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Water quality profile of fresh water wetland of Atpadi in Sangli District, Maharashtra (India)

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Abstract

This paper presents a study on influence on environmental parameters on water quality at wetland of Atpadi in Atpadi tehsil of Sangli district on the basis of water quality index (WQI). WQI was determined on the basis of various parameters like pH, dissolved oxygen, total alkalinity, total hardness, calcium, magnesium, chlorides, total dissolved solids and biological oxygen demand for which no earlier reports are available on these water bodies. During this investigation, it was observed that some parameters are within the range prescribed by World Health Organization, Indian Council of Medical Research, Bureau of Indian Standard etc. But some parameters are beyond the permissible limit.

Keyword*: Fresh water wetland*, *Atpadi reservoir*, *WQI*, *Sangli district*, *Maharashtra*

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 Quality Index (WQI) is one of the most effective tools to communicate information on the quality of water to concerned citizens and policy makers (WHO 1993, APHA 1992). 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 a 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 solides and biological oxygen demand. The water quality index is unitless single dimensional number between 0 and 100.

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Material and methods

Study area

The fresh water wetland of Atpadi of Atpadi Tehsil is located in Sangli district (74^{O} 37' N latitude and 17^{O} 19' E longitude) of southeastern Maharashtra in India. A year can be broadly divided into three seasons; summer season from March to May, rainy season from June to October and winter from November to February.

Morphometry of Wetland

The total capacity of storage is 309.09 Mcft and dead storage is 27.15 Mcft. The catchment area of reservoir is 204.8 km. Total length of dam including slipway is 1068 M with 323 M is only the length of slipway. It is of clear overflow type. Earthen type of dam having height of 16.50 M. Total water spread is 11.16 hectare having 36 hectare of submergence area. The bottom of wetland is rocky hence aquatic macrophytes are poorly developed. 1959 to 1969 was the duration of reservoir construction.The water is formerly used for irrigation but also for washing, bathing and pisciculture activities. The wetland stores rain water received from adjoining catchment area and is much influenced by anthropogenic activities.The sampling sites were selected by considering the inflow, outflow and anthropogenic activities. Three sampling sites for wetland were selected for

monthly analysis. The water samples were collected approximately 10–15 meters from border line of 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.The calculation of WQI was made using weighted arithmetic index method. (Brown *et al*., 1970 and 1972) as follows.

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. Hortton (1965) proposed that first WQI and classification of WQI by considering various water bodies.For calculations of WQI, selection of parameters has great importance which widens the quality index. Nine physico chemical parameters namely pH, dissolved oxygen (DO), total alkalinity, total hardness, calcium, magnesium, chlorides, total dissolved solids (TDS) and biological oxygen demand (BOD) 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 Disscussion

The average values of Atpadi wetland of various parameters are used for WQI calculations and depicted in Table 1. The average pH of reservoir was 8.0 during August and 9.17 during May. The values of pH remained alkaline throughout the study period. But the annual fluctuations were negligible, indicating good buffering capacity. According to WHO (1993) the desirable pH of drinking water is 7.0 to 8.5. The water pH ranging between 6.5 to 9.0 at daybreak is most suitable for better aquaculture (Jhingran 1982). In the present work the highest values of pH during summer may possibly be due to removal of sufficient amount of CO_2 by photosynthetic process of the aquatic system. (Solanki *et al*. 2005, Kaur *et al.* 1997). It is interesting here to note that, dissolved oxygen rises appreciably during summer and decreases in monsoon months. However, very little variation was observed during summer and monsoon. The amount of dissolved oxygen was 4.21 mg/l in August and 8.55 mg/l in May. The minimum dissolved oxygen limit for fish growth is 4.0 mg/l (Jhingran 1982).

Table 1 WQI Calculation of Atpadi wetland by considering mean values of year Aug. 2010 to July 2011

Sr. No.	Parameters	Standard Values (Sn)	1/Sn	Unit weight (Wn)	Observed Values	Quality rating (qn)
1.	**pH**	7	0.143	0.236	8.46	97.333
2.	**Dissolved Oxygen**	5	0.200	0.330	6.44	84.000
3.	**Total Alkalinity**	120	0.008	0.014	310.168	258.473
4.	**Total Hardness**	500	0.002	0.003	265.945	53.189
5.	**Calcium**	75	0.013	0.022	45.157	60.209
6.	**Magnesium**	30	0.033	0.055	20.128	67.093
7.	**Chlorides**	250	0.004	0.007	44.248	17.699
8.	**Total Dissolved Solids**	500	0.002	0.003	398.666	79.733
9.	**Biological Oxygen Demand**	5	0.200	0.330	3.017	60.340
WQI = 79.726						

***Except pH all values are expressed as mg/l**

According to APHA (1992) the lowest dissolved oxygen for maintaining fish in healthy condition is 5.0 mg/l and the critical value is 3.0 mg/l. In present study the range of dissolved oxygen was found optimum for fish growth. Relatively higher values of dissolved oxygen during summer probably as a result of photosynthetic activity (Solanki *et al.* 2007). Similar type of observation was made by Khare *et al.* (2007).

The range of total alkalinity varied from 150.33 mg/l to 476 mg/l. Alkalinity reduced in monsoon and increased in summer.Many workers have observed similar pattern of variation in total alkalinity which support present findings (Shrivastava 2005, Hujare 2008, Sukhija 2007, Sharma and Jain 2000, Chatterjee and De 2008, Raveen *et al.* 2008).

Moyle (1949) have classified water into nutrient status based on alkalinity as follows,

1 to 15 mg/l	nutrient poor
16 to 60 mg/l	moderately rich
More than 60 mg/l	nutrient rich

Based on the above classification the reservoir show nutrient rich status. Hardness values were recorded within 223 mg/l in the month of December to 329.67 mg/l in May. Definite pattern of seasonal variation was noticed i. e. maximum during summer and minimum was noticed during winter. Hujare and Mule (2008) and Pundhir and Rana (2002) have also noticed maximum hardness in summer and minimum in winter. Calcium content of Atpadi reservoir ranged between 31.88 mg/l to 52.89 mg/l. Calcium content was found minimum during winter and maximize in summer. Subhashini and Saradhamani (2005) have recorded similar pattern of change in calcium content.The concentration of magnesium in Atpadi reservoir varied from 16.31 mg/l to 25.82 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. According to WHO (1993) and BIS (1991) the permissible limit for magnesium content in drinking water is 50 mg/l. The present results of reservoirs are within the permissible limit. Sobha and Harilal (2005) have recorded similar observation at Ampalthara. Similar pattern of changes were also recorded by Khare *et al*. (2007), Subhashini and Saradhamani (2005).The content of chloride for Atpadi wetland was 36.5 mg/l in December and 52.79 mg/l in May. In present investigation, chloride values were found increased during summer and decreased in winter. According to WHO (1993) and BIS (1991) permissible limit of chloride is 200 mg/l for drinking water. The water from the reservoir was below limit. 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 Anand and Sharma (2000), Vijay Kumar *et al*. (2005) and Khare *et al*. (2007).The amount of total dissolved solids detected from water samples at Atpadi were 275 mg/l and 603 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

There was steep fall in total dissolved solids values during winter season, while content increased during summer. Rincy and Tessy (2010) and Shrivastava and Alam (2007) have observed higher concentration of total dissolved solids during pre-monsoon season. Sukhija (2007) has recorded minimum total dissolved solids values during December. Biochemical oxygen demand at Atpadi reservoir was 2.103 mg/l and 3.787 mg/l. Minimum BOD values were observed during December and maximum during May. Similar fluctuations in BOD values were reported by Subhashini and Saradhamani (2005), Vijay Kumar *et al.* (2005) and Chatterjee and De *(*2008). WHO (1993) specify that the drinking water should be devoid of BOD. Accordingly the present values for reservoir suggested the contaminating status. It may be due to human and cattle activities in and around the reservoirs. Singh and Gupta (2004), Raghuwanshi (2005), Sudeep *et al*. (2008) and Agrawal *et al*. (2004) 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.

Table 3 WQI as per Abbasi (2002)

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

Conclusion

According to Bhargava (1989) classification of WQI, the water of Atpadi wetland is in permissible category. As per Classification of Abbasi (2002) the wetland water is good to excellent indicating pollution less water for local inhabitants.

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