Physico-Chemical Analysis of Groundwater and Effect of Climatic Change in Angul-Talcher Area

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Abstract-

In this paper, the linear regression model using ANN and the linear regression model using MS Excel were developed to estimate the physico-chemical concentrations in groundwater using pH, EC, TDS, TH, HCO_3 as input parameters and Ca, Mg and K as output parameters. A comparison was made which indicated that ANN model had the better ability to estimate the physic-chemical concentrations in groundwater. An analytical survey along with simulation based tests for finding the climatic change and its effect on agriculture and water bodies in Angul-Talcher area is done. The various seasonal parameters such as pH, BOD, COD, TDS,TSS along with heavy elements like Pb, Cd, Zn, Cu, Fe, Mn concentration in water resources has been analyzed. For past 30 years rainfall data has been analyzed and water quality index values has been studied to find normal and abnormal quality of water resources and matlab based simulation has been done for performance analysis. All results has been analyzed and it is found that the condition is stable.

Keywords- Regression Model, ANN, Excel, Physico-Chemical Parameters, Water Quality Index, Rainfall

I. INTRODUCTION

Life is possible on Earth due to the presence of water. Groundwater is simply the water that can be found underground. This doesn't include surface water bodies, but instead includes the water that fills in spaces between sand, rocks, and soil beneath the surface of the earth. 30% of the freshwater on the face of the earth is stored as groundwater. India possesses various types of climate that ranges from alpine to tropical type from the north to south border because of its diverse topography and steep slope. Generally there are four seasons in India: summer (June-September), post-monsoon (October-November), winter (December-February) and pre-monsoon (March-May) (Yogacharya, 1998). In the 21st century, human will perhaps face more devastating, environmental threat namely due to global warming and thereby climate change. Climate change is interrelated with agriculture. Agriculture land occupies nearly 20% of the total area of India (UNEP,2001). Climatic factors like precipitation and temperature have significant impact in agriculture. Lack of rains can create scientifically curious practices. Rainfall is a natural climatic feature whose forecasting is demanding. It is responsible for depositing most of earth's fresh water and is a major component of water cycle. Insufficient rainfall for long period causes drought. This can affect the economic growth of developing countries.

II. LITERATURE REVIEW

Gorelick et al (1983) attempted to identify the locations and magnitudes of aquifer pollutant sources in which least squares regression and linear programming for least absolute error estimation were each combined with groundwater solute transport simulation. In identifying pollutant sources minimizing either least absolute or least squared errors was successful.

Mahar and Datta (2000) proposed inverse model identifies unknown sources of pollution by using measured values of pollutant concentration at selected locations. Performance of the developed model was also evaluated for a condition when concentration measurements were missing during few initial time periods after the pollution sources become active.

Khatua and Stanley (2006) "Ecological Debt: a case study from Orissa, India." studied the broad aim of elaborating on the social and ecological costs of large-scale mining, thereby contributing to a better understanding of the concept of ecological debt from the perspective of resource-based communities in Orissa.

Reza and Singh (2010) presented the study to reveal the seasonal variations in the river water quality with respect to heavy metals contamination. The concentrations of trace metals such as cadmium, chromium, copper, cobalt, iron, manganese, nickel, lead, mercury and zinc were determined using atomic absorption spectrophotometer. Most of the samples were found within limit of Indian drinking water standard (IS: 10500). The data generated were used to calculate the heavy metal pollution index of river water. The mean values of HPI were 36.19 in summer and 32.37 for winter seasons and these values are well below the critical index limit of 100 because of the sufficient flow in river system. Mercury and chromium could not be traced in any of the samples in the study area.

Prakash and Datta (2014) this study aims at improving the accuracy of source identification results by using concentration measurement from an optimally designed monitoring network. A linked simulation optimization based methodology is used by optimal source identification. This performance evaluation results show improvement in the efficiency in source identification when such designed monitoring networks are utilised.

Fard et al (2016) estimated the distribution of heavy metals in groundwater of Lakan Lead-zinc mine by the application of artificial methods to data analysis such as ANN, ANN-BBO, MANFIS. A comparison between the predicted and measured data indicated that the MANFIS model had the most potential to estimate distribution of heavy metals in groundwater with higher degree of accuracy and robustness.

III. STUDY AREA

The district of Angul lies between 20˚31' N and 21˚40' N latitude and 84˚15' E to 85˚23' E longitude. The district covers a geographical area of 6232 square kilometres and stands as 11th largest district among 30 districts in the state. Angul is situated at an average height of 139 meters above mean sea level and at a distance of 160 km, from the state capital Bhubaneswar. Angul-Talcher area is one of the major industrial zones in the state of Orissa. The area is recognised as one of the 24 problem areas identified by Central Pollution Control Board, Delhi in respect of industrial pollution hazard. The area is fast emerging as a big source of coal and thermal power in the country.The major industries are the Mahanadi Coal Fields Ltd at Talcher, NALCO Captive Power Plant, at NALCO, Angul, NALCO Smelter Plant at NALCO, Angul, National Thermal Power Station (NTPC) at TTPS Talcher etc. Coal is the prime mineral resource of the district. Talcher area has extensive coal .In fact, Angul is the leading district in the production of coal in Odisha.

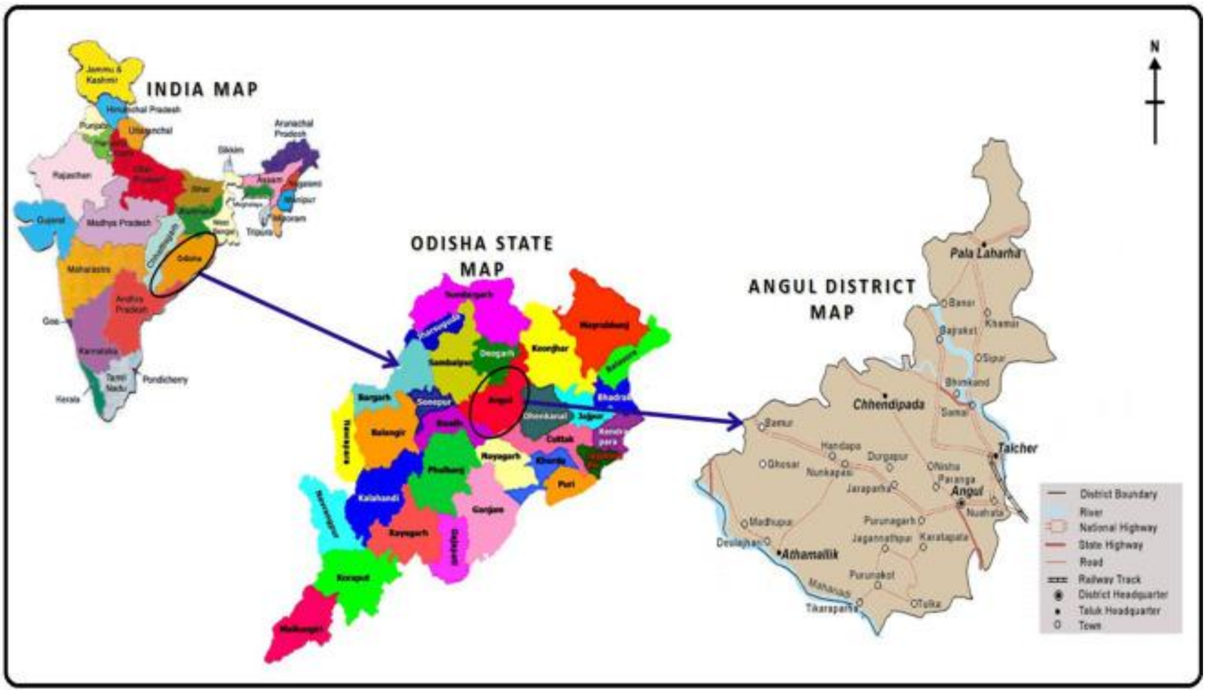

Figure 1: Angul District Map

IV. METHODOLOGY

A. Data Analysis

A correlation matrix was created. Using this table, the parameters pH, TDS, EC, TH, HCO3 were selected to be the model inputs due to their strong correlations with the Ca, Mg, K concentrations. The model outputs were concentrations of the metals including Ca, Mg, K. In this study, normalization of the data (inputs and outputs) was carried out in the range of (0,1) using Eq.1.

$$P_n = \frac{P - P_{min}}{P_{max} - P_{min}} \quad (1)$$

Where P_n is the normalized parameter, P denotes the actual parameter, P_{min} represents a minimum of the actual parameters, and P_{max} stands for a maximum of the actual parameters

The mean square error (MSE) can be calculated as follows (Eq.2):

$$MSE = \frac{1}{n}\sum_{i=1}^{n}(y_i - y_i')^2 \quad (2)$$

Where y_i is the measured value, y_i' denotes the predicted value, and n stands for the number of samples. The lower the MSE, the more accurate the prediction is. Furthermore, the efficiency criterion, R^2, is given by Eq.3. In statistics, the coefficient of determination, denoted R^2 or r^2, is the proportion of the variance in the dependent variable that is predictable from the independent variable(s).

$$R^2 = 1 - \frac{\sum_{i=1}^{n}(y_i - y_i')^2}{\sum_{i=1}^{n} y_i^2 - \frac{\sum_{i=1}^{n} y_i'^2}{n}} \quad (3)$$

Where R^2 efficiency criterion represents the percentage of the initial uncertainty explained by the model. The best fitting between the measured and predicted values, which is unlikely to occur, would have MSE=0 and R^2=1.

We can use this method to calculate the Pearson correlation by using Eq (4)

$$\gamma = \frac{N\sum xy \sum(x)\sum(y)}{\sqrt{[N\sum x^2 - \sum(x^2)]\,[N\sum y^2 - \sum(y^2)]}} \quad (4)$$

Where r = Pearson r correlation coefficient, N= number of value in each data set, Σxy = sum of the products of paired scores, Σx = sum of x scores, Σy = sum of y scores, Σx^2 = sum of squared x scores, Σy^2 = sum of squared y scores.

Linear Regression Analysis:

The regression tool in excel's data analysis determines the coefficients (a_i) that yields the smallest residual sum of squares, which is equivalent to the greatest correlation coefficient squared, R^2, for equation (5). This is known as linear regression analysis.

Regression line general form-

$$y = b_0 + b_1 * x \quad (5)$$

where y = dependent variable, b_0 = intercept, b_1 = slope, x = independent variables

It is assumed to have n observations of y versus different values of x_i.

B. Artificial Neural Network

ANNs have different structures including at least two layers that is input and output layers. Between these two layers, there can be one or more layers called hidden layers. A typical multilayer perceptron with one hidden layer can be mathematically expressed as indicated in Eqs. 6-9

The outputs of the hidden layer (Z_j) are obtained as (1) summing the products of the inputs (X_j) and weight vectors (a_{ij}) and a hidden layer bias term (a_{ij}; see Eq. 6), and (3) transforming this sum using transfer function g (see Eq. 7). Similarly, the outputs of the output layer (Y_k) are obtained by (2) summing the products of the hidden layer outputs (Z_j) and weight vectors (b_{jk}) and output layer bias term (b_{0k}; see Eq. 8), transforming this sum using transfer function g (see Eq. 9).

$$u_j = \sum_{i=1}^{N_{inp}} x_i\, a_{ij} + a_{0j} \quad (6)$$

$$Z_j = g(u_j) \quad (7)$$

$$v_k = \sum_{j=i}^{N_{hid}} Z_j\, b_{jk} + b_{0k} \quad (8)$$

$$Y_k = g(v_k) \quad (9)$$

C. Water Quality Index(WQI)

Indexing of Water quality is the method to express the water quality in the term of rating with respect to scale of different categories. There are four categories, namely bad, medium, good and very good according to the classification criteria recommended by National Sanitation Foundation Water Quality Index (NSF-WQI. Water quality index rating was carried out to quantify overall water quality status of the area.

$$WQI= \sum_{i=1}^{n} W_i I_i$$

where, I_i is the sub index for i^{th} water quality parameter,
W_i is the weight (in terms of importance) associated with i^{th} parameter,
n is the number of water quality parameters.

D. Assessment of Trace/Heavy Elements in River Water

Trace/heavy elements such as Lead (Pb), Cadmium (Cd), Zinc (Zn), Copper (Cu), Nickel(Ni), Iron (Fe), Cobalt (Co), Manganese (Mn), Chromium (Cr) and Mercury(Hg) has been assessed and details of statistical analysis is given in Table 1 and Table 2

The study reveals that heavy metals were found in summer and winter season only. There was no detection of heavy metals in any of the water samples during monsoon and post-monsoon season. The trace/heavy elements showed slightly higher concentrations during summer season than the winter season.

Table 1: Statistical Variation for Trace/Heavy Elements of River Water in Various Seasons

Parameters	**Trace/heavy elements concentrations in river water (µg/l)**			
	Summer		***Winter***	
	Range	**Mean ± Sd**	**Range**	**Mean ± Sd**
Lead (Pb)	<10.0-27.0	12.1 ±5.23	<10.0	---
Cadmium (Cd)	0.4 - 4.00	1.8 ±1.93	0.4 - 0.70	0.43 ±0.1
Zinc (Zn)	<0.5- 80.1	15.9 ±28.5	0.5 - 75.5	11.3 ±21.4
Copper (Cu)	<1.0 - 4.70	1.94 ±1.25	<1.0 - 4.20	1.55 ± 0.9
Nickel (Ni)	<9.0 - 44.3	15.7 ±12.2	0.0 - 52.0	16.4 ±13.2
Iron (Fe)	<5.0 -64.6	20.3 ±20.9	<5.0 - 95.0	23.3 ±27.8
Cobalt (Co)	<4.0 - 5.60	4.13 ±0.64	<4.0 - 5.30	4.5 ±0.4
Manganese (Mn	<1.5 - 102	24.5 ±33.7	1.50 - 98.0	24.1 ±32.9
Chromium (Cr)	<0.3	---	<0.3	---
Mercury (Hg)	< 0.1	**....**	<0.1	---

Assessment of Trace/Heavy Elements in Canal Water

The study shown the trace/heavy elements were found during summer and winter season only. There was no detection of heavy metals in any of the water samples during monsoon and post-monsoon season. Most of the trace elements concentrations being higher during the summer season than winter. In most of the samples, the trace/heavy elements concentrations were found within the permissible limit (IS: 10500).

Table 2: Statistical Variation for Trace/Heavy Elements of Canal Water in Various Seasons

Parameters	**Trace/Heavy elements concentration of canal water (ug/1)**			
	Summer		***Winter***	
	Range	**Mean ± Sd**	**Range**	**Mean ± Sd**
Lead (Pb)	<10.0 – 26	23.0 ±5.7	<10.0 - 19.1	21.0 ±4.3
Cadmium (Cd)	0.4 - 2.6	1.0 ±1.1	0.4 - 6	0.5 ±0.1
Zinc (Zn)	0.7 - 6.3	2.6 ±2.2	0.5 - 4.1	1.5 ±1.3
Copper (Cu)	1.0-6.3	3.6 ±1.9	<1.0 - 3.6	2.4 ±1.1
Nickel (Ni)	9.0-43.7	17.0 ±12.1	<9.0 - 33.4	13.0 ±8.2
Iron (Fe)	5.0 - 48.0	17.9 ±13.6	<5.0 - 35.0	13.6 ±9.8

Cobalt (Co)	4.0 - 9.3	7.7 ± 2.3	<4.0 - 8.2	5.7 ±2.2
Manganese (Mn)	<1.5-4.1	2.8 ±1.2	<1.5 - 3.2	2.2 ±0.8
Chromium (Cr)	<0.3	---	0.3	---
Mercury (Hg)	O.I	---	0.1	---

V. RESULTS AND DISCUSSION

Statistical Analysis of the data describes implementation of the aforementioned methods to predict the physic-chemical parameters in groundwater of Angul and Talcher area. Descriptive statistics of the data are shown in table-3

Table 3: Descriptive statistics of data

Variable	Samples	Minimum	Maximum	Average	STDV
pH	20	7.12	7.83	7.504	0.21979
EC	20	240	1620	788.5	328.38
TDS	20	116.18	888.95	424.76	181.3
TH	20	90	430	258	101.77
HCO3	20	61	561.2	252.23	110.52
Ca	20	10	126	55.8	33.162
Mg	20	4.86	65.61	28.798	15.857
K	20	0.7	41	7.465	10.402

A. Correlation Matrix

Correlation measures the strength between the two variables and the direction of the relationship. It is calculated through the sample variance of the data variables. The value of the correlation coefficient varies between +1 and -1 in case of strength of relationship. If the value of the correlation coefficient is around +1 and -1 then it is said to be a perfect degree of association between the two variables. When the correlation coefficient value goes towards 0, the relationship between the two variables will be weaker.

Table 4: Correlation matrix between heavy metal concentrations and independent variables

	Ph	EC	TDS	TH	Ca	Mg	Na	K	HCO3	Cl	SO4	F	Cu	Fe	Mn	Pb	Zn
pH	1																
EC	-0.65	1															
TDS	-0.64	0.99	1														
TH	-0.74	0.8	0.79	1													
Ca	-0.58	0.42	0.43	0.76	1												
Mg	-0.41	0.7	0.67	0.58	-0.07	1											
Na	-0.28	0.8	0.79	0.29	-0.11	0.59	1										
K	-0.03	0.46	0.5	0.04	-0.12	0.22	0.64	1									
HCO3	-0.47	0.83	0.81	0.47	0.1	0.6	0.85	0.53	1								
Cl	-0.69	0.9	0.9	0.86	0.64	0.53	0.58	0.25	0.6	1							
SO4	-0.31	0.47	0.51	0.52	0.27	0.47	0.23	0.26	0.05	0.4	1						
F	0.38	0.01	0.03	-0.22	-0.39	0.14	0.26	0.26	0.08	-0.21	0.27	1					
Cu	0.08	-0.27	-0.25	-0.26	-0.07	-0.31	-0.19	0.01	-0.22	-0.27	-0.07	-0.32	1				
Fe	0.01	-0.1	-0.08	-0.08	0.11	-0.27	-0.11	-0.07	-0.15	-0.08	0.09	-0.19	0.63	1			
Mn	0.35	-0.29	-0.25	-0.3	-0.09	-0.35	-0.21	0.2	-0.2	-0.4	0.13	0.41	0.16	0.4	1		

Pb	-0.48	0.39	0.4	0.35	0.48	-0.05	0.22	0.1	0.29	0.41	0.19	-0.05	0.16	0.54	0.01	1	
Zn	-0.32	-0.18	-0.19	-0.12	-0.24	0.11	-0.16	-0.13	-0.03	-0.28	-0.05	-0.01	0.23	0.05	0.11	0.08	1

We have found out the smallest least squares of the metals Mg, Ca and K by using regression (linear) model. In Table 5 the number of inputs is five (pH, TDS, EC, TH, HCO_3) and the target is one (Ca). Similarly in Table 6 the number the number of inputs is five (pH, TDS, EC, TH, HCO_3) and target is one (Mg). In Table 7 the number of inputs is five (pH, TDS, EC, TH, HCO_3) and target is one (K) . In above 3 cases three linear regression model is demonstrated to find out the least square in which error is less.

Analysis of target Ca

Input: [pH TDS EC TH HCO3]

Output: Ca

Regression Correlation of Target and Output: Ca

Table 5: Predicted value of Calcium

Sl No.	1	2	3	4	5	6	7	8	9	10
Observed Ca	42.00	30.00	10.00	70.00	92.00	88.00	118.00	92.00	28.00	26.00
Predicted Ca	42.00	30.00	10.00	70.00	92.00	79.89	118.03	92.00	27.91	26.00
Error	0.00	0.00	0.00	0.00	0.00	8.11	-0.03	0.00	0.09	0.00

Sl No.	11	12	13	14	15	16	17	18	19	20
Observed Ca	28.00	58.00	70.00	58.00	46.00	48.00	20.00	42.00	126.00	24.00
Predicted Ca	30.82	57.97	70.00	58.00	46.00	60.94	20.00	42.00	126.00	24.00
Error	-2.82	0.03	0.00	0.00	0.00	-12.94	0.00	0.00	0.00	0.00

Analysis of target Mg

Input: [pH TDS EC TH HCO3]

Output: Mg

Regression Correlation of Target and Output: Mg

Table 6: Predicted values of Magnesium

Sl No.	1	2	3	4	5	6	7	8	9	10
Observed Mg	17.01	26.73	15.80	4.86	44.96	19.44	20.66	38.88	26.73	49.82
Predicted Mg	17.03	36.61	15.80	4.90	45.00	19.58	20.84	39.03	26.75	49.87
Error	-0.02	-9.88	0.00	-0.04	-0.04	-0.14	-0.18	-0.15	-0.02	-0.05

Sl No.	11	12	13	14	15	16	17	18	19	20
Observed Mg	25.52	19.44	20.66	29.16	26.73	65.61	13.37	20.66	27.95	61.97
Predicted Mg	25.52	19.47	4.30	25.10	26.75	65.07	13.37	20.68	28.11	62.87
Error	0.00	-0.03	16.36	4.06	-0.02	0.54	0.00	-0.02	-0.16	-0.90

Analysis of target K

Input: [pH TDS EC TH HCO3]

Output: K
Regression Correlation of Target and Output: K

Table 7: Predicted values of Potassium

Sl.No.	1	2	3	4	5	6	7	8	9	10
Observed K	10.90	1.00	1.40	6.20	2.00	5.30	3.40	1.20	1.20	0.70
Predicted K	10.90	1.00	1.40	6.23	2.00	5.30	-1.97	2.65	1.25	0.79
Error	0.00	0.00	0.00	-0.03	0.00	0.00	5.37	-1.45	-0.05	-0.09

Sl.No.	11	12	13	14	15	16	17	18	19	20
Observed K	2.50	4.10	30.40	10.60	10.80	2.60	2.50	9.40	2.10	41.00
Predicted K	2.50	4.10	30.40	10.60	10.80	2.60	2.50	9.40	2.10	41.00
Error	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

B. Analysis of Ca, Mg, K using Linear Regression

In statistics, the residual of an observed value is the difference between the observed value and the estimated value of the quantity of interest. The residual output of Ca (Table 8), residual output of Mg (Table 9) and residual output of K (Table 10) given below denotes the error we get is more as compared to the error we get in linear regression of Ca, Mg, K using ANN. The error we see is more as compared to the error in ANN. Thus we conclude that excel is a poor choice for analysis.

Table 8: Residual Output of Ca

Observation	*Predicted Observed Ca*	*Residuals*
1.00	57.09	-15.09
2.00	56.95	-26.95
3.00	56.82	-46.82
4.00	56.68	13.32
5.00	56.54	35.46
6.00	56.41	31.59
7.00	56.27	61.73
8.00	56.14	35.86
9.00	56.00	-28.00
10.00	55.87	-29.87
11.00	55.73	-27.73
12.00	55.60	2.40
13.00	55.46	14.54
14.00	55.33	2.67
15.00	55.19	-9.19
16.00	55.06	-7.06
17.00	54.92	-34.92
18.00	54.78	-12.78
19.00	54.65	71.35
20.00	54.51	-30.51

Table 9: Residuals Output of Mg

Observation	*Predicted Observed Mg*	*Residuals*
1.00	19.70	-2.69
2.00	20.66	6.07
3.00	21.62	-5.82
4.00	22.57	-17.71
5.00	23.53	21.43
6.00	24.49	-5.05
7.00	25.45	-4.79
8.00	26.40	12.48
9.00	27.36	-0.63
10.00	28.32	21.50
11.00	29.28	-3.76
12.00	30.23	-10.79
13.00	31.19	-10.53
14.00	32.15	-2.99
15.00	33.11	-6.38
16.00	34.06	31.55
17.00	35.02	-21.65
18.00	35.98	-15.32
19.00	36.94	-8.99
20.00	37.89	24.08

Table 10: Residuals Output of K

Observation	*Predicted Observed K*	*Residuals*
1.00	0.85	10.05
2.00	1.55	-0.55
3.00	2.25	-0.85
4.00	2.94	3.26
5.00	3.64	-1.64
6.00	4.33	0.97
7.00	5.03	-1.63
8.00	5.73	-4.53
9.00	6.42	-5.22
10.00	7.12	-6.42
11.00	7.81	-5.31
12.00	8.51	-4.41
13.00	9.20	21.20
14.00	9.90	0.70
15.00	10.60	0.20
16.00	11.29	-8.69
17.00	11.99	-9.49
18.00	12.68	-3.28
19.00	13.38	-11.28
20.00	14.08	26.92

C. Water Quality Index (WQI)

In general, water quality index rates the health of a stream with a single number. That number is placed on a relative scale that rates the water quality in categories ranging from very bad to excellent. Based on the estimated value of WQI, the water is categorized as per table 11.

Table 11: Descriptor Categories of NSF-WQI Values

NSF-WQI	Descriptor Category
O to25	Very Bad
26 to 50	Bad
51 to 70	Medium
71 to 90	Good
91 to 100	Excellent

Table 12: Statistical Variation Categories of WQI for River Water

Codes	**Summer**	**Pre-Monsoon**	**Post-monsoon**	**Winter**	**Range**	**Mean ± Sd**	**Category (on mean values)**
W1	81	89	83	68	68-89	80 ±9	Good
W2	77	78	84	76	76-84	79 ±3	Good
W3	73	82	84	79	73-84	80 ±5	Good
W4	65	79	87	79	65-87	78 ±9	Good
W5	67	83	72	81	67-83-	76 ±7	Good
W6	50	71	67	68	50-71	64 ±9	Medium
W7	60	78	73	69	60-78	70±7	Medium
W8	57	75	64	71	57-75	67 ±8	Medium
W9	59	70	70	67	59-70	66 ±5	Medium
W10	50	73	70	66	51- 73	65 ±10	Medium
W11	59	85	61	67	59-85	68 ±12	Medium
W12	62	84	71	60	60 - 84.	69 ±11	Medium

D. Prediction of Rainfall

Matlab based Simulation result for rainfall prediction:

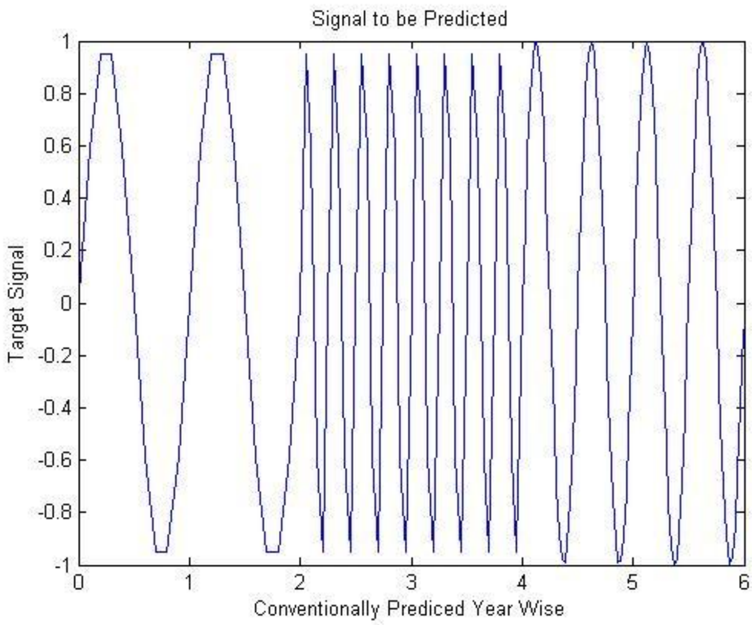

Figure 2: Rainfall Prediction

On the basis of Rainfall data collected for 30 years, the data has been simulated in MATLAB Simulation environment to predict the Rainfall data for next 6 years. This figure 2 represents the target Signal that is value to be achieved for the normal climatic behaviour in the Talcher-Angul Area

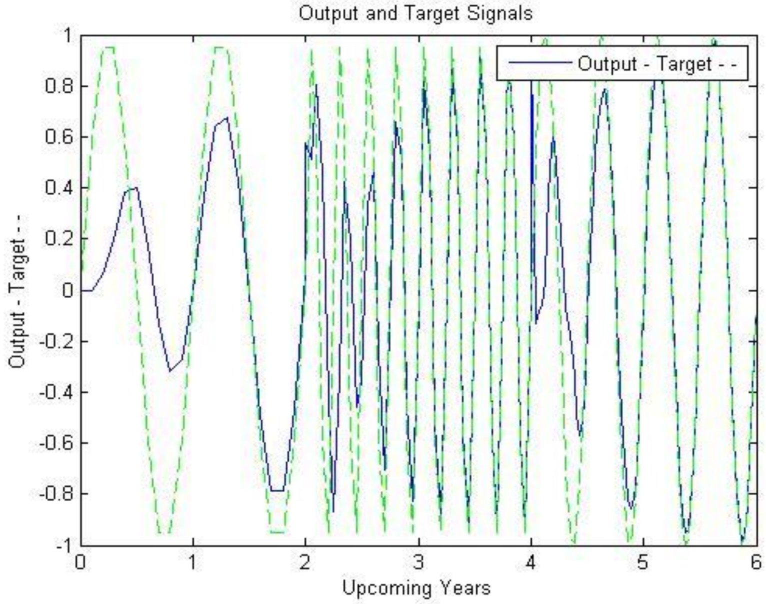

Figure 3: Comparison graph of actual and predicated data using matlab simulation

This Figure 3 represents comparisons between the actual and predicted output for the rainfall. Here -1 to +1 denotes the range in which -1 is the lower limit and +1 is the upper limit, within which the range of all the parameters lies. It is expected from the simulation results that the output (the rainfall) will hit the actual target in the upcoming years and rainfall will become more stable from previous years (due to all rules and regulations taken by the government and local people).

VI. CONCLUSION

In this paper, the linear regression model using ANN and the linear regression model using MS Excel were developed to estimate the physico-chemical concentrations in groundwater using pH, EC, TDS, TH, HCO_3 as input parameter and Ca, Mg and K as output parameters and the following remarks were concluded-It was determined that the ANN model was a reliable technique for estimating physico-chemical parameters in groundwater with more degree of accuracy.

In this thesis Climatic Change and Its Effect on Agriculture and Water Bodies in Angul-Talcher Area has been studied, seasonal and climatic changes changes in physico-chemical characteristics along with its water quality for the talcher-angul reason is studies. Sometimes the parameters are fluctuating but after the simulation results derived from the dataset we found it is in stable conditions. Most of the parameters varied within the recommended limit for drinking water as well as agriculture purpose like pH, BOD, COD, TDS, TSS and other concentrations of heavy elements like Pb, Cd, Zn, Cu, Fe, Mn those are the limiting parameters for making the source unfit for human consumption ,environment of Water Bodies and agricultural benefit. From the study we found the observed Water Quality Index (WQI) values lies in Good category. All results are found under the threshold hazardous values, so the climatic changes and its effect found to be in stable conditions and it is predicted the same will continue for next 10 to 15 years.

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