RJC
http://www.rasayanjournal.com

RASĀYAN *J. Chem.*
Vol.4, No.2 (2011), 686-692
ISSN: 0974-1496
CODEN: RJCABP

PHYSICO-CHEMICAL ASSESSMENT OF WATER QUALITY OF RIVER CHAMBAL IN KOTA CITY AREA OF RAJASTHAN STATE (INDIA)

Nitin Gupta, S.M.Nafees, M.K.Jain* and S. Kalpana
Environmental Chemistry Laboratory,
P.G. Department of Chemistry, Govt. College, Kota, Rajasthan
*E-mail: mkjres2008@gmail.com

ABSTRACT

Over the past several years deterioration in water quality has gradually rendered the Chambal River water unsuitable for various beneficial purposes and to maintain and restore the wholesomeness of river water in terms of its ecological sustainability is the logical necessity of today. The River Chambal passes through the Kota City, an industrial and educational town of Rajasthan state and due to various anthropogenic activities its water gets contaminated in the area. Although the self purification characteristics of river reduce pollutants at measurable extent but undesired substances adds to the water at proportionally higher rate and exerts impact on physicochemistry of water making it unsafe for intended purpose. Being the problem concerned with everyone's health it was considered worthwhile to carryout physicochemical study by determining various parameters for water quality of River Chambal along with Kota City area during pre-monsoon seasons of the years 2007 to 2009 and indicated its suitability for intended purpose. The overall water quality of River Chambal was observed moderately polluted in City area in pre-monsoon period.

Keywords: Water quality**,** physicochemical parameters, self purification.

INTRODUCTION

Rivers play a major role in integrating and organizing the landscape, and moulding the ecological setting of a basin. They are the prime factors controlling the global water cycle and in the hydrologic cycle, they are the most dynamic agents of transport[2]. People along the river use water for many purposes. However, the surface water quality is deteriorating due to anthropogenic activities, industrialization, farming activities, transportation, urbanization, animal and human excretions and domestic wastes[6]. Variation in the quality and quantity of river water due to natural and anthropogenic activities is widely studied in the case of several world rivers. Riedel et al.[11] examined the spatio-temporal variation in trace elements in Patuxent river, Maryland, while Sileika et al.[15] reported the variations in nutrient level in the Nemunas river of Russia. Schaefer and Alber[14] studied nitrogen and phosphorus in Altamaha river, Georgia, while Quadir et al.[10] studied the Nullah Aik, a tributary of the river Chenab. Gupta and Chakrapani[4] studied the Narmada river basin; Kannel et al.[7] the river Bagmati, and Sundaray et al.[21] the Mahanadi basin. Among Indian rivers, those flowing through the Indo- Gangetic Plains are the most studied. Subramanian[20] documented inconsistent down-stream variations in river water chemistry. Singh and Singh[18], and Mukherjee et al.[8] documented the physical, chemical and biological aspects of the Ganga river. Heavy metals such as Cr, Mn, Fe, Co, Ni, Cu, Zn, and Pb in the sediments of the Ganga river basin have been analysed[9,19]. There are several studies on the tributaries of the Ganges, including the rivers Yamuna[13,16], Gomti[3,17] and Hindon[6] documenting different physico-chemical aspects.

The present study focuses on the river Chambal that flows through heart of the Kota City, one of the prominent industrial and educational town of Rajasthan state in India, catering to the needs of several millions of people. The river is currently facing tremendous pressure due to encroachments, discharge of untreated domestic and industrial waste, dumping of solid waste and illegal diversion of water. However, the river remains less examined with regard to important base-line information. This paper focuses on the

present pollution status of river Chambal which is determined by analyzing few of the physicochemical parameters given in Table -3.

EXPERIMENTAL

Study area: Kota City

The district Kota (Fig.-1) lies between 24°25' and 25°51' North latitudes and 75°31' and 77°26' East longitudes with total area of 5767.97 Sq Kms. "Kota City" is located at extreme South of it at 25°11' North latitude and 75°51' East longitude occupying total area of 238.59 Sq Kms with average height 253.30 meters from sea level. The district Kota ends with boundaries of Sawai Madhopur, Bundi and Tonk district in North West, Chittorgarh in West, Jhalawar in South and Baran in East.

The city has extreme climate. Temperature varies between 6°C – 48°C; the average rain fall is about 880 mm and humidity annually ranges from 8 – 88%. Summers are full of dust storms. Wind velocity varies from 2 to 22 Km/hour. According to 2001 census total population of district was 1568525, which according to a survey in 2005-06 became 1748592. Kota is a prime industrial town of Rajasthan with historical importance of its own. In last decade, Kota city has emerged as "educational city" of India mainly because of its excellence in coaching for entrance examination of national and state level technological institutes for engineering and medical courses. Kota's name is also well known for its "Kota sarees", "Kota stone" and now for Kota's Kachouri and Namkeens. It is well connected with all major cities of India by broad gauge railway system. National highway 12 Jaipur to Jabalpur and 76 Shivpuri to Pindwara passes through the city.

Geomorphologically Kota City situated in Northan part of Malwa Plateau. The only perennial river "Chambal" originating from the hills of Western Madhya Pradesh passes through the district.

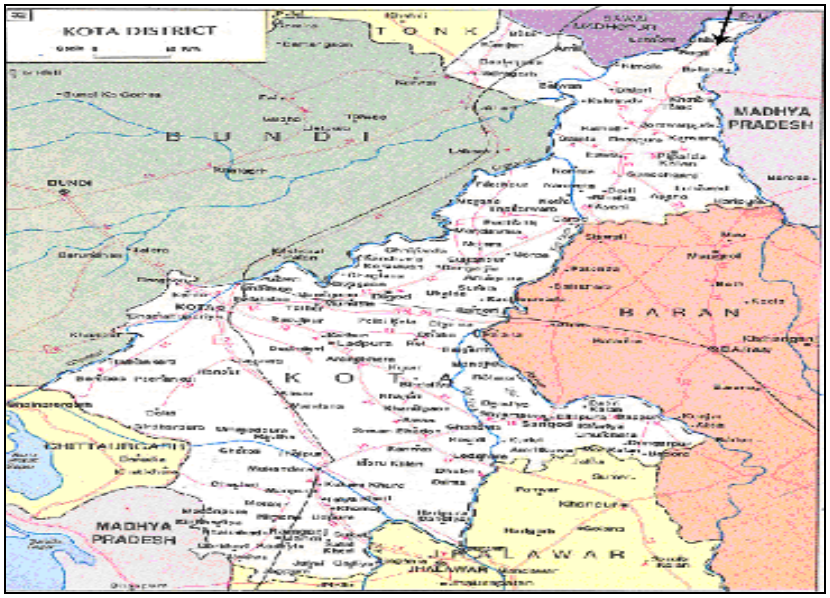

Fig.-1: Kota, the study area

Chambal River

Old mythological name of this large river is Charmanyawati. River Chambal, a principle tributary of River Yamuna, originates in the Vindhyan ranges from Manpur near Mhow in Indore district of Madhya Pradesh at East longitudes 73°20' and North latitudes 22°27' at an elevation of 354 meter from sea level. It enters Rajasthan near Chourasigarh & flow through Kota, Sawai Madhopur, and Dholpur Districts over a length of 376 Km. Chambal finally enters in Uttar Pradesh and meets Yamuna river.

Chambal River like most rivers in India plays an integral role in the lives of thousands of communities living along the banks of the river. Kota City is located at the bank of river. River Chambal flow across the Kota city. Chambal River water is used for irrigational, drinking, domestic and industrial

purpose by the localities.

Garbage & Polluted water of entire Kota city is being dumped in the Chambal River in the absence a proper sewage system. The Rajasthan Urban Infrastructure Development Project (RUIDP) is given the responsibility of Chambal River water purification project costing Rs. 209.90 crores. The central government will bear 70% of the cost & the state government shall give the remaining amount.

The main stress in the project has been given on changing the existing sewerage system to avoid water pollution in Chambal River. Two sewerage treatment plants in operation at Dhakadkhedi & Balita Village and few more plants have to be installed to keep the water of the Chambal River clean. The polluted water of the city will be carried to these water treatment plants through sewerage pipelines for treatment and the treated water will be delivered to near by agricultural fields.

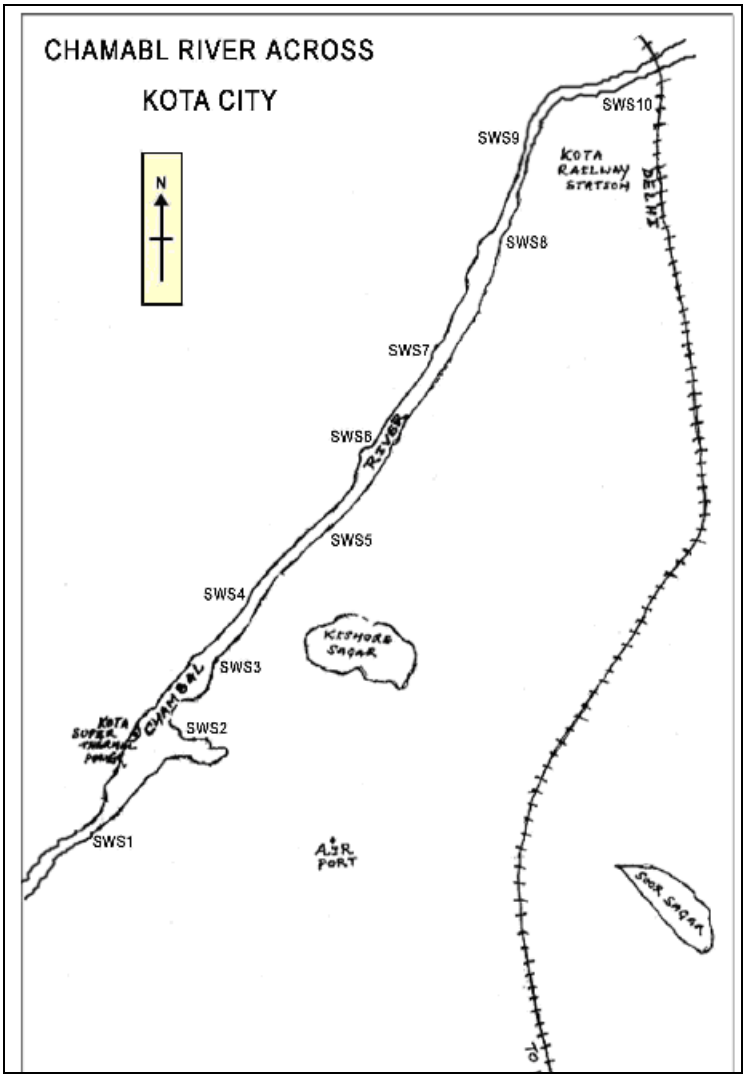

Fig.-2: Sampling locations at Chambal river

Sampling techniques and analysis

For this purpose ten locations and four points at each location were chosen along the river Chambal in Kota City, Kota. Samples were collected in sterilized polypropylene bottles using standard procedure of grab or catch as per the methods of APHA (1995) in pre-monsoon season of the years 2007 -

2009. Sampling locations and respective sampling coding is shown in Table-1. Physicochemical parameters such as pH, conductivity, temperature, turbidity, total dissolved solids, total hardness, calcium hardness, magnesium hardness, chloride, total alkalinity, ammonia, sulphate, nitrate, fluoride, sodium, potassium, dissolved oxygen, chemical oxygen demand, biological oxygen demand and iron were selected and estimated quantitatively as per standard methods & procedures of APHA (1995). All the chemicals used were of AR grade used for this purpose. Details of the analysis methods are summarized in Table -2.

Table-1: Sampling locations on River Chambal in Kota City Area

S.No.	Location	Sample Code
1	Near Chambal Garden	SWS 1
2	Near Kota Barrage	SWS 2
3	Near cremational Center	SWS 3
4	Near Chhoti Samadh Mandir	SWS 4
5	Near Nayapura Bridge	SWS 5
6	Near Brijraj Place	SWS 6
7	Near Ganwadi	SWS 7
8	Near Balita	SWS 8
9	Near Bhadana	SWS 9
10	Near Railway Station Bridge	SWS 10

Table-2: Parameters and methods employed in the physicochemical examination of water samples

S.No.	Parameters of water analysis	Method employed
1	pH	Potentiometric
2	Tempeature (^oC)	Thermometric
3	Conductivity (µS/cm)	Potentiometric
4	Turbidity (NTU)	Nephelometric
5	Total Dissolved Solids	Gravimetric
6	Total Alkalinity (as $CaCO_3$)	Titrimetric
7	Total Hardness (as $CaCO_3$)	Titrimetric
8	Calcium Hardness (as $CaCO_3$)	Titrimetric
9	Magnesium Hardness (as $CaCO_3$)	Titrimetric
10	Chloride (as Cl^-)	Titrimetric
11	Nitrate (as $NO3^-$)	Spectrophotometric
12	Sulphate (as SO_4^{2-})	Spectrophotometric
13	Fluoride (as F^-)	Ion Selective electrodes
14	Sodium (as Na^+)	Flame Photometric
15	Potassium (as K^+)	Flame Photometric
16	Iron (as Fe^{2+})	Spectrophotometric
17	Total Ammonia (as NH_3)	Spectrophotometric
18	Dissolved Oxygen (as O_2)	Titrimetric
19	Chemical Oxygen Demand (as O_2)	Titrimetric
20	Biochemical Oxygen Demand (asO_2)	Titrimetric

Table-3: Average values of Physico-chemical parameters of Chambal River water along with Kota City during , Pre-monsoon season of years 2006 – 2008

S.No	Parameter	Sample Code									
		SWS 1	SWS 2	SWS 3	SWS 4	SWS 5	SWS 6	SWS 7	SWS 8	SWS 9	SWS 10
1	pH	8.10	8.25	7.90	7.65	7.50	7.75	7.80	7.95	7.80	8.10
2	Tempeature (^oC)	30	33	32	32	31	32	31	31	33	31

3	Conductivity (µS/cm)	298	348	312	304	328	336	286	314	304	320
4	Turbidity (NTU)	5.1	4.8	6.2	3.9	5.7	8.2	6.3	7.1	4.7	6.8
5	Total Dissolved Solids (mg/L)	188	219	197	192	207	212	180	198	192	202
6	Total Alkalinity (mg/L)	130	148	126	118	112	124	128	130	126	136
7	Total Hardness (mg/L)	134	146	138	140	142	140	140	136	132	134
8	Calcium Hardness (mg/L)	92	102	96	88	94	98	92	86	90	84
9	Magnesium Hardness (mg/L)	42	44	42	52	48	42	48	50	42	50
10	Chloride (mg/L)	15.2	18.9	16.2	16.7	17.3	14.9	15.6	17.3	16.2	18.9
11	Nitrate (mg/L)	10.6	17.9	23.7	28.8	26.4	34.7	29.7	36.5	31.4	29.6
12	Sulphate (mg/L)	13.4	16.4	20.2	18.8	24.9	23.8	22.2	18.8	26.4	24.9
13	Fluoride (mg/L)	0.25	0.31	0.26	0.29	0.38	0.31	0.27	0.49	0.41	0.44
14	Sodium (mg/L)	16.7	25.8	22.2	18.8	17.8	25.3	24.8	29.3	30.2	34.6
15	Potassium (mg/L)	2.6	3.1	2.8	3.8	3.1	2.7	2.9	3.8	2.6	3.4
16	Iron (mg/L)	0.13	0.17	0.11	0.14	0.18	0.13	0.15	0.12	0.11	0.13
17	Total Ammonia (mg/L)	0.12	0.35	0.49	0.63	0.52	0.75	0.64	0.55	0.65	0.42
18	Dissolved Oxygen (mg/L)	6.1	5.7	5.3	4.9	5.1	4.6	4.3	4.8	5.3	5.5
19	Chemical Oxygen Demand (mg/L)	7.4	13.8	16.7	22.5	36.4	26.4	38.8	26.4	32.4	28.8
20	Biochemical Oxygen Demand (mg/L)	1.2	2.0	3.4	6.4	8.8	7.2	12.2	8.4	11.2	10.6

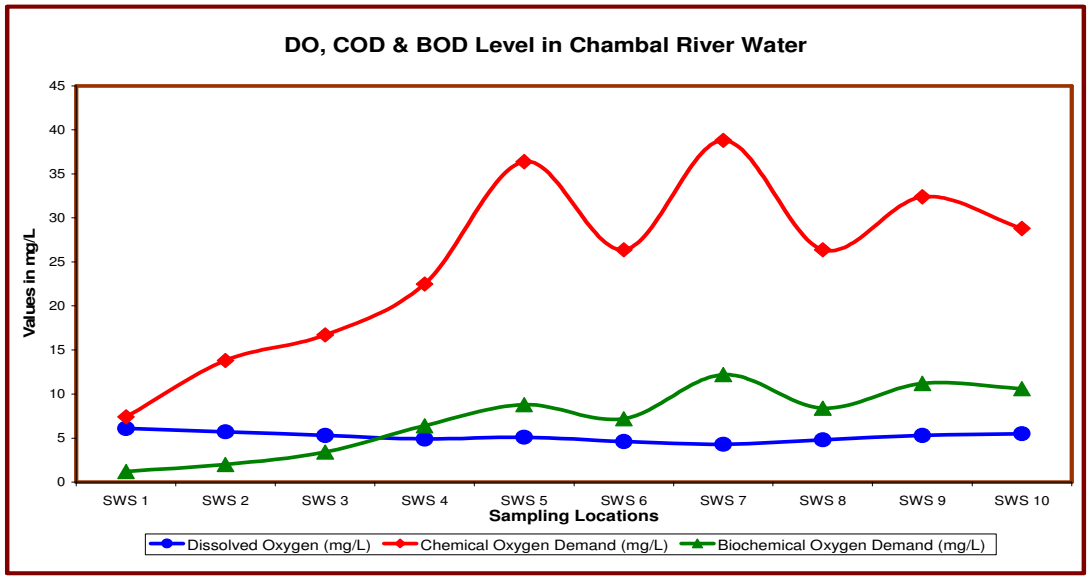

Fig.-3

RESULTS AND DISCUSSION

The physicochemical characteristics of surface water samples obtained from ten sampling locations of river Chambal along Kota City, Kota during pre-monsoon season of years 2007-2009 are shown in Table-3.

The pH value of all the water samples analysed in pre-monsoon season were in acceptable limit and the average value of three years analysis was varied from 7.50 to 8.25. The permissible limit of pH

value of drinking water is specified as 6.5 to 8.5. Temperature of river water in pre-monsoon season ranged from 30°C to 33°C Conductance ranged from 286 µS to 348 µS. The temperature and conductance do not affect water quality used for drinking purpose.

Turbidity ranged from 3.9 to 8.2 NTU. Turbidity is due to colloidal and extremely fine dispersion. Suspended matters such as clay also contribute to turbidity. Particles dispersed due to solid waste disposal also contribute to turbidity. The values of Total Dissolved Solids were ranged from 180 to 219 mg/L. Total alkalinity in all the samples was varied from 112 to 148 mg/L showing the alkaline nature of river water. According to IS 10500 the maximum permissible limit of alkalinity for drinking water is 200 mg/L.

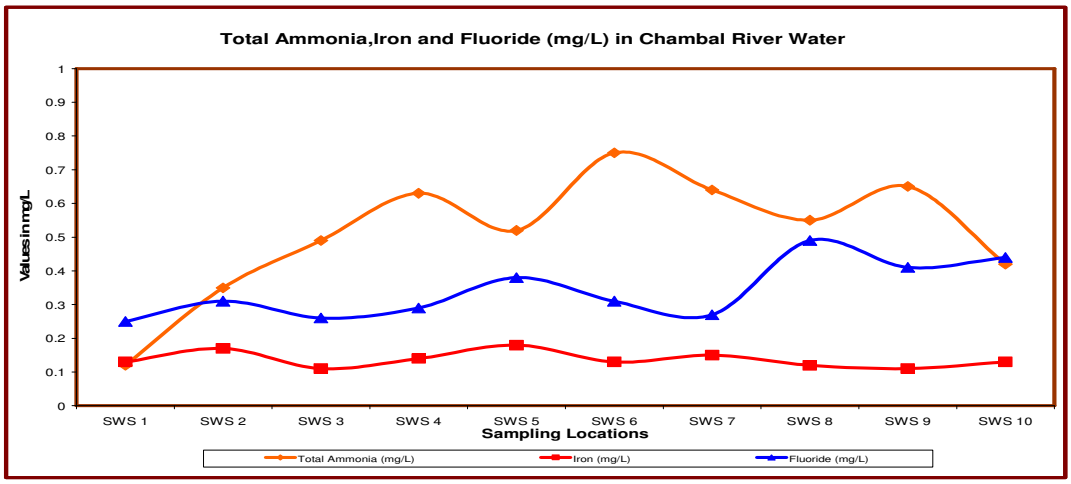

Fig.-4

Total hardness in study area was ranged from 132 – 146 mg/L. The calcium hardness observed a maximum value of 102 mg/L and minimum value of 84 mg/L. Magnesium hardness observed a maximum value of 52 mg/L and a minimum of 42 mg/L. The higher values of hardness in pre-monsoon season were due to presence of high dissolved minerals usually of calcium and magnesium.

Chloride imparts a salty taste and some times higher concentration causes laxative effect in human beings. The chloride concentration was ranged from 14.9 to 18.9 mg/L. The values observed are within the specified limit of 250 mg/L as per IS 10500. Nitrate ion concentration is very important in drinking water because if it exceeds 45 mg/L it causes blue babies (methamoglobinemia) in children. The values in the study area were ranged from 10.6 to 36.5 mg/L. Organic pollution is observed to cause increase the nitrate content.

The sulphate ion is one of the important anion present in natural water produce cathartic effect upon human beings when it is present in excess. The value ranged from 13.4 to 26.4 mg/L. The higher values of sulphate content may be contributed due to bio chemical, anthropogenic sources and industrial process etc. The fluoride ion concentrations in the study were within the specified limit and ranged from 0.25 to 0.49 mg/L.

Sodium concentration in all the analyzed samples in pre-monsoon season was varied from 16.7 to 34.6 mg/L. Slightly high concentration in surface water of river was may be due to addition of untreated industrial and domestic waste. Generally potassium concentration in natural water is very low but due to pollution concentration may increase to a measurable extent. In present investigation potassium concentration was ranged from 2.6 to 3.8 mg/L.

Iron ion concentration was ranged from 0.11 to 0.18 mg/L in the studied samples. Iron ion concentration in natural water is very low. In present study iron contamination in river water may be due to industrial effluent and automobile activities performed on the bank of river.

Presence of ammonia in water is a significant indication of pollution due to untreated domestic, industrial and sewage effluents. In present investigation ammonia content in water samples was varied from 0.12 to 0.75 mg/L, which indicate that water is moderately polluted.

Dissolved oxygen in river samples was varied from 4.30 to 6.10mg/L. Comparative low dissolved oxygen content indicate the mild pollution of river water due to organic waste. Chemical oxygen demand was ranged from 7.40 to 38.80 mg/L. High values of COD at some location indicate that river water was highly contaminated with chemically oxidisable inorganic and organic substances. Values of biological oxygen demand which is a indicator of bi-oxidisable organic substances was varied from 1.20 to 12.20 mg/L. Observed values clearly indicate that river water is moderately polluted by organic wastes.

CONCLUSION

Analyzed data clearly reveals that at some places river water is highly polluted but overall river water along Kota City area is moderately polluted by organic as well as inorganic substances. This is happened due to disposal of untreated domestic and sewerage effluents in river directly through so many drains from city area. It was also observed at some locations solid waste also dumped in river making conditions worse. To sustain the river water quality for intended purpose, the diversion of local drains which carry effluents from various sources from city area has to be made possible. Presently two STPs are in operation, few more STPs have to be installed for this holy purpose.

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[RJC-705/2011]