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An Assessment of Water Quality of Borgaon Reservoir in Sangli District of Maharashtra, India

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Abstract

The study reveals on study on influence on environmental parameters on water quality at Borgaon reservoir in Kavathe-Mahankal tahsil of Sangli district on the basis of water qualityindex (WQI). WQI was determined on the basis of various parameters like pH, dissolved oxygen, total alkalinity, total hardness, calcium, magnesium, chlorides, total dissolved solids (TDS) and biological oxygen demand (BOD) for which no earlier reports are available on this water body. During this investigation, it was observed that some parameters were within the range prescribed by WHO, ICMR, BIS etc. But some parameters are beyond the permissible limit.

Keywords: Borgaon reservoir, WQI, Kavathe-Mahankal and Sangli district.

Introduction

Fresh water has become a scarce commodity due to over exploitation and pollution of water. Increasing population and its necessities has lead to the deterioration of surface and subsurface water. Water and life are two sides of the same coin. Life initiates and grows in the lap of water. Water is very vital to all forms of lives from very small organisms to very complex systems of plants, animals and human being. The purity of water varies from place to place in nature. Water is the prime natural resource, a basic human need and a precious national asset. The quality of water is of vital concern for mankind since it is directly linked with human welfare. Water is utilized for domestic purpose, for industrial applications, agriculture purpose, as well as for inland fishery. Water Quality Index (WQI) is one of the most effective tools to communicate information on the quality of water to concerned citizens and policy makers[1-3].

The WQI evaluates the values to each water quality parameter relative to its objective value. WQI is based on some important parameters that can provide a simple indicator of water quality. It gives the public general idea of the possible problems with water in a particular region. Nine parameters were taken for WQI calculations namely, pH, dissolved oxygen, total alkalinity, total hardness, calcium, magnesium, chlorides, total dissolved solids and biological oxygen demand. The water quality index is unit less single dimensional number between 0 and 100.

Material and Methods

Study Area: Sangli district is situated between 16.46 to 17.1° N and 73.43 to 75.0° E latitudes. The total geographical area of the district is 8601.5 sq. km. having 25, 83,524 population according to the 2001 census (figure 1, 2).

Geographically, Sangli district is divided into two zones viz. area adjoining Krishna river basin and eastern drought prone area away from basin with low rainfall and typical arid geographical set up. This region includes Khanapur, Atpadi, Kavathe- Mahankal, Jath and eastern part of Tasgaon tahsil. This eastern region shows scarcity of water leading to general dry climate (figure 3).

This is minor irrigation reservoir near Borgaon village about 34 km. away from district place in Kavathe-Mahankal tahsil. It is constructed during 1982-1987 by the Irrigation Department. Purposely it is constructed for irrigation but now-a-days it is used for fishing activities and for other human activities. It is useful for Borgaon and Yogewadi villagers. The main source of water is used for irrigation purpose and fishery.

The catchment area of reservoir is 13.47sq.km. The total capacity of storage is 57.71 Mcft with dead storage of 5.62 Mcft. Length of dam including slipway is 469 M which is of clear overflow type. Height of dam is 13.79 M which is of earthen type. The total submergence area is 16 hectare. The bottom of reservoir is rocky type. The reservoir stores rain water received from adjoining catchment area and is much influenced by anthropogenic activities (figure 4).

The sampling sites were selected by considering the inflow, outflow and anthropogenic activities. Three sampling sites for each reservoir were selected for monthly analysis. The water samples were collected approximately 10–15 meters from border line of each wetland in pre-cleaned five liter plastic cans and immediately brought to the laboratory for various physico-

chemical analysis. Therefore, sampling sites were constant through out the annum.

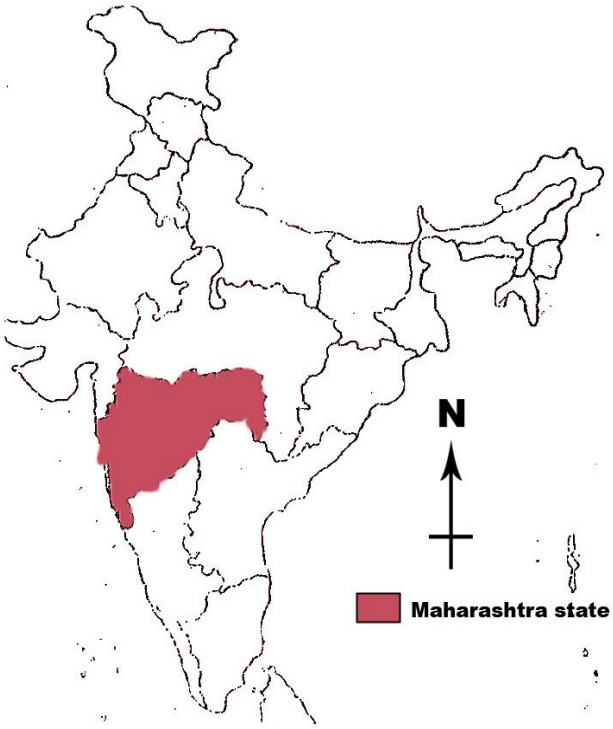

Figure-1
Map of India showing location of Maharashtra State

Figure-2
Map of Maharashtra showing location of Sangli district.

Figure-3
Map of Sangli District

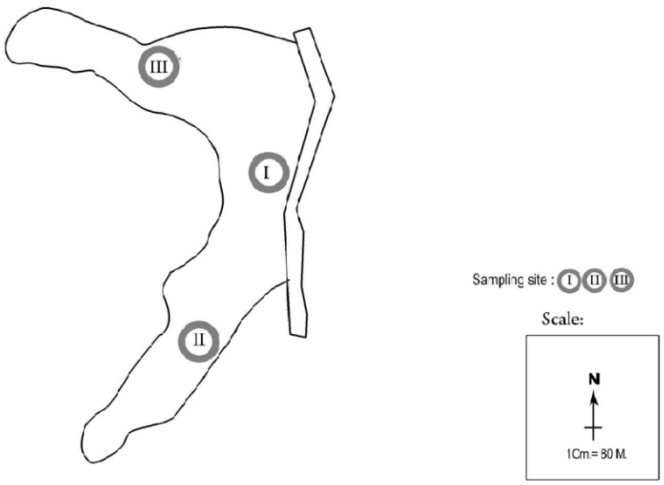

Figure-4
Submergence Area of Borgaon Reservoir

The calculation of WQI was made using weighted arithmetic index methods[4,5].

Water Quality Index: In lakes the pollution increases through surface run off and precipitation of chemical pollutants of industry, domestic and agriculture. Anthropogenic activities are one of the important factors of pollution. The first WQI and classification of WQI by considering various water bodies [6].

For calculations of WQI, selection of parameters has great importance which widens the quality index. Nine physico chemical parameters namely pH, dissolved oxygen, total alkalinity, total hardness, calcium, magnesium, chlorides, total dissolved solids and biological oxygen demand were used to calculate WQI.

Calculations of quality rating (q_n): Let there be n, water quality parameters and quality rating (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. The q_n is calculated by using the following expression -

$$Q_n = 100 (V_n - V_{10}) / (S_n - V_{10})$$

Where, Q_n= Quality rating for the n^{th} water quality parameter. V_n= estimated value of n^{th} parameter at a given sampling stations. S_n = standard permissible value of n^{th} parameter, V_{10}= ideal value of n^{th} parameter in pure water.

All the ideal values n^{th} parameter (V_{10}) are taken as zero for the drinking water except for pH = 7.0 and dissolved oxygen = 14.6 mg/L.

Calculation of quality rating for pH: For, pH, ideal value is 7.0 (neutral water) and permissible value is 8.20. Therefore, quality rating for pH is calculated from following relation,

$$q_{pH} = 100 [(V_{pH} - 7.0), (8.20 - 7.0)]$$

Where, V_{pH} = observed value of pH.

Calculation of quality rating for dissolved oxygen: The ideal value is for dissolved oxygen is 14.6 mg/L. and standard permissible value for drinking water is 5 mg/L. Therefore, quality rating is calculated from following relation,

$$q_{DO} = 100 [(V_{DO} - 14.6), (5 - 14.6)]$$

Where, V_{DO} = measured value of dissolved oxygen.

Calculation of unit weight (W_n): The unit weights (W_n) for various water quality parameters are inversely proportional to the recommended standards for the corresponding parameters.

$$W_n = K \backslash S_n$$

Where, W_n= unit weight for n^{th} parameters, S_n = standard value n^{th} parameters. K= constant for proportionality.

Calculation of WQI: WQI is calculated from the following equation.

$$WQI = \sum q_n w_n / \sum w_n$$

Results and Discussion

The average values of Borgaon reservoir of various parameters are used for WQI calculations and depicted in table 1.

The average pH of Borgaon reservoir was 8.45. The values pH remained alkaline throughout the study period. But the annual fluctuations were negligible, indicating good buffering capacity. The desirable pH of drinking water is 7.0 to 8.5[1]. The water pH ranging between 6.5 to 9.0 at daybreak is most suitable for better aquaculture[7].

In the present work the highest values of pH during summer may possibly due to removal of sufficient amount of CO_2 by photosynthetic process of the aquatic system[8, 9].

It is interesting here to note that, dissolved oxygen was rises appreciably during summer and decreases in monsoon months. However, very little variation is observed during summer and monsoon for both the reservoirs.

The amount of dissolved oxygen in Borgaon is 6.40 mg/L. The minimum dissolved oxygen limit for fish growth is 4.0 mg/L[7]. The lowest dissolved oxygen for maintaining fish in healthy condition is 5.0 mg/L and the critical value is 3.0 mg/L [10]. In present study the range of dissolved oxygen is found optimum for fish growth. Relatively higher values of dissolved oxygen during summer probably as a result of photosynthetic activity [11]. Similar type of observations also recorded by researcher[12].

Table-1
WQI Calculation of Borgaon reservoir by considering mean values of year Aug. 2011 to July 2012

Sr. No.	Parameters	Standard Values (Sn)	1/Sn	Unit weight (Wn)	Observed Values	Quality rating (qn)
1.	pH	7	0.143	0.236	8.456	97.067
2.	DO	5	0.200	0.330	6.406	84.378
3.	Total Alkali.	120	0.008	0.014	173.5	144.583
4.	Total Hard.	500	0.002	0.003	297.165	59.433
5.	Calcium	75	0.013	0.022	39.124	52.165
6.	Magnesium	30	0.033	0.055	14.928	49.760
7.	Chlorides	250	0.004	0.007	30.239	12.096
8.	TDS	500	0.002	0.003	558.249	111.650
9.	BOD	5	0.200	0.330	2.88	57.600
WQI = 76.275						

Except pH all values are expressed as mg/L.

Table-2
WQI as per Bhargava (1989)

WQI Values	Classification
90>	Excellent
65 to 89	Permissible
39 to 64	Marginally Suitable
11 to 34	Inadequate for use
0<	Totally unsuitable

Table-3
WQI as per Abbasi S. A. (2002)

WQI	Description	Class
63-100	Good to Excellent	A
50-63	Good	B
38-50	Bad	C
38	Very Bad	D,E

The range of total alkalinity varied from 144.16 to 229.33 mg/L with average value 173.5 mg/L at Borgaon During winter total alkalinity declines while, rises up to summer season. Many workers have observed similar pattern of variation in total alkalinity which support present findings of many workers [13-17].

Hardness values were recorded within 251.20 mg/L to 334.33 mg/L with mean 297.16 mg/L. Definite pattern of seasonal variation was noticed i. e. Maximum during summer and minimum was noticed during winter[18,19]. Same pattern of seasonal variation was noticed for Bhambarde and Lengre reservoirs in Khanapur tahsil of Sangli district[20].

At Borgaon calcium content ranged between 33.39 mg/L to 42.03 mg/L. Calcium content was found minimum during winter and maximize in summer, this view has also been supported by the more findings[21-23].

The concentration of magnesium in Borgaon reservoir varied from 12.66 mg/L to 16.95 mg/L. Maximum magnesium content was observed in summer season. The concentration of magnesium was minimum than concentration of calcium possibly due to lesser occurrence of magnesium minerals in bottom strata of reservoir.

The permissible limit for magnesium content in drinking water is 50 mg/L.[1, 24]. The present results of reservoir were within the permissible limit. Similar observations were recorded at Ampalthara[25].

The average value of chloride for Borgaon was 30.23 mg/L. In present investigation, chloride values in reservoir were found increased during summer and decreased in winter. The permissible limit of chloride is 200 mg/L for drinking water[1,24]. Therefore, it is noted that the water is fit for drinking. The chloride concentration reached maximum during summer, as the level of reservoir attained low level. However, this may be one of the reasons the values decreased steadily through monsoon and reached minimum in winter due to dilution. Similar condition was observed by many researchers[26,16, 27, 12].

The amount of total dissolved solids detected from water sample at Borgaon was 347.16 mg/L to 738.0 mg/L. There was steep fall in total dissolved solids values during winter season, while content increased during summer. Similar observations of higher concentration of total dissolved solids during pre-monsoon season [28, 29]. Minimum total dissolved solids values were recorded during December[15].

Biological Oxygen Demand at Borgaon reservoir was 2.88 mg/L. Minimum BOD values were observed during October, November and maximum during May. Similar fluctuations in BOD values were reported[22,27,17]. The drinking water should be devoid of BOD[1]. Accordingly, the present values for the reservoir suggested the contaminating status. It may be due to human and cattle activities in and around the reservoirs. Researchers have explained that, the highest values of BOD during summer were attributed to biological activity, due to high organic decomposition during summer. In winter, microbial activity lowers hence values of BOD decreases[30-33].

Conclusion

Classification of WQI, the water of Borgaon reservoir is in permissible category[34]. As per Classification, this reservoir water is good to excellent indicating pollution less water for local inhabitants [35]. Similar pattern of water quality profile was recorded from fresh water wetland of Atpadi[36-40.]

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