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Original Research Paper

Water Quality Status of Sidhewadi Reservoir of Sangli District, Maharashtra (India)

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ABSTRACT

This paper attempts a study on influence on environmental parameters on water quality of Sidhewadi reservoir in Tasgaon tahsil 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 (TDS) and biochemical oxygen demand (BOD) for which no earlier reports are available on this water body. During the investigation, it was observed that some parameters are within the range prescribed by WHO, ICMR, BIS, etc. but some parameters are beyond the permissible limit.

INTRODUCTION

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, industrial applications, agriculture purpose, and for inland fishery.

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.

Freshwater has become a scarce commodity due to overexploitation and pollution of water. Increasing population and its necessities have lead to the deterioration of surface and subsurface water.

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, ICMR 1975).

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 indication 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. The water quality index is unitless single dimensional number between 0 and 100.

MATERIALS AND METHODS

Study area: Sidhewadi is a medium irrigation reservoir near Tasgaon tahsil in Sangli district. This reservoir was constructed during the year 1972 to 1977. Irrigation Department has constructed earthen dam riveted with stones. This reservoir is very useful to nearby villagers of Sawalaj, Sidhewadi and Waiphale. The water is mainly used for irrigation purpose and fishery. But now it is used for human activities also.

The catchment area is 65 sq.km. Total capacity of storage is 302.95 Mcft and dead storage is 87.56 Mcft. The total length of dam including slipway is 959 m in which length of slipway is 216 m and it is without gate. The dam is earthen type, having 19 m dam height. The submergence area is near about 146 hectare. The bottom of reservoir is silted. The reservoirs store 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 were selected for monthly analysis. The water samples were collected approximately 10-15 meters from shoreline in pre-cleaned five-L plastic cans and immediately brought to the laboratory for various physico-chemical analysis. The sampling sites were constant throughout the year.

The calculation of WQI was made using weighted arithmetic index method (Brown et al. 1970, 1972).

Water quality index (WQI): In lakes, the pollution increases through surface run off and entry of chemical pollutants from industry, domestic and agriculture. Anthropogenic activities are one of the important factors for pollution. Hortton (1965) proposed first WQI and classification of WQI

by considering various water bodies.

For calculation 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 biochemical 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 station.

S_n = Standard permissible value of n^{th} parameter

V_{10} = Ideal value of n^{th} parameter in pure water.

All the ideal values of 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 by the following equation.

$$WQI = \Sigma q_n w_n / \Sigma w_n$$

RESULTS AND DISCUSSION

The average values of Sidhewadi reservoir of various parameters used for WQI calculations are depicted in Table 1.

The average pH of Sidhewadi reservoir was 8.38. The values 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 and 9.0 at daybreak is most suitable for aquaculture (Jhingran 1982). In the present work, the higher values of pH during summer are 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 to note here that dissolved oxygen rises appreciably during summer and decreases in monsoon months. However, very little variation is observed during summer and monsoon for the reservoir.

The amount of dissolved oxygen in Sidhewadi is 5.58 mg/L. The minimum dissolved oxygen limit for fish growth is 4.0 mg/L (Jhingran 1982). According to APHA (1985) 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 the present study the range of dissolved oxygen was found to be optimum for fish growth. Relatively higher values of dissolved oxygen during summer are as a result of photosynthetic activity (Solanki et al. 2007). Similar type of observation were also made by Khare et al. (2007).

The range of total alkalinity varied from 142.67 mg/L to 458.0 mg/L with average value of 293.61 mg/L. During rains total alkalinity declines, while it rises later up to summer season. Many workers have observed similar pattern of variation in total alkalinity which support present findings (Shrivastava (2005), Hujare (2008), Sukhija (2007), Sharma & Jain (2000), and Chatterjee & De (2008).

Hardness values were recorded ranging from 116.33 mg/L to 393 mg/L with mean value of 252.22 mg/L. Definite pattern of seasonal variation was noticed i.e., maximum during summer and minimum during winter. Hujare & Mule (2008) and Pundhir & Rana (2002) have also noticed maximum hardness in summer and minimum in winter. Patil (2011) has noticed definite pattern of seasonal variation of hardness in Bhambarde and Lengre reservoirs in Khanapur tahsil of Sangli district.

The calcium content ranged between 39.29 mg/L and 58.53 mg/L. Calcium content was found to be minimum during winter and maximum in summer; this view has also been supported by the findings of Awasti & Tiwari (2004).

Table 1: WQI calculation of Sidhewadi reservoir by considering mean values of year August 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	8.38	92.200
2.	DO	5	0.200	0.330	5.58	93.511
3.	Total Alkali.	120	0.008	0.014	293.61	244.677
4.	Total Hard.	500	0.002	0.003	252.22	50.444
5.	Calcium	75	0.013	0.022	49.38	65.837
6.	Magnesium	30	0.033	0.055	27.50	91.677
7.	Chlorides	250	0.004	0.007	46.85	18.739
8.	TDS	500	0.002	0.003	547.97	109.594
9.	BOD	5	0.200	0.330	2.58	51.660
WQI = 80.173						

Except pH all the 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 (2002).

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

Subhashini & Saradhamani (2005) have recorded similar pattern of change in calcium content.

The concentration of magnesium in Sidhewadi reservoir varied from 21.94 mg/L to 58.22 mg/L. Maximum magnesium content was observed in summer season. The concentration of magnesium was lower 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 are within the permissible limit. Sobha & Harilal (2005) have recorded similar observation at Ampalthara. Similar pattern of changes were also recorded by Khare et al. (2007), Subhashini & Saradhamani (2005).

The average value of chloride was 46.85 mg/L. In present investigation, chloride values were found to be increased during summer and decreased in winter. According to WHO (1993) and BIS (1991) permissible limit for chloride is 200 mg/L for drinking water. 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 that the values decreased steadily through monsoon and reached minimum in winter due to dilution. Similar condition was observed by Anand & Sharma (2000), Sharma & Jain (2000), Vijay Kumar et al. (2005) and Khare et al. (2007).

The amount of total dissolved solids was 341.33 mg/L and 824.67 mg/L. There was steep fall in total dissolved solids values during winter season, while content increases during summer. Rincy & Tessy (2010) and Shrivastava & 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 (BOD) was 2.58 mg/L. Minimum BOD values were observed during October and November, and maximum during May. Similar fluctuations in BOD values were reported by Subhashini & Saradhamani (2005), Vijay Kumar et al. (2005) and Chatterjee & De (2008). WHO (1993) specify that the drinking water should be devoid of BOD. 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. Singh & 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.

The WQI calculated for the reservoir is 80.173 (Table 1). According to classification of WQI by Bhargava (1989) (Table 2), the water of Sidhewadi reservoir is in permissible category; and as per the classification of Abbasi (2002) (Table 3), the reservoir water is good to excellent indicating pollution free water for local inhabitants.

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