

Assessment of Water Quality Index of Different Sources of Water Supply in Jabalpur City

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ABSTRACT: The present study was carried out to assess the water quality index of different sources of water supply in Jabalpur city based on weighted arithmetic WQI. This has been determined by collecting the samples from Intake points of sources of raw water used for supply. The intake points are as follows 1.Pariyat 2.Khandari 3.Lalpur 4.Ramnagra. The samples were analysed for various physicochemical parameters. For calculating the WQI, the following parameters has been considered: Ph, Electrical conductivity, Total dissolved Solids, Total alkalinity, Total Hardness, chlorides, Nitrates, Sulphate, DO, BOD, and Turbidity. The sums of these are substituted in the equation to obtain WQI. This made authors to analyse the WQI of intake points used for water supply in Jabalpur city with an objective to assess the water quality for drinking and domestic purposes.

KEYWORDS: WQI, Electrical conductivity, BOD, DO.

I. INTRODUCTION

Water is essential to the survival of all living beings on our planet. We need consumption of water for our good health. In general, people might lack water about 3-5 days if more than we could have died. Nowadays water quality of surfaces sources degrading due to anthropogenic activities, urbanisation, rapid increasing population leads to pressure on existing sources, discharge of untreated sewage directly into the water sources etc [1]. So it's become very important to do continuous monitoring of certain water quality indicators or parameters in order to keep the health of water bodies at good condition [2].

Water Quality Index is significant method to summarise large amount of water quality data into single numeric value that indicates its quality (e.g. excellent, good, poor etc) & make easy to report to managers and the public in a consistent manner [3]. A WQI provides a single number that expresses overall water quality at a certain location and time, based on several water quality parameters [4]. WQI is useful tool in comparison of different sources of water in terms of water quality and give general idea to policy makers and public of the possible problems with the particular water sources [5].

The indices are among the most effective ways to communicate the information on water quality trends for the water quality management [6].

Jabalpur is one of the most famous cities of Madhya Pradesh India. This City is located at 23°10'North Latitude and 79°57'East longitude, at an altitude of 393 meters above mean sea level [7]. The water sources for drinking water supply in the Jabalpur are met by three major surface water supply projects are 1.Khandari Reservoir and Gaur River Water Supply Project; 2. Pariyat and Phagua Nallah Water supply Project and 3.Narmada River Water Supply Project [8].

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II. MATERIALS AND METHODS

Water samples were collected from the four different sampling locations in Jabalpur City. The sampling locations were selected as follows 1. Pariyat Reservoir, 2. Khandari Reservoir, 3. Lalpur and 4. Ramnagra. Sampling locations were selected according to the intake point of raw water used by water supply department. The samples were stored in 1.0 litre plastic bottles which were well rinsed with 3 times with distilled water. BOD 300ml bottles were used for DO and BOD test [9]. Sample collection was usually completed during mornings between 9.00AM to 12.00 PM every for further analysis. Samples were assessed for 11 parameters namely pH, Electrical Conductivity, Turbidity, Total Dissolved Solid, Total Hardness, alkalinity, Nitrates, Sulphates, Chlorides, dissolved oxygen, BOD following the procedures outlined in the standard methods for the examination of water and wastewater [10].

III. CALCULATION OF WATER QUALITY INDEX

The calculations of WQI are done as per weighted arithmetic water quality index which was originally proposed by Horton (1965) and developed by Brown et al (1972) [11][12]. IS 10500 and WHO standards of drinking water were used for WQI calculations. Weighted arithmetic water quality index method classified the water quality according to the degree of purity by using the most commonly measured water quality parameters [3]. This method has been widely used by the scientists [4].

The weighted water quality index (WQI_A) is in the following form:

$$WQI_A = \frac{\sum_{i=1}^n W_i Q_i}{\sum_{i=1}^n W_i}$$

Where n is the number of parameters,
 W_i is the relative weight of the ith parameter and
 Q_i is the water quality rating of the ith parameters.

The unit weight (W_i) of the various water quality parameters are inversely proportional to the recommended standards for the corresponding parameters. According to Brown et al (1972), the value of Q_i is calculated using following equation:

$$Q_i = 100[(V_i - V_{id}) / (S_i - V_{id})]$$

where V_i is the observed value of the ith parameter,
 S_i is the standard permissible value of the ith parameter and
 V_{id} is the ideal value of the ith parameter in pure water.
All the ideal values (V_{id}) are taken as zero for drinking water except pH and dissolved oxygen [13].

For pH, the ideal value is 7.0 (pure water) and a permissible value is 8.5 (for polluted water). Therefore, the quality rating for pH is calculated from the following equation:

$$Q_{pH} = 100[(V_{pH} - 7.0) / (8.5 - 7.0)]$$

Where V_{pH} = observed value of pH.

For dissolved oxygen, the ideal value is 14.6 mg/l and the standard permissible value for drinking water is 5 mg/l. Therefore, its quality rating is calculated from the following equation:

$$Q_{DO} = 100[(V_{DO} - 14.6) / (5.0 - 14.6)]$$

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Where V_{DO} =observed value of dissolved oxygen.

Calculations of Relative weight (W_n): The unit weight (W_n) to various water quality parameters is inversely proportional to the recommended standards for the corresponding parameters.

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

Where,

W_n =unit weight for nth parameter

S_n = standard permissible value for nth parameter

K = proportionality constant

$$K = \frac{1}{\sum \frac{1}{S_n}}$$

TABLE 1 Classification of water quality based on weighted arithmetic WQI [3]

WQI	STATUS	GRADING`
0-25	Excellent water quality	A
26-50	Good water quality	B
51-75	Poor water quality	C
76-100	Very poor water quality	D
Above 100	Unsuitable for Drinking	E

TABLE 2. Drinking Water standards recommending Agencies and methods employed (all values except pH and Electrical conductivity are in mg/l) [14][15].

S.No	PARAMETERS	STANDARDS	RECOMMENDED AGENCY/STANDARDS	METHODS
1.	pH	6.5 - 8.5	IS 10500	Digital pH meter
2.	Turbidity, NTU	5	IS 10500	Nephlo-turbidity meter
3.	Electrical Conductivity, $\mu s / cm$	1400	WHO	conductometry
4.	Alkalinity, mg/l	200	IS 10500	Titration Method
5.	Chloride, mg/l	250	IS 10500	Argentometric method
6.	Total Hardness, mg/l	300	IS 10500	EDTA Method
7.	BOD, mg/l	5	WHO	BOD ₅ at 20°C
8.	DO, mg/l	5	WHO	Modified wrinkler method
9.	Nitrates, mg/l	45	IS 10500	spectrophotometer
10.	Sulphate, mg/l	200	IS 10500	spectrophotometer
11.	TDS, mg/l	500	IS 10500	Filtration Method

IV. RESULT AND DISCUSSIONS

The various physico-chemical parameters of different sources are analysed according to CPCB lab manual Water quality Test.

Table 3 below gives the observed values (V_i) of the (11) selected physicochemical parameters of water samples (collected in month of sept. 2017) at Pariyat, standard drinking water according to IS 10500 – 2012 and WHO, unit weights (W_i), water quality (Q_i) and W_iQ_i .

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TABLE 3:- PARIYAT RESERVOIR WQI CALCULATION

S. No	Parameters	Observed Value	Standards (S_n)	Unit weight (w_n)	Quality Rating (Q_n)	$W_n Q_n$
1.	pH	7.61	6.5-8.5	0.1316	40.66	5.350
2.	Turbidity, NTU	2.2	5	0.2238	44	9.847
3.	Conductivity, $\mu\text{s/cm}$	217	1400	7.992×10^{-4}	15.5	0.0123
4.	Alkalinity, mg/l	28	200	5.595×10^{-3}	14	0.0783
5.	Chloride, mg/l	4	250	4.476×10^{-3}	1.6	7.161×10^{-3}
6.	Total Hardness, mg/l	60	300	3.73×10^{-3}	20	0.0746
7.	BOD, mg/l	2.4	3	0.373	80	29.84
8.	DO, mg/l	7.1	5	0.2238	78.125	17.484
9.	Nitrates	3.95	45	0.0248	8.777	0.2176
10.	Sulphate	13.88	200	5.595×10^{-3}	6.94	0.0388
11.	TDS	144	500	2.238×10^{-3}	28.8	0.0644
				$\sum W_n = 0.9994$ ~ 1		$\sum W_n Q_n = 63.014$

$$WQI = \frac{\sum W_n Q_n}{\sum W_n} = \frac{63.014}{1} \quad WQI = 63.014 \text{ (Poor Water Quality)}$$

The WQI value of Pariyat falls within 51-75 of the classification of water quality based on weighted arithmetic WQI method as given in Table 2. It indicates Poor Quality and must therefore be treated to avoid water related diseases.

TABLE 3:- KHANDARI RESERVOIR WQI CALCULATION

S. No	Parameters	Observed Value	Standards (S_n)	Unit weight (w_n)	Quality Rating (Q_n)	$W_n Q_n$
1.	pH	7.51	6.5-8.5	0.1316	34	4.4744
2.	Turbidity, NTU	1.6	5	0.2238	32	7.1616
3.	Conductivity, $\mu\text{s/cm}$	191.3	1400	7.992×10^{-4}	13.664	0.0109
4.	Alkalinity, mg/l	23	200	5.595×10^{-3}	11.5	0.0643
5.	Chloride, mg/l	2.99	250	4.476×10^{-3}	1.196	5.353×10^{-3}
6.	Total Hardness, mg/l	54	300	3.73×10^{-3}	18	0.06714
7.	BOD, mg/l	2.2	3	0.373	73.333	27.353
8.	DO, mg/l	7.3	5	0.2238	76.041	17.0179
9.	Nitrates	1.943	45	0.0248	4.3177	0.1070
10.	Sulphate	4.58	200	5.595×10^{-3}	2.29	0.0128
11.	TDS	105	500	2.238×10^{-3}	21	0.0469

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				$\sum W_n = 0.999433$ ~ 1	$\sum W_n Q_n =$ 56.320
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$$WQI = \frac{\sum W_n Q_n}{\sum W_n} = \frac{56.320}{1} \quad WQI = 56.32 \text{ (Poor Water Quality)}$$

The WQI value of Khandari falls within 50-75 of the classification of water quality based on weighted arithmetic WQI method as given in Table 3. It indicates poor water quality therefore must treated to use to avoid water related diseases.

TABLE 4:- LALPUR (WATER QUALITY INDEX)

S. No	Parameters	Observed Value	Standards (S_n)	Unit weight (w_n)	Quality Rating (Q_n)	$W_n Q_n$
1.	pH	7.35	6.5-8.5	0.1316	23.333	3.070
2.	Turbidity, NTU	0.3	5	0.2238	6	1.3428
3.	Conductivity, $\mu\text{s} / \text{cm}$	328.5	1400	7.992×10^{-4}	23.464	0.0187
4.	Alkalinity, mg/l	14	200	5.595×10^{-3}	7	0.039165
5.	Chloride, mg/l	1.99	250	4.476×10^{-3}	0.796	3.562×10^{-3}
6.	Total Hardness, mg/l	76	300	3.73×10^{-3}	25.33	0.0944
7.	BOD, mg/l	1.4	3	0.373	46.666	17.406
8.	DO, mg/l	7.9	5	0.2238	69.791	15.619
9.	Nitrates	3.74	45	0.0248	8.311	0.2061
10.	Sulphate	0.937	200	5.595×10^{-3}	0.4685	2.621×10^{-3}
11.	TDS	118	500	2.238×10^{-3}	23.6	0.0528
				$\sum W_n = 0.999433$ ~ 1		$\sum W_n Q_n =$ 37.855

$$WQI = \frac{\sum W_n Q_n}{\sum W_n} = \frac{37.855}{1} \quad WQI = 37.855 \text{ (Good Water Quality)}$$

The WQI value of Lalpur falls within 25-50 of the classification of water quality based on weighted arithmetic WQI method as given in Table 4. It indicates good water quality.

TABLE 5. RAMNAGRA (WATER QUALITY INDEX)

S. No	Parameters	Observed Value	Standards (S_n)	Unit weight (w_n)	Quality Rating (Q_n)	$W_n Q_n$
1.	pH	7.31	6.5-8.5	0.1316	20.666	2.7196
2.	Turbidity, NTU	0.5	5	0.2238	10	2.238
3.	Conductivity, $\mu\text{s} / \text{cm}$	341.1	1400	7.992×10^{-4}	24.364	0.0194
4.	Alkalinity, mg/l	16	200	5.595×10^{-3}	8	0.04476
5.	Chloride, mg/l	2.99	250	4.476×10^{-3}	1.196	5.353×10^{-3}
6.	Total Hardness, mg/l	72	300	3.73×10^{-3}	24	0.08952
7.	BOD, mg/l	1.6	3	0.373	53.33	19.892

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8.	DO, mg/l	7.6	5	0.2238	72.9166	16.318
9.	Nitrates	3.86	45	0.0248	8.577	0.2127
10.	Sulphate	1.517	200	5.595×10^{-3}	0.7585	4.243×10^{-3}
11.	TDS	123	500	2.238×10^{-3}	24.6	0.0550
				$\sum W_n = 0.99943$ ~ 1		$\sum W_n Q_n =$ 41.59

$$WQI = \frac{\sum W_n Q_n}{\sum W_n} = \frac{41.59}{1}$$

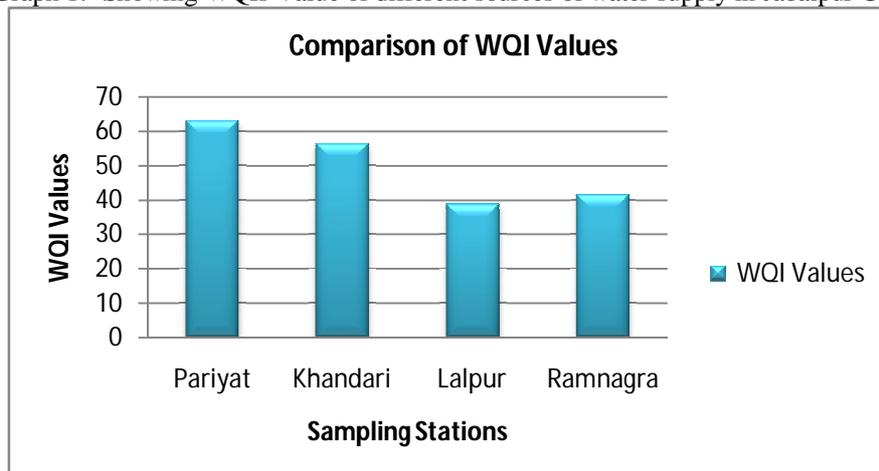
WQI = 41.59 (Good Water Quality)

The WQI value of Ramnagra falls within 26-50 of the classification of water quality based on weighted arithmetic WQI method as given in Table 5. It indicates good water quality.

TABLE 6:- Summarised WQIs Value of different sources[3]

Sampling point	WQI Value	Status	GRADING
Pariyat	63.01	Poor Water Quality	C
Khandari	56.32	Poor Water Quality	C
Lalpur	37.85	Good Water Quality	B
Ramnagra	41.59	Good Water Quality	B

Graph 1:- Showing WQIs Value of different sources of water supply in Jabalpur City



V. CONCLUSION

The objective of the study was to assess the Water Quality Index of different sources of water supply in Jabalpur City. The WQI of pariyyat, khandari, lalpur and Ramnagra were 63.01, 56.32, 38.85 and 41.59 respectively and clear indicating that water quality of lalpur and ramnagra are good But, WQI of Khandari and pariyyat indicating poor water quality and therefore be treated before use to avoid water related diseases. By comparing WQI of four Water

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Sources used for supply through which i found that best water quality is of Lalpur then ramangra followed by khandari. The poorest water quality among them is of pariyat.

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