Correlation Analysis of Physico-chemical Parameters and Water Quality of Chambal River. A Case Study of Kota City

A. Jain, S. Jain, N. Nagar, P. Kachhawah[#], V. Devra
P.G. Department of Chemistry
J.D.B. Govt. Girls College, Kota-324001(Raj.)
[#]Aklank P.G. Girls College, Kota-324009 (Raj.)

***Abstract*— Today, water is one of the major issues confronting humanity and we are facing crises as regarding the quantity and quality of water supply. The escalation in the global population and the quest for continued development is leading to conflicting pressure on water resources. Such resources are the ultimate recipient of pollution from various socioeconomic activities associated with urbanization, agriculture, mining, etc. The present study of Chambal water pollution at industrial city, Kota is studied by keeping in view that treated and untreated city waste, which includes industrial effluents, human waste, solid waste etc., is ultimately added to the river Chambal. In this study identify the possible sources of water pollution and its extent by physico-chemical analysis of water samples, then assess the river water pollution and correlation among various parameters with relation to their sources and their levels is Chambal river.**

Keywords—Chambal River; polluted sources; Physico-chemical analysis; correlation analysis.

I. INTRODUCTION

Water is essential for the survival of living beings. But today this resource has been the most exploited natural system since man strode the earth. Due to rapid population growth, agricultural and industrial developments, the quality of water in river is being degraded continuously making it unsuitable for various uses. In India all major rivers basins are facing the threat of pollution from the disposal unguided and untreated municipal industrial waste water resulting in degradation of quality of water.

In India many studies highlighted the pollution problems of river water. These studies emphasized mainly on physico-chemical parameters or biological aspects of river [1-4]. Industrial, sewage and municipal waters are being continuously added to water reservoirs affect physico-chemical quality of water making them unfit for use of livestock and other organisms [5, 6]. Uncontrolled domestic waste water discharged into the river has resulted in eutrophication of river as evidence by substantial algae bloom, dissolved oxygen depletion in the subsurface water [7]. Several studies have been conducted so far, to evaluate the physico-chemical properties of various rivers in India [8-10]. So far as the water pollution studies of river Chambal is concerned, a superficial attempt has been analyze the physico-chemical characteristic of Chambal River [11, 12]. In the present study the various issues related to river water monitoring quality of assessment have been discussed for the Kota region of Rajasthan. Kota is the biggest industrial city of the Rajasthan in our country. It is situated (25^{o} $11^{'}$ N and 75^{o} $51^{'}$ E) on the eastern bank of river Chambal in the southern part of Rajasthan and with an elevation of 273 m above sea levels on the south east of Aravali ranges. It is the main source of water in many industries, like factories, thermal glass and chemical industries. All these industries polluted the river water as well as ground water. So the major source of pollution in Chambal River at Kota is industrial waste and untreated domestic discharges. According to WHO estimate about 80% of water pollution in developing country, like India is caused by domestic waste.

The present investigation has visualized the status of identification of major pollution sources of water physico-chemical analysis of water samples collected from different sampling stations. (Table-1)

TABLE-1 DISTANCE & DETAILS OF SAMPLE POINTS

Sampling Point	Place	Distance from Chambal River(km)
P 1	Near Chambal Garden	0
P 2	Near Thermal discharge point	2.7
P 3	Alania	25
P 4	Jagpura	15
P 5	Kansuwa	8
P 6	Chendrasel	26

The chief objectives of the present are study as follows:

1. Identification of major pollution sources of water.
2. Physico – chemical study of water samples collected from different sampling stations.
3. Correlation analysis of various parameters of different sources responsible for river water pollution.

II. SAMPLE COLLECTION AND METHODOLOGY

Selection of the sampling station on the basis of nature and amount of pollution added to the River Chambal. The respective samples physico-chemical studied of water are

collected from May 11 to April 12 in cleaned hard rubber and polythene bottles with double cap device. The water was collected up to brim of the bottle leaving no air gap to ensure the prevention of premature release of dissolved gases from the water. Sample analysis is done on the same day of its collection. The sample was analyzed as per standard methods [13]. All collected samples were regularly analyzed in the laboratory, the method used are indicated in parenthesis. For physical parameters - pH (glass electrode method), alkalinity (titration method), total hardness (EDTA method), Dissolve oxygen (Winkler's method), Biological oxygen demand (Dilution method), and chemical parameters – chloride (Argentometric method), sulphate (turbidmetric method), sodium & potassium(Flame photometer), calcium & magnesium (EDTA method, complexometric titration).

All solutions are prepared with double distilled water. Stock solutions of fluorides, chloride, iron, calcium, copper and magnesium containing 1000 ppm are used for preparation of the standards for the calibration curves to ascertain the accuracy of straight line person's correction coefficient is calculated. The values are found to 0.99.

III. RESULT AND DISCUSSION

The average value of physico-chemical analysis of polluted water samples collected from the 6 sites from Chambal River from Kota city in the month of May 11 to April 12. Mostly being alkaline through it has no direct effect on human health. Life processes depend on and are sensitive to the hydrogen ion concentration in the medium which depend on factors, like photosynthetic activity, rainfall, nature of materials involved, discharge of effluents sewage etc. The pH value of all sampling sites is relatively high in January and February and become low in monsoon and summer (Fig.1). The higher value during winter is an attributed to the increased production in aquatic ecosystem which utilized carbon from carbonate, sulphur from sulphate, and nitrogen from nitrate, phosphorous from phosphate converting them into hydroxyl ion with an increase in pH. The lower pH value during monsoon is due to high turbidity. High temperature in summer enhances the microbial activity, causing excessive production of CO_2 and reduction in pH. The permissible limit of pH in drinking water is within in 6.5 to 8.5 is according to IS: 10500 (BIS, 1991). The value of pH in all sites is within the permissible range.

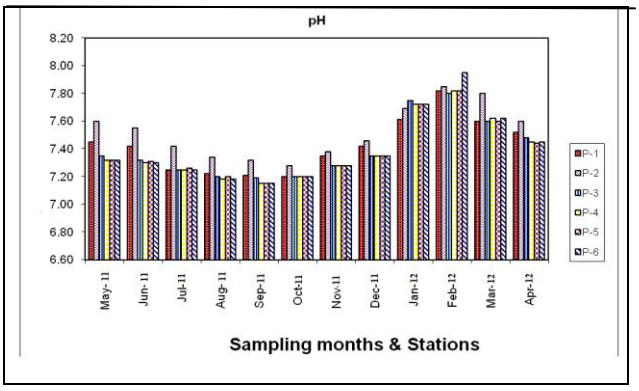

Fig: 1 Sampling months and Stations

The temperature of river water reaches maximum up to 34°c in summer and low as 20°c in winter. The wind velocity is comparatively high during summer and pre monsoon period. The relative humidity was lowest in the month of April and highest during July to September.

Turbidity in water is caused by suspended matter, such as clay, slit, finely divided organic and inorganic matter, soluble colored organic compounds and plankton and other microscopic etc. The turbidity values decreases rapidly on aging and by the end of monsoon (Fig. 2). The muddy color of River water disappears and turbidity decreases.

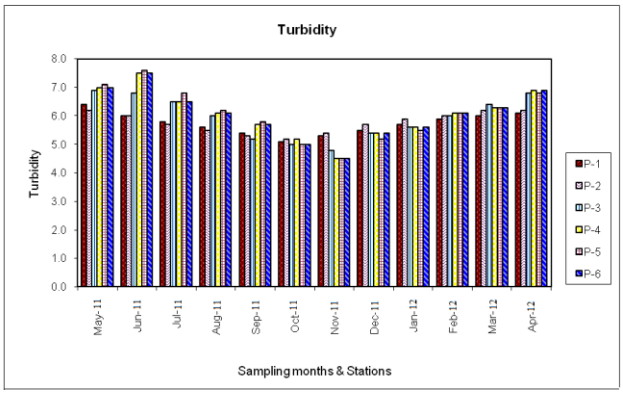

Fig: 2 Sampling months and Stations

During the monsoon, the process of photosynthesis is comparatively inhibited and no microscopic plant life is found even on the surface of the river. The reduction of solar ray penetration during monsoon causes lowering pH and dissolves oxygen. Free ammonia, silica and bacteriological counts give a positive correlation, where as sulphate, phosphate and chloride show inverse relationship with respect to turbidity.

The conductivity is a numerical expression of the ability of an aqueous solution to carry an electrical current. The electrical conductivity varied from 500 – 1800 µmhos/cm. chemically pure water does not conduct electricity. Any rise in the electrical conductivity of water indicated pollution.

Water hardness was understood to be a measuring of the capacity of water to precipitate soap. The total hardness was found in the range of 140 – 500 mg/l in all six sites (Fig. 3). The mineralization of the river is maximum in summer resulting in considerable increase in calcium, magnesium, sulphate, phosphate, chloride and other ionic concentration. The total effect of increased anionic and cationic concentration in river is reelected in terms of increase in hardness and alkalinity values. The alkalinity values of all sample sites in due to bicarbonate contraction calculated in terms of calcium carbonate. The average hardness and alkalinity of sampling sites are (140-650 mg/l and 150 – 350 mg/l) respectively. The hardness of river is maximum in summer and minimum in monsoon due to frequent flooding in the raining season which washes away the mineral contributing hardness. The hardness and alkalinity of river in all sampling sites is within the permissible range.

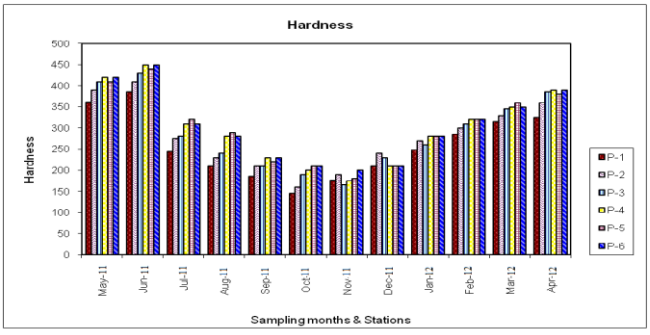

Fig: 3 Sampling months and stations

Solids refer to matter suspended or dissolved in water or wastewater. Solids may affect water or effluent quality adversely in a number of ways. Water with high dissolved solids generally is at inferior water. The values of total dissolved solids of the study area range from 400 – 1200 mg/l.

In portable water the salty taste produced by chloride concentration is variable and dependent on the chemical composition of water. Some water containing 25 mg/l may have a detectable salty taste if the cation is sodium. The chloride was found in the range of 23 – 80 mg/l in all six sampling sites. Chloride in drinking water is within 250 mg/l as per IS: 10500 (BIS 1991). High concentration of chloride reported to give an undesirable taste to water.

Nitrate concentrations are varied from 6.0 to 25.0 mg/l, which is above WHO limit [14]. Nitrates generally owe their origin mainly to anthropogenic sources. The high value of nitrates in water samples may be attributed to the presence of garbage in vicinity of water sources and excessive use of nitrogenous fertilizers in agriculture sector.

Dissolved oxygen is an important water quality parameter in assessing water pollution. Oxygen is fixed water either due to the direct dissolution from the atmosphere or a result of primary production. Organic decomposition depletes the level of dissolve oxygen. The D.O. ranges from 4.0 – 7.0 (Fig. 4). The maximum value of DO may be due to release of water from siphon and due to photosynthetic process in aquatic ecosystem. The decrease in D.O may be attributed to pollution due to domestic and agricultural waste. The depletion of oxygen content leads to undesirable obnoxious odors under anaerobic conditions. The biological oxygen demand (BOD) values varied from 4.2 - 6.5. The BOD values clearly indicate pollution, which may be attributed to the maximum biological activity. The concentration of oxygen demand (COD) steadily increased as a result of gradual addition of inorganic and contaminates. The Chambal receives effluent from thermal power plant and chemical industries etc.

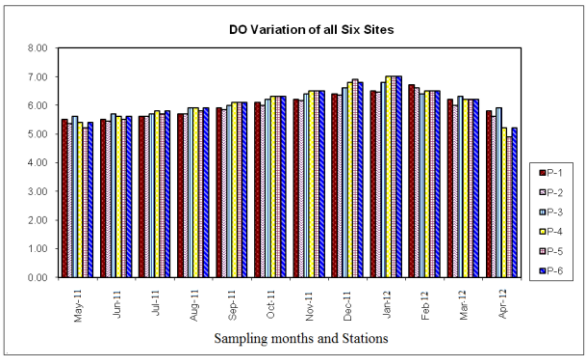

Fig. 4. Sampling months and stations

The Sulphate was also within the prescribed limits, that is 200 mg/l (ICMR) in all sites. The high sulphate content at site 2 is caused by discharge of sulphuric acid and salts from thermal power plant.

The fluoride concentration of the river and its tributaries is almost uniform, ranging from 0.6 – 1.5 ppm. This is well within the tolerance limit for human consumption. Fluoride concentration less than 1 ppm produces dental caries and more than 1.5 ppm causes fluorosis.

Calcium & magnesium were high from the prescribed limit (75 mg/l for ca and 30 mg/l for mg prescribed by ISI). The discharge of sewage and sludge cause an increase in magnesium, while complex, chemicals discharge from the thermal power plant in the river is likely to have increased the calcium and resultant hardness.

The elements with atomic number greater than 20, excluding alkali metals, alkaline earth, lanthanides and actinides are termed as heavy metals. All the heavy metals are highly toxic and present in very small concentration. Therefore these are called trace element. The metals like Pb, Hg, Cr and Cd have been identified as most hazardous pollutants, owing to their tendency to accumulate in food chain through which they ultimately reach human system some of these heavy metals are needed to be essentially present in water at optimum concentration to ensure good health.

The present study showed that lead, zinc, iron, copper, cadmium & nickel were below the permissible limit.

IV. CORRELATION BETWEEN WATER QUALITY PARAMETERS

The dependability of water quality parameter on each other in the samples of water collected from the above sampling sites was determined by regression analysis by determining correlation coefficient of the various parameters investigated. The study of the above results gives an idea of the bearing a single parameter determined has relation on other parameters. These correlation coefficient values are helpful in calculating the concentration of water quality of the parameters of the water samples with the help of equation representing linearity

$$Y = Ax + B \quad (1)$$

The relation is valid between the parameters when their correlation co-efficient is real equal to one. Such dependency between the parameters was found to exist between a numbers of parameter determined as is obvious from the correlation co-efficient values given in (Table-2). Highly significant and positive correlation has been observed between TDS-Ca(r =0.804), TDS – alkalinity (r =0.889), TDS–Ec (r =1). This suggests that the presence of calcium, alkalinity, and conductivity in the study sites greatly influences the TDS and conductivity. Turbidity–pH (r =0.859) Ca-Ec (r =0.803), Alkalinity-Ec (r =0.889) were positively and significantly correlated. The significant correlation of Electric conductivity, TDS with hardness, SO_4^{2-}, Ca^{+2} and mg^{2+} indicate the presence of sulphate of calcium and magnesium.

Table-2 Correlation between different water parameters.

Table - 2

Parameters	pH	Turbidity	TDS	Hardness	Ca	Mg	BOD	DO
pH	1	0.859	0.318	-0.010	0.391	0.522	-0.086	0.474
Turbidity		1	0.391	0.260	0.374	0.265	-0.223	0.416
TDS			1	0.447	0.804	0.409	-0.174	-0.272
Hardness				1	0.804	0.758	-0.535	-0.142
Ca					1	0.508	-0.428	0.036
Mg						1	-0.269	0.385
BOD							1	0.443
DO								1

Table - 2 (continue)

Parameters	COD	Alakalinity	Conductivity	Chloride	Iron	Sulphate	Lead	Fluoride
pH	-0.049	0.004	0.318	-0.397	-0.055	0.128	0.272	-0.145
Turbidity	-0.134	0.134	0.391	0.415	0.052	-0.037	0.051	-0.108
TDS	0.221	0.889	1.0	-0.166	-0.056	-0.189	-0.013	-0.176
Hardness	0.277	0.444	0.447	0.312	0.207	-0.607	-0.268	0.434
Ca	0.204	0.711	0.803	0.027	0.257	-0.410	-0.004	0.101
Mg	0.383	0.176	0.265	0.442	0.227	-0.669	-0.096	0.669
BOD	-0.168	-0.348	-0.223	-0.117	-0.247	0.605	-0.689	-0.220
DO	0.284	0.4	0.4	-0.272	-0.5	0.409	0.1	-0.24
COD	1	0.125	0.221	0.390	-0.263	-0.682	-0.002	0.096
Alkalinity		1	0.889	0.306	-0.130	-0.113	-0.202	-0.057
Conductivity			1	-0.166	-0.055	-0.189	-0.013	-0.176
Chloride				1	-0.028	-0.425	0.062	0.709
Iron					1	-0.213	0.028	0.450
Sulphate						1	0.301	-0.509
Lead							1	-0.021
Fluoride								1

V. CONCLUSION

The value of physico-chemical parameters indicates that the quality of water of sampling sites of the district is slight to increase to permissible rating of pollution. Therefore necessary water treatment is recommended before using water for drinking purpose. Due to the growing urbanization and population, a natural resource of Chambal River is getting exploited. All the domestic sewage and industrial effluents are being dumped into the river. The correlation coefficient values are helpful in calculating the concentration of water quality of the parameters of the water samples. Activated carbon filtration, distillation, ion exchange reverse osmosis, ultraviolet radiations etc are some technique that can be applied to raise the quality of water.

REFERENCES

[1] B.B. Ghose and A.K. Basu, "Observation on estuarine pollution of the Hooghly by the effluents from a chemical factory complex at Reshasa, West Bengal," Env. Health, vol. 10, pp. 209-218, 1968.

[2] S. Gupta and D.N. Shukla, "Physico-chemical analysis of sewage water and its effect on seed germination and seedling growth of *Sesamum indicum*," J. Nat. Res. Develpoment, vol. 1, pp. 15-19, 2006.

[3] B.D. Patil and R.V. Tijare, "Studies on water quality of Godchiroli lake," Poll. Res., vol. 20, pp. 257-259, 2001.

[4] R.P. Singh and P. Mathur, "Investigation of variations in physico-chemical characteristics of a fresh water reservoir of Ajmer city, Rajasthan," Ind. J. Env. Sci., vol. 9, pp. 57-61, 2005.

[5] B.K. Dwivedi and G.C. Pandey, "Physico-chemical factors and algal diversity of two ponds(Girija Kund and Maqubara Pond), Faizabad," Poll. Res., vol. 21, pp. 361-370, 2002.

[6] M. Chaurasia and G.C. Pandey, "Study of physico-chemical characteristics of some water ponds of Ayodhya-Faizabad," Indian J. of Environ. Protection, vol. 27(11), pp. 1019-1023, 2007.

[7] A.K. Pandey and G.C. Pandey, "physico-chemical characteristics of city sewage discharge into river Saryu at Faizabad-Ayodhya," Him. J. Env. Zool., vol. 17, pp. 85-91, 2003.

[8] G. Dayal, "Groundwater quality of rural and urban settlements of Agra," J. Nat. Con., vol. 4, pp 89-93, 1992.

[9] A.K. Hazarika and A. Dutta, "Ecology of Jongal Balahu Garh (Min Pam), A historical pond of Central Assam (Nagoon)," J. Natcon, vol. 11, pp. 111-120, 1999.

[10] B. Padmanabha and S.L. Belagali, "Comparative study on the water quality index of 4 lakes in the Mysore city," Indian J. Env. Prot., vol.25, pp. 873-876, 2005.

[11] S.K. Agarwal, "Ecology of Chambal river at Kota," Acta Ecologia, vol. 8, pp. 13-19, 1986.

[12] S.P. Mathur, and N. Maheshwari, "Water quality and environment in and around industrialized city of Kota," Indian J. Env. Prot., vol. 20 (10), pp. 917-922, 2006.

[13] APHA, "Standard methods for the examination of water and waste water," American Public Health Association, Washington DC. vol. 20, 1995.

[14] WHO, Guideline for drinking water quality, Recommendation World Health Organization, Geneva. Vol. 1, 1984.