



Assessment of Physico-chemical Parameters and Water Quality Index of Bhavanisagar Reservoir, Tamil Nadu

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Abstract: The present study employs the technique of WQI to provide the overall quality of water. The evaluation of physico-chemical parameters values were within or below permissible limits which was also confirmed by WQI indicated that the water of the reservoir was oligotrophic in nature and an ideal source for drinking and irrigation purposes. The adequate nutritional load of the water would suffice a balanced growth of micro and macro organisms and provides a well-balanced and sustained aquatic ecosystem.

Keywords: Water quality, Quality assessment, WQI, Physico-chemical parameters, Bhavanisagar reservoir

Dynamic function of an ecosystem is determined by the water availability of the region. About 3/4th of the world's total surface is covered by water in which 1.2% is surface water which is used for human consumption. In India, monsoon prevails from June – September, which is mainly fed by Southwest and Northeast monsoon with average rainfall of 4000 billion cubic meters from which only 18% can be used for conventional purposes (Panda 2011). This sudden influx of periodic water supply to the system causes a change which may result in flood. Reservoirs are artificial catchment built across perennial or long season stream for multi – variant purpose i.e. man – made surface impoundment impeding water flow, for irrigation, fisheries, flood control and hydro – electric power supply. According to the area covered the reservoirs are classified as small, medium and large. India has 19,370 reservoirs consisting of 3,153,366 ha area of the region, out of which Tamil Nadu accounts for holding large number of small reservoirs. The inflow and outflow of the water to the reservoirs alters the reservoir ecosystem from natural ecosystem which is a distinct feature of reservoir. The surface flow of rainwater obstructed by the reservoir, act as a source of potable water after various treatments. The variation of reservoir ecosystem from the natural environment alters hydrological properties, deviating from the natural environment may be compatible or incompatible depends on the quality of water determining parameters. The quality must be checked to prevent deterioration of water availability for the human consumption. Rapid industrialization and urbanization results in deterioration of the water quality making the water unfit for human consumption and domestic purposes. Periodic assessment of the analytical parameters is essential for

protection, preservation and utilization of water resources. In a water quality study, analytical parameters vary according to the purpose of study and function of water body (Sawant et al 2013). Physical and chemical parameters are the quality determinants of a water body. Water Quality Index (WQI) is a suitable method to assess the quality of surface water, through determining the relative weight of analytical parameters in terms of concentration (Tyagi et al 2013, Bora et al 2017). The present study gives a detailed analysis of physico-chemical parameters to assess the water quality and WQI is calculated.

MATERIAL AND METHODS

Study area: Bhavanisagar Dam located at latitude 11°28' N and longitude 77°06' E, is constructed below the confluence of River Moyer and River Bhavani of Tamil Nadu. The reservoir is built 280.2 m above the Mean Sea Level (MSL). The height of the reservoir is about 40 meters (120ft) and the capacity is about 32.8 TMC (Thousand Million Cubic). Heavy rainfall in the study area is during low-pressure depressions and cyclones during the northeast monsoon period. The dam is fed by both Southwest and Northeast monsoon. The amount of rainfall is about 621mm (458 mm during monsoon and 163mm during in non-monsoon months) and the higher is towards coast.

Sampling method: Water samples were collected on fortnight intervals from June 2019 - October 2019. Surface sampling were done at two sampling points of latitude and longitude 11°28'14"N 77°06'52"E named as S1 and 11°28'15"N 77°06'49"E named as S2. Sterilized polyethylene bottles of one litre capacity were used for collecting samples. Three samples for each sampling point were taken for

concordance and the average is calculated. Dissolved oxygen, pH and temperature were carried out at the collection site, other parameters and heavy metals were analysed in laboratory using the standard procedure given by Bureau of Indian Standards (BIS) (IS 3025-42 1992) (IS 3025-34 1998) (IS 3025-41 1992) (IS 3025-47 1994) (IS 3025-49 1994) (IS 3025-52 2003). Standard limits were set in reference with WHO and BIS.

WQI assessment: Weighted arithmetic water quality index (WAWQI) method was employed to determine the WQI. Commonly used 10 water quality parameters were considered to determine the quality of water. The water quality rating as per WAWQI method is given in Table 1. The calculation of WQI was made by using the following equation:

$$WQI = \sum Q_i W_i / \sum W_i$$

The quality rating scale (Q_i) for each parameter is calculated by using this expression

$$Q_i = 100[(V_i - V_o) / S_i - V_o]$$

Where,

V_i is estimated concentration of i th parameter in the analysed water

V_o is the ideal value of this parameter in pure water

$V_o = 0$ (except pH = 7.0 and Dissolved Oxygen = 14.6 mg/l)

S_i is recommended standard value of i th parameter.

The unit weight (W_i) for each water quality parameter is calculated by using the following formula:

$$W_i = K/S_i$$

Where,

K = proportionality constant and can be also calculated by using the following equation:

$$K = 1 / \sum (1/S_i)$$

RESULTS AND DISCUSSION

The water quality was assessed considering the physico- chemical parameters and overall rating was given by Weighted Arithmetic Water Quality Indices (WAWQI) are tabulated in Table 2 & 3.

Physical parameters: The pH in water samples ranges from 8.1-8.6 indicate the alkaline nature of water. But the basic nature increased and fluctuated from 8.3-8.7 from August till October due to the influence of rain water by the dilution of the chemical parameters. The temperature range was from 28°C to 29°C. The color variation during the study period was significant, the transition from transparent to greenish color occurred during September and October signifies an elevated amount of chlorophyll content due to the increase in primary producers of water due to nutrient input from rains (Pires et al 2017).

Chemical parameters: Total dissolved solids were maximum

Table 1. Water quality rating as per WAWQI method

WQI value	Rating of water quality	Grading
0-25	Excellent water quality	A
26-50	Good water quality	B
51-75	Poor water quality	C
76-100	Very poor water quality	D
Above 100	Unsuitable for drinking purpose	E

Table 2. Estimated physico-chemical parameters of water sample from June - October, 2019

Parameters (mg l ⁻¹)	June	July	August	September	October	Permissible limits (mg l ⁻¹)	
						BIS	WHO
pH	8.1±0.1	8.2±0.1	8.6±0.1	8.5±0.1	8.5±0.1	6.5-8.5	6.5 - 9.5
Temperature	28±1.8	29.2±0.9	28±1.4	29.5±0.5	29.2±0.9	-	-
Total dissolved solids	48.2±5.7	78.6±5.8	62.2±13.0	45.7±2.7	44.5±1.4	500-2000	500 - 1000
Total suspended solids	0.2±0.08	0.7±0.2	0.3±0.1	0.1±0.05	0.1±0.09	-	-
Total solids	49.7±2.0	50±6.7	62.9±18.0	54.5±4.0	50.2±2.0	-	-
Chloride	17.5±3.0	23.6±5.0	16.8±3.3	21.3±4.9	15±3.0	250	200
Total alkalinity	35±15.0	46±7.5	41.2±16.0	25±7.0	37.5±11.0	200	100
DO	3.3±0.1	3.7±0.3	3.6±0.1	5.0±0.7	4±0.5	4 - 6	4 - 6
Sulphate	2.3±2.0	4.8±0.6	2.0±2.3	0	0	200	250
Total hardness	32.5±10.0	34±12.0	35±5.7	31.2±8.5	35±9.0	200	500
Sodium	0.1±0.0	0.09±0.1	0.3±0.3	0	0	180	200
Calcium	7.8±1.0	6.0±3.0	8.3±5.0	5.5±1.9	10±4	75	75
Magnesium	6.5±1.0	7.7±2.2	2.2±0.2	4.1±0.2	0	30	50
Nitrate			BDL			45	50
Phosphorus			BDL			-	-

during July and August but the TDS levels remained constant during June, September and October. The variation was due to dilution of water in reservoir by rain water. The average range of TDS was from 44.5 mg l⁻¹-78.6 mg l⁻¹. A corresponding increase in Total suspended solids were observed with increase TDS by 0.7 mg l⁻¹ during July. The highest value of both parameters signifies the inflow of water fed by monsoon. The maximum value of alkalinity was recorded during July with an average range of 25 mg l⁻¹- 47 mg l⁻¹. The high value may indicate the process of weathering in the reservoir during high temperature. The above phenomenon was observed by Singh et al (2005) at Gomathi River, India. The DO ranged from 3.3 mg l⁻¹- 5.0 mg l⁻¹. The highest value corresponds to the increase in the oxygen production in post – monsoon period. The increase in DO during September was due to the easy exchange of air between the atmosphere and water surface. The lowest value of 3.3mg/l was observed during June due to the effects of high temperature. The concentration of calcium and the magnesium ions present in the form of Mg²⁺ and Ca²⁺ in water determines the total hardness. The total hardness was between 32.5 mg l⁻¹ and 35 mg l⁻¹. Similar results were observed by Ramteke (2013) in Savithri reservoir, Maharashtra. The values obtained from the analysis for the total hardness indicates that the water is soft and lies between the ranges of 0 mg l⁻¹ -75 mg l⁻¹. The average range of magnesium was between 6.5 mg l⁻¹ and 7.7 mg l⁻¹. The magnesium was either very low or in BDL. Chloride constitutes the salt taste of water. The highest and lowest values of chloride were observed in S1 during July and October was 28.6 mg l⁻¹ and 10.6 mg l⁻¹, respectively are less than the permissible limits indicating the soft nature of water (Asok et al 2014). The concentration of heavy metals was in Below Detectable Level (BDL) which indicates that the water is free from pollutants and suitable for irrigation and for

drinking purposes. Similar studies were made by Semy et al (2019) at Tsurang River, Nagaland; Rahmanian et al (2015) at State of Perek, Malaysia and Abhishek et al (2020) at Rohtak, Haryana.

The estimated values of physico-chemical parameters were lower than permissible limits, indicate a very less nutritional load – a characteristic feature of Oligotrophic water. Walker et al (2007) in a special report entitled “Nutrients in Lakes and Reservoir” states: The oligotrophic water supports a very limited source for the survival of biological components where one or more macronutrients (Nitrogen, Phosphorus and Carbon) are absent and enhances water quality for drinking and irrigation purposes. Moreover, reservoir exhibits very low variability in its parameters and nutritional load due to its dynamic nature. The movement of water from higher gradient to lower gradient (Reservoir) limits the flow of nutrients to the lower gradient and hence a less nutritional load is obtained from the watershed areas. Anthropogenic activities and domestic wastes can induce certain organic, inorganic substances and heavy metals to the water which might contribute to the nutrient availability and when released in excess leads to eutrophication and pollution of the water. Data generated from our study depicts that the DO level of the Bhavanisagar reservoir and BDL of phosphorus supports the oligotrophic nature of water also the absence of eutrophication and BDL of heavy metals indicates the water is suitable for human consumption and irrigation.

WQI is commonly used for the detection and evaluation of water pollution. WQI were determined for the two samples during the study period by considering 9 parameters. According to the water quality rating status the value at the two sampling stations were between the range of 0-25. This indicates that overall water quality during the time period of

Table 3. WQI rating for sampling months - June – October, 2019

Parameters	Common weighing factor	Quality rating for sampling months				
		Jun	July	August	September	October
pH	0.0359	220.0	240.0	320.0	300.0	300.0
TDS	0.0005	9.6	15.7	12.4	9.1	8.9
TA	0.0022	29.2	38.5	34.3	20.8	31.3
TH	0.0009	10.8	11.3	11.7	10.4	11.7
NO ₃	0.0060	-	-	-	-	-
Cl	0.0011	7.0	9.4	6.7	8.5	6.0
Fe	0.8981	-	-	-	-	-
SO ₄	0.0013	1.2	2.4	1.0	-	-
DO	0.0539	117.7	113.5	114.6	99.5	110.4
WQI		14.3	14.8	17.7	16.2	16.8

June-October was suitable for drinking and irrigation. The quality status though deteriorated during the month of August, September and October the range was within the level of excellent. The variation was due to influence of rainfall over water.

CONCLUSION

Bhavanisagar reservoir is a catchment of flood waters from the watershed areas that are not frequently accessed by humans. Hence, anthropogenic intervention, domestic wastes and other chemical effluents are absent or very less due to which the nutritional content is checked. The lower nutrition load signifies the oligotrophic nature of water, sustains a stable aquatic ecosystem which do not lead to algal bloom and eutrophication. The physico-chemical assessment and WQI method used to determine the quality of water indicates that the water quality is excellent for the consumption and for the purpose of irrigation. As the water in the reservoir is used for drinking and irrigation purposes the values are ideal for the both purposes.

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REFERENCES

- Abhishek Nandal, Naveen Kaushik, Yadav SS, Rao AS, Neetu Singh and Gulia SS 2020. Water quality assessment of pond water of Kalanaur block, Rohtak, Haryana. *Indian Journal of Ecology* **47**(1): 1-6.
- Asok SV and Thomas J 2014. Spatial evaluation of pond water quality using Gis: A study from Athiyannoor block Panchayath, Thiruvananthapuram, Kerala, India. *International Journal of Scientific and Research Publications* **5**(10): 1-5.
- Bora M and Goswami DC 2017. Water quality assessment in terms of water quality index (WQI): Case study of the Kolong River, Assam, India. *Applied Water Science* **7**(6): 3125-3135.
- IS 3025 1992, Reaffirmed 2009: *Method of Sampling and Test (physical and chemical) for Water and Wastewater*, Part 42: Copper (First Revision). ICS 13.060.50.
- IS 3025-34 1988: Methods of sampling and test (physical and chemical) for water and wastewater, Part 34: Nitrogen [CHD 32: Environmental Protection and Waste Management]
- IS 3025-41 1992: Methods of sampling and test (physical and chemical) for water and wastewater, Part 41: Cadmium [CHD 32: Environmental Protection and Waste Management]
- IS 3025-47 1994: Methods of Sampling and Test (physical and chemical) for Water and Wastewater, Part 47: Lead [CHD 32: Environmental Protection and Waste Management].
- IS 3025-49 1994: Methods of sampling and test (physical and chemical) for water and wastewater, Part 49: Zinc [CHD 32: Environmental Protection and Waste Management].
- IS 3025-52 2003: Methods of Sampling and Test (physical and chemical) for Water and Wastewater, Part 52: Chromium [CHD 32: Environmental Protection and Waste Management].
- Panda R 2011. A growing concern: How soon will India run out of water? *Journal of Global Health* **1**(2): 135.
- Pires APF, Leal J, Da S and Peeters ETHM 2017. Rainfall changes affect the algae dominance in tank bromeliad ecosystems. *PLOS ONE* **12**(4): e0175436.
- Rahmanian N, Ali SHB, Homayoonfar M, Ali NJ, Rehan M, Sadeef Y and Nizami AS 2015. Analysis of physiochemical parameters to evaluate the drinking water quality in the state of Perak, Malaysia. *Journal of Chemistry* **185**: 1-10.
- Ramteke KK 2013. Assessment of seasonal variations of water quality parameters of Savitri Reservoir, Poladpur, Raigad District, Maharashtra. *Assessment* **8**(4): 1337-1342.
- Sawant R and Chavan N 2013. Water quality status of Mahagaon reservoir from Gadhinglaj tahsil from Maharashtra. *International Journal of Science, Environment and Technology* **2**(6): 1196-1204.
- Semy K and Singh MR 2019. Assessment on the water quality of Tsurang river, Nagaland Affected by coal mining drainage. *Indian Journal of Ecology* **46**(4): 845-849.
- Singh KP, Malik A and Sinha S 2005. Water quality assessment and apportionment of pollution sources of Gomti river (India) using multivariate statistical techniques: A case study. *Analytica Chimica Acta* **538**(1-2): 355-374.
- Walker JL, Younos TM, and Zipper CE 2007. *Nutrients in lakes and reservoirs: A literature review for use in nutrient criteria development*. Virginia Water Resource Research Center (VWRRC) - Special Report, 122p.
- WHO 2007. *Guidelines for drinking-water quality*, 4th edition, World Health Organisation, Geneva.