International Journal of Engineering Technology and Management Sciences
Website: ijetms.in Issue: 6 Volume No.6 October - November – 2022
DOI:10.46647/ijetms.2022.v06i06.026 ISSN: 2581-4621

Assessment of Water Quality of Manasbal Lake using CCME-WQI Index

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ABSTRACT
Water purity generally refers to a general description about the character of water. Lakes having good trait properties make it high economic resources for an ecosystem and nature as well. A comparative study of different Physio-chemical assessment of different water quality parameters of Manasbal Lake was studied. The study was carried out during the month of June 2019- to May 2020 and 8 randomly sampling was chosen. The measurements made by the CCME-WQI index of the is above 80, representing good quality. A total of 12 water quality parameters were selected namely PH, Turbidity, TDs, Conductivity, Chloride, Alkalinity, Hardness, Calcium Hardness, Nitrate, phosphate, sulphate and Free CO_2 were analysed. All the parameters were analysed through standard analytical procedure. The present scenario of Manasbal Lake from ecological point of view has reached a critical stage, if not properly conserved it will likely deteriorate and in future will turn into highly eutrophic state.

Keywords-- Manasbal Lake, physio-chemical parameters, eutrophication.

1. Introduction

The earth has a plenty of water but unfortunately, only about 0.3 % is usable by humans that comprise of freshwater and lakes (0.009%), inland seas (0.008%), soil moisture (0.005%), atmosphere (0.001%), rivers (0.0001%), groundwater (0.279%) and other composed of ocean (97.2%), glaciers and other ice (2.15%) (Bibi et al. 2016). Water is an elixir of life. It is a vital element of human survival. The fresh water is a fresh commodity (Mukhtar, Faizanul, et al 2014). The rate at which we deplete and degrade our fresh aquatic resources poses a great threat to our future life support system (Badar et al 2007). To ensure fresh water availability from the local water sources has become a big challenge (Kanakiya, et al 2014)). Water is not only essential for life; it also remains one of the most important vehicles of transmitting disease in humans and an important cause of infant mortality in many developing countries (Ford, 1999). According to research, these some developing countries have a high frequency of waterborne diseases such as cholera, diarrhoea, dysentery, and hepatitis, which kill at least a hundred thousand children and adults each year (Raji and Ibrahim, 2011; Oguntoke et al. 2009). According to the WHO, around 80 percent of infections in underdeveloped countries are caused by drinking contaminated water, and about 3.1 percent of deaths are caused by unsanitary and poor water quality (Javaid, Momina, et al2022, Khan et al. 2013). At present water resources are in a serious problem due to encroachment, unplanned urbanization and industrialization. Environmental status of lakes all over the world is in varying degrees of degradation (Manderia.S et al 2013).water can be contaminated by microbiological, physical and chemical pollutants. Each of which is related to different causes and health- associated issues and results.

Kashmir valley for the most famous all over the world for its natural beauty as well as numerable form of Lakes (Riyaz, Muzafar, et al 2021). Wet lands, rivers, pounds, springs, and streams, (Sualiha et al 2018) among these famous water bodies present in Kashmir valley one of the lake is Manasbal Lake. It is the deepest (12m deep) of all the fresh water Lakes fed by ground water in Kashmir valley (Sarah et al 2012). The present study was carried to one of the most beautiful lake of Kashmir MANASBAL LAKE. The lake is surrounded by mountains all around. The lake is situated at an altitude of 1583m above, the sea level between geographical, coordinates, of 34.14- 36 16'N latitude

DOI:10.46647/ijetms.2022.v06i06.026 ISSN: 2581-4621

and 74.4’ 74.43 longitude. The lake catchment area covers an area of about 22 km^2 (Abu-Bakr et al 2008) (Ganaie et al 2015). As the water quality of the lakes in Kashmir is not monitored regularly and data on the water quality of Manasbal Lake are very meagre. The water quality deteriorated considerably due to hyper-eutrophication, illegal construction, organic matter dumping, sewage and other pollutants (Beymer-Farris and Betsy A 2011; najar et al 2012); Murtaza et al 2017; Shah and Shamim A 2012; Sahu et al 2018).

Fig. 1 Manasbal lake.

It is important to study the water quality of the Lake. The Lake is undergoing considerable shrinkage mainly due to human activities. Govt. of Kashmir have allotted various projects to prevent the major lakes of Kashmir from pollutants (Dal Lake, Wular Lake etc.) (Qadri, Humaira et al 2007; Shubeena et al 2018) But no attention has been taken towards the deteriorating conditions of Manasbal Lake, which is on the verge of extinguish (Fazal, Shahab et al 2012; Singh, omkar et al 2007). The main aim of the study is to assess the Water Quality of Manasbal Lake using CCME-WQI index

2. MATERIALS AND METHODS.

Water samples were collected in specific bottles according to standard methods. Water samples were collected from Eight sampling sites on monthly basis (June 2019- May 2020) for the analysis of different physio-chemical parameters. The water samples for chemical analysis were kept in airtight polyethylene bottles that were clearly labeled and tightly closed to prevent air from getting in. pH, Turbidity TDs and Conductivity were recorded on the spot, while samples for chemical analysis were transferred to the lab immediately and evaluated within 24 hours of sampling in accordance with Mackereth (1978), CSIR (1975), APHA (1998), and Wetzel and Likens (1998). (2000).

2.1 CCME-WQI

Water quality index is an important tool to determine the status of drinking water quality in urban, rural and industrial areas (Noori, Roohollah, ET al.2019). It integrates all the parameters while comparing with the standards recommended by the government authorities to safeguard human health (Ali, Syed Yakub, ET al.2021). There are several water quality indices that have been developed to aid water quality divisions in USA, Canada, and Malaysia (Said, Ahmend et al. 2004). However, most of these indices are based on the WQI developed by the U.S. National Sanitation Foundation (NSF). CCME water quality index have been used extensively in Canada. The CCME WQI comprises three factors and is well documented (Canadian Council of Ministers of the Environment (CCME, 2001). It is based on a formula developed by the British Columbia Ministry of Environment, Lands and Parks and modified by the Alberta Environment (Ashok Lumb et al., 2006). The index is based on a combination of three elements namely Scope (the percentage of variables that exceed the permitted quality standards; F1), Frequency (number of separate tests for the variables that do not reach quality standards; F2), and Amplitude (the extent to which the failed tests exceed the permissible quality

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standards; F3). The CCMEWQI model is a mathematical framework for evaluating ambient water quality in relation to water quality goals. The 10 factors will be examined in the calculation: PH, TDs, Turbidity, Alkalinity, Free carbon dioxide, Sulphate, Nitrate, Hardness, Calcium, and Chloride. It is customizable in terms of the type and amount of water quality variables to be tested. According to the CCME WQI water quality is ranked in the following 5 categories Excellent, Good, Fair, Marginal and poor; table 1

F1 scope:
Scope measures the extent of noncompliance with water quality guidelines over the time period of interest, i.e. the number of parameters whose objective limits are not met. It was directly adopted from the British Columbia Water Quality.

$$F1 = \left[\frac{\text{Number of failed variables}}{\text{Total number of variables}}\right] \times 100 \qquad (1)$$

Where, the variables denote the water quality parameters for which objective values (threshold limits) have been established and observed values at sampling sites are available for index calculation.
F2 Frequency:
The frequency with which the objectives are not met (i.e. how many times the tested or observed value was outside of acceptable limits), which represents the percentage of individual tests that do not meet the objectives ("failed tests").

$$F2 = \left[\frac{\text{Number of failed Tests}}{\text{Total number of Tests}}\right] \times 100 \qquad (2)$$

F3 Amplitude:
The amount by which the objectives are not met (amplitude) that represents the amount by which the failed test values do not meet their objectives, and is calculated in three steps.

<u>Step 1 Calculation of Excursion value</u>:
The number of times an individual's concentration exceeds (or falls below, when the objective is a minimum) the objective is referred to as an "excursion" and is expressed as follows. When the test value must not be greater than the objective.

$$\text{Excursion}_i = \left[\frac{\text{Failed test value}_i}{\text{Objective}_i}\right] - 1 \qquad (3a)$$

For the cases in which the test value must not fall below the objective:

$$\text{Excursion}_i = \left[\frac{\text{Objective}_i}{\text{Failed test value}_i}\right] - 1 \qquad (3b)$$

<u>Step 2- Calculation of Normalized Sum of Excursions:</u>
Individual test deviations from objectives are added together and divided by the total number of tests to determine the aggregate amount by which individual tests are out of compliance (both those meeting objectives and those not meeting objectives). This variable, known as the normalised sum of excursions, or NSE, is calculated as follows:

$$NSE = \frac{\sum_{i=1}^{n} excursion}{Total\ number\ Tests} \qquad (4)$$

Step 3- Calculation of F3:
F3 (Amplitude) is then computed using an asymptotic function that scales the normalised sum of the excursions from objectives (NSE) to produce a value between 0 and 100.

$$F3 = \frac{nse}{0.01nse + 0.01} \qquad (5)$$

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The CCME WQI is then calculated as:

$$CCMEWQI=100-\frac{\sqrt{F1^2+F2^2+F3^2}}{1.732} \quad (6)$$

The divisor 1.732 normalises the resulting values to a range of 0 to 100, with 0 representing "worst" water quality and 100 representing "best" water quality. After determining the CCME WQI value. The quality of water is ranked by assigning it to one of the following categories:

CCME Water quality value and ranking, Table 1

CCME WQI	RANKING	Water Quality Characteristics
95-100	Excellent	Water quality is protected with a virtual absence of threat conditions very close to natural and pristine levels
80-94	Good	water quality is protected with only a minor degree of threat or impairment conditions rarely depart from desirable levels
65-79	Fair	Water quality is usually protected but occasionally threatened or impair, condition sometimes depart from desirable levels
45-64	Marginal	water quality infrequently threatened or impaired conditions often depart from natural or desirable levels
0-44	poor	Water quality is almost always threatened or impaired condition usually depart from natural or desirable levels

Table 1

3. STUDY AREA

Manasbal is a gorgeous oblong shaped lake with aesthetic appeal and important ecosystem functions. It is recognised as Kashmir's "Supreme Gem of All Lakes." It is situated between 1,585 and 1,600 metres (5,200 and 5,249 feet) above sea level and between (34°14’ 38" N to 34° 15’ 26" N latitude and 74° 39’ 07" E to74°41' 20" E longitude). The lake is approximately 5 kilometres long and 1.2 kilometres wide, with a surface area of 2.81 kilometers2. The lake's maximum depth is roughly 13 metres in the centre. Manasbal Lake is around 30 kilometres north of Srinagar, Jammu & Kashmir's summer capital. It is surrounded by mostly rural areas, with three villages overlooking the lake: Kondabal, Jarokbal, and Gratbal. This lake is encircled on all four sides by mountains. Precipitation (rain and snowfall) and springs (more than 1,200 natural springs) are the main sources of water in Manasbal Lake. A regulated outflow channel transports lake water to the Jhelum River. The lake provides water for fishing and the cultivation of food and fodder plants. The lake not only serves as a source of water, but also as a hub for navigation and transportation, fishing, the harvesting of commercially valuable flora, as well as sightseeing and tourism. The abundance of lotus (Nelumbo nucifera) on the lake's periphery (which blooms in July and August) adds to the clarity of the water.

4. RESULTS AND DISCUSSION

The results of various physicochemical parameters of Manasbal Lake are based on eight water sampling sites, are summarized below in the table 1. The pH values for Manasbal Lake fluctuated from 7.0 at site M1 in January 2020 to a maximum of 8.90 at site M3 and M7 in July 2019, with an

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Website: ijetms.in Issue: 6 Volume No.6 October - November – 2022
DOI:10.46647/ijetms.2022.v06i06.026 ISSN: 2581-4621

overall annual mean of 7.98. Overall average value of all the sites are taken into account, the water body was found to be alkaline in nature (Ali and Urfan 2014; Kanikya et al 2014; parvez et al 2014). The values of Turbidity fluctuated from 2.43 mg/l at site M6 in January 2020 to 5.01 mg/l at site M4 in May 2020, the overall annual mean being 3.48 mg/l. Turbidity of water is actually the expression of optical property in which the light is scattered by the particles present in the water. Clay, slit, organic matter, phytoplankton and other microscopic organisms cause turbidity in lake water (Ouma, Yashon O., et al.2018). High turbidity shows presence of large amount of suspended solids (Serajuddin, Md, et al 2019). The values of TDs fluctuated from 100 mg/l at site M4 in July 2019 to 502 mg/l at site M7 in January 2020, the overall annual mean being 249.52 mg/l. The Total Dissolved Solids (TDS) mainly indicate the presence of various kinds of minerals and metallic ions which are comprised both colloidal and dissolved solids in water. It is also an important chemical parameter for quality water (Uddin, Md Ripaj, et al.2020). Conductivity varied in the range of 140 µS/cm at site M5 in June 2019 to 350 µS/cm at site M7 in October 2019, the overall annual mean being 258.33 µS/cm. Conductance has been used for assessing the trophic status of water bodies (Carr et al. 2008). The conductivity of Water bodies is influenced by incoming waters, seasonal rainfall pattern, evaporation rates, drainage type and trophic status (Kumar, Rohitashw, et al.2022). The values at Free carbon Dioxide varied from 0 mg/l at site M8 in July 2019, May 2020 to 26 mg/l at site M7 in November 2019, with a mean annual value of 11.58 mg/l. the increase in photosynthetic activity by aquatic plants leads to a decrease in free CO2 in the spring and summer season (Scott, Russell L., et al.2009). The values of Alkalinity fluctuated from a minimum value of 55 mg/l at site M8 in June 2018 to a maximum value of 272 mg/l at site M3 in November 2019, with an overall annual mean of 137.74 mg/l. Alkalinity is a measure of buffering capacity of water and is important for aquatic life in a freshwater system. The carbonate and bicarbonate together determine the total alkalinity of an aquatic system which is used to differentiate the soft and hard water bodies (Van Wyk et al.1999). The values of Chloride fluctuated from 11 mg/l at site M5 in July 2019 to 50 mg/l at site M8 in May 2020, the overall annual mean being 24.06 mg/l. The higher degree of chlorides indicates high degree of organic pollutants particularly that of animal origin (Dar, Sajad Husssain, et al 2016; Kanakiya et al 2014). The values are well below the WHO guidelines for drinking water maximum permissible level 250.00 mg/l. It is considered that chloride concentrations more than 200 mg/l is risky for human consumption and causes unpleasant taste of water (Pant, Ramesh R., et al.2019). Data pertaining to Hardness showed a range of 96 mg/l at site M4 in July 2019 to 210 mg/l at site M3 in February 2020, the overall annual mean being 164.93 mg/l. The higher value attributed to the inflow of directly discharge of domestic and sewage wastes by the local village into the lake (parvez et al 2014). data pertaining to Calcium hardness showed a range of 16.4 mg/l at site M2 in September 2019 to 173.4 mg/l at site M1 in November 2019, the overall annual mean being 113.46 mg/l. Calcium hardness is directly related to hardness and is essential for various metabolic processes in all living organisms including man (Dar, Ishtiyak Ahmad Et Al. 2019). Ca is an important content and is present abundantly in natural water bodies. Its sources were surrounding rock and soil and decomposition process in water (Osman and Khan Towhid 2013). Data pertaining to sulphate showed a range of 0.4 mg/l at site M3 in May 2020 to 16.4 mg/l at site M1 in June 2019, the overall annual mean being 3.30 mg/l. Sulfate mainly is derived from the dissolution of salts of sulfuric acid and abundantly found in almost all water bodies (Meride, Yirdaw et al 2016). High concentration of sulfate may be due to oxidation of pyrite and mine drainage etc. Water with higher concentration of sulphate may cause intestinal disorders (Singh, Abhay Kumar, et al.2008). Nitrate varied in the range of 108 µg/l at site M3 in May 2020 to 460 µg/l at site M3 in October 2019, the overall annual mean being 286.92 µg/l. Nitrate is an important nutritional factor in any water body that indicates the nature (oligo-trophic, meso-trophic, and eutrophic) and rate of eutrophication. There are many sources of NO3 -N like sewage, domestic runoff, and runoff from the farmlands (Odiyo, J. O., et al.2012). Data pertaining to Phosphate showed Phosphate was virtually missing at sites M5 and M7 in May 2020 to 502 µg/l at site M7 in January 2020, the overall annual mean being 230.42 µg/l. Phosphate enhance the growth of plankton and water plants that serve the food fishes and aquatic life. However if the excess

DOI:10.46647/ijetms.2022.v06i06.026 ISSN: 2581-4621

phosphorus is present, it may result in the eutrophication which is very harmful for aquatic life (Wurtsbaugh, Wayne A. et al. 2019).
The CCME WQI was used to analyses the water quality data in a straightforward and accessible manner. The index classification schema is used to turn the CCME WQI values into ranks. When compared to the WQI categories provided by CCME (2001), the lake is deemed to be of Good quality. The CCME WQI value of lake was 88.64.

Average results of physico-chemical and analyses of eight sites during the year 2019-2020.

Parameters	PH	EC	TUR	ALK	HAR	CAL	SUL	CL	free co2	TDS	phos	nitrate
M1	7.73	266.67	3.48	131.75	162.50	113.25	5.38	19.77	14.60	197.17	0.20	0.29
M2	7.84	262.92	3.57	166.08	173.50	125.71	5.11	25.58	11.17	210.58	0.21	0.23
M3	8.14	274.58	2.82	167.08	160.33	114.10	2.90	25.75	9.67	208.42	0.21	0.33
M4	7.98	261.24	4.48	157.25	166.00	116.28	2.84	23.08	10.00	203.33	0.20	0.30
M5	7.85	235.42	3.20	121.67	162.92	113.84	3.78	19.58	10.78	202.75	0.13	0.30
M6	7.74	240.17	2.90	155.33	145.27	102.03	2.03	24.33	9.31	234.00	0.23	0.25
M7	8.46	253.17	3.76	104.17	196.54	141.44	2.00	23.33	14.78	380.75	0.30	0.26
M8	8.10	272.50	3.67	98.58	152.36	105.41	2.40	31.08	12.34	359.17	0.36	0.35

TABLE 1

CONCLUSION

Different water quality parameters of the Manasbal were investigated in this study. The report states right away that the lake water is unfit for human consumption. It needs to be treated before it can be used for drinking. According to the measurements made by the CCME-WQI index of the is above 80, representing good quality. There are obvious signs that the lake environment is degrading. The lake area is demising and the quality of water is deteriorating. It is unfortunate that the Government is silent on the deteriorating condition of these lakes. Construction activity in and around these lakes should be completely prohibited. There must be sincere planning, intelligent direction, coordinated efforts and deft execution to educate local community about the prime importance of the lake. The present study emphasis the need for immediate remedial measures for protection and construction of these lakes in order to save it from further deterioration.

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