River Water Quality Management through Correlation Studies

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ABSTRACT

Adequate supply of fresh and clean drinking water is basic need for all human being on the earth. It is the duty of scientists to test the available water in any locality in and around any area. As a part of society it is a must. The resulting degradation of quality of water in water body creates a condition so that water can not be used for intended beneficial uses including bathing and recreation. The present study is aimed to suggest some effective measures for the river water quality management with correlation studies with the help of statistical regression analysis of ten data points of Gagan river water at Moradabad. 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. The analysis attempts to establish the nature of the relationship between the variables and thereby provides a mechanism for prediction or forecasting. To find an approach to water quality management through correlation studies between various water quality parameters, the statistical regression analysis for ten 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 an important water quality parameter and it is found to be significantly correlated with eleven parameters namely biological oxygen demand, chloride, free CO_2, chemical oxygen demand, pH, phosphate, sulphate, total hardness, total dissolved solids, total solids and total suspended solids out of fifteen water quality parameter studied and it is moderately correlated with other four parameters namely dissolved oxygen, fluoride, magnesium and silica. It may be suggested that Gagan river water quality at Moradabad can be checked effectively by controlling the conductivity of river water. Present study may be treated as one step towards management strategy for lakes.

INTRODUCTION

Adequate supply of fresh and clean drinking water is basic need for all human being on the earth. It is the duty of scientists to test the available water in any locality in and around any area. As a part of society it is a must. The resulting degradation of quality of water in water body creates a condition so that water can not be used for intended beneficial uses including bathing and recreation. The examination of water are necessary for the reasons : to assess its quality to provide a pure and wholesome water to the public for drinking and other purposes: to find out whether water is suitable for the specific industrial purpose, and if so, to choose the most effective treatment; to determine the extent of pollution and to suggest a possible remedy to determine the efficiency towards natural purification when sewage and industrial wastes are discharged into water courses; and to ascertain the effect of rain fall on water quality.

Water-borne diseases and water-caused health problems are mostly due to inadequate and incompetent management of water recourses. Safe water for all can only be assured when access, sustainability and equity can be guaranteed. Chemicals in water can be both naturally occurring or induced by human interference and can have serious effects. The present study is aimed to suggest some effective measures for the river water quality management with correlation studies with the help of statistical regression analysis of ten data points of Gagan river water at Moradabad (Khan, 2005; Madhuri, 2004; Ramamurthy, 2007).

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. 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 (Mulla, 2007, Draper, 1966, Snedecor, 1967; Kumar, 2005).

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.

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.

MATERIAL AND METHODS

Sixteen different water quality physico-chemical parameters including conductivity at ten different Gagan river water sites at Moradabad 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, turbidity, conductivity and fluoride, Century CP901 pH meter, Century nephelometer, 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.

Table 1 : Brief description of sampling sites

S.No.	No. and name of site	Location of site	Apparent water quality	Noticed activities
1	I,D/S River at Sirsa Manihar	50 meter East to site no.II	Objectionable odour and colour	Nil
2	II, River at Taiya-Moda	6 km. North- East to site no. I	Odourless, colour 250 units	Nil
3	III, River at Chaudharpur	6 km. from Taiya-Moda, site no. IV	Odourless, colour 400 units	Very occasional funeral activities
4	IV, River at Malgadda	8 km. West to Moradabad city	Odourless, colour 150 units	Receives agricultural run off
5	V, U/S River at Mbd-Dlh bridge	About 4.5 km. East to site no. VI	Appears contaminated	Sand digging, cattle bathing and laundering of clothes
6	VI, Mixed discharge at Mbd-Dlh bridge	50 meter East to site no. VII	Pungent smell of H_2S, colour 420 units	Nil
7	VII, U/S River at Mbd-Sambhal bridge	3.5 km. East to site no. IX	Not good	Occasional human and cattle activity
8	VIII, Mixed discharge at Mbd-Sambhal bridge	50 meter East to site no. X	Objectional pungent smell, colour 450 units	Nil
9	IX, D/S River at Mbd-Sambhal bridge	50 meter to mixing up of effluent of site no. XI	Objectionable odour	Nil
10	X, River at Seekandarpur-Patti	16 km. East to site no. X	Water quality appears better	Receives agricultural run off

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 –

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

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

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

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

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

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

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.

RESULTS AND DISCUSSION

Site-wise estimated values of sixteen 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 ten data points of river water at Moradabad, India.

Conductivity = +0.006´Biological Oxygen Demand+0.323 (5)
n = 10, r = 0.992, F = 526, S = 0.02

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

Conductivity = +0.008´Chloride+0.274 (6)
n = 10, r = 0.979, F = 191, S = 0.03

Conductivity =+0.004´CO_2+0.090 (7)
n = 10, r = 0.874, F = 26.037, S = 0.08

Conductivity=+0.002´Chemical Oxygen Demand+0.231 (8)
n = 10, r = 0.950, F = 74.897, S = 0.05

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

Sl. 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	Site No. IX	Site No. X	W.H.O. Standards
1.	Conductivity(μS/cm)	0.398	0.418	0.400	0.415	0.424	0.778	0.418	0.824	0.426	0.416	0.300
2.	pH	7.78	7.72	7.81	7.82	8.0	7.10	7.31	6.81	8.08	8.16	7.0-8.5
3	Chloride (ppm)	13	14	13	18	16	49	21	65	14	19	200
4.	Total Hardness (ppm)	150	158	150	150	158	210	166	204	150	148	100
5.	Magnesium (ppm)	37	28	17	47	11	83	36	74	50	35	30
6.	Dissolved Oxygen (ppm)	5.0	4.0	5.3	4.5	6.7	0	8.5	2.0	11.0	8.7	5.0
7.	Biological Oxygen Demand (ppm)	14.5	16.0	13.5	16.0	16.5	80.0	15.0	75.0	14.5	13.0	6.0
8.	Chemical Oxygen Demand (ppm)	108	100	80	72	60	260	92	220	80	72	10
9.	Total Solids (ppm)	338	432	398	418	418	658	444	824	422	432	500
10.	Total Dissolved Solids (ppm)	260	292	284	290	314	416	316	470	292	298	500
11.	Total Suspended Solids (ppm)	78	140	114	128	104	242	128	354	130	134	-
12.	Free CO_2 (ppm)	83.6	92.4	81.4	77.0	61.6	182.6	107.8	138.6	94.6	81.4	10.0

Conductivity = -0.034´Dissolved Oxygen+0.685 (9)
n = 10, r = 0.701, F = 7.645, S = 0.12

Conductivity = +0.001´Total Solids-0.023 (10)
n = 10, r = 0.965, F = 110, S = 0.04

Conductivity = +0.002´Total Dissolved Solids-0.283 (11)
n = 10, r = 0.971, F = 135, S = 0.04

Conductivity = +0.001´Total Suspended Solids+0.197 (12)
n = 10, r = 0.945, F = 68.049, S = 0.05

Conductivity = +0.286´Fluoride+0.271 (13)
n = 10, r = 0.653, F = 5.978, S = 0.13

Conductivity = +0.006´Magnesium+0.239 (14)
n = 10, r = 0.843, F = 19.651, S = 0.09

Conductivity = -0.309´pH+2.863 (15)
n = 10, r = 0.931, F = 18.957, S = 0.09

Conductivity = +0.069´Phosphate+0.323 (16)
n=10, r = 0.949, F = 73.117, S = 0.05

Conductivity = +0.031´Silica+0.162 (17)
n = 10, r = 0.892, F = 15.397, S = 0.10

Conductivity = +0.034´Sulphate+0.316 (18)
n = 10, r = 0.892, F = 30.357, S = 0.07

Conductivity = +0.006´Total Hardness-0.630 (19)
n = 10, r = 0.978, F = 112, S = 0.04

Critical and logical analysis of above regression equations reveal following facts regarding correlation studies among various physico-chemical parameters when conductivity is taken as a dependent variable.

Conductivity shows significant correlation with eleven water quality parameters namely biological oxygen demand, chloride, free CO_2, chemical oxygen demand, pH, phosphate, sulphate, total hardness, total dissolved solids, total solids and total suspended solids 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 four parameters namely dissolved oxygen, fluoride, magnesium and silica of water is also noticed during the regression analysis.

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 eleven parameters out of fifteen parameters studied for all the ten data points. The parameters are : biological oxygen demand, chloride, free CO_2, chemical oxygen demand, pH, phosphate, sulphate, total hardness, total dissolved solids, total solids and total suspended solids concentration of water. The conductivity is also moderately correlated with other four parameter studied namely dissolved oxygen, fluoride, magnesium and silica 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. Present study may be treated as one step ahead towards management strategy for lakes.

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