An Approach to River Water Quality Management through Correlation Study among Various Water Quality Parameters

Navneet Kumar

Department of Applied Science,
College of Engineering, Teerthankar Mahaveer University,
Moradabad-244001, Uttar Pradesh, India
navkchem@gmail.com

Abstract : Water the most vital source for all kinds of life on this planet is also the resource, adversely affected both qualitatively and quantitatively by all kinds of human activities on land, in air or in water. To find an approach to water quality management through correlation studies between various water quality parameters, the statistical regression analysis for eight data points of Gagan river water of different sites at Moradabad was performed. The comparison of estimated values with W.H.O. standards revealed that water of study area is polluted with reference to a number of physico-chemical parameters studied. Regression analysis suggests that conductivity of river water is found to be significantly correlated with ten parameters out of fifteen water quality parameters studied and it is moderately correlated with other four parameters. It may be suggested that the Gagan river water quality at Moradabad can be checked very effectively by controlling the conductivity of water. Present study may be treated one stop forward towards the water quality management.

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1. Introduction

Water also known as blue gold, one of the most priceless gifts of Nature is also regarded as the life line on Earth, because evolution of life and development of human civilization could not have been possible without water. Rivers are the important water resources and are being used for various purposes viz; drinking, irrigation and recreation. All great civilizations of the world evolved around the rivers (Madhuri 2004, Balasankar 2000). Rivers have been life line to the Earth and supposed to be yardstick to measure the society. A dirty river means a dirty society. Rapidly increasing population, indiscriminate, urbanization and rapid industrialization along the rivers have put tremendous pressure on water resources and their quality (Biswas 2000, Khan 2004).

The statistical regression analysis has been found to be a highly useful tool for correlating different parameters. Correlation analysis measures the closeness of the relationship between chosen independent and dependent variables (Jain 2002, Sharma 2005, Singanan 1995). The analysis attempts to based on best subset procedure (R and F value) is used in water quality parameters for predicting the river water quality management. Correlation analysis are developed in explaining variation in river water quality using routinely measured various water quality parameters (Mulla 2007, Draper 1981). If the correlation coefficient is nearer to +1 or –1, it shows the probability of linear relationship between the variables x and y . This way analysis attempts to establish the nature of the relationship between the variables and thereby provides a mechanism for prediction or forecasting (Weisberg 1980, Montgomery 1982, Snedecer 1967).

Moradabad is a B class city of western Uttar Pradesh having urban population more than 38 lacs. Moradabad is situated at the bank of Ram Ganga river and its altitude from the sea level is about 670 feet. It is extended from Himalaya in north to Chambal river in south. It is at 28°20', 29°15' and 78°4', 79°E. District Bijnor and Nainital are in the north, Rampur in the east, Ganga river in the west and district Budaun is in the north of district Moradabad. Moradabad has seen rapid industrialization and population growth during the last few decades. The major industries are brassware, steelware, paper mills, sugar mills, crushers, dye factories and a number of associated ancillaries. Most of these industries and different kinds of human activities are playing their roles in multiplying the level of water pollution (Sinha 2004).

Gagan river is originated from a pond at Harganpur of Nazibabad which is in district Bijnor. It travers through J.P.Nagar and Moradabad covering the total length of about 150 km. In South-East of Moradabad it mixes up with Ram Ganga river at

Seekanderpur-Patti. Two small rivers, Bann and Karula-I originating from district Bijnor are also mixing at the right bank of Gagan river at Moradabad city. A number of densely populated villages are situated on both side of river Gagan. Thousands of people are depended on river water for their daily routine. The Gagan river water seems to be highly polluted and unfit for human and animal consumption.

2. Material and Methods

Fifteen different water quality physico-chemical parameters including conductivity at eight different Gagan river water sites at Moradabad in January 2007 were estimated following standard methods and procedures of sampling and estimation (APHA 1995, Merck 1974). All chemicals of Anal R grade were used for quantitative analysis. For the determination of pH, conductivity, phosphate, fluoride and sulphate, Century CP901 pH meter, RI 215 R conductivity meter and Hach spectrophotometer 2010 were used respectively. A brief description of sampling sites for quantitative estimation of water quality parameters is presented in Table 1.

To find the relationship between two parameters x and y, the Karl Pearson's correlation coefficient, r is used and it is determined as follows:

$$r = \frac{n\sum xy - \sum x \sum y}{\sqrt{[n\sum x^2 - (\sum x)^2][n\sum y^2 - (\sum y)^2]}} \quad (1)$$

here, n = number of data points ; x = values of x–variable ; y = values of y–variable

To evaluate the straight–line by linear regression, following equation of straight line can be used –

$$y = ax + b \quad (2)$$

here, y = dependent variable ; x = independent variable ; a = slope of line; b = intercept on y–axis

$$a = \frac{n\sum xy - \sum x \sum y}{n\sum x^2 - (\sum x)^2} \quad (3)$$

$$\text{and} \quad b = \bar{y} - a\bar{x} \quad (4)$$

here, $\bar{x}$ = mean of all values of x ; $\bar{y}$ = mean of all values of y

To study the correlation between various water quality parameters, the regression analysis was carried out using computer software SPSS, version–7.5.

3. Result and Discussion:

Site-wise estimated values of fifteen Gagan river water quality physico-chemical parameters with their prescribed W.H.O. standards are presented in Table 2 (W.H.O. 1984). The comparison of estimated values of different parameters with W.H.O. standards indicated that river water is polluted with reference to all the parameters studied and water quality management is urgently needed in the study area.

Following regression equations were obtained through statistical regression analysis of data presented in Table 2, taking conductivity as dependent variable for all the eight data points of river water at Moradabad, India.

Conductivity =+0.005×Free CO_2-0.090 (5)
n = 8, r = 0.958, F = 28.726, S = 0.08

here, n = number of data points ; r = correlation coefficient ; F = variance ratio; S = standard error of estimate

Conductivity = +0.010×Calcium-0.805 (6)
n = 8, r = 0.915, F = 26.802, S = 0.08

Conductivity = +0.005×Total Hardness-0.303 (7)
n = 8, r = 0.907, F = 20.814, S = 0.12

Conductivity = -0.493×pH+3.761 (8)
n = 8, r = 0.903, F = 18.737, S = 0.11

Conductivity = +0.001×Total Solids+0.032 (9)
n = 8, r = 0.967, F = 79.971, S = 0.07

Conductivity=+0.001×TDS-0.007 (10)
n = 8, r = 0.998, F = 2688, S = 0.01

Conductivity = +0.002×TSS+0.310 (11)
n = 8, r = 0.827, F = 15.184, S = 0.14

Conductivity=+0.003×COD+0.008 (12)
n = 8, r = 0.946, F = 26.324, S = 0.09

Conductivity=-0.092×DissolvedOxygen+0.734 (13)
n = 8, r = 0.837, F = 13.764, S = 0.16

Conductivity = +0.007×BOD+0.407 (14)
n = 8, r = 0.828, F = 12.324, S = 0.16

Conductivity = +0.145×Fluoride+0.458 (15)
n = 8, r = 0.805, F = 10.391, S = 0.17

Conductivity = +0.030×Silica as SiO_2-0.158 (16)
n = 8, r = 0.972, F = 100.419, S = 0.06

Conductivity = +0.117×Phosphate+0.150 (17)
n=8, r = 0.965, F = 75.440, S = 0.07

Conductivity = +0.048×Sulphate+0.065 (18)
n = 8, r = 0.926, F = 20.821, S = 0.11

Table 1. A brief description of sampling sites

S.No.	Site No. & Name	Location of site	Apparent water quality	Noticed activities
1	**I, U/S River at Sirsa Manihar**	25 km West to Moradabad city	Objectionable odour, colour 450 units	Nil
2	**II, Bann river at Sirsa Manihar**	50 meter West to site no. I	Odourless, colorless, flora and fauna in good quantity	Occasional bathing and fishing
3	**III,D/S River at Sirsa Manihar**	50 meter East to site no.II	Objectionable odour and colour	Nil
4	**IV, River at Taiya-Moda**	6 km. North- East to site no. I	Odourless, colour 250 units	Nil
5	**V, River at Chaudharpur**	6 km. from Taiya-Moda,	Odourless, colour 400 units	Very occasional funeral

		site no. IV		activities
6	**VI, River at Malgadda**	8 km. West to Moradabad city	Odourless, colour 150 units	Receives agricultural run off
7	**VII, U/S River at Moradabad-Delhi bridge**	About 4.5 km. East to site no. VI	Appears contaminated	Sand digging, cattle bathing and laundering of clothes
8	**VIII, Mixed discharge at Moradabad-Delhi bridge**	50 meter East to site no. VII	Pungent smell of H2S, colour 420 units	Nil

Table 2. Site-wise estimated values of water quality physico-chemical parameters with their W.H.O. Standards

S. No.	Parameters	Site No.I	Site No.II	Site No.III	Site No.IV	Site No.V	Site No.VI	Site No.VII	Site No.VIII	W.H.O.Standards
1.	Conductivity(µS/cm)	0.880	0.071	0.685	0.825	0.691	0.713	0.448	0.360	0.300
2.	pH (ppm)	6.05	7.14	6.14	6.17	6.21	6.29	6.29	7.25	7.0-8.5
3.	Total Hardness (ppm)	216	98	164	194	180	176	156	212	100
4.	Calcium (ppm)	140	83	147	153	147	150	140	117	100
5.	Fluoride (ppm)	0.93	0.10	0.81	0.88	0.87	0.83	0.71	1.80	1.0
6.	Dissolved Oxygen (ppm)	0.0	6.4	2.6	0.0	0.0	0.0	0.0	4.0	5.0
7.	Biological Oxygen Demand (ppm)	24.0	4.8	25.0	25.5	28.5	23.0	25.0	45.0	6.0
8.	Chemical Oxygen Demand (ppm)	264	40	212	268	168	160	172	208	10
9.	Total Solids (ppm)	740	72	556	890	600	612	456	320	500
10.	Total Dissolved Solids (ppm)	590	50	480	580	484	478	314	252	500
11.	Total Suspended Solids (ppm)	150	22	76	310	116	134	142	68	-
12.	Free CO_2 (ppm)	140.8	48.4	132.0	143.2	123.2	129.8	121.0	160.6	10.0
13.	Silica as SiO_2(ppm)	35	7	30	28	27	28	22	18	-
14	Phosphate (ppm)	5.5	0.0	4.8	6.2	4.2	4.75	3.2	0.78	-
15	Sulphate (ppm)	16	2	12	13	10	10	9	14	200

Conductivity shows significant correlation with ten water quality parameters namely chemical oxygen demand, free CO_2, pH, Silica as SiO_2, phosphate, total hardness, calcium, total dissolved solids, total solids and sulphate concentration of water with value of regression coefficient, r more than 0.90 or near to 0.90 i.e. there is more than 90% association in data. This correlation coefficient measures the degree of association or correlation that exists between two variables, one taken as dependent variable. The greater the value of regression coefficient, the better is the fit and more useful the regression variables. The values of variance ratio, F are high and standard error of estimate, S is low and these are also necessary requirements for significant correlation. Moderately significant correlation of conductivity with other five parameters namely biological oxygen demand, dissolved oxygen, fluoride and total suspended solids of water is also noticed during the regression analysis.

4. Conclusion

On the basis of above discussion it may be concluded that conductivity is an important physico-chemical water quality parameter. Conductivity shows highly significant correlation with ten parameters out of fifteen parameters studied for all the eight data points. The parameters are: chemical oxygen demand, free CO_2, pH, Silica as SiO_2, phosphate, total hardness, calcium, total dissolved solids, total solids and sulphate concentration of water. The conductivity is also moderately correlated with other four parameter studied namely biological oxygen demand, dissolved oxygen, fluoride and total suspended solids of water. Since other parameters and their functions can be explained by using these conditions, utilization of such methodology will thus greatly facilitate the task of rapid monitoring of the status of pollution of water economically and this is the most important part of any pollution study to suggest some effective and economic way for water quality management. On the basis of present study it may be suggested confidently that the Gagan river water quality at Moradabad of study area can be checked effectively by controlling conductivity of water and this may also be applied to water quality management of other study areas.

Correspondence to:
Dr. Navneet Kumar
Assistant Professor
Department of Applied Science,
College of Engineering,
Teerthankar Mahaveer University,
Moradabad, Uttar Pradesh-244001, India
E-mail:navkchem@gmail.com

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