Original Article

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WQI at Different Stations along the Mula River

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Abstract

The present study was intended to calculate Water Quality Index (WQI) of a Mula River Rahuri, Ahmednagar District in order to ascertain the quality of water for public uses and other purposes. This paper deals with the study on the influence of environmental parameters on the water quality of reservoir. Water Quality Index, indicating the water quality in terms of index number, offers a useful representation of overall quality of water for public as well as in the pollution abatement programmes and in water quality management. In this study Water Quality Index was determined on the basis of various physico-chemical parameters like pH, Electrical Conductivity, Total dissolved Solids, Total Hardness, dissolved oxygen, calcium, Magnesium, Biochemical Oxygen Demand, Chemical Oxygen Demand.

Keywords: Reservoir; Physico-Chemical Parameters; Drinking Water Quality.

Introduction

The surface water bodies, 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 a developmental activities. Mula reservoir which lies in Rahuri Tehsil of Ahmednagar district to provide water for domestic, irrigation as well as industrial purposes. It is with this background, the present work was carried out between 2013 and 2014. Water quality index provides a single number that expresses overall water quality at a certain location and time based on several water quality parameters. A single number cannot tell whole storyof 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. Water quality indices incorporate data from multiple water quality parameters into a mathematical equation.

Study Area

Mula Basin is situated on 19° 21' 30" N latitude, and 74° 34' 30" E longitudes at 555.650 m above mean sea level. The Mula rises on the eastern slopes of the Sahyadri between Ratangad and Harishchandragad. For the first 25 km., it flows parallel to the Pravara draining the southernmost Kotul valley of Akola taluka. The river is incised in a deep valley almost from its source and its steep valley-sides are highly dissected by deep gullies formed by mountain torrents which rush into the main stream. Skirting the large market village of Kotul it takes a bend to the south, winding past the rocky precipitous slopes at the foot of Baleshwar hills. It then flows through the south-west parts of Sangamnertaluka and follows an easterly course between Shevgaon and Parnertalukas flowing in a deep bed between rugged hills on the north and the table land of Vasunda on the south. It then takes a sudden turn to the north-east and enters the plains in the same direction for another 30 km. It joins the Pravara at the village of Tilapur. The total

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length of the river from its source to its confluence with the Pravara is 145 km.; except in lower parts of its course on account of an entrenched course, the Mula is used for agriculture only in alluvial flats on the foot of the rugged ledges cutting into the river-bed. Sample locations were shown in **Figure 1.**

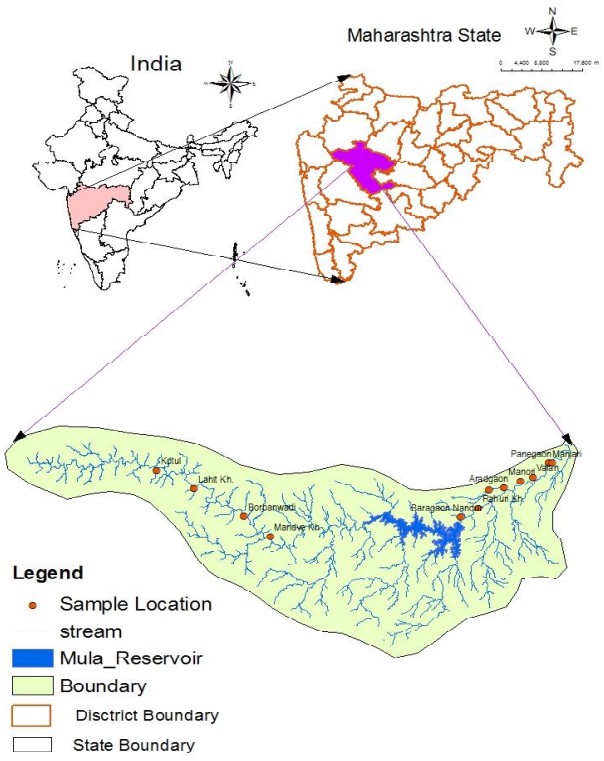

Fig. 1: Sample locations along the Mula River

Materials and Methods

The Reservoir water samples of Mula Dam were collected aseptically in 1 L plastic bottles and analyzed for various properties. These bottles were properly labeled and then the sample bottles were kept in the Refrigerator. Standard methods for river water analysis were given in **Table1**.

In this study, Water-quality index (WQI) was calculated for assessing the water quality at Mula Reservoir in pre, post monsoon and rainy season 2013-14. WQI of Mula reservoir was calculated as proposed by Tiwari and Mishra (1985). WQI is calculated by using standards of drinking water quality recommended by the World Health Organization (WHO), Bureau of Indian standards(BIS) and Indian Council of Medical Research (ICMR). The weighted arithmetic index method has been used for the calculation of WQI of the water Sample. Further, quality rating or sub index (q_n) was calculated using the following expression (1). In order to calculate WQI nine important parameters pH, dissolved oxygen (DO), total dissolved solids(TDS), electrical conductivity(EC), Calcium(Ca), magnesium(Mg), Alkalinity, Hardness and BOD used. These parameters maximum contribute for the quality of reservoir.

$$q_n=100[V_n-v_{io}]/[S_n-v_{io}] \quad (1)$$

Table 1: Standard method for River water analysis

Sr. No.	Particulars	Methods	Reference
1.	pH	Potentiometric	Jackson(1973)
2.	EC	Conductometric	Jackson(1973)
3.	Alkalinity	Potentiometric titration	APHA, 2000
4.	Hardness	Titrimetric (EDTA)	APHA, 2000
5.	BOD	Winkler titration	Franson(1985)
6.	COD	Reflux	Franson(1985)
7.	TDS	Gravimetric	Franson(1985)
8.	Ca^{++} and Mg^{++}	Versenate titration	Page *et al.* (1982)
9.	DO	Winkler method	APHA, 2000
10.	Temperature	Thermometer	APHA, 2000

Let there be n water quality parameters and quality rating or sub index (q_n) corresponding to n^{th} parameter is a number reflecting the relative value of this parameter in the polluted water with respect to its standard permissible value.

q_n = Quality rating for the nth water quality parameter

V_n = Estimated value of the nth parameter at a given sampling station.

S_n = Standard permissible value of the nth parameter.

V_{io} =Ideal value of nth parameter in pure water. (i.e., 0 for all other parameters except the parameter pH and Dissolved oxygen (7.0 and 14.6 mg/l respectively).

Weightage

Factors which have higher permissible limits are less harmful because they can harm quality of river

water when they are present in very high quantity. So weightage of factor has an inverse relationship with its permissible limits. Therefore

$W_n \alpha 1/S_n$ or $W_n = K/S_n$ (2)

Where, K = constant for proportionality

W_n = unit weight for the n^{th} parameters.

S_n = Standard value for n^{th} parameters.

Values of K are calculated as: $K = \frac{1}{\Sigma(\frac{1}{Sn})}$ (3)

$$\Sigma(\frac{1}{Sn}) = \frac{1}{Sn(pH)} + \frac{1}{Sn(DO)} + \frac{1}{Sn(EC)} + \frac{1}{Sn(TDS)} + \frac{1}{Sn(Ca)} + \frac{1}{Sn(mg)} + \frac{1}{Sn(hardness)} + \frac{1}{Sn(Alalinity)} + \frac{1}{Sn(BOD)} \quad (4)$$

The weightage of all the factors are calculated on the basis of the above equation.

The overall Water Quality Index was calculated by aggregating the quality rating with the unit weight linearly.

$WQI = Óq_n W_n / ÓW_n$ (5)

Table 2: Drinking Water standards recommending Agencies and unit weights.(All values except pH and Electrical Conductivity are in mg/L)

Sr. No.	Parameters	Standards	Recommended agency	Unit Weight
1.	pH	6.5-8.5	ICMR/BIS	0.2190
2.	Electrical conductivity	300	ICMR	0.371
3.	Total Dissolved Solids	500	ICMR/BIS	0.0037
4.	Alkalinity	120	ICMR	0.0155
5.	Hardness	300	ICMR/BIS	0.0062
6.	Calcium	75	ICMR/BIS	0.025
7.	Magnesium	30	ICMR/BIS	0.061
8.	Dissolved Oxygen	5.00	ICMR/BIS	0.3723
9.	Biological Oxygen Demand	5.00	ICMR	0.3723

Table 3: Water Quality Index (WQI) and status of water quality (Chatterji and Raziuddin 2002)

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

Results and Discussion

Table 4: Physicochemical properties of stagnant surface water sample in Mula River (Pre-season) 2/2/14 to 7/2/14

Location	Ca (mg/l)	Mg (mg/l)	pH	Ec	TDS (mg/l)	COD (mg/l)	BOD (mg/l)	DO (mg/l)	Hardness (mg/l)	Alkalinity (mg/l)	Temp (°c)	WQI
BaragaonNandur	3.2	0.3	8.6	0.543	347.5	970	3.3	7.0	0.09375	44	15	53.83
RahuriBudruk	2.5	0.7	8.7	0.932	596.5	1310	25	7.1	0.28	96	14	167.65
RahuriKhurd	2.5	0.4	8.3	0.671	429.4	890	5.2	7.0	0.16	44	15	61.07
Deswandi	4.3	2.3	8.5	0.279	178.5	1310	25	8.5	0.53488	56	13	161.27
Aradgaon	8.9	0.8	8.5	0.136	87.04	1100	21	2.3	0.08989	150	12	**50.25**
Valan	6.2	2.1	8.1	0.214	136.96	510	3.0	7.1	0.33871	70	13	**48.08**
Manori	5.2	2.1	8.3	0.217	138.8	630	2.7	4.1	0.40385	30	13	55.96
Manjari	6.1	2.0	8.5	0.134	85.76	210	2.8	0.8	0.32787	80	14	67.76
Panegaon	6.8	2.9	8.2	0.147	94.08	1010	3.2	1.3	0.42647	98	16	65.76
Mula Dam	2.1	0.2	7.6	0.112	71.68	45	0.1	0	0.09524	30	14	**15.33**
Kotul	4.3	2.3	8.1	0.240	153.6	112	1.2	0	0.53488	20	17	**17.98**
LahitKhurd	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	-
Borbanwadi	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	-
MandaveKhurd	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	-

Table 5: Physicochemical properties of flowing water sample in Mula River (Post-season) 3/12/14 to 7/12/14

Location	Ca (mg/l)	Mg (mg/l)	pH	Ec	TDS (mg/l)	COD (mg/l)	BOD (mg/l)	DO (mg/l)	Hardness(mg/l)	Alkalinity (mg/l)	Temp (°c)	WQI
BaragaonNandur	2.5	1.4	8.2	0.447	286.1	840	6.4	0	0.56	14	15	84.79
RahuriBudruk	2.2	0.1	8.1	0.844	540.2	1300	32	1.3	0.045	46	14	212.38
RahuriKhurd	1.5	1.2	8.4	0.761	487.0	490	11.4	1.9	0.8	22	15	107.61
Deswandi	4.1	2.0	7.8	0.179	114.5	1200	31	0	0.48	26	13	207.54
Aradgaon	8.2	1.2	6.6	0.125	80	910	33	2.9	0.146	30	12	205.17
Valan	3.3	3.4	6.5	0.239	152.9	830	7.3	7.0	1.030	10	15	62.50
Manori	6.3	2	7.5	0.209	133.7	320	5.4	6.3	0.317	5	13	55.67
Manjari	5.1	2.0	7.6	0.135	86.4	110	7.2	1.8	0.391	20	19	78.09
Panegaon	6.4	2.9	7.7	0.190	121.6	811	9.0	2.7	0.453	48	18	86.39
Mula Dam	2.2	0.2	7.8	0.110	70.4	100	13.6	0.1	0.090	10	13	117.21
Kotul	4.4	2.3	8.1	0.443	283.52	115	12.4	7.0	0.522	05	17	95.99
LahitKhurd	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	-
Borbanwadi	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	-
MandaveKhurd	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	-

Table 6: Physicochemical properties of surface water sample in Mula River (Rainy season) 5/6/14 to 13/6/14

Location	Ca (mg/l)	Mg (mg/l)	pH	Ec	TDS (mg/l)	COD (mg/l)	BOD (mg/l)	DO (mg/l)	Hardness (mg/l)	Alkalinity (mg/l)	Temp (°c)	WQI
BaragaonNandur	2.9	0.2	7.8	0.499	319.4	950	6.1	1.1	0.068	10	15	76.08
RahuriBudruk	2.4	0.5	8.0	0.823	526.7	1605	25	1.2	0.208	26	12	175.46
RahuriKhurd	2.5	1.4	8.2	0.651	416.6	870	10.4	1.5	0.56	20	11	101.50
Deswandi	3.9	2.2	8.5	0.317	202.1	1309	21	0.3	0.564	15	10	162.29
Aradgaon	7.3	1.8	8.5	0.132	84.48	1090	23	2.1	0.246	10	12	167.67
Valan	4.1	1.1	8.1	0.223	142.9	925	6.3	4.0	0.268	05	13	72.36
Manori	4.9	1.3	8.3	0.310	198.4	620	4.4	3.3	0.265	03	17	66.54
Manjari	5.9	0.4	8.4	0.143	91.52	245	5.2	0.8	0.067	12	12	78.28
Panegaon	6.0	0.3	8.0	0.153	97.92	1005	8.0	1.7	0.05	28	16	86.38
Mula Dam	2.5	0.4	7.6	0.101	64.64	115	5.4	0.3	0.16	05	10	72.42
Kotul	2.9	1.5	8.3	0.449	287.4	125	13	1.4	0.517	02	17	115.95
LahitKhurd	7.6	1.5	8.4	0.445	284.8	1310	21	1.7	0.197	Dry	16	157.46
Borbanwadi	8.1	1.9	8.2	0.432	276.4	947	31	1.9	0.234	Dry	21	206.54
Mandavekhurd	7.8	0.2	8.0	0.441	282.2	246	43	2.8	0.025	Dry	19	263.60

The above water quality is also supported by the following physicochemical parameters variations observed during the different season of the study. Among all the physicochemical parameters selected for the Water Quality Index calculations, pH is an important parameter which determines the suitability of water for various purposes. In the present study pH ranged between 6.5 to 8.6.In many of the collections the pH remained exactly neutral. However, when the average values for three seasons are taken into account the waterbody was found to be slightly alkaline. Ambasht (1971), Petre (1975), Shardendu and Ambasht (1988), Swarnalatha and Narasingarao (1993) and Sinha (1975) have also made similar observations in their studies on different waterbodies. Electrical conductivity and total dissolved solids were also found to be very high.The concentration of dissolved oxygen regulates the distribution of flora and fauna. The present investigation indicated that the concentration of dissolved oxygen fluctuated between 0 mg / l and 8.5 mg / l. seasonally, the concentration of dissolved was more during rainy season and least during post season. The Bio-chemical oxygen demand is a parameter to assess the organic load in a water body. Many researchers have recorded higher BOD values in polluted water. The BOD concentration ranged between 0.1mg / l to 43mg / l indicating the fact that the water body is eutrophic. From the foregoing observations of the physicochemical parameters, it can be concluded that the water body shows the characters of eutrophication except the case of Mula Dam and Kotul. Low dissolved oxygen, high bio-chemical oxygen demand indicate the entropic status of water body. Hence, application of Water Quality Index technique for the overall assessment of the water quality of a water body is a useful tool. Water Quality Index value of fourteen sampling locations on the basis of calculations of physicochemical parameters for all the seasons were shown in **Figure 2**.

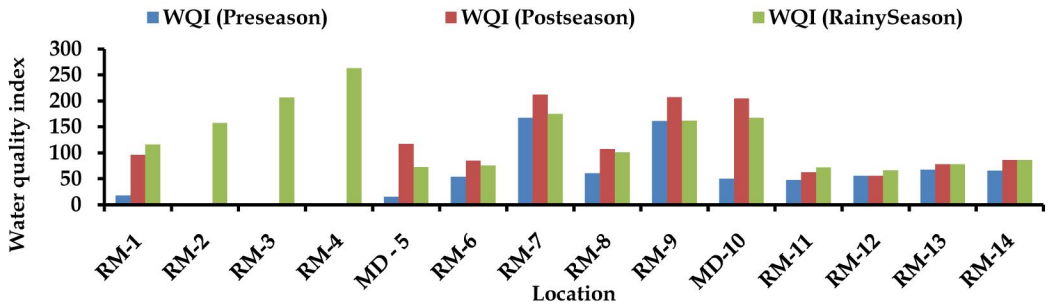

Fig. 2: Showing the Water Quality Index value of fourteen sampling locations on the basis of calculations of physicochemical parameters.

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