate and Nitrate. The maximum WQI value was found to be 98 and minimum value 27 in the study area. The computed WQI showed that 1.8% of water sample fell in the 'good' to 'excellent' water category. On the otherhand 48.2% of water samples fell in the 'fair' to 'poor' category indicating that the water was not suitable for direct consumption and required treatment. After treatment, the waterwas used for drinking purpose.

Tiwari et al (1986)studied the correlation among physio-chemical factors of groundwaters of 50 wells located in and around Meerut city, Uttar Pradesh, India. Tiwari et al (1986 a) have obtained a linear relationship between COD and BOD for river Ganga at Kanpur, India.
SK.Pathak, Shambhu Prasad and Tanmay Pathak had calculated water quality index of river Bhagirathi. Eleven parameters like pH, Electrical Conductivity, Total Dissolved Solids, Total Suspended Solids, Dissolved Oxygen, Total Alkalinity,Total Hardness, Chloride, Nitrate, and Sulphate were considered for determining the quality of its water for public use, recreation and other purposes. From the calculation of water quality index the quality of Bhagirathi river at Uttarkhand in different seasons was known.
Ibrahim Bathusha and Saseetharam (2006) concluded in their study on physio-chemical characteristics of 36 samples in the selected location of Coimbatore city that the Electrical Conductivity and Total Dissolved Solids was highly correlated with most of the other parameters. They also revealed that after the measurement of EC the concentration of TDS, Hardness and Chlorides could be estimated.
Singh (1996) made systematic study on 35 locations in Jhunjhunu district of Rajasthan by considering 14 water quality parameters and obtained neither perfect positive nor perfect negative correlation between any two parameters. Correlation coefficient obtained was greater than or equal to 0.6 between nine pairs of parameters with 0.858 between Calcium and Total Hardness, high correlation between carbonates and bicarbonates and low correlation between sodium and magnesium,and potassium and sodium and potassium.

III. STUDY AREA

General description of the proposed research work is Kathajodi River basin. The basin has latitude 20.4568567 and longitude 85.8321902. Kathajodi river is an area of the Mahanadi River in Odisha, India. It branches off at Naraj then immediately is bifurcated. The southern branch of this river is known as Kuakhai, which means Crow's pool and flows into the Puri district. Its mouth is closed by a bar for the flow of little water flows into it except at flood times. The river Kathajodi is said to have been originally a comparatively small stream. Its name implies that it could at one time be crossed by a plank of wood known as Katha in Odia. River Kathajodi has been the source of potable water for the people of Cuttack as well as numerous villages located downstream. Cuttack is the second highest populated city after the capital city of Bhubaneswar in Odisha. The total area of the basin is 192.58 Kms having population of 6.1lakhs (2011). It is situated at the deltaic position of river Mahanadi and Kathajodi. The waste and waste water generated from Cuttack is dumped into the river Kathajodi without any treatment. A systematic study was undertaken to access the impact of discharged waste and on the river water for a period of 3 years covering all the 3 major rivers. According to the sources of contamination different points were chosen for study. The study was on various physio-chemical and microbiological parameters.
The city Cuttack lies on the east coast of India in the state of Odisha between Latitude : 20º30ˈ N and Longitude : 85 º49ˈ60ˈˈ E. The river Mahanadi and Kathajodi surrounded the city forming a delta on which the city Cuttack is situated. The river Kathajodi receives discharge from river Mahanadi. The Cuttack city is situated on the N-E side of this river Kathajodi which receives the sewage of city.

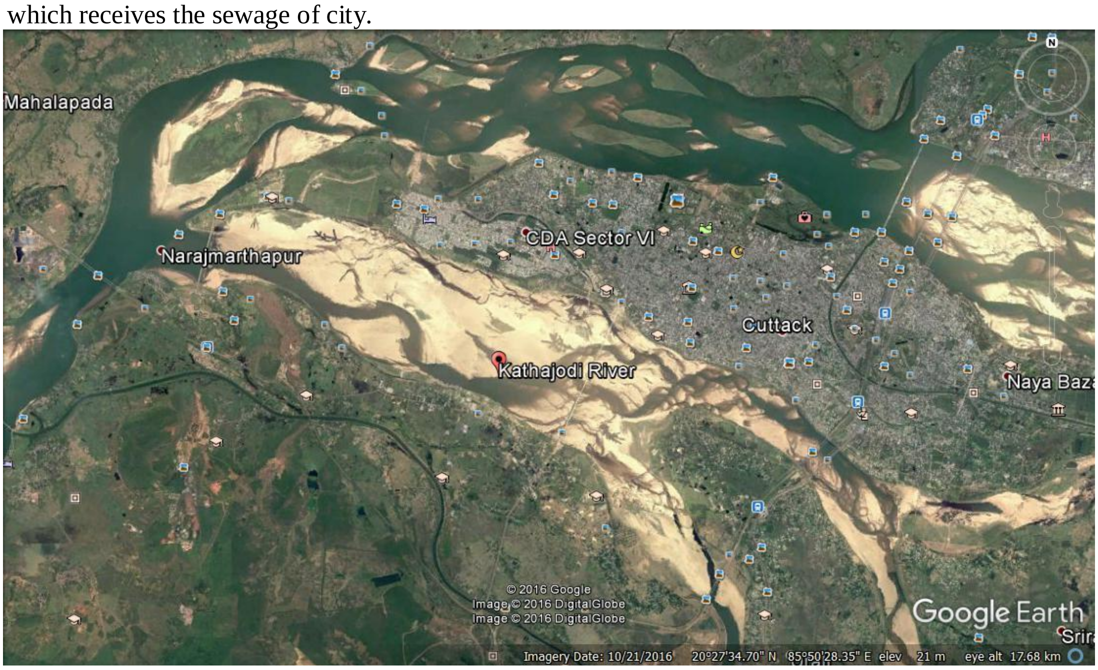

Fig.1 Kathajodi River map taken from Google Earth

IV. METHODOLOGY

A. Data Collection and analysis

For assessment of surface water quality of the Kathajodi river basin, systematic samplings were carried out during different seasons (winter, summer, rainy) over a period of 3 years (2011, 2012, 2013). The complete datasets were divided into three seasons viz.., summer, rainy, winter. The Summer season includes the month of March, April, May, June. The rainy season includes month of July, August and September. The winter season includes month of October, November, December ,January and February. Twelve physical, chemical and biological water quality parameters are selected for the analysis. The parameters are pH, Dissolved Oxygen(DO), Total Dissolved Solids(TDS), Total Suspended Solids(TSS), Alkalinity, Biological Oxygen Demand(BOD), Nitrate, Total Hardness, Total Coliform, Chloride, Nitrate, Calcium, Magnesium. The collected water quality parameters from three gauging stations viz., Upstream near High Court, Downstream near Government Press and Further Downstream near Sankhataras data are tested, analysed, and validated. In the present study 14 parameters were considered and calculated the WQI and Correlation Coefficients along with water quality characteristics

B. Water Quality Index(WQI)

Water Quality Index (WQI) is an excellent management general administrative tool in communicating water quality information. This index has been widely field tested and applied to data from a number of different geographical areas all over the world in order to calculate WQI of various water bodies critical pollution parameters were considered. WQI is defined as a rating reflecting the composite influence of different water quality parameters, which is calculated from the point of view of the suitability of human consumption. This concept of water quality was firstly used by Horton(1965), and then developed by Brown et.al(1970) and further improved by Deininger (Scottish Development Department, 1975). WQI is one of the most effective tools to express that water quality that offers a simple, stable, reproducible unit of measure and communicate information about water quality to the policy makers and concerned citizens (Singh et.al 2013). The is also used for estimating quality of water on line, but accuracy of the depends upon the judicious selection of the parameters.

Weighted Arithmetic Water Quality Index Method :

Weighted arithmetic water quality index method classified the water quality according to the degree purity by using the most commonly measured water quality variables. The method has been widely used by the various scientists and calculation of WQI was made by using the following equation :

$WQI = \sum QiWi / \sum Wi$

The quality rating scale (Qi) for each parameter is calculated by using the expression :

$Qi = 100[(Vi - Vo)/(Si - Vo)]$

where,

Vi is estimated concentration of ith parameter in the analysed water.

Vo is the ideal value of the parameter in pure water .

Vo = 0 (except PH = 7.0 and DO = 14.6mg/L)

Si is recommended standard values of the ith parameter .

The unit weight (Wi) for each water quality parameter is calculated by using the formula :

$Wi = K / Si$

Where,

$K = 1/\sum(1/Si)$

C. Correlation Analysis using MS-Excel:

Correlation is a term that refers to the strength of a relationship between two variables. A strong or high correlation means that two or more variables have a strong relationship with each other, while a weak or low correlation means that the variables are hardly related. Correlation analysis is the process of studying of that relationship with available statistics data.

Correlation Coefficient (r) :

The most widely used type of correlation coefficient is the Pearson 'r'. This analysis assumes that the two variables being analyzed are measured on at least interval scales, meaning they are measured on a range of increasing value. Correlation coefficient measures the strength of association between two variables of interest that is whether one variable generally increases as the second increases, whether it decreases as the second increases, or whether that patters of variation are totally unrelated.

The coefficient is calculated by taking the covariance of the two variables and dividing it by the product of their standard deviation. Correlation coefficient can range from -1.00 to +1.00. The value of -1.00 represents a perfect negative correlation, which means that as the value of one variable increases, the other decreases. While a value of -1.00 represents a perfect positive relationship, meaning that as one variable increases in value, so does the other.

Let x and y be two variables and (Xi,Yi) be n pairs of observed values of these variables (I = 1,2,3…… n). These correlation coefficient r between the variables x and y is given by equation,

$r = n\Sigma xy - \Sigma x \Sigma y / \sqrt{[n\Sigma x^2 - (\Sigma x)^2][n\Sigma y^2 - (\Sigma y^2)]}$ ………………………………….(1)

where, the summations are taken above 1 to n (no. of obs). The values of observed parameters a and b was considered with the help of equations 2 and 3.

$a = n\Sigma xy - \Sigma x \Sigma y / n\Sigma x^2 - (\Sigma x)^2$……………..(2)

D. Regression Analysis:

$y = ax + b$……………………..(3)

E. Artificial Neural Network (ANN):

Artificial Neural Network (ANN) is a system which performs information processing. An ANN resembles or it can be considered as a generalization of mathematical model of human brain assuming that

- Information processing occurs at many simple elements called neurons.
- Signals are passed between neurons over connections links.
- Each connection link has an associated weight, which in a typical neural net multiplies the signal transmitted.

Table 2: Summary of Descriptive Statistics For Water Quality Parameters

Statistics for summer season

WQPs	pH	TSS	TDS	Alk	BOD	DO	TC	Cl	NITRATE	TH	Ca	Mg
'Minimum'	6.40	24.00	78.00	42.00	4.00	4.80	980.00	12.60	0.84	46.00	28.00	18.00
'Maximum'	6.80	40.60	164.00	74.00	7.20	6.60	36000.00	34.00	6.20	92.00	62.00	35.00
'Mean'	6.58	34.18	115.33	57.56	5.61	5.80	14708.89	25.11	3.40	71.33	43.33	27.89
'STD'	0.16	5.08	33.23	9.74	1.20	0.68	12091.82	7.55	1.91	14.66	11.49	5.21
'Variance'	0.03	25.79	1104.00	94.78	1.43	0.46	146212211.11	56.95	3.65	215.00	132.00	27.11

Statistics for winter season

WQPs	pH	TSS	TDS	Alk	BOD	DO	TC	Cl	NITRATE	TH	Ca	Mg
'Minimum'	6.80	6.40	54.00	46.00	2.40	5.40	480.00	4.40	0.48	32.00	19.00	14.00
'Maximum'	7.60	18.20	142.00	82.00	5.60	7.60	18000.00	28.00	4.60	72.00	54.00	27.00
'Mean'	7.13	10.27	94.44	65.33	4.31	6.33	7297.78	17.60	2.27	55.33	34.22	21.11
'STD'	0.32	3.80	32.46	11.87	1.17	0.86	5927.53	9.90	1.44	11.87	11.43	3.59
'Variance'	0.10	14.43	1053.78	141.00	1.36	0.74	35135644.44	97.97	2.08	141.00	130.69	12.86

Statistics for rainy season

Minimum'	6.40	24.00	78.00	42.00	4.00	4.80	980.00	12.60	0.84	46.00	28.00	3.00
'Maximum'	6.80	40.60	164.00	74.00	7.20	6.60	36000.00	34.00	6.20	92.00	62.00	35.00
'Mean'	6.58	34.18	115.33	57.56	5.61	5.80	14708.89	25.11	3.40	71.33	43.33	27.89
'STD'	0.16	5.08	33.23	9.74	1.20	0.68	12091.82	7.55	1.91	14.66	11.49	5.21
'Variance'	0.03	25.79	1104.00	94.78	1.43	0.46	146212211.11	56.95	3.65	215.00	132.00	27.11

V. RESULTS AND DISCUSSIONS

Statistics for three season based parameters values is shown in Table 2. From the WQI analysis it was observed that quality of water each year. Three locations were taken for analysis but not a single location was suitable for the purpose of drinking in of the seasons. It is observed that the condition of water is worst in rainy WQI increases in all the locations. The computed WQI values ranges from 51.44 to 117.855 for winter season, values ranges from 57.07 to 176.25 for summer season and values from 52.60 to 143.24 for rainy season is shown in the Table 3.

Table 4: Water Quality Value in the three years at three locations

Water Quality	**WQI Values**	**Grade of water**	**WQI samples**	**% of water samples**
Excellent water	0 – 25	A	0	0
Good Water	26- 50	B	0	0
Poor Water	51- 75	C	9	33.33 %
Very Poor Water	76 – 100	D	6	22.22 %
Unsuitable for drinking	Above 100	E	12	44.44 %

The correlation coefficient refers to the relationship between two variables which shows how one variable predicts the other. The coefficient is calculated by taking the covariance of the two variables and dividing it by the product of their standard deviation. A strong or high correlation means that two or more variables have a strong relationship with each other, while a weak or low correlation means that the variables are hardly related. The correlation coefficients (r) among various water quality parameters of surface water of the study area in winter, summer, and rainy season were calculated and the values of correlation coefficients (r) are given in Table

Correlation Coefficient of water quality parameter in winter season

WQPs	pH	TSS	TDS	Alka	BOD	DO	TC	Cl	Nit	TH	Ca-H	Mg-H
pH	1.000											
TSS	-0.650	1.000										
TDS	-0.844	**0.883**	1.000									
Alka	-0.697	0.662	**0.809**	1.000								
BOD	-0.774	0.624	**0.876**	**0.912**	1.000							
DO	**0.844**	-0.742	-0.959	-0.822	-0.923	1.000						
TC	-0.853	**0.853**	**0.936**	**0.861**	**0.849**	-0.913	1.000					
Cl	-0.897	0.654	**0.909**	**0.873**	**0.961**	-0.960	**0.913**	1.000				
Nit	-0.829	0.799	**0.933**	**0.914**	**0.914**	-0.931	**0.985**	**0.948**	1.000			
TH	-0.520	**0.805**	**0.804**	**0.894**	**0.804**	-0.754	0.791	0.710	**0.817**	1.000		
Ca-H	-0.788	**0.839**	**0.921**	**0.928**	**0.886**	-0.898	**0.983**	**0.906**	**0.991**	**0.870**	1.000	
Mg-H	0.682	-0.212	-0.383	-0.350	-0.463	0.448	-0.528	-0.564	-0.492	-0.168	-0.458	1.000

The results of statistical analysis which are shown in Table -3 (winter season) gave an indication that
pH has strong positive correlation with DO, moderately strong correlation with Mg-H and negative correlation with all the other parameter.
TSS has strong positive correlation with TDS, TC, TH, Ca-H and moderately strong correlation with Alka, BOD, CL, Nit, while negatively correlated with DO and Mg-H.
TDS has Alka, BOD, TC, CL, Nit, TH, Ca-H and strongly negative correlation with DO and Mg-H.
Alka has strong positive correlation with BOD, TC, CL, Nit, TH, Ca-H and negatively correlated with DO and Mg-H.
BOD has strong positive correlation with TC, CL, Nit, TH, Ca-H negative correlation DO and Mg-H.
DO has negative correlation with all the parameter.
TC has strongly positive correlation with CL, Nit, Ca-H moderately strong correlation TH and negatively correlation with Mg-H.
CL has strong positive correlation with Nit and Ca-H.
Nit has strong correlation with TH and Ca-H while TH has strong correlation with Ca-H.

Correlation Coefficient for water quality parameters during Summer Season

WQPs	*pH*	*TSS*	*TDS*	*Alka*	*BOD*	*DO*	*TC*	*Cl*	*Nit*	*TH*	*Ca-H*	*Mg-H*
pH	1.00											
TSS	-0.46	1.00										
TDS	-0.15	**0.84**	1.00									
Alka	-0.54	**0.91**	0.68	1.00								
BOD	-0.22	**0.89**	**0.95**	**0.80**	1.00							
DO	0.07	-0.81	-0.97	-0.66	-0.97	1.00						
TC	-0.43	**0.87**	**0.89**	**0.82**	**0.91**	-0.89	1.00					
Cl	-0.34	**0.89**	**0.83**	**0.83**	**0.95**	-0.89	**0.89**	1.00				
Nit	-0.42	**0.91**	**0.87**	**0.88**	**0.94**	-0.89	**0.98**	**0.95**	1.00			
TH	-0.50	**0.98**	**0.84**	**0.93**	**0.88**	-0.81	**0.92**	**0.87**	**0.94**	1.00		
Ca-H	-0.37	**0.92**	**0.96**	**0.82**	**0.94**	-0.92	**0.97**	**0.88**	**0.95**	**0.94**	1.00	
Mg-H	-0.59	0.73	0.27	0.78	0.40	-0.24	0.46	0.50	0.55	0.72	0.45	1.00

The results of the statistical analysis which are shown in Table -1(Summer Season) gave an indication that
TSS has strong positive correlation with TDS, Alka, BOD, TC, Cl, Nit, TH and Ca-H, moderately correlated with Mg-H while negatively correlated with DO.
TDS has strong positive correlation with BOD, TC, Cl, Nit, TH and Ca-H, moderately correlated with Alka and weak correlation with Mg-H while negatively correlated with DO.

Alka has strong correlation with BOD, TC, Cl, Nit, TH and Ca-H, moderately correlated with Mg-H and negatively correlated with DO.

BOD has strong correlation with TC, Cl, Nit, TH and Ca-H, moderately correlated with Mg-H and negatively correlated with DO.

DO has strongly negative correlation with all the water quality parameters.

TC has strongly positive correlation with Cl, Nit, TH, Ca-H and moderately correlated with Mg-H.

Cl has strong correlation with Nit, TH, Ca-H and moderately correlated with Mg-H.

Nit has strong correlation with TH, Ca-H and moderately positive correlation with Mg-H.

TH has strong positive correlation with Ca-H and moderately positive correlation with Mg-H while Ca-H is moderately positive with Mg-H.

Correlation Coefficient of water quality parameters in Rainy Season

WQPs	*pH*	*TSS*	*TDS*	*Alka*	*BOD*	*DO*	*TC*	*Cl*	*Nit*	*TH*	*Ca-H*	*Mg-H*
pH	1.00											
TSS	-0.60	1.00										
TDS	-0.62	**0.99**	1.00									
Alka	-0.67	**0.98**	**0.99**	1.00								
BOD	-0.41	**0.93**	**0.91**	**0.91**	1.00							
DO	0.47	-0.96	-0.97	-0.95	-0.93	1.00						
TC	-0.77	**0.94**	**0.96**	**0.97**	**0.81**	-0.89	1.00					
Cl	-0.46	**0.88**	**0.86**	**0.83**	**0.89**	-0.87	0.77	1.00				
Nit	-0.71	**0.97**	**0.99**	**0.98**	**0.87**	-0.94	**0.97**	**0.81**	1.00			
TH	-0.68	**0.89**	**0.89**	**0.91**	**0.83**	-0.83	**0.91**	**0.87**	**0.87**	1.00		
Ca-H	-0.70	**0.96**	**0.96**	**0.96**	**0.87**	-0.91	**0.96**	**0.91**	**0.95**	**0.96**	1.00	
Mg-H	-0.45	0.50	0.46	0.55	0.50	-0.42	0.55	0.54	0.45	0.80	0.61	1.00

The results of statistical analysis which are shown in Table -2 gave an indication that

TSS has strongly positive correlation with TDS, Alka, BOD, TC, CL, Nit, TH, Ca-H and negative correlation with DO while weak correlation with Mg-H.

TDS has strongly positive correlation with Alka, BOD, TC, CL, Nit, TH, Ca-H weak correlation with Mg-H and negative correlation with DO.

Alka has strong positive correlation with BOD, TC, CL, Nit, TH, Ca-H and weak correlation with Mg-H and negative correlation with DO.

BOD has strong positive correlation with TC, CL, Nit, TH, Ca-H and weakly correlated with Mg-H while negative correlation with DO.

DO has negative correlation with all the parameters.

TC has strong positive correlation with Nit, TH, Ca-H and moderately positive correlation with CL while weak correlation with Mg-H.

CL has strong correlation with Nit, TH, Ca-H and weak correlation with Mg-H.

Nit has strong correlation with TH , Ca-H and weak correlation with Mg-H.

TH has strong correlation with Ca-H.

Least Square of the Relation (Y=AX+B) among strongly positive correlated parameters in Winter season

Y(dependent)	**X(independent)**	**Correlation**	**b**	**a**	**Regression Equation**	**R square**
pH	DO	0.8442	5.1435	0.314	0.314DO + 5.1435	0.712
TSS	TDS	0.883	0.5051	0.1034	0.1043TDS +0.5051	0.8780
TDS	TC	0.9355	57.056	0.0051	0.0051TC+57.056	0.8752
Alka	Ca-H	0.9275	32.362	0.9634	0.9634Ca +32.3620	0.8604
BOD	CL	0.9239	2.317	0.1133	0.1133CL + 2.3170	0.9239
TC	Nit	0.9853	-1897.7	4048.9	4048.9Nit -1897.7	0.9709
CL	Nit	0.947	2.8337	6.5018	6.5018Nit + 2.8337	0.8979
Nit	Ca-H	0.9906	-2.0068	0.125	0.125Ca – 2.0068	0.9813
TH	Ca-H	0.8704	24.391	0.9041	0.9041Ca + 24.391	0.7517

Least Square of the Relation (Y=AX+B) among strongly positive correlated parameters in Summer Season

Y(dependent)	X(independent)	correlation	b	a	Regression equatior	R square
TSS	Alka	0.909	0.4747	0.8574	Alka 0.8574+ 0.4747	0.8279
TDS	Ca	0.956	-4.4899	2.7652	Ca 2.7652- 4.4899	0.9142
Alk	TH	0.925	13.705	0.6241	TH 0.62417+13.705	0.8572
BOD	Cl	0.948	1.8352	0.1504	CL0.1504+1.8352	0.8997
TC	Nit	0.979	6394.4	6202.8	Nit 6202.8 +6394.4	0.9594
CL	Nit	0.945	12.403	3.75	Nit 3.75 +12.403	0.8932
Nit	Ca	0.948	-3.4266	0.1576	Ca 0.1576 - 3.4266	0.8903
TH	Ca	0.943	19.136	1.2045	Ca 1.2045 +19.136	0.8908

Least Square of the Relation (Y=AX+B) among strongly positive correlated parameters in Rainy Season

Y(dependent)	X(independent)	Correlation	b	a	Regression equation	R square
TSS	TDS	0.988	7.0726	0.2627	0.2627TDS+7.0726	0.9767
TDS	Alka	0.988	-35.515	2.1256	2.1256Alk -35.515	0.9774
TDS	Nit	0.985	53.177	19.931	19.931Nit + 0.985	0.9708
Alka	TC	0.968	47.301	0.0016	0.0016TC +0 968	0.9385
BOD	CL	0.889	0.121	0.2431	0.2431CL + 0.889	0.7918
TC	Nit	0.972	-2627.2	5663	5663Nit -2627.2	0.9464
CL	TH	0.869	1.2325	0.257	0.257TH + 1.2325	0.7555
Nit	Ca	0.953	-3.1135	0.1505	0.1505Ca -3.1135	0.9087
TH	Ca	0.964	12.783	1.2708	1.2708Ca + 12.783	0.929

The regression analysis was done for the parameters having strongly positive correlation with the other parameters in summer season.

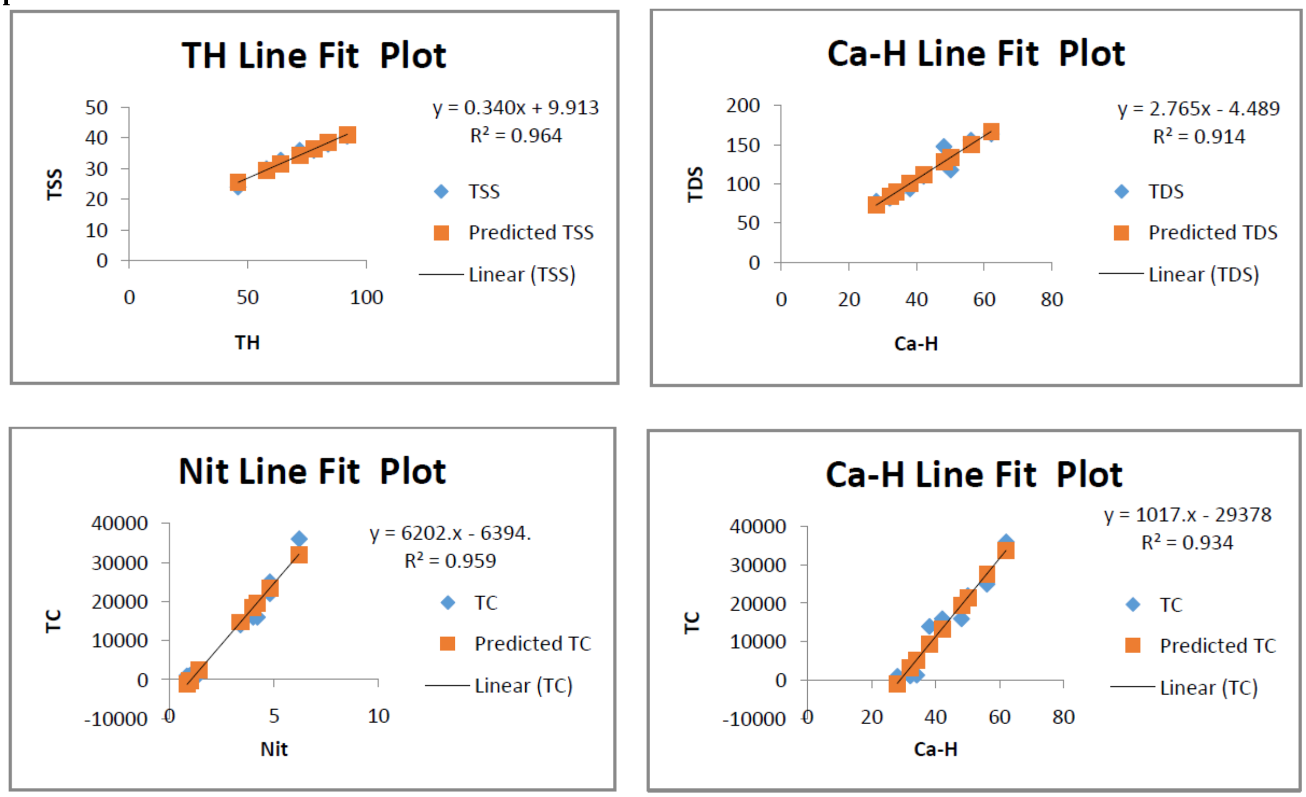

Fig 2 Linear Plot between TSS Vs TH, Ca Vs TDS, Nit Vs TC and Ca Vs TC of surface water in summer season.

The regression analysis was done for the parameters having strongly positive correlation with the other parameters in Rainy Season

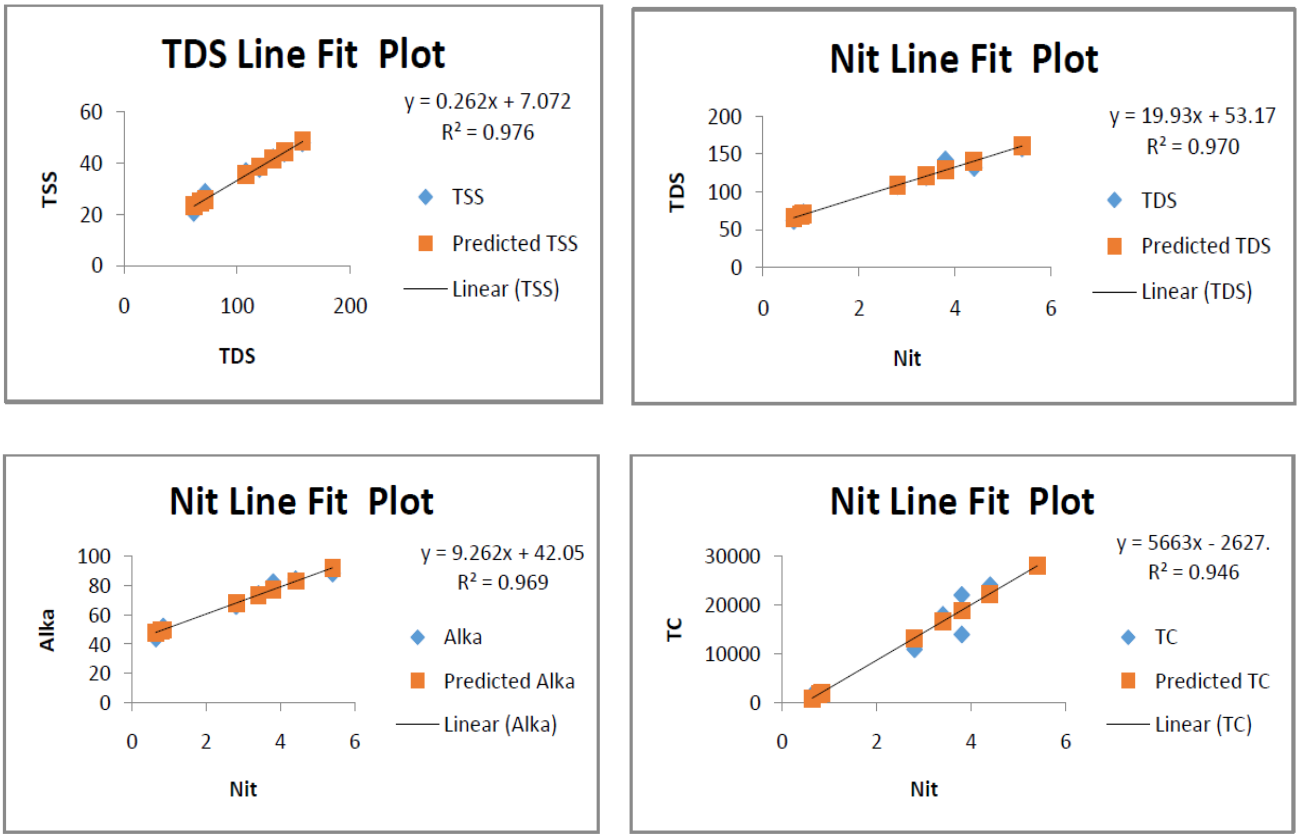

Fig. 3 Linear Plot between Nit Vs Alka, TDS Vs TSS, Nit Vs TDS, Nit Vs TC of surface water in rainy season.

The regression analysis was done for the parameters having strongly positive correlation with the other parameters in Winter season

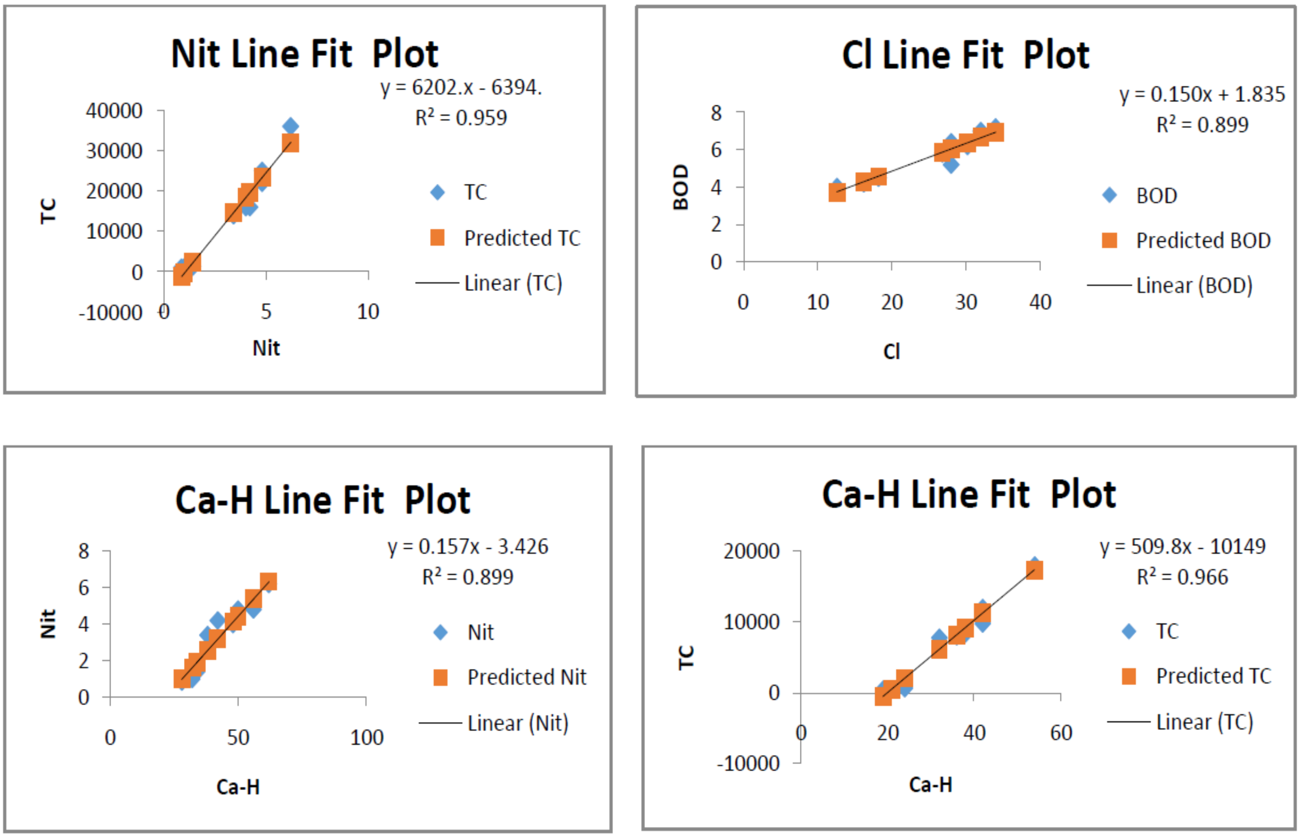

Fig. 4 Linear Plot between TC Vs Nit, BOD Vs Cl, Ca Vs Nit, Ca Vs TC of surface water in winter season.

Comparison between Linear Regression model and Artificial Neural Network model for the significantly correlated parameters.

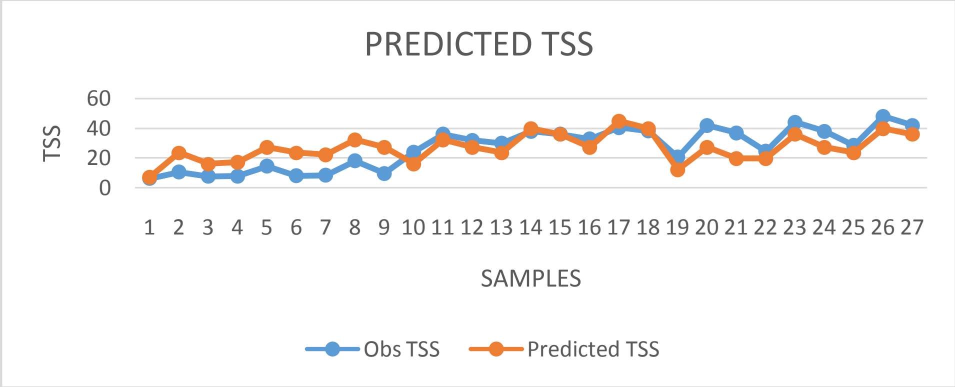

Fig 5SimpleLinear Regression Predicted TSS

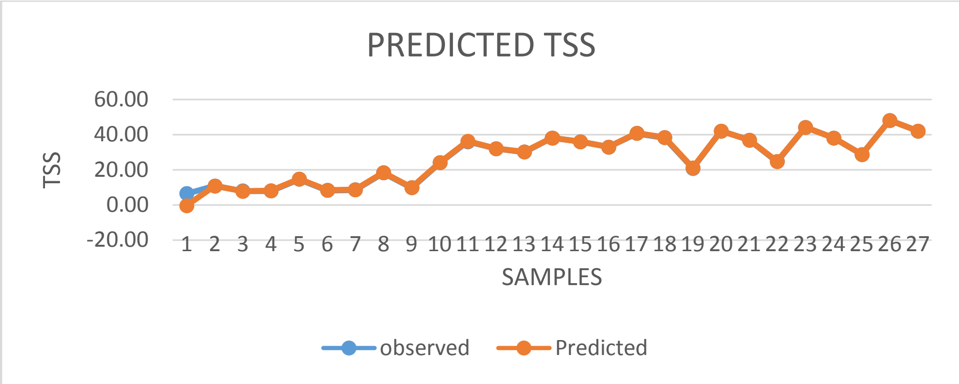

Fig 6 ANN Predicted TSS

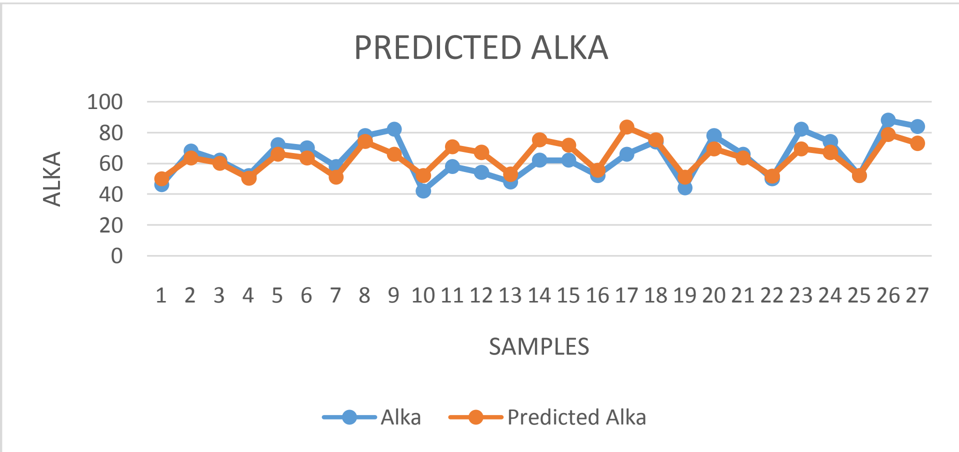

Fig 7 Simple Regression Predicted ALKA

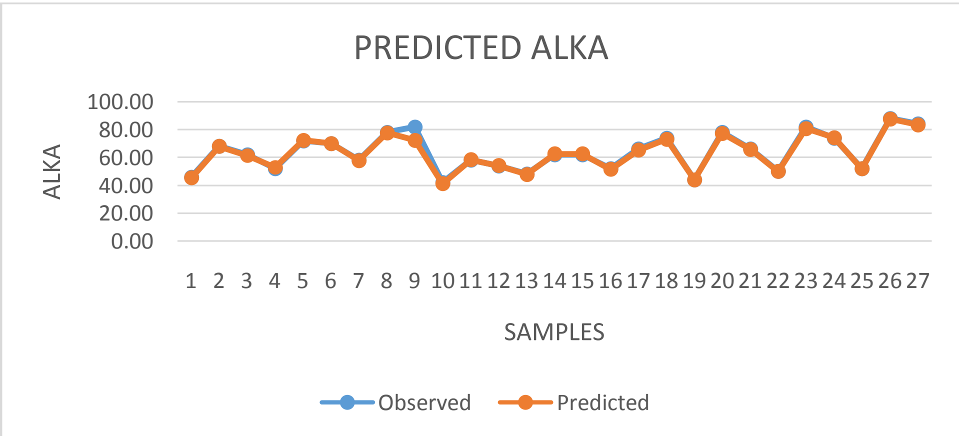

Fig 8ANN Predicted ALKA

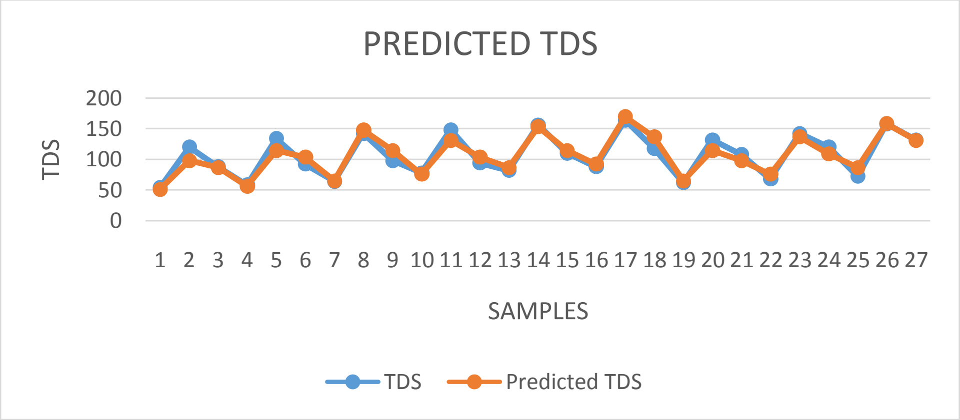

Fig. 9Simple Linear Regression Predicted TDS

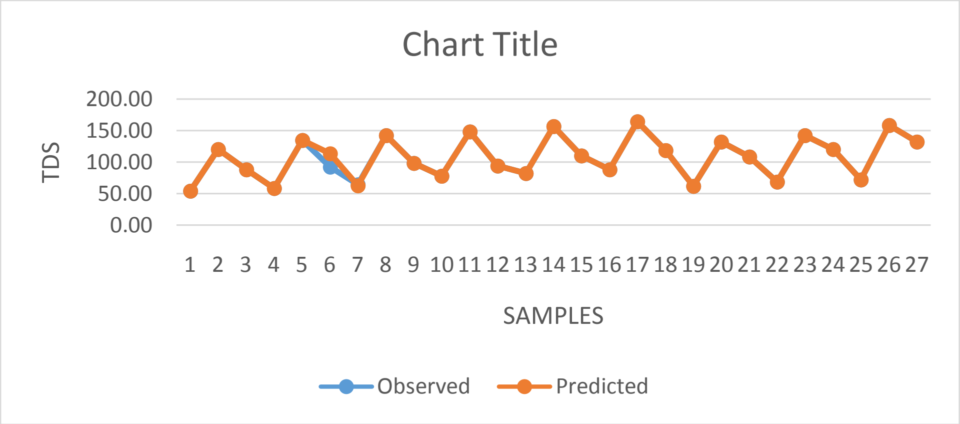

Fig.10 ANN Predicted TDS

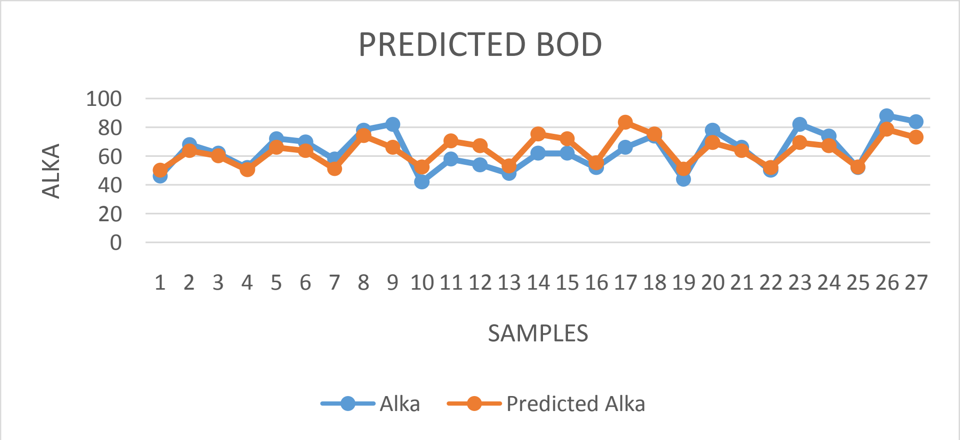

Fig. 11Simple Regression Predicted BOD

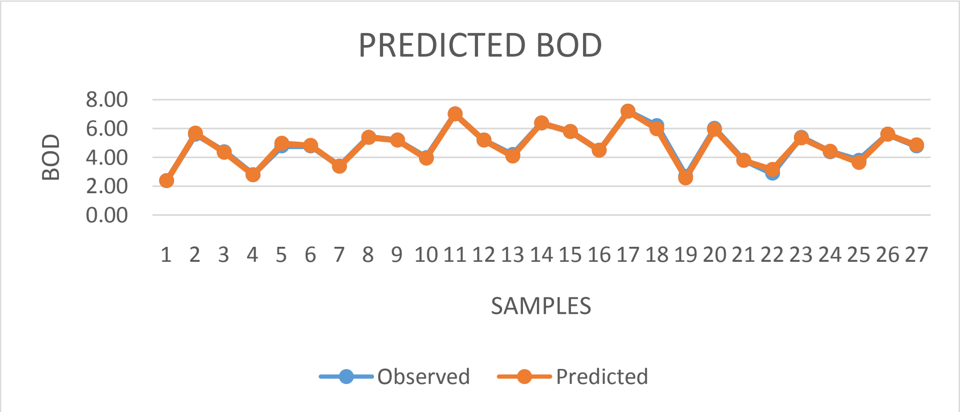

Fig. 12ANN Predicted BOD

The results show that the ANN based model has great potential to simulate and predict the TSS, Alkalinity, TDS, BOD with acceptable accuracies of Mean Square Error (MSE) : TSS_{MSE} = 1.78 ; TDS_{MSE} = 0 ; $Alkalinity_{MSE}$ = 3.77 and BOD_{MSE} = 8E-03. The results are shown in figs 5-12. On close observation of graphs of these two models, it is evident that most errors for regression model are little more than error generated by the ANN model.

VI. CONCLUSION

From the study of surface water by means of 12 physical and chemical parameters of the study area identify with the intention of water quality was poor, very poor and inappropriate for drinking purpose. The calculated WQI values lies between 51.44 to 117.85 during winter season, values lies between 57.07 to 176.25 during summer season and during rainy season WQI values lies between 52.60 to 143.245. So the water of the study area falls under poor quality water which is unsuitable for drinking purpose. In this study linear regression model and ANN based model was compared and it was concluded that the ANN based model gives better results for this study area. The pollution load increases due to the disposal of domestic sewage and industrial effluents into the surface water .It is recommended that water analysis should be carried out from time to time to monitor the rate and kind of contamination. It is need of human to expand awareness among the people to maintain the cleanness of water at their highest quality and purity levels to achieve a healthy life.

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REFERENCES

[1] Akkaraboyina, M.K. and Raju, B.S.N. Assessment of water Quality Index of River Godavari at Rajahmundry. Universal Journal of Environmental Research and Technology.2(3), 161-167 (2012).

[2] Bandyopadhyay, G. and Chattopadhyay, S. “Single hidden layer artificial neural network models versus multiple linear regression model in forecasting the time series of total ozone,” Int. J. Environ.Sci. Tech., Vol. 4, No. 1, pp. 141-149, 2007.

[3] Balasubramaniam, A. and Sastri, J.C.V. “Studies on the quality of groundwater of Tambaraparani River basin, Tamil Nadu”, Nat, Semi, Groundwater Mang, Tamil Nadu, Agricultural University, Coimbatore, pp.124-128, 1985.

[4] Chandra Sekhar, M. and Satya Prasad, M.V.K. “Regression model for assessment of dissolved pollutants in Krishna river”, Journal of IndianWater Resources Society, Vol. 25, No. 4, pp. 46-49, 2005.

[5] Dash, J.R., Dash, P.C. and Patra, H.K. “A Correlation and regression Study on the ground water quality in rural areas around Angul-Talcher Industrial zone”, Indian Journal of Environmental Protection, Vol. 26, No. 6, pp. 550-558, 2006.

[6] Gopal Krishna, Surjeet Singh, “Assessment of water quality index of groundwater in Rajkot District, Gujurat, India, Journal of Earth science and climatic change. Vol. 7 No.3, 2015.

[7] Ibrahim Bathusha, M. and Saseetharan, M.K. “Statistical study on physio-chemical characteristics of ground water of Coimbatore southzone”, Indian Journal of Environmental Protection, Vol.26, No.6,pp.508-515, 2006.

[8] K.Ambiga and R. Anna Durai. “Development of water quality index and regression model for assessment of groundwater quality”, International Journal of Advanced Remote Sensing and GIS. Vol.4 Issue No.1 pp. 931-943, 2015.

[9] Tiwari, T.N., Das, S.C. and Bose, P.K. “Correlation among water quality parameters of groundwater of Meerut District”, ActaSciencialndica. Vol. 12, No.3, pp. 111-113, 1986.

[10] Tiwari, T.N. and Manzoor Ali. “Water quality index for Indian rivres”,Ecology and pollution of Indian Rivers, Ed. R.K.Trivedi, Ashishpublishing House, New Delhi, pp. 271-286, 1988.