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Original Research Paper

Water Quality Profile of Kas Reservoir of Satara District, Maharashtra, India

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ABSTRACT

The present study was intended to calculate water quality index (WQI) of Kas reservoir. The quality was assessed by examining various physico-chemical parameters namely pH, total alkalinity, total hardness, total dissolved solids, dissolved oxygen, biochemical oxygen demand and chloride for which no earlier reports are available on this water body. The quality of water was assessed for public consumption, recreation and other purposes. From the investigation, it was found that some of the parameters like pH, dissolved oxygen, hardness and chlorides are within the permissible limits but others like TDS and BOD exceeded slightly above the permissible limits laid by WHO, BIS and ICMR. The results indicate excellent status of the water body. But in future there is a need by authorities to take some concrete steps for maintenance of the reservoir for better health of people residing in that area.

INTRODUCTION

Reservoirs form unique biological freshwater ecosystems on the earth. These water bodies store freshwater from adjoining areas during the rainy season. There is a progressive deterioration of water quality throughout the world. The reason is contamination and pollution of water due to addition of pesticides, fertilizers, inorganic and organic salts from topsoil and geological strata, and industrial wastes. An appreciable amount of work has been done on various aspects of reservoir ecology in India. The quality of water is getting vastly deteriorated due to unscientific waste disposal, improper water management and carelessness towards environment. This leads to scarcity of potable water affecting the human health.

The Kas reservoir is situated in the Western Ghat region, 28 km from Satara town. The water storage capacity of the reservoir is 1.2 TMC. Water from the reservoir is used for drinking, domestic and irrigation purposes. The water quality index is the indicator of the quality of water. It is useful for a variety of purposes such as planning tool for managing water resources use and communicating water quality information to the public and to decision makers. WQI for drinking water has been used to find out the water quality of Kas reservoir. The potability of water was assessed by this index because agricultural runoff and animal excreta are also poured into the reservoir through various discharging points which increase pollution load of water above the safe limits.

MATERIALS AND METHODS

Water samples were collected for physico-chemical analysis from the three sites of Kas reservoir from June 2008 to May 2010 in 10-L plastic cans. Sample collection was completed during morning hours from 8 a.m. to 10 a.m. pH and dissolved oxygen were monitored at the sampling spots while total solids, total alkalinity, biochemical oxygen demand, chloride, nitrate and total hardness were analysed in the laboratory in accordance with the methods given by Trivedy & Goel (1986) and APHA (1992).

Water quality index (WQI): The concept of indices to represent gradation in water quality was first proposed by Horton (1965). Water quality index indicates the quality of water in terms of index number which represents overall quality of water for any intended use (Tables 1, 2).

For calculation of WQI, selection of parameters has great importance. Since, selection of too many parameters might widen the water quality index and importance of various parameters depend on the intended use of water, physico-chemical parameters namely pH, TDS, total hardness, chloride, nitrate, DO and BOD were used to calculate WQI. The calculation of WQI was made using weighted arithmetic index method (Brown et al. 1970, 1972) in following steps.

***Calculation 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 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 for the 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.

$$W_n = K/S_n$$

Where, W_n = Unit weight for n^{th} parameter,

S_n = Standard value of n^{th} parameter

K = Constant for proportionality

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

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

RESULTS AND DISCUSSION

The average values of various physico-chemical parameters, drinking water standards, unit weights (W_n), quality rating (Q_n), sub-index value ($Q_n W_n$) and WQI of Kas reservoir are depicted in Tables 3, 4 and 5.

The average value of pH of Kas reservoir is 6.45 to 6.78 and its higher values were recorded during summer which may be due to high growth rate of algal population utilizing CO_2 through photosynthetic activity. The pH value finds the support with Mohanta & Patra (2000). In present investigation pH values were within the ICMR standards (7.0 to 8.5).

The value of DO varied from 6.17 to 6.32 mg/L at all the sites. The slightly lower values can be attributed to addition of run-off containing oxidizable organic matter and local human activity, and consequent biodegradation and decay of vegetation at higher temperature leading to consumption of oxygen from water.

Table 1: WQI as per Bhargava (1989).

WQI Value	Classification
90>	I Excellent
65-89	II Permissible
39-64	III Marginally suitable
11-34	IV Inadequate for use
0<	V Totally unsuitable

Table 2: WQI as per Abbasi (2002).

Sr.No.	WQI	Description	Class
1	63-100	Good to excellent	A
2	50-63	Good	B
3	38-50	Bad	C
4	38	Very Bad	D, E

Hardness was recorded from 45 mg/L to 66 mg/L. Higher values of hardness can be attributed to low water level, higher rate of decomposition and high rate of evaporation. Similar observations were recorded by Dakshini & Soni (1997), Kumar (2000) and Mohanta & Patra (2000) due to addition of sewage and large scale human use, which might cause elevation of hardness. The values of calcium were higher than magnesium supported by Patil et al. (2004) and decreased values of magnesium are due to plankton and algal uptake (Rath et al. 2000).

The TDS values ranged from 175 to 235 mg/L. The amount of total dissolved solids was higher during winter season, which may be due to runoff discharging dissolved material into the reservoir. The same observation has been made by Gonzalez et al. (2004). Concentration of chloride was found to vary from 12.18 to 30.69 mg/L at all the sites. Higher values of chloride can be attributed to reduced flow of river and large amount of sewage being poured into it. Similar observations were recorded by Chinmoy & Raziuddin (2002), Kumar (2000) in Mayarakshi river. Low chloride concentration might be due to dilution of river water and rapid flow of water. Sandwar & Prasad (2000) registered similar observations in the River Ganga.

The alkalinity of the water samples ranged between 32.30 mg/L and 38.50 mg/L. The higher values are due to increase in carbonates and bicarbonates, evaporation of water and increase in biological activity. A similar finding has also been recorded by Surve et al. (2005) and Garg et al. (2007).

BOD values varied from 5.41 mg/L to 7.82 mg/L at all the sites. The peak values of BOD were due to high concentration of dissolved and suspended organic matter in water (Jameel 1998).

Table 3: Physico-chemical characteristics and WQI of water at Site I.

Sr. No.	Parameters	Site I	Ideal Value(V_{10})	Standard Value(S_i)	Unit Weight Factor(W_n)	Quality rating (q_n)	($q_n w_n$)
1	pH.	6.45	7.0	8.20	0.2261	45.8333	10.365
2	Dissolved Oxygen	6.17	14.6	5.00	0.37088	86.8750	32.2202
3	Total Alkalinity	32.30	0.000	120	0.01554	26.9167	0.4160
4	Total Dissolved Solids	235	0.000	1000	0.00185	23.500	0.04347
5	Total Hardness	45	0.000	500	0.00371	9.0000	0.0334
6	Calcium	6.96	0.000	75	0.02473	9.2800	0.2295
7	Magnesium	5.38	0.000	30	0.06181	17.9333	1.1085
8	Chloride	30.69	0.000	600	0.00309	5.1150	0.0158
9	Nitrate	4.96	0.000	45	0.04121	11.0222	0.4542
10	BOD	5.41	0.000	5.00	0.37088	108.20	40.129

Water quality index (WQI) = 75.922; The values are in mg/L except pH.

Table.4. Physico-chemical characteristics and WQI of water at Sites II.

Sr. No.	Parameters	Site II	Ideal Value(V_{10})	Standard Value(S_i)	Unit Weight Factor(W_n)	Quality rating (q_n)	($q_n w_n$)
1	pH	6.78	7.0	8.20	0.2261	18.33	4.140
2	Dissolved Oxygen	6.26	14.6	5.00	0.37088	80.064	29.6941
3	Total Alkalinity	35.70	0.000	120	0.01554	29.7500	0.4597
4	Total Dissolved Solids	210	0.000	1000	0.00185	21.000	0.03885
5	Total Hardness	50	0.000	500	0.00371	10.0000	0.0371
6	Calcium	7.82	0.000	75	0.02473	10.4267	0.2578
7	Magnesium	5.12	0.000	30	0.06181	17.0667	1.0549
8	Chloride	12.18	0.000	600	0.00309	2.034	0.00627
9	Nitrate	3.25	0.000	45	0.04121	7.2222	0.29762
10	BOD	6.20	0.000	5.00	0.37088	124.000	45.989

Water quality index (WQI) = 73.491; The values are in mg/L except pH.

Table 5: Physico-chemical characteristics and WQI of water at Site III.

Sr. No.	Parameters	Site III	Ideal Value (V_{10})	Standard Value (S_i)	Unit Weight Factor (W_n)	Quality rating (q_n)	($q_n w_n$)
1	pH	6.64	7.00	8.20	0.2261	30.0000	6.7844
2	Dissolved Oxygen	6.32	14.6	5.00	0.37088	86.2500	31.9884
3	Total Alkalinity	38.50	0.000	120	0.01554	32.0833	0.4958
4	Total Dissolved Solids	175	0.000	1000	0.00185	17.500	0.03237
5	Total Hardness	66	0.000	500	0.00371	13.2000	0.0490
6	Calcium	6.82	0.000	75	0.02473	9.09333	0.2248
7	Magnesium	4.43	0.000	30	0.06181	14.7667	0.9128
8	Chloride	22.32	0.000	600	0.00309	3.72	0.01149
9	Nitrate	3.50	0.000	45	0.04121	7.7778	0.3205
10	BOD	7.82	0.000	5.00	0.37088	156.4	58.005

Water quality index (WQI) = 88.335; The values are in mg/L except pH.

The nitrate values were observed between 3.25 mg/L and 4.96 mg/L. The values of nitrate are within the limit of ICMR standards WHO (1983) and ICMR (1975). Nitrate is one of the most important nutrients in an aquatic ecosystem. Generally water bodies polluted by organic matter exhibit higher values of nitrate (Shanti et al. 2002).

Application of WQI is a useful method in assessing the quality of waters. The WQI of the Kas reservoir ranged from 73.491 to 88.335 indicating that the water is of good to excellent quality as per Abbasi (2002), and of permissible class as per Bhargava (1989).

REFERENCES

Abbasi, S.A. 2002. Water Quality Indices, State-of-the-Art. Pondicherry University, Centre for Pollution Control & Energy Technology.

APHA 1992. Standard Methods for the Examination of Water and Wastewater. 18th edition, American Public Health Association,

Washington DC.
Bhargava, D.S. 1989. Expression for Drinking Water Supply Standards. ASCE, 111: 304-317.
Brown, R.M., McClelland, N.I., Deininger, R.A. and Ronald, G.T. 1970. A Water Quality Index-Do we dare? Water Sewage Works, 11: 339-349.
Brown, R.M., McCleiland, N. J., Deininger, R.A., and O'Connor, M.F. 1972. A Water Quality Index-Crossing the psychological barrier. Jenkis, S.H. (ed.) Proc. Int. Conf. on Water Poll. Res., Jerusalem, 6; 187-197.
Chinmoy Chatterjee and Raziuddin, M. 2002. Determination of water quality index (WQI) of a degraded river in Asansol industrial area (West Bengal). Nature Environment and Pollution Technology, 1: 181-189.
Dakshini, K.M.M. and Soni, J.K. 1979. Water quality of sewage drains entering Yamuna in Delhi. Indian J. Environ. Health, 21: 354-361.
Garg, Deepshika, Goyal, Sunita, Chaturvedi, Samiksha and Singh, R.V. 2007. Positional survey of the groundwater quality of Bharatpur area during monsoon season. J. Curr. Sci., 10; 131-136.
Gonzalez, E.J., Ortaz, M., Panaherrera, C. and Infante, A. 2004. Physical and chemical features of a hypertrophic reservoir permanently stratified. Hydrobiologia, 522; 301-310.
Horton, R.K. 1965. An index number system for rating water quality. J. Water Pollution Control Administration, 37: 3000.
ICMR 1975. Manual of Standards of Quality for Drinking Water Supplies. Indian Council of Medical Research, New Delhi.
Jameel, A. 1998. Physicochemical studies in Vyyakondan channel water of Cauvery. Poll. Res., 17: 111-114.
Kumar, A. 2000. A quantitative study of the pollution and physicochemical conditions of the River Mayurkshi in Santhal Paragana (Bihar). In: Kumar, A. (Ed.) Pollution and Biomonitoring of Indian Rivers, ABD Publishers, Jaipur. pp. 246-251.
Mohanta, B.K. and Patra, A.K. 2000. Studies on the water quality index of River Sanamachhakandana at Keonjhar Garh, Orissa. Poll Res., 19: 377-385.
Patil, P.R., Chaudhari, D.N. and Kinage, M.S. 2004. Water quality status of Padmalaya Erondal at Jalgaon district, (M.S.). Environ. Ecol., 22: 65-68.
Rajendran Nair, M.S. 2000. Seasonal variation of physicochemical factors and its impact on the ecology of pond at Imalia (Vidisha). J. Ecobiol., 12: 21-27.
Rath, P., Bhatta, D., Sahoo, B.N. and Panda, U.C. 2000. Multivariate statistical approach to study physico-chemical characteristics in Nandira Brahmani river, Angul-Talcher Belt, Orissa, India. Poll. Res., 19: 701-710.
Sandwar, B.B. and Prasad, J. 2000. Physico-chemical characteristics of Ganga River water at Mokamah (Begusarai) Bihar. In: Kumar, A. (Ed.) Pollution and Biomonitoring of Indian Rivers, ABD Publishers, Jaipur. pp. 130-132.
Shanti, K., Ramasamy, K. and Lakshmanaperumalasamy, P. 2002. Hydrobiological study of Singanallur lake at Coimbatore, India. Nature Environment and Pollution Technology, 1: 97-101.
Surve, D.R., Ambore, N.E. and Pule, J. S. 2005. Correlation coefficient of some physicochemical characteristics of Barul dam water, District Nanded (M.S.), India. Poll. Res., 24: 653-656.
Trivedy, R.K. and Goel, P.K. 1986. Chemical and Biological Methods for Water Pollution Studies. Envron. Publications, Karad, pp. 247.
WHO 1983. International Standards for Drinking Water. World Health Organization, Geneva.