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Determination of WQI of River Yamuna Between Mathura and Agra Region

ATUL KUMAR, R.C. SHARMA and BABITA RATHORE

Departmant of Chemistry, CMJ University, Shillong, Meghalaya (India)

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Abstract

The present study was intended to calculate Water Quality Index (WQI) of five sample stations of river Yamuna from upstream of Mathura and downstream of Agra over a period of about one year from April 2002 to Jan 2003.

WQI, indicating the water quality in terms of index number, offers a useful representation of overall quality of water for public or for any intended use as well as in the pollution abatement programmes and in water quality management. A number of parameters affect the usability of water for a particular purpose. In this study water quality index (WQI) was determined on the basis of four physico-chemical parameters viz. pH, D.O., B.O.D and chloride.

On the basis of observations and results the water quality index value of upstream of Mathura and Agra has been found to be superior to other selected point but not suitable for drinking purpose.

Introduction

It is well known that clean water is absolutely essential for several purposes for healthy living[1]. The surface waterbodies, which are the most important sources of water for human activities are unfortunately under severe environmental stress and are being threatened as a consequence of developmental activities. Rapid industrial development in the last few decades has added huge loads of pollutants to our rivers[2,3]. Humans produce bodily wastes that enter the river and polluted water[4,5]. The chemistry of river waters is dictated by supply of various elements from both natural and anthropogenic sources[1,6]. The condition of these waterbodies is rather pathetic. Most of the water bodies disappeared due to encroachment and pollution. It is with this background, the present work was undertaken between April 2002 and Jan 2003.

Water Quality Index (WQI) provides a single number that expresses overall water quality at a certain location and time, based on several water quality parameters. The objective of water quality index is to turn complex water quality data into information that is understandable and usable by the public. A single number cannot tell the whole story of water quality; there are many other water quality parameters that are not included in the index. However, a water quality index based on some very important parameters can provide a simple indicator of water quality. In general, water quality indices incorporate data from multiple water quality parameters into a mathematical equation that rates the health of a water body with number[7].

In major Indian rivers water quality index has been calculated by Tiwari and Mishra[8] and Tiwari *et al*.[9] to determine the state of pollution. Although a lot of work has been carried out on the Indian rivers water quality index with different parameters by Lakshminaryan[10], Agarwal[11], Chatoupadhaya[12], Shrivastava[13], Singh *et al.*[14], Kumar *et al.*[15], Murthy[16], Yadav and Kumar[5], Yogendra and Puttaiah[7] but no work has been conducted on the WQI of our choosen area.

Materials and Methods

Study Area :

Pollution of river Yamuna is increasing steadily between Mathura and Agra region due to rapid pollution growth, industrial proliferation, urbanization, increasing living standards and wide spheres of human activities. Water quality index was calculated from the water quality parameters to assess the status of water quality of the river Yamuna for drinking purposes. The present study was conducted over a period of ten months (April 2002 to Jan 2003) to examine the following four parameters- pH, D.O., B.O.D and Chloride from river Yamuna water at five different sampling stations viz. Upstream of Mathura (near to Keshi Ghat- S1), Downstream of Mathura (Gokul Barrage- S2), upstream of Agra (Kailas Ghat- S3), Jawahar Bridge (S4) and downstream of Agra (rear to Taj Mahal- S5).

Water Sampling :

Water samples were collected regularly once a month from each site during the period between April 2002 to March 2003.

The water samples were collected in polyethylene containers or bottles of five liters capacity which were rinsed three times with samples and the collected samples were preserved and analyzed as per details contained in list – 1 (Appendix) in order to retard biological action, hydrolysis of chemical compounds and complexes and also to reduce volatility of constituents. Temperate, pH and dissolved oxygen (D.O.) were measured on the spot at the time of collection of water samples. For heavy metal studies, samples were also collected[17].

Appendix
List – 1
Sampling/Handling/Preservation

Parameters	Container	Optimum Storage Time	Method of Preservation
Turbidity	P	Within few days	Refrigerated
TDS	P	Several days	Refrigerated
pH	P.G.(B)	Analysed immediately	-
Alkalinity	P.G(B)	Analysed same day	Refrigerated
Total Hardness	P.G.(B)	Analysed same day	Refrigerated
Chlorides	P.G.	No time limit	Refrigerated
Dissolved Oxygen	P.	Same day As soon as possible	Within 2 hours
Biochemical Oxygen Demand	P.G.	Same day	-
Chemical Oxygen demand Used H_2SO_4 to acidify	P.G.	Same day	
Kheldahal nitrogen	P.G.	Same day (analysed as soon as possible)	Added H_2SO_4 Refrigerated
Nitrate	P.G.	No time limit	Added HCl
Sulphate	P.G.	Same day	
Phosphate	F	Analysed as soon as Possible	
Fluoride	F		
Heavy metals	P.G.(A)	No time limit	

Methodology :

Water Quality Index (WQI) was determined by using the data of four physico-chemical parameters (pH, D.O., B.O.D., Chloride) studied in laboratory during April 2002 to Jan 2003. Water Quality Indices of river Yamuna was estimated at five sampling stations from Mathura to Agra viz. Upstream of Mathura (near to Keshi Ghat- S_1), Downstream of Mathura (Gokul Barrage- S_2), upstream of Agra (Kailas Ghat- S_3), Jawahar Bridge (S_4) and downstream of Agra (rear to Taj Mahal- S_5).

Water Quality Index has been estimated over a period of ten months (April 2002 to Jan 2003). Water Quality Index was calculated by using the method as quoted by Yogendra and Puttaiah[7]. For calculating WQI the following equations were used:

(i) Quality rating (qn)=100 $[(V_n-V_i)/ (V_s-V_i)]$ where

V_n = Actual amounts (Presents in the polluted water of the n^{th} parameter)

V_i= The ideal values of this parameter since.

[V_i= 0, for the suitable water except pH and D.O., of which 7.0 and 14.6 mg/lit, respectively].

V_s= it is standard.

(ii) Unit weight (W_n) for various parameters are inversely proportional to the recommended standard (S_n) of the corresponding parameters.

$W_n=K/S_n$

W_n= Unit weight for n^{th} parameters.

S_n= Standard value for n^{th} parameters

K= Constant for propotionality

(iii) WQI = WQI = $\Sigma q_n W_n / \Sigma W_n$

Table-1
Water quality parameters their ICMR/WHO standard and assigned unit weight

Water quality parameters	ICMR/WHO standard mg/l	Unit weight
pH	6.5-8.5	0.2190
Dissolved oxigen (D.O)	5	0.3723
Biological Oxigen demand (B.O.D)	5	0.3723
Chloride (Cl^-)	250	0.0074

Table-2 Vn and Qn values of different parameters of Yamuna river water (up stream of Mathura-Near to Keshi Ghat S1)

	Apr. 02		May.02		Jun.02		Jul.02		Aug.02	
	V_n	Q_n	V_n	Q_n	V_n	Q_n	V_n	Q_n	V_n	Q_n
pH	8.1	73.33	8.2	80.00	8.2	80.00	7.4	26.67	7.5	33.33
Dissolved oxigen (D.O)	7.3	76.04	5.8	91.67	5.6	93.75	7.0	79.17	6.5	84.38
Biological Oxigen demand (B.O.D)	21.0	420.00	21.7	434.00	22.5	450.00	13.2	264.00	14.0	280.00
Chloride (Cl^-)	283	113.20	294	117.60	306	122.40	228	91.20	222	88.80

	Sept.02		Oct.02		Nov.02		Dec.02		Jan.03	
V_n	Q_n	V_n	Q_n	V_n	Q_n	V_n	Q_n	V_n	Q_n	
pH	8.0	66.67	7.9	60.00	8.1	73.33	8.0	66.67	8.0	66.67
Dissolved oxigen (D.O)	7.5	73.96	7.4	75.00	6.8	81.25	7.2	77.08	8.2	66.67
Biological Oxigen demand (B.O.D)	15.5	310.00	16.0	320.00	16.9	338.00	16.2	324.00	16.2	324.00
Chloride (Cl^-)	244	97.60	265	106.00	283	113.20	271	108.40	269	107.60

Table-3 Vn and Qn values of different parameters of Yamuna river water (Gokul barrage S2)

	Apr. 02		May.02		Jun.02		Jul.02		Aug.02	
	V_n	Q_n	V_n	Q_n	V_n	Q_n	V_n	Q_n	V_n	Q_n
pH	8.3	86.67	8.3	86.67	8.4	93.33	7.8	53.33	7.9	60.00
Dissolved oxigen (D.O)	3.1	119.79	3.4	116.67	3.2	118.75	4.6	104.17	4.9	101.04
Biological Oxigen demand (B.O.D)	29	580.00	27.5	550.00	28.8	576.00	21.7	434.00	21.2	424.00
Chloride (Cl^-)	293	117.20	297	118.80	302	120.80	230	92.00	231	92.40

	Sept.02		Oct.02		Nov.02		Dec.02		Jan.03	
	V_n	Q_n	V_n	Q_n	V_n	Q_n	V_n	Q_n	V_n	Q_n
pH	8.1	73.33	8.2	80.00	8.1	73.33	8.1	73.33	8.3	86.67
Dissolved oxigen (D.O)	5.3	96.88	5.9	90.63	5.4	95.83	6.1	88.54	5.1	98.96
Biological Oxigen demand (B.O.D)	20.4	408.00	18.2	364.00	19.7	394.00	17	340.00	20.7	414.00
Chloride (Cl^-)	254	101.60	283	113.20	299	119.60	280	112.00	282	112.80

Table-4 Vn and Qn values of different parameters of Yamuna river water (Up stream of Agra-Kailash Ghat S3)

	Apr. 02		May.02		Jun.02		Jul.02		Aug.02	
	V_n	Q_n	V_n	Q_n	V_n	Q_n	V_n	Q_n	V_n	Q_n
pH	8.3	86.67	8.4	93.33	8.4	93.33	7.8	53.33	7.8	53.33
Dissolved oxigen (D.O)	5.9	90.63	4.6	104.17	4.4	106.25	6.4	85.42	6.7	82.29
Biological Oxigen demand (B.O.D)	24.0	480.00	25.0	500.00	25.9	518.00	17.4	348.00	18.0	360.00
Chloride (Cl^-)	293	117.20	298	119.20	305	122.00	225	90.00	221	88.40

	Sept.02		Oct.02		Nov.02		Dec.02		Jan.03	
	V_n	Q_n	V_n	Q_n	V_n	Q_n	V_n	Q_n	V_n	Q_n
pH	7.9	60.00	8.2	80.00	8.2	80.00	8.1	73.33	8.1	73.33
Dissolved oxigen (D.O)	6.9	80.21	6.5	84.38	6.6	83.33	7.5	73.96	7.2	77.08
Biological Oxigen demand (B.O.D)	17.5	350.00	18.4	368.00	18.0	360.00	18.0	360.00	18.3	366.00
Chloride (Cl^-)	242	96.80	266	106.40	280	112.00	277	110.80	282	112.80

Table-5 Vn and Qn values of different parameters of Yamuna river water (Jawahar Bridge S4)

	Apr. 02		May.02		Jun.02		Jul.02		Aug.02	
	V_n	Q_n	V_n	Q_n	V_n	Q_n	V_n	Q_n	V_n	Q_n
pH	8.4	93.33	8.4	93.33	8.5	100.00	7.9	60.00	7.9	60.00
Dissolved oxigen (D.O)	4.9	101.04	4.0	110.42	4.2	108.33	5.4	95.83	6	89.58
Biological Oxigen demand (B.O.D)	28.1	562.00	31.5	630.00	30.0	600.00	22.4	448.00	22.0	440.00
Chloride (Cl^-)	315	126.00	320	128.00	324	129.60	235	94.00	245	98.00

	Sept.02		Oct.02		Nov.02		Dec.02		Jan.03	
	V_n	Q_n	V_n	Q_n	V_n	Q_n	V_n	Q_n	V_n	Q_n
pH	7.9	60.00	8.2	80.00	8.2	80.00	8.1	73.33	8.2	80.00
Dissolved oxigen (D.O)	6.4	85.42	6.1	88.54	6.3	86.46	6.6	83.33	6.2	87.50
Biological Oxigen demand (B.O.D)	23.0	460.00	22.7	454.00	20.5	410.00	19.6	392.00	20.5	410.00
Chloride (Cl^-)	259	103.60	281	112.40	295	118.00	290	116.00	298	119.20

Table-6 Vn and Qn values of different parameters of Yamuna river water (Down stream of Agra-rear to Taj Mahal S5)

	Apr. 02		May.02		Jun.02		Jul.02		Aug.02	
	V_n	Q_n	V_n	Q_n	V_n	Q_n	V_n	Q_n	V_n	Q_n
pH	8.5	100.00	8.5	100.00	8.6	106.67	7.9	60.00	7.9	60.00
Dissolved oxigen (D.O)	3.0	120.83	3.0	120.83	2.9	121.88	3.6	114.58	3.5	115.63
Biological Oxigen demand (B.O.D)	34.0	680.00	33.0	660.00	36.0	720.00	29.0	580.00	28.8	576.00
Chloride (Cl^-)	328	131.20	339	135.60	337	134.80	241	96.40	265	106.00

	Sept.02		Oct.02		Nov.02		Dec.02		Jan.03	
	V_n	Q_n	V_n	Q_n	V_n	Q_n	V_n	Q_n	V_n	Q_n
pH	8.2	80.00	8.3	86.67	8.3	86.67	8.2	80.00	8.2	80.00
Dissolved oxigen (D.O)	3.4	116.67	3.2	118.75	4.1	109.38	4.0	110.42	3.7	113.54
Biological Oxigen demand (B.O.D)	28.0	560.00	30.0	600.00	29.5	590.00	29.5	590.00	29.5	590.00
Chloride (Cl^-)	250	100.00	285	114.00	298	119.20	302	120.80	307	122.80

Table-7. Water quality index (WQI) of river Yamuna in between Mathura and Agra region

	Apr. 02	May.02	Jun.02	Jul.02	Aug.02
Upstream of Mathura (Near to Keshi Ghat S1)	207.59	220.49	227.46	138.90	147.9
Gokul Barrage (S2)	288.75	276.07	288.35	219.07	215.55
Up stream of Agra (Kailash Ghat S3)	239.23	253.61	261.33	178.89	182.29
Jawahar Bridge (S4)	276.23	305.92	295.13	222.76	217.33
Downstream of Agra (rear to Taj Mahal S5)	330.61	322.97	347.88	280.58	279.52

	Sept.02	Oct.02	Nov.02	Dec.02	Jan.03
Upstream of Mathura (Near to Keshi Ghat S1)	163.00	165.8	178.2	169.60	165.60
Gokul Barrage (S2)	210.89	193.2	205.3	181.70	217.10
Up stream of Agra (Kailash Ghat S3)	179.22	192.3	188.9	183.80	187.30
Jawahar Bridge (S4)	223.45	226.9	209.3	199.70	209.70
Downstream of Agra (rear to Taj Mahal S5)	278.25	296.00	288.60	287.50	288.70

Result and Discussion

ICMR Standard values of selected parameters and unit weight (W_n), V_n and quality rating (q_n) of different parameters at selected sites has been calculated. WQI value at these sites on the river Yamuna between Mathura to Agra region have been presented (Tables 1-7)

For the present study it has been assumed that water having WQI < 50 will be treated as fit for human consumption, WQI < 100 will be excessive polluted and > 100 will be considered as severely polluted (table given below).

A decisive study of table 7 reveals many important features concerning the status of water quality of river Yamuna in all five sampling stations of the study area.

Table: Water quality index (WQI) and Status of water quality (Chatterjee and Raziuddin[17])

Water quality levels (WQI)	Water 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

According to the table 7 it is clear that the value of water quality index is more than 100 in all the sampling stations. The higher value of WQI at S5 may be due to many nallas of city foundary effluents, domestic sewage, agriculture run off, washing, bathing, cremation and dumping of human and animal dead bodies. The WQI lower has been found at the sampling station S1 which is situated at upstream of

Mathura.

According to WQI values for each sampling stations water is not suitable for drinking purpose before its treatment.

Conclusion

The water of river Yamuna is highly contaminated at all the stations during the course of study and it is unfit for consumption, domestic and irrigation purposes. Some steps are needed urgently to improve the quality of river Yamuna.

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