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Investigations on Water Pollution in Kota Barrage Waters based upon Physico-Chemical Characteristics

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ABSTRACT: Water is the essence of life on earth and totally dominates the chemical composition of all organisms. Plentiful supply of water of desired quality is basic to a country's existence and economy. However, the economic development propelled by industrial revolution and green revolution has caused pollution in the water bodies. Disposal of municipal waste into water bodies particularly into rivers is a major concern for water security. Chambal river is the primary source for supply of drinking water to Kota city and some other parts of Rajasthan. Several studies have pointed out existence of deadly pollutants in the Chambal River. Kota Barrage is on the Chambal river and is situated in Kota. Drinking water to Kota city is supplied by filtering water taken from the barrage. In this paper, we present study of pollution in the Kota Barrage from September 2009 to August 2010. For the study, physico-chemical characteristics of barrage water at upstream and downstream have been investigated at four sampling sites. Our study found higher level of pollution in the downstream in comparison to upstream waters. This may be due to higher level of (i) anthropogenic activities, (ii) dumping of solid waste, and (iii) discharge of waste water into downstream as compared to into upstream waters.

KEYWORDS: Physico-chemical characteristics, Kota barrage, Chambal, Water Pollution

I. INTRODUCTION

Water is an integral constituent of life and also one of the most important natural resource. Water, apart from human consumption, is also required for agriculture and industrial activities. In spite of two third of the earth being occupied by water bodies, only 0.31% is present as fresh water for human beings, plants and animals to share. This fresh water wealth is distributed in lakes, rivers, as ground water, as soil moisture and in atmosphere.

There are 67,429 water bodies in India, covering about 4.1 million hectares. Out of these 2175 are natural, covering about 1.5 million hectares and 65,254 are manmade occupying about 2.6 million hectares [1].

Life in an aquatic ecosystem directly or indirectly depends on water quality. Alteration in physico-chemical characteristics of water affects the biota in terms of number and diversity. Presently, most of the aquatic ecosystems of the world receive millions of liters of sewage, industrial and agricultural effluents. These effluents contain materials from simple nutrients to highly toxic substances. Changes in the aquatic environment accompanying anthropogenic pollution are of growing concern and require monitoring of surface water. Lentic water bodies are of great significance for they are sources of recharging the underground water used for irrigation, drinking, and domestic use. Quality of water of surrounding water bodies acquires paramount importance for the health and the economy of the people in the catchment area.

All aquatic systems consist of interdependent abiotic and biotic components. Abiotic components consist of the environment and nature of water i.e. the mineral component in dissolved state and other physico-chemical characteristics such as pH, dissolved oxygen, alkalinity, hardness, chloride, nitrate, sulphate etc. Abiotic factors make up the basic environmental structure of aquatic habitats. These factors acting singly in a synchronized manner exert significant influence upon aquatic life, and hence are important tools to access the water quality.

Water pollution accounts for a large number of mortalities and incapacitation, both in underdeveloped and developed countries. Regular monitoring of water bodies is very important not only for prevention of outbreak of diseases and occurrence of other hazards but also checks the water from further deterioration. Water bodies are ruined through the indiscriminate discharge of untreated waste water either out of ignorance of the consequences or due to the failure to adequately treat the ever increasing volumes of urban and industrial waste water in the country.

In a lotic system, the physical and chemical characteristics change rapidly during the year along its course. All rivers in the country receive domestic waste water and other effluents from both point and non-point sources. There is a large seasonal variation in the physico-chemical characteristics of water due to anthropogenic activities like washing, mass bathing, immersion of idols and ashes of dead human beings and other different kinds of offering.

Kota divison is located in the south east part of the state of the Rajasthan at the edge of Malva plateau at $23^{0}45´$ to $25^{0}53´$North latitudes and $75^{0}9´$ to $77^{0}27´$East longitudes. The Chambal River flows through Kota city and several of its tributaries flow around the city. Several dams have been constructed on these rivers. Apart from these dams, there are numerous man made ponds constructed for collecting rain water. Kota Barrage, Alnia dam, Abhera pond, Kishore Sagar pond and Sajidahera nallah are few of the water bodies existing in and around Kota city. These water bodies play an important role in maintaining the hydrology of the area and are large storage sinks during rain fall periods that control and influence subterranean water resources.

Kota Barrage is constructed on the Chambal River. Water of the Barrage is utilized to for irrigation as well as for municipal supply. Looking to the significance and importance of the water body, present study was planned and carried out over a period of 12 months.

No study on the physico-chemical properties of upstream and downstream water of Kota Barrage has been carried out so far. The study presented in this paper is the first such attempt. The present study has been carried out at four different places along the river with one sampling station on the upstream and three sampling stations along the downstream of the Kota Barrage. Samples were collected every month over a period of 12 months during September 2009 to August 2010. The samples were analyzed for pH, dissolved oxygen, COD, BOD, alkalinity, hardness, chloride, nitrate, sulphates, TDS, Calcium, Magnesium. Our study found higher level of pollutants in the downstream in comparison to upstream waters.

Rest of the paper is organized as follows: Literature survey is presented in section 2. Study area is described in the next section. Observations are presented in section 4 followed by results and discussion in the next section. Conclusions are drawn in the final section.

II. LITERATURE REVIEW

Birge and Juday [2] studied the waters of Winconsin lakes. They investigated the dissolved gases and the organic matter present in the lakes and classified the lakes into soft, medium and hard water lakes.

Different aspects in river and lake ecology were investigated by Talling [3] in some tropical African waters. Philipose [4] and Zafar [5,6], gave important accounts on the taxonomy of the lakes. According to Hutchinson [7], eutrophication was already a problem during the period of Romans. Vollenweider [8] studied the role of Nitrogen and Phosphorus in the eutrophication.

Khalil [9] studied the water quality profile of lake Mariut (Egypt). During investigations he concluded that eutrophication increase with organic population, agricultural and industrial drains and sewage disposal.

In India, where several water bodies viz. lakes, rivers and reservoirs are located, little work has been done in the field of limnology.

Ray and David [10] observed for river Ganga at Kanpur that in aquatic environment, sodium and potassium follows the same trend i.e. running water have a lower concentration than surrounding water. Philipose [11] studied the physico-chemical factors and suggested that some elements are required by most living organism in small but critical concentration for normally health growth (regarded as the “Micro nutrients” or “Essential trace elements”) but excess concentration cause toxicity.

Provosoli [12] showed that Na and K are necessary for the growth of the blue green algae and increasing concentration of alkali metals leads to flourishing population of these prokaryotes. Higher sodium concentration in aquatic environment limit the biological diversity, due to osmotic stress.

Zafar [13] observed that when organic matter decomposed in water complex proteins were converted into nitrogenous organic matter and finally into nitrates by the bacterial activity. Verma and Shukla [14] studied physico-chemical condition of fresh water in Muzaffar Nagar (Uttar Pradesh). Kumar et. al. [15] reported that the extant of water pollution can be assessed by analyzing the physico-chemical and biological characteristics of the habitat. Rajasthan extensive work on hydrological studies in Rajasthan was carried out by Bohra [16-18] on certain reservoir of Jodhpur.

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Gotterman [19] and Cole [20] give the method of physical and chemical analysis. Mhatre et. al. [21] observed reduction in the diversity of organism along Kalu river due to the contamination of water an sediments by the pollutants including heavy metals from a numbers of industries. Goel et.al. [22] and Gopal [23] has carried out studies on water bodies in Jaipur. S.K. Agarwal [24,25] studied the problem of eutrophication, limnological characteristics and impact of sewage drains in Chambal river at Kota. Bhargava [26] investigated the shallow water bodies of Didwana and Shambhar in Rajasthan.

Thresh et. al. [27] attributed the nitrogen richness of fresh water bodies to the pollution of animal region. Rao and Rao [28] studied physico-chemical characteristics of lotic habitats. Chopra and Hashim [29] studied the effect of bathing on river water quality of Ganga river at different ghats of Haridwar. Singh and Singh [30] observed variation and correlation of dissolved oxygen content with the effluent quality and state of river Ganga at Varanasi.

In recent years Kaur et. al. [31] studied physico-chemical status of Kanjali wetland Punjab. Sharma et. al. [32], made analysis of the different physical and chemical characteristics of water of major sewage drains which opens into the holy river Yamuna at Mathura. Sharma et. al. [33] studied some limnological aspects in Ahar river, Udaipur with respect to human interference and organic waste management.
Noor [34] studied variations in physico-chemical parameters of river at Bihar. Mandal and Verma [35], investigated the effect of coal mine effluents on the physico-chemical environment of a fish pond located in Lalmatia coal mine area of Godda district of Jharkhand and revealed an organic loading to the pond induced by mine effluents. Awasthi and Tiwari [36] studied seasonal trends in abiotic factors of Govindgarh lake, Rewa in Madhya Pradesh.

Behbahaninia [37] reported that due to pollution physico-chemical parameters of river Jafrood were negatively affected. According to Patni et. al. [38], water quality of lake is deteriorating rapidly due to intense human activities and influx of pollutants from surroundings. Sharma and Yadav [39] studied physico-chemical characteristics of Kayad lake, Ajmer. They concluded that higher values for TDS, organic matter and total alkalinity are indicatives of eutrophic nature of a water body.

Studies on hydrology and its impact on biotic diversity in costal areas were carried by Mukherji et. al. [40]. According to Khapekar and Nandkar [41] water quality index (WQI) indicates the quality of water in terms of index number which represent the overall quality of water for any intended use. Neelkanth et. al. [42], studied limnology of Asundi pond of Haveri district in Karnataka, with special reference to correlation among the physico-chemical properties of water. Shankar et. al. [43] studied the impact of anthropogenicity on ground water quality and suggested remedial measures in Bellandur in the south of Bangalore.

Verma et. al. [44] studied on seasonal variation of water quality in Betwa river at Bundelkhand region, India. The impact of Nagaon paper mill effluent on the sediment of the effluent discharging water occurs in water and sediment was studied by Sarma et. al. [45].

Correlation of Molluscan diversity with physico-chemical characteristics of water of Ramsagar reservoir, India were studied by Garg et. al. [46]. Evaluation of water quality along the bank of river Hoogly (Kolkata Metropolitan Area) using the physico-chemical parameter and water quality index were studied by Datta et. al. [47]. Patralekh et. al.[48] carried out the physico-chemical analysis of Shivganga pond of Jharkhand. They reported that the higher concentrations of chloride in water bodies might be due to dumping of sewage, organic matter of animal origin, immersion of mud made painted iodols and images. Mondal Datta et. al. [49] studied physico-chemical characteristics of water bodies of Burdwan Municipal area, West Bengal, India. Drinking water quality management through correlation studies among various physico-chemical parameters reported by Kumar et. al. [50].

III. STUDY AREA

The Chambal river originates in the Vindhyas and enters in Rajasthan near Kaukhera village (Chittorgarh district). Up to Kota city it passes through bare rocks and hilly tracts. Near Kota city, it enters the alluvial plains and passes through tectonic plain up to Sawai Madhopur, ultimately Chambal joins the river Yamuna in Uttar Pradesh passing through Dholpur district. On its way, the river Chambal receives many tributaries like Kali Sindh, Parbati, Mej, Parvan etc.

Study Area

The Kota Barrage is the fourth in the series of Chambal Valley projects, located about 0.8 km upstream of Kota city in Rajasthan. Water released after power generation at Gandhi Sagar dam and Jawahar Sagar dams is diverted by Kota Barrage for irrigation in Rajasthan and in Madhya Pradesh through canals on the left and the right sides of the river. The work on this dam was completed in 1960. The total catchment area of Kota Barrage is 27,332 km^2, of which the free catchment area below Jawahar Sagar dam is just 137 km^2. The live storage is 99 mm^3. It is an earth fill dam with a concrete spill way. The right and left main canals have a head works discharge capacity of 188 and 42 m^3/sec., respectively. The total length of the main canals, branches and distribution system is about 2,342 km, serving an area of 2.290 km^2 of CCA. The Barrage operates 18 gates to control flow of flood and canal water downstream, and serves as bridge between parts of Kota on both sides of the river.

Salient Features of Kota Barrage

Location	Near Kota City In Rajasthan across the Chambal River
Catchment Area	27454 Sq. Km.
Rainfall	81cm.Average
Storage Capacity	98.67 Million Cu. M.
Length of Dam at Top	557.68 M.
Height Of Dam	37.3 M.
Nature of Dam	Earthen Dam with Masonry Spillway
Area Submerged at FRL	5.82 Sq. Km.
Full Reservoir Level	R.L. 260.30 M.
Maximum Water Level	R.L. 261.20 M.

Source:- Chambal Valley Development, Project, Irrigation Department, Rajasthan

Study sites

Kota Barrage is situated within Kota city. Total distance of Kota Barrage from Railway junction and Government College, Kota is about 7.5 Km and 4.0 Km respectively.

For the proposed study the selected area was divided into four sampling stations (shown in plate 1 to 4) namely:

1. **Sajidehra**- situated on the upstream of Kota Barrage. At this site a nallah joins the river called Sajidehara nallah. This site is approximately 7 Km from Government College, Kota.
2. **Kunhari**- is 3 Km away from Government College, Kota and situated in downstream of Kota Barrage. This site is polluted due to anthropogenic activities like washing, bathing etc.
3. **Kherli Purohit**- is approximately 4 Km away from Government College, Kota. At this site domestic waste and municipal sewage is discharge into the water. A graveyard is situated near this site. Sometimes ashes of burnt bodies are immersed at this site.
4. **Dadwara**- situated on the downstream of Kota Barrage, is situated in downstream, approximately 7 Km away from Government College. Here vegetable waste is thrown into water frequently. Apart from this other anthropogenic activities like washing, bathing are also common at this site.

IV. Observations

Table - 1

Monthly variations in physico-chemical parameters of Kota Barrage at Sajidahera (Site I)

S.No.	Parameters	Unit	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.
1	pH		7.8	7.8	8.0	8.1	8.2	8.2	8.3	8.2	8.4	8.4	7.5	7.8
2	Total Alkalinity	mg/l	90.00	92.00	95.10	95.00	98.00	95.00	100.0	108.0	115.2	120.0	86.00	88.00
3	Total Hardness	mg/l	130.0	120.0	123.0	122.0	130.0	155.2	160.0	160.0	170.0	160.0	110.0	110.0
4	Calcium	mg/l	60.00	70.00	61.00	61.25	71.00	83.15	85.00	80.00	90.00	80.00	60.00	62.00
5	Magnesium	mg/l	50.00	50.00	62.00	60.75	59.00	52.05	65.00	75.00	60.00	60.00	50.00	48.00
6	Chloride	mg/l	60.00	60.00	62.40	63.10	63.00	65.18	65.00	70.00	72.00	74.00	60.00	50.00
7	Sulphate	mg/l	35.00	37.10	35.50	40.00	54.00	39.00	42.00	50.00	34.00	38.00	30.00	34.00
8	Nitrate	mg/l	20.00	22.00	18.00	20.00	24.00	20.00	26.00	25.00	32.00	30.00	18.00	20.00
9	TDS	mg/l	390.0	384.0	370.0	340.0	355.0	320.0	344.0	408.0	400.0	420.0	380.0	372.0
10	COD	mg/l	45.00	50.00	35.00	42.00	42.40	44.20	41.70	55.00	53.12	54.00	42.00	40.00
11	BOD	mg/l	1.8	1.4	1.9	2.8	2.3	2.0	2.5	2.7	2.9	3.0	1.5	2.0
12	DO	mg/l	5.2	6.7	5.6	5.2	5.6	5.0	3.5	4.0	3.6	3.5	5.1	5.2

Table - 2

Monthly variations in physico-chemical parameters of Kota Barrage at Kunari (Site II)

S.No.	Parameters	Unit	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.
1	pH		8.1	8.0	7.7	8.0	8.3	8.2	8.0	7.9	8.4	8.3	7.4	7.7
2	Total Alkalinity	mg/l	110.0	115.10	135.20	120.2	143.9	134.7	140.0	141.7	138.4	143.0	147.4	120.0
3	Total Hardness	mg/l	130.0	140.00	120.20	134.4	145.0	140.2	150.3	145.2	148.0	152.0	110.2	120.0
4	Calcium	mg/l	70.00	72.20	68.70	77.40	78.30	75.20	82.40	98.00	78.00	92.15	68.40	70.25
5	Magnesium	mg/l	60.00	56.40	47.10	49.00	46.10	51.90	52.40	55.20	48.00	46.00	40.00	45.00
6	Chloride	mg/l	70.00	64.00	66.40	63.70	70.20	67.10	65.00	70.40	72.10	80.15	55.00	59.00
7	Sulphate	mg/l	37.00	18.00	30.10	35.40	20.20	50.50	40.20	60.30	60.40	40.00	20.00	35.40
8	Nitrate	mg/l	18.00	18.00	20.10	22.50	15.20	19.40	20.40	22.10	26.10	22.40	15.50	12.10
9	TDS	mg/l	420.0	140.00	400.00	320.0	360.0	370.4	410.0	465.0	540.0	500.0	430.0	435.0
10	COD	mg/l	75.00	74.00	73.00	64.00	69.00	72.00	76.00	74.20	80.40	70.80	70.00	65.00
11	BOD	mg/l	1.9	2.0	2.1	1.7	2.3	1.9	2.4	2.3	3.0	2.8	2.0	2.2
12	DO	mg/l	3.1	4.8	5.0	4.9	4.0	4.4	5.3	5.4	4.4	5.2	5.0	5.2

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Table - 3
Monthly variations in physico-chemical parameters of Kota Barrage at Kherli Purohit (Site III)

S.No.	Parameters	Unit	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.
1	pH		8.2	7.8	8.1	7.7	8.2	8.0	8.2	7.9	7.5	8.0	7.3	8.0
2	Total Alkalinity	mg/l	170.0	180.4	165.10	175.0	200.0	225.4	220.0	215.5	170.0	180.0	160.0	175.0
3	Total Hardness	mg/l	120.00	130.0	125.50	140.0	217.0	180.0	210.0	170.0	200.0	220.0	205.5	200.5
4	Calcium	mg/l	80.00	70.50	90.50	105.0	90.00	89.00	100.7	76.70	68.90	78.00	72.70	80.75
5	Magnesium	mg/l	60.00	50.50	54.40	60.00	56.00	50.00	46.40	56.50	60.00	48.40	50.50	60.00
6	Chloride	mg/l	90.00	80.00	80.75	80.00	78.50	89.90	92.20	95.00	100.0	110.0	70.00	75.50
7	Sulphate	mg/l	50.00	55.20	50.00	52.00	50.50	51.70	60.70	65.00	70.50	70.00	50.00	55.00
8	Nitrate	mg/l	20.00	18.00	21.00	20.90	22.00	16.80	18.00	20.10	20.00	22.00	17.50	10.00
9	TDS	mg/l	440.00	400.5	390.00	420.0	400.5	425.7	410.0	480.0	500.0	520.0	410.0	400.8
10	COD	mg/l	65.00	60.60	64.50	40.50	70.40	45.40	60.10	72.50	50.10	60.50	60.20	70.10
11	BOD	mg/l	1.90	2.0	2.0	2.5	1.8	3.0	3.8	3.8	4.0	3.7	3.0	2.0
12	DO	mg/l	3.90	4.2	5.0	4.5	4.2	5.7	4.7	5.3	5.0	5.2	7.0	6.5

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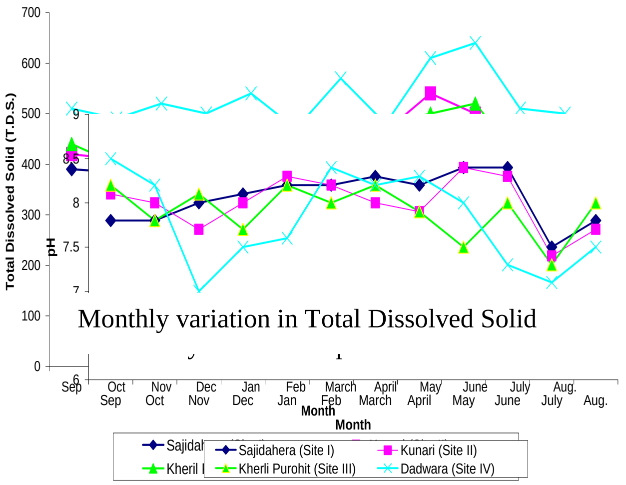
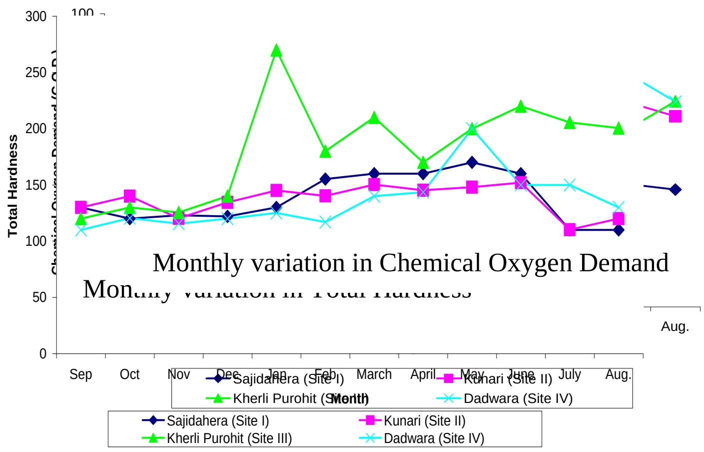
Table - 4
Monthly variations in physico-chemical parameters of Kota Barrage at Dadwara (Site IV)

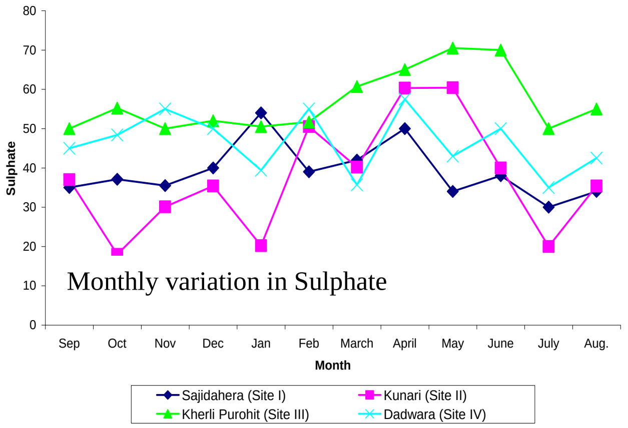
S.No.	Parameters	Unit	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.
1	pH		8.5	8.2	7.0	7.5	7.6	8.4	8.2	8.3	8.0	7.3	7.1	7.5
2	Total Alkalinity	mg/l	120.50	125.5	130.00	135.4	127.4	140.0	140.0	142.5	147.2	120.0	115.0	110.0
3	Total Hardness	mg/l	110.00	120.5	115.50	120.0	125.0	117.0	140.0	143.5	200.0	150.0	150.0	130.0
4	Calcium	mg/l	60.00	75.20	70.00	81.20	80.70	75.00	70.50	82.50	70.00	80.50	82.40	70.90
5	Magnesium	mg/l	50.00	42.40	40.00	42.10	35.10	35.00	30.00	35.40	40.50	35.00	50.00	45.00
6	Chloride	mg/l	70.00	72.40	73.70	77.50	65.50	69.10	65.70	70.80	95.20	90.00	70.10	65.00
7	Sulphate	mg/l	45.00	48.40	55.00	50.00	39.40	55.00	35.70	57.50	43.00	50.00	35.00	42.50
8	Nitrate	mg/l	22.00	30.00	34.00	24.00	26.00	16.50	28.00	14.00	22.00	26.40	18.00	17.00
9	TDS	mg/l	510	490.5	520.00	500.5	540.0	470.0	570.0	480.0	610.0	640.0	510.0	500.0
10	COD	mg/l	70.00	64.70	71.50	66.50	75.50	61.50	90.00	91.50	72.50	70.50	80.00	70.00
11	BOD	mg/l	2.0	1.8	3.0	2.8	2.0	3.2	2.7	1.9	2.6	2.0	2.9	3.0
12	DO	mg/l	2.7	4.0	4.2	4.8	4.3	4.0	5.0	4.6	5.2	4.8	6.0	5.0

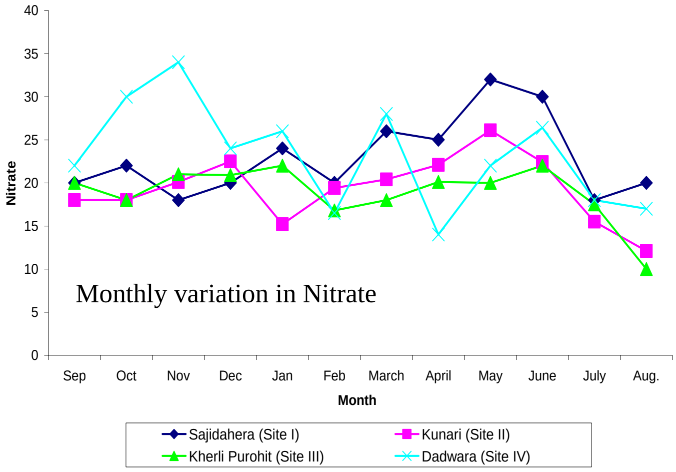


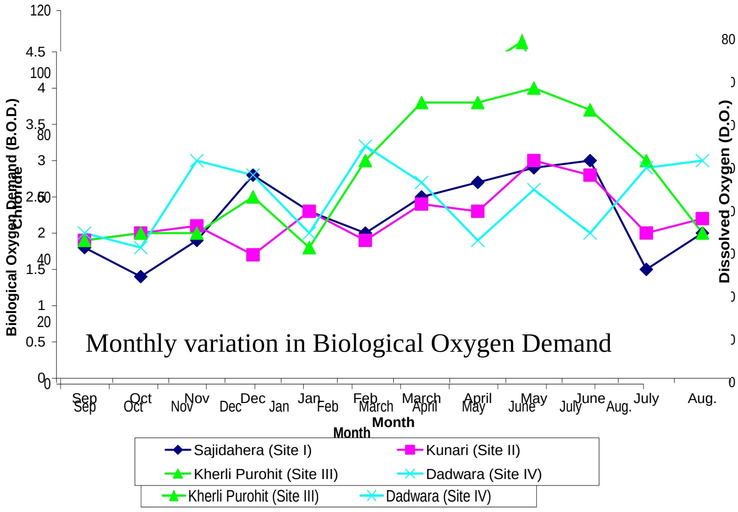
Monthly variation in Total Dissolved Solid

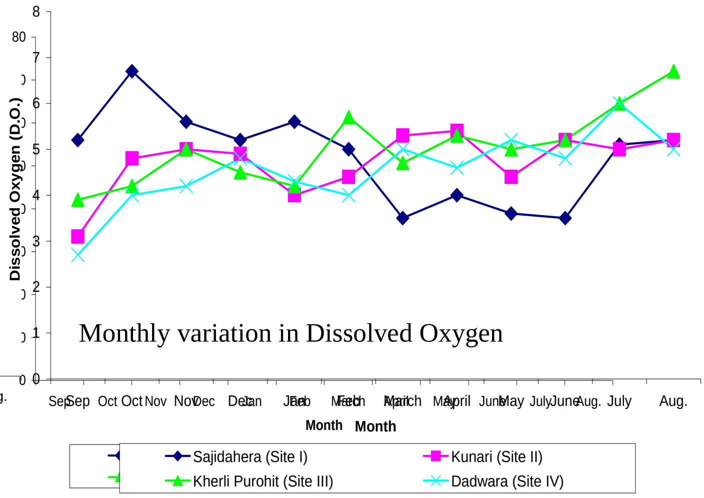


Monthly variation in Chemical Oxygen Demand


Monthly variation in Sulphate
Sulphate
Month
Sep
Oct
Nov
Dec
Jan
Feb
March
April
May
June
July
Aug.
Sajidahera (Site I)
Kunari (Site II)
Kherli Purohit (Site III)
Dadwara (Site IV)


Monthly variation in Nitrate
Nitrate
Month
Sep
Oct
Nov
Dec
Jan
Feb
March
April
May
June
July
Aug.
Sajidahera (Site I)
Kunari (Site II)
Kherli Purohit (Site III)
Dadwara (Site IV)


Monthly variation in Biological Oxygen Demand
Biological Oxygen Demand (B.O.D.)
Month
Sep
Oct
Nov
Dec
Jan
Feb
March
April
May
June
July
Aug.
Sajidahera (Site I)
Kunari (Site II)
Kherli Purohit (Site III)
Dadwara (Site IV)


Monthly variation in Dissolved Oxygen
Dissolved Oxygen (D.O.)
Month
Sep
Oct
Nov
Dec
Jan
Feb
March
April
May
June
July
Aug.
Sajidahera (Site I)
Kunari (Site II)
Kherli Purohit (Site III)
Dadwara (Site IV)

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V. RESULTS AND DISCUSSION

Physico-chemical properties of Kota Barrage at upstream and downstream sampling sites are presented in Tables 1-4. The corresponding variations are shown graphically as well. From the graphs, it is clear that the pollution levels are higher at all the sites during February to June. Once monsoon sets in during July, the increased water flow into the barrage and subsequent release of water from the barrage brings the pollution levels down.

Total alkalinity of water of Kota Barrage at selected sampling sites was ranged between 86.00 mg/l to 225.40 mg/l. Maximum value (225.40 mg/l) was observed during the month of February at Kherli Purohit (Site III). The minimum value of total alkalinity (86.00 mg/l) was recorded during the month of July at Sajidahera (Site I). Observations reveal that slightly higher values were recorded during summer season. Similar observations were also recorded earlier (Chatterjee and Raziduddin, 2002). Das (1978) stated that total alkalinity indicates polluted water body. Kherli Purohit (Site III) seems be slightly polluted on the basis of values of total alkalinity. Higher values of alkalinity at this site might be due to agricultural run off and domestic waste. Das [51] stated that higher values of alkalinity indicate pollution in the water body. Kherli Purohit (Site III) seems be slightly more polluted on the basis of values of total alkalinity. Higher values of alkalinity at this site might be due to agricultural runoff and domestic waste.

Hardness of water is indicative of suitability of its use in drinking, washing, cooking and other domestic purposes. Hardness in water is caused by metallic ions dissolved in water. In our study, total hardness values ranged between 110.00 mg/l to 220.00 mg/l. Highest value (220.00 mg/l) was recorded at Kherli Purohit (site III) during the month of June and lowest value (110.00 mg/l) was recorded during monsoon season. Higher values at this site indicate higher pollution level. Das Gupta and Purohit [52] are of the opinion that the concentration of hardness increases during the post monsoon season and decreases towards monsoon season. In the present study also, similar trend of hardness was observed. Addition of rain water during monsoon might be the reason of its lower values in rainy season. This supports the findings of Pandit [53].

Chloride metabolically depicts pivotal role in photolysis of water and phosphorylation in autotrophs. It is considered as pollution indicator when present in higher concentrations. Table 1-4 reveals the chloride concentration of different sites. Maximum value was recorded 100.00 mg/L in the month of May at Kherli Purohit (Site III) and minimum value was observed 50.00 mg/l at Sajidahera (Site I) in the month of August during present study period. Lower values in the monsoon may be due to increase in water level caused by rains. Its maximum content was observed during summer. This was in accordance with Mahananda et. al. [55]. Values of chloride content in the water of study area are under the permissible limits. Chloride value can be influenced by weathering of soil and rocks, atmospheric precipitation environmental factors and pollution sources like industrial and municipal waste water [56].

Sulphate values ranged from a minimum of 20.00 mg/l at Kunari (Site II) in the month of July to a maximum of 70.50 mg/l at Kherli Purohit (Site III) in the month of May. Maximum values were recorded during summer months and minimum during rainy season. The present observation finds support with the work of Kannan [56]. In the present study sulphate at all the four sites was below permissible limit i.e., 250 mg/l.

During study period, concentration of nitrates varied from 10.00 mg/l to 34.00 mg/l. Highest value of nitrate (34.00 mg/l) was observed at Dadwara (site IV) in the month of November. Minimum value (10.00 mg/l) was observed at Kherli Purohit (site III) during the month of August. In the study area matters of organic origin is probably the cause for higher concentration of nitrates. Nitrate content is within the permissible limits when compared to BIS permissible limits of 50 mg/l at all sampling sites during the study period.

Total dissolved solids ranged between 320.00 mg/l to 640.00 mg/l. Highest value (640.00 mg/l) was observed at Dadwara (Site IV) in the month of June. Lower values were observed during winter season. The TDS values exhibited an increasing trend in post monsoon season owing to the reason that during post monsoon season dissolution of more quantity of constituents of soil particles takes place as ground water table increases during these months.
COD values in the water indicate that the water needs more oxygen to stabilize organic substances or rapid oxidative degradation. In this process it consumes dissolved oxygen. COD values were found to vary between 35.00 mg/l to 91.50 mg/l. Maximum value (91.50 mg/l) was recorded at site IV during the month of April and that of minimum (35.00 mg/l) at site I during the month of November. Higher values of COD were recorded during the summer season. Higher values indicate evaporation of water during summer and lower values during rainy and winter season due to dilution by rain water. The recorded values suggested that during the course of investigation at all four sides the COD values were much

above the permissible limits of 20 mg/l. The higher COD values at Dadwara (Site IV) might be due to continuous discharge of sewage and other allochthonous materials in the water.

BOD values ranged between 1.5 mg/l to 4.0 mg/l during the present study in the study area. Maximum BOD value (4.0 mg/l) was recorded at site III during the month of May and it was minimum (1.5 mg/l) at site I during the month of July. This may be due to reduced water flow in the downstream during summer season.

DO is an important parameter to Judge the quality of water. Concentration and distribution of DO forms basis for proper understanding of aquatic ecosystem. It is essential for the metabolism of all aquatic organisms which perform aerobic respiration.

DO values ranged between 2.7 mg/l to 6.7 mg/l. Maximum value (6.7 mg/l) was recorded at Sajidahera (Site I) during the month of October and minimum (2.7 mg/l) at Dadwara (Site IV) in the month of September. DO values in natural and waste waters depend on the physical, chemical and biochemical activities prevailing in the water body. Lower values of DO indicate poor trophic status of water body. Lower amount of DO at Site IV might be due to the standing state of water, least water current, greater decomposition and increased respiration by heterotrophic organisms, which is in conformity with findings of Saha and Chaudhary [57].

VI. CONCLUSIONS

Following conclusion could be draw from the present investigations:

1. Concentration of major physico-chemical parameters exhibited an increasing trend during post monsoon season as compared to pre monsoon season. This is attributed to the dissolution of salts and minerals in soil through the recharge of groundwater by rainfall and raising the water table during the monsoon season.
2. Large scale anthropogenic activities, dumping of solid waste and discharge of waste water have resulted in getting water polluted. Pollution was comparative more in the downstream area. The observed plant species also point that the waters are polluted. To avoid future hazardous effects on the environment, effective pollution control measures must be taken. Legislation should be framed against anthropogenic activities.
3. Last but not the least; nothing can be achieved without participation of people, voluntary organizations, institutions and pressure groups which play an important role in framing and implementation of government policies. This will ensure stopping of further harm to aquatic bodies effectively.

REFERENCES

1. Ramachandra, T. V., N. Ahalya, and Rajasekara Murthy. "Aquatic ecosystems: conservation, restoration and management." *Aquatic ecosystems-Conservation, restoration and management* (2005): 26-50.
2. Birge, E.A. and Juday, C. 1911. The inland lakes of Wisconsin. The dissolved gases of the water and their biological significance. Wisconsin Geol. Nat. Hist. Surv. Bull. 64 Sci. Ser. 13 : 1-22.
3. Talling, J.F. 1957. Diurnal changes of stratification and photosynthesis in some tropical African Waters. Proc. Roy. Soc. 147 (B) : 57 – 83.
4. Philipose, M.T. 1960. Fresh water phytoplankton of inland fishers.Proc.Sym.Algal ICAR,New Delhi:272-291.
5. Zafar, A.R. 1959 .Taxonomy of lakes. Hydrobiol. 13 : 287-299.
6. Zafar, A.R. 1964. On the ecology of algae in certain fish ponds in Hyderabad. India. I. Physico-chemical complexes. Hyderabad, 23 : 176-196.
7. Hutchinson, G.E. 1961. INULA summary of investigation on Lagodi Montrosi : Manuscript Ist. Ital. Hydrobiol. p. 14 in OECD report.
8. Vollenweideer, R.A. 1965. Scientific fundamentals of eutrophication of lakes and flowing water with special reference to nitrogen and phosphorus as factors in eutrophication. O.E.C.D., Paris.
9. Khalil, Magdy, T., 2000. Impact of Pollution on productivity and 1755isheries of lake Mariut, Egypt. Int. J. Ecol. Environ. Sci. 26 : 463-478.
10. Ray, P. Singh, S.B. and Sehgal, K. L. 1966. A study of some aspects of ecology of the river Ganga and Jamuna at Allahabad, U.P. in 1958-59. Proc. Nat. Acad. Sci. India. 36 : 335-372.
11. Philipose,M.T. 1967. Chlorococcales,ICAR,New Delhi.: pp. 365.
12. Provasoli, Luigi. "Algal nutrition and eutrophication." Internat Symp Eutrophication Proc. 1969.
13. Zafar, A. R. "Limnology of the Hussainsagar Lake, Hyderabad, India." Phykos 5.1–2 (1966): 115-216.
14. Verma, S. and Shukla, G.R. 1970. Physico-chemical condition of a tank, Muzaffar-nagar, U.P. in relation to biological productivity. Engivron. Hlth. 12 : 110- 128.
15. Kumar, H.D., Bisaria, G.P., Bhandari, L.M., Rana, B.G. and Sharma, V. 1974. Ecological studies on algae isolated effluents in an oil refinery, fertilizer factory and a brawery. Indian J. Environ. Hlth. 16 : 247-255.

16. Bohra, B.P. 1976. Some aspects of limnology of Padam Sagar and Ranisagar, Jodhpur. Ph. D. thesis, University of Jodhpur, India.
17. Bohra, B.P. 1977. Comparative limnology and primary productivity of two adjacent lakes, Padam Sagar and Rani Sagar in semi-arid region of Rajasthan, India. C.I.F.E. Newsletter 11 & 12 : 1-15.
18. Bohra, B.P. 1978. Observations on diurnal rhythm of 1756hysic-chemical factors and zooplankton ant Chand Baori, Jodhpur. Comp. Physico. Ecol. 3 (2) : 91-94.
19. Gotterman, H. L., Clymo, R.S. and Ohmstad, M. A. M. (1978), Methods for physical and chemical analysis of fresh water. IBP Hand Book No. B, 2nd ed. Black Wells scientific publications. Oxford : 213.
20. Cole, G. A (1979). Text book of limnology. Second ed. C. V. Mosby Company, St. Louis. Missouri, U.S.A., 426 pp.
21. Mhatre G.N. Chaphekar, S.B., Ramani Rao, I.V. Patol M.R. and Haldar, B.C. (1980) effects on industrial pollution on the Kalu River Ecosystem. Environ. Pollut. 23 (1) : 67-68.
22. Goel, P.K., Gopal, B. and Trivedi, R.K. 1980. Impact of sewage on freshwater ecosystem. I General features of water bodies and sewage II Physico-chemical characteristics of water and their seasonal changes. Int. J. Ecol. Environ. Sci. 6 :83-116.
23. Gopal, B., Goel, P.K., Sharma, K.P. and Trivedi, R.K. 1981, Limnological study of fresh water reservoir, Jamwa Ramgarh (Jaipur). Hydrobiol. 83 : 283-294.
24. Agarwal, S.K. 1982. Eutrophication of Chambal river at Kota. Acta. Ecol. 4:5-9.
25. Agarwal S.K. 1983. Water quality of sewage drains entering Chambal river at Kota. Acta. Ecol. 5: 26-29.
26. Bhargava, S.C. 1983. Ecology and productivity of salt lakes of Rajasthan desert and culturing shrimp, Artemia for Aquaculture. MAB project, Deptt. of Environment, New Delhi
27. Thresh, J.C., Suckling, E.V. and Beale, J. F. (1949). The Examination of water supplies, (Ed) by Taylor, E.W.
28. Rao,P.S. and Rao,K.S. 1986.Pollution due to pilgrim bathing during Kumbh mela in Kshipra river(Ujjain). J. Hydrobiol. 2 (4) : 47-55.
29. Chopra, A.K. and Hashim, J. 1990. Effect of bathing on water quality of Ganga at different ghats of Hardwar, Himalaya. J. Env. Zoo. 4 (2) : 158-165.
30. Singh G.S. and Singh, A.S. 1994. Variation and Correlation of dissolved oxygen with effluent quality and stage of river Ganga at Varanasi, India. Indian J. Environ. Hlth. 36 (2) : 79-83.
31. Kaur, H., Bath, K.S., Mander, G. and Jerath, N. 2000. Physico-chemical status of Kanjali wetland, Punjab (India). J. Environ. & Poll. 7 (1) : 39-42.
32. Sharma, H. B., Agarwal, P.K. and Prabha, S. 2000a. Water quality of sewage drains entering Yamuna river at Mathura (U.P.). J. Environ. Biol. 21 (4) : 375-378.
33. Sharma, L.L., Sharma, S.K., Saini, V.P. and Vyas, R.N. 2000 b. Some Limnological aspects of seasonal pools in Ahar river, Udaipur with reference to human interference and organic waste management J. Ecol. Env. & Cons. 6 (1) : 81-85.
34. Noor, A.Md (2001). Studies on variations in physico-chemical parameters of pond at Hathwa (Bihar). J. Environ & Poll. 8 (2) : 179-181.
35. Mandal, N. K., and P. K. Verma. “Impact of coal mine effluent on 1756hysic-chemical characteristics of pond water in coalfield area of Godda District, Jharkhand.” Nature, Environment and Pollution Technology 1.3 (2002): 231-234.
36. Awasthi, Usha and Tiwari, S. 2004. Seasonal trends in abiotic factors of a lentic habital (Govind garh lake) Rewa, M.P., India. Eco. Env. & Cons. 10 (2) : 165 -170.
37. Behbahaninia, A., (2005). Physico-chemical characteristics and pollution levels of heavy metals in jajrood river. J. Environ quality. Vol. 103, No 1-6, 29-37.
38. Patani, S., Bharti Prakesh and Aarti Sharma 2006. Monitoring of Budha Pushkar Lake with special reference to Physico-chemical characteristics. Indian Jonrnal of Environmental science 10 (2) 2006, pp. 159-161. Green Earth foundation.
39. Sharma, N. and Indu Yadav. 2007. Physico- chemical sharacties of Kayad lake Ajmer, Rajasthan, Indian. Indian Journal of Environmental Science 11 (2) 2007, pp. 137-140. Green Earth Foundation.
40. Mukehrji, D. A. Banerjee and G.K.Sen, 2007. Physico-chemical and Biostatus of Digha coast of West Bengal. Environment and Ecology 25 (4) : 846-854.
41. Khapekar, R.R. and P.B. Nandkar. 2007. water quality Index (WQI) of Koradi Thermal Power Station. Environment & Ecology 25 (3) : 690-695.
42. Neelkanth P. Maganur, Ravishankar D. Kanamadi and Vijay Kumar A. Kudari, 2007. Limnological of Asundi Pond of Haveri District. Karnataka, India. Environment and Ecolgy 255 (4A) : 1282- 1288.
43. Shankar, B.S., N. Balasubramanya and K.S, Rajashekerappa. 2007. Impact of Anthropogenic City on Ground water Quality and Remedial Measures. 2007. Environment and Ecologys 25 S (4A) : 1343-1347.
44. Verma, Sarita. "Seasonal variation of water quality in Betwa river at Bundelkhand region, India." Global Journal of Environmental Research 3.3 (2009): 164-168.

45. Sarma, K. P., and B. Talukdar. "Sediment characteristic and concentration of heavy metals in water and sediment of the effluent discharging water body of Nagaon paper mill, Assam, India." Asian Journal of Water, Environment and Pollution 6.4 (2009): 97-102.
46. Garg, R. K., R. J. Rao, and D. N. Saksena. "Correlation of molluscan diversity with physico-chemical characteristics of water of Ramsagar reservoir, India." International Journal of Biodiversity and Conservation 1.6 (2009): 202-207.
47. Datta, Diptendu, Prasanta Kumar Banerjee, and Siddhartha Datta. "Evaluation of Water Quality along the Bank of River Hoogly (Kolkata Metropolitan Area) Using the Physico-Chemical Parameter and Water Quality Index." Asian Journal of Water, Environment and Pollution 6.3 (2009): 19-26.
48. Patralekh, M., S.K. Sinha, A. Kumar and L.N. Patralekha. 2010. Analgsis of some physico-chemical parameters of shivGanga pond of B. Deoghar, Jharkhand, India. Environment & Ecology 28 (2 A) : 1022-1025.
49. Mondal, N. K., et al. "Study of Physico-chemical Characteristics of Water Bodies of Burdwan Municipal Area, West Bengal, India." Asian Journal of Water, Environment and Pollution 7.2 (2010): 93-96.
50. Kumar, Navneet, and D. K. Sinha. "Drinking water quality management through correlation studies among various physicochemical parameters: A case study." International journal of environmental sciences 1.2 (2010): 253-259.
51. Das, S.M. and Pathani, S.S. 1978. A study on the effect of lake ecology on productivity of Mahaseer (Tortor and Tor- putitora) in Kumaon lakes, India, Matsya 4 :25-31.
52. Dasgupta, Adok M. and K. M. Purohit. 2000. Correlation coefficient of some physico-chemical characteristics of surface and ground waters of Rajgangapur. Part I Indian. J. Env. Prot. 20 : 681-686.
53. Pandit, B. 1986. A Comparative Study of pond and reverine ecosystan stress. Ph.D. thesis. Bhag. Uni.I Bhagalpur, India.
54. Mahananda, B.H., M.R. Mahananda and B.P. Mohanty. 2005. Studies on the physico-chemical and biological para meters of a fresh pond ecosystem as an indicator of water pollution. Ecology :, Envirnment and conservation II (3-4) : 537-541.
55. Ownbey, C.R. and D.A. Kee. 1967. Chlorides in Lak Erie. Proc. conf. Great lakes Res. Int. Assoc. Great Lakes Res 10 : 382- 389
56. Kannan, K. 1991. Fundamentals of Environmental Pollution. S. Chand and Company Ltd., New Delhi.
57. Saha. L.C. and H. K. Chaudhary. 1985. Phytoplankton density in relation to abiotic factors of a pond at Bhagalpur Comp. Physiol. Ecol. 10 : 98-100.