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# Application of WQI for Assessment of Water Quality of River Chambal in Kota, Rajasthan (India)

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**ABSTRACT** Water is the pivotal requisite for existence of life on earth. Fresh water reservoirs are the treasured alms of nature to man. But imprudent acts of human causing their defilement have led many of them in jeopardy. Present study aims to determine Water Quality Indices (WQI) at five sites of the river Chambal flowing through the Kota city, Rajasthan (India). For computing WQI eight physicochemical parameters of each site were analyzed. WQI's were then used to deduce the water quality at the studied sites. Water at sites 1,3,4,5 was found fit for drinking which was in accordance to BIS standards while site 2 turned up befouled. Anthropogenic activities and industrial effluents are the possible reasons for the poor quality of water at this site.

**KEYWORDS:** Water quality, WQI, Physico chemical analysis, Water samples

## I. INTRODUCTION

Water is a necessary component of life. About 75% of the earth's surface is covered with water but, out of it only 1% is available as fresh water. Although there is very limited fresh water on earth even then today world is grappling with overexploitation, misuse, mismanagement and contamination of freshwater resources. Shooting human population, rapid industrialization and urbanization and improper agricultural practices are the main causes of deterioration of these valuable assets. Discharge of untreated industrial effluents, agricultural wastes and raw sewage directly into these water stores slowly converts this natural wealth into stinking cesspools.

Water quality index (WQI) is a useful tool which categorizes water samples into different classes and provides them rating on the basis of their quality [1]. WQI compiles all the water quality parameters into a single form to provide the composite influence of individual parameter on the overall quality of water [2]. Horton, 1965[3] was pioneer to present the concept of Water Quality Index (WQI) after which many other variants have also come forth like SDD, 1976 [4]; Ottaa W.R., 1978 [5]; Dunnette, 1979[6]; Miller et al. 1986 [7]; Smith, 1990 [8]; Cude, 2001 [9]. All these indices are able to collate data from a variety of variables into a single number, they combine parameters which are in different units into a single metric, and easily communicate the water quality by scoring it [10]. Thus WQI is a useful means to determine the present status of a water body with reference to its water quality.

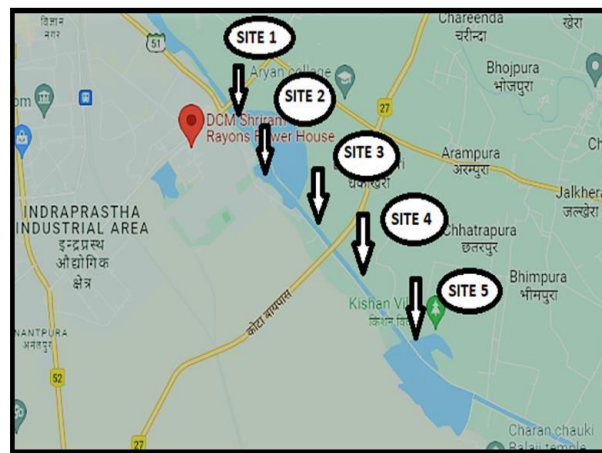
The objective of the present work is to discuss the water quality of river Chambal running through the Kota city of Rajasthan, India by the aid of water quality indices.

## II. STUDY AREA

Kota is a famous educational and industrial city which is situated in the southern part of Rajasthan, India (25°11' N and 75°51' E). It lies in the south east of Aravalli ranges at an elevation of 273 m above the sea level. The city is situated on the eastern bank of the river Chambal which is also known as the “Lifeline of Kota”. The river is a major source of water supply for various industries, irrigation, drinking purpose and other requirements.

Present study was carried on water of a canal of the Chambal running through the DCM industrial area of the Kota city (Raj). Following five sites spread over a stretch of approx. 10 kms were selected for the present study (Fig. 1)

- Sharv Siddh Shani Mandir opp DCM (Site 1)
- Near Sen. Sec School, Shriram nagar (Site 2)
- Near Overbridge (Site 3)
- Dadhdevi modh (Site 4)
- Ummedganj Pakshi Vihar (Site 5)



(Fig. 1)

## III. MATERIAL AND METHODS

For estimation of water quality of river Chambal physicochemical analysis of water samples collected from all the five sites was done. Mean values of the parameters obtained by this analysis were used for determining the water quality indices.

### (A) Physicochemical analysis

Methods used for physicochemical analysis were according to APHA, 2005 [11]. Water samples were collected in first quarter of 2020. According to the recommendations of APHA (2005), PVC bottles treated with Iodine were used for collection of samples. Following eight physicochemical parameters were analyzed during the study:-

Parameter	Method applied
1. Dissolved Oxygen (DO)	Iodometric
2. Biochemical Oxygen Demand (BOD)	5 Day BOD
3. Total Dissolved Solids (TDS)	TDS meter



4. Total hardness (TH)	Titrimetric
5. pH	Electrometric
6. Copper	Colorimetry
7. Arsenic	Colorimetry
8. Molybdenum	Colorimetry

AR grade reagents and double distilled water were used for all preparations. pH, temperature, and TDS were determined at the spot with the help of digital meters. Rest parameters were analyzed in the laboratory within 3 to 6hr of collection.

**(A) Computation of Water Quality Index**

The Weighted Arithmetic Index Method (WAIM) proposed by Brown et al.,1972 [12] was used for the calculation of WQI. The standards of drinking water quality recommended by the Bureau of Indian Standards (BIS) have been used for calculation of WQI. Methodology of calculating WQI by WAIM is as following:-

Step 1: Calculate the Unit Weight ( $W_n$ ) factor for each parameter

$$W_n = \frac{K}{S_n}$$

$W_n$  = Unit weight of the  $n^{th}$  parameter

$S_n$  = Standard desirable value of the  $n^{th}$  parameter

$K$  = Constant

Where

$$K = \frac{1}{\frac{1}{S_1} + \frac{1}{S_2} + \frac{1}{S_3} + \dots + \frac{1}{S_n}} = \frac{1}{\sum 1/S_n}$$

[The summation of unit weight factors of all selected parameters is 1 (unity)]

Step 2. Calculate the sub-Index ( $Q_n$ ) value by using the formula

$$Q_n = (V_n - V_o) \frac{(S_n - V_o)}{(V_n - V_o)} \times 100$$

Where  $Q_n$  = The sub-Index of the  $n^{th}$  parameter

$V_n$  = Mean concentration of the  $n^{th}$  parameter

$S_n$  = Standard desirable value of the  $n^{th}$  parameter

$V_o$  = Actual values of the parameters in pure water (generally  $V_o=0$  for most of the parameters except pH and DO where for pH it is 7 and for DO it is 14 mg/L)



Step 3. Combining Step 1 & Step 2, WQI is calculated as following

$$WQI = \frac{\sum W_n Q_n}{\sum W_n}$$

#### IV. RESULTS AND DISCUSSION

Eight physical and chemical parameters at five sites of river Chambal were analyzed for determining the WQI. These parameters were DO, BOD, TDS, Total Hardness, pH, Copper, Arsenic and Molybdenum. The outcomes of physico chemical analysis are shown in Table 1. The value range of different parameters for all five sites is as following :- DO (between 11 to 18.5 mg /L), BOD (between 2.5 to 6 mg/L), TDS (between 131 to 158 g/L), Total Hardness (between 112.5 to 187.5), pH (between 8.25 to 8.75), Copper (between 0 to 0.03 mg/L), Arsenic (0 mg/L) and Molybdenum (0 mg/L) A comparison was made between the studied physical and chemical parameters with the corresponding values of BIS 10500 : 2012 (Bureau of Indian Standard) for drinking water. It was observed that for all studied sites, the mean values of most of the parameters were below the maximum limits with the exception of mean values of BOD at sites 1, 2 and 5; the mean value of Copper at site 2 and the mean value pH at site 5.

Water Quality Indices were computed for all the studied sites by the Weighted Arithmetic Index Method (WAIM) using the mean values of the parameters. The proportionality constants (K), unit weights (Wn) and Qn for all eight parameters of all the five sites are given in Table 2,3,4,5 and 6 respectively. The WQI values of the studied sites 1,2,3,4 and 5 were found to be 0.2714, 222.8378, 0.2373, 0.23930 and 0.3018 respectively.

According to Chatterji and Raziuddin, 2002 [13] water can be classified into five categories on the basis of WQI as described below

Water Quality Index	Water Quality Status
0 -25	Excellent Water Quality
26-50	Good Water Quality
51-75	Poor Water Quality
76-100	Very Poor Water Quality
>100	Unsuitable for drinking

Considering the above classification, according to the present study on the basis of computed WQI values the water of river Chambal at different sites belong to following categories

Location	WQI value	Water Quality Status
Site 1	0.2714	Excellent Water Quality
Site 2	222.8378	Unsuitable for drinking
Site 3	0.2373	Excellent Water Quality
Site 4	0.23930	Excellent Water Quality
Site 5	0.3018	Excellent Water Quality



## V. CONCLUSION

The results indicate that out of the five sites studied, water at four sites (Site1, 3,4,5) was found suitable for human consumption while at site 2 it was unfit. The reasons behind it might be the vicinity of the site 2 to the DCM industry and dense human population of this area. Industrial wastes and anthropogenic activities like dumping of raw sewage and household wastes directly into the river water are the possible responsible reasons for the pollution of water at this site. Therefore suitable measures are needed to prevent further deterioration of water quality at site 2 also strategies are needed to improve the water quality in order to regain the pristine nature of the river.

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Table 1:- Comparative physico-chemical analysis of study sites of river Chambal

Parameters	SITE 1				SITE 2				SITE 3				SITE 4				SITE 5			
	Min	Max	Mean	SD	Min	Max	Mean	S D	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD
Dissolved Oxygen (mg/L)	9	15	12	±4.24	10	12	11	±1.41	14	17	15.5	±4.24	14	23	18.5	±6.36	10	14	12	±2.83
BOD (mg/L)	5	6	5.5	±2.83	4	8	6	±2.83	4	5	4.5	±0.71	2	3	2.5	±0.71	5	6	5.5	±0.71
TDS(mg/L)	136	145	140.5	±6.36	154	162	158	±5.66	137	142	139.5	±3.54	135	143	139	±5.66	128	134	131	±4.24
Total Hardness (mg/L)	100	125	112.5	±17.68	95	150	122.5	±38.89	150	175	162.5	±17.6	150	200	175	±35.56	175	200	187.5	±17.68
pH	8.1	8.4	8.25	±0.21	8.2	8.3	8.25	±0.07	8.2	8.4	8.3	±0.14	8	9	8.5	±0.71	8.3	9.2	8.75	±0.63
Copper (mg/L)	0	0	0	±0	0	0.03	0.03	±0.021	0	0	0	±0	0	0	0	±0	0	0	0	±0
Arsenic	0	0	0	±0	0	0	0	±0	0	0	0	±0	0	0	0	±0	0	0	0	±0
Molybdenum	0	0	0	±0	0	0	0	±0	0	0	0	±0	0	0	0	±0	0	0	0	±0

Table 2:- WQI of Site 1

SITE 1						
Parameters	Mean	BIS Standards (Sn)	Ideal Value (V0)	unit weight	Qn	WnQn
Dissolved Oxygen (mg/L)	12	5	14	0.00148	22.222	0.0330
BOD (mg/L)	5.5	5	0	0.00148	110	0.1632
TDS(mg/L)	140.5	500	0	0.00001	28.1	0.0004
Total Hardness (mg/L)	112.5	200	0	0.00004	56.25	0.0021
pH	8.25	8.5	7	0.00087	83.33	0.0727
Copper	0	0.01	0	0.74178	0	0.0000
Molybdenum	0	0.07	0	0.10597	0	0.0000
Arsenic	0	0.05	0	0.14836	0	0.0000
						0.2714

Table 3:- WQI of Site 2

SITE 2						
Parameters	Mean	BIS Standards (Sn)	Ideal Value (V0)	unit weight	Qn	WnQn
Dissolved Oxygen (mg/L)	11	5	14	0.00148	33.333	0.0495
BOD (mg/L)	6	5	0	0.00148	120	0.1780
TDS(mg/L)	158	500	0	0.00001	31.6	0.0005
Total Hardness (mg/L)	122.5	200	0	0.00004	61.25	0.0023
pH	8.25	8.5	7	0.00087	83.3333	0.0727
Copper	0.03	0.01	0	0.74178	300	222.5348
Molybdenum	0	0.07	0	0.10597	0	0.0000
Arsenic	0	0.05	0	0.14836	0	0.0000
						222.8378

Table 4:- WQI of Site 3

SITE 3						
Parameters	Mean	BIS Standards (Sn)	Ideal Value (V0)	unit weight	Qn	WnQn
Dissolved Oxygen (mg/L)	15.5	5	14	0.00148	16.666	0.0247
BOD (mg/L)	4.5	5	0	0.00148	90	0.1335
TDS(mg/L)	139.5	500	0	0.00001	27.9	0.0004
Total Hardness (mg/L)	162.5	200	0	0.00004	81.25	0.0030
pH	8.3	8.5	7	0.00087	86.666	0.0756
Copper	0	0.01	0	0.74178	0	0.0000
Molybdenum	0	0.07	0	0.10597	0	0.0000
Arsenic	0	0.05	0	0.14836	0	0.0000
						0.2373

Table 5:- WQI of Site 4

SITE 4						
Parameters	Mean	BIS Standards (Sn)	Ideal Value (V0)	unit weight	Qn	WnQn
Dissolved Oxygen (mg/L)	18.5	5	14	0.00148	50	0.0742
BOD (mg/L)	2.5	5	0	0.00148	50	0.0742
TDS(mg/L)	139	500	0	0.00001	27.8	0.0004
Total Hardness (mg/L)	175	200	0	0.00004	87.5	0.0032
pH	8.5	8.5	7	0.00087	100	0.0873
Copper	0	0.01	0	0.74178	0	0.0000
Molybdenum	0	0.07	0	0.10597	0	0.0000
Arsenic	0	0.05	0	0.14836	0	0.0000
						0.2393

Table 6:- WQI of Site 5

SITE 5						
Parameters	Mean	BIS Standards (Sn)	Ideal Value (V0)	unit weight	Qn	WnQn
Dissolved Oxygen (mg/L)	12	5	14	0.00148	22.220	0.0330
BOD (mg/L)	5.5	5	0	0.00148	110.000	0.1632
TDS(mg/L)	131	500	0	0.00001	26.200	0.0004
Total Hardness (mg/L)	187.5	200	0	0.00004	93.750	0.0035
pH	8.75	8.5	7	0.00087	116.667	0.1018
Copper	0	0.01	0	0.74178	0.000	0.0000
Molybdenum	0	0.07	0	0.10597	0.000	0.0000
Arsenic	0	0.05	0	0.14836	0.000	0.0000
						0.3018



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