Study of Physiochemical Characteristics of Jodhpur Lakes

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Abstracts: *With the passage of time freshwater resources are dwindling day by day. The freshwater is one of the most precious natural resources of paramount importance for any nation on this globe. The indiscriminate exploitation of these resources due to the insatiable greed of human being has further led to their deterioration. Physiochemical monitoring of Kaylana as well as Takht Sagarv Lake water were conducted at different time interval during the year 2011. Both these lakes are primarily being used to quench the thirst of inhabitant of that area. The numerous samplings were chosen on the basis of their significance. The thorough analysis was carried out for the different water quality parameters (WQP) such as temperature, pH, DO, BOD, COD, Nitrate, chlorophyll "a", TP, TDS, conductivity and FC . The results found in the present investigation shows that the sewage and the discharge of untreated effluents have enormously contributed to the pollution in the Kaylana as well as Takht Sagar Lake. The water in these two lakes are mainly lifted from the Rajasthan canal and is considered not hygienic for the consumption of human use. This is the matter of grave concern and requires serious attention for the planners. The considerable augmentation of the water quality and enhancement of the carrying capacity of the lake after successful implementation of the project vividly reveals its success. It was evaluated that TSI index of Kaylana as well as Takht Sagar Lake falls in the category of mesotrophic, which indicates the moderate nutrients level and productivity in the lake. This is particularly contributed by the nutrients discharge from the surrounding areas. It is seen that both the lakes possess clear water quality and their beds are submerged with numerous aquatic plants.*

On the basis of the arduous study conducted in these lakes, it is concluded that the test was conducted on 11 WQP, only five parameters viz. pH, DO, BOD, FC and chlorophyll-a are mainly responsible as the major stressor, which is hampering the WQ of these lakes. It is observed that WQ of the Kaylana as well as Takht Sagar Lake as a whole and WQ pertaining to depth reveal that the lake WQ falls in the bracket of "B" class WQ. The WQ of these lakes is found to be conducive for bathing and irrigation purpose only. The WQ of the lake could be substantially improved by taking major initiative such as landscape development and meticulous management of solid waste disposal.

Key words: *Water quality, lake, parameters, sampling*

1. Introduction:

In nature, water is the natural resource which has been found in plenty. This is the easily available resource which has been harvested by the man to full fill the various demands and to support the life system. It has been noticed that, the human population is increasing so rapidly, hence the demand of water for various uses are also increasing enormously, which has led to the deterioration of water quality (WQ) in nature [1]. Water quality parameters (WQP) are an essential tool, which enable us to judge the suitability of water for its designated uses and to ameliorate existing conditions. In order to assess the optimum development and effective management for the multifarious beneficial uses, the current information is required which is obtained by different WQP [2]. The water availability is not uniform on the surface of the earth and with the passage of time its availability is dwindling like anything. In present scenario, the availability of freshwater is the cause of grave concern in term of water quantity as well as quality [3]. The numerous studies have been conducted to assess the WQ of different water bodies viz. lakes and ponds in India [4-21].

The present study is an attempt to assess the WQ of Kaylana and Takht Sagar lake of Jodhpur city where the unchecked anthropogenic activities and enormous environmental stress have further degraded the WQ, which in turn, has accelerated the eutrophication of these lakes. In current study WQ index as well as trophic indexes has been evaluated of these lakes at different locations.

2. Material and methods:

2.1 Studies site:

The study sites are located in northeast part of Jodhpur city for Kaylana Lake and southern part for Takht Sagar Lake. The Jodhpur is one of the oldest historical city of Rajasthan having rich cultural heritage and tradition.

The study area comprises of 42 Km^2 each for Kaylana and Takht Sagar Lake. The lake lies within the geographical coordinates of 26°18'4" N latitude and 72°86'5" E longitude. The study area primarily falls in the category of drought prone area, with a scanty rainfall. To the northeast of the lake, in Machia Park, Vindhyan type of rocky sand stone deposits are found in abundance. In continuation of the lake downstream, there is another storage reservoir known as Takht Sagar, which is used to supply the drinking water to the city of Jodhpur. The Salient features of Kaylana and Takht Sagar lakes have been shown in Table 1.

Table 1: *Salient feature of Kaylana and Takht Sagar Lake*

S. No.	Feature	Kaylana	Takhat Sagar
1.	Construction Period	1872 AD	1932 AD
2.	Type of Dam	Earthen	Earthen
3.	Location		
	-Latitude	26°18'	26°18'
	-Longitude	73°01'	73°01'
4.	Catchment Area	42 km^2	42km^2
5.	Submergence area	0.78 km^2	-
6.	Maximum Depth	17.6 m	21.3 m
7.	Source of Water	Rain Water and canal	Water from Kaylana
8.	Water Use	Potable Water	Boating and potable
9.	Sewage Water inflow	Negligible	Negligible

2.2 Methods and physico-chemical analysis

During the study period, water samples at different locations have been taken at different time interval in the year 2011. The water sample at eight locations (T1–T8) has been taken for Takht Sagar and at seven locations (K1-K7) for Kaylana Lake as shown in Table 2.

Table 2: *List of Sampling Locations of Kaylana and Takht Sagar Lake*

S. No.	Types of lake	Sample Code No.	Name of Sampling Location	Location					
				Latitude			Longitude		
				°	m	S	°	m	S
1	Takht sagar	T1	Near to platform (Centre)	26	17	8.9	72	58	26
2	Takht sagar	T2	Near to Pumphouse	26	16	8.57	72	58	01
3	Takht sagar	T3	Sidhnath temple	26	16	975	72	58	01
4	Takht sagar	T4	Upper hatchery bandh	26	17	220	72	58	15
5	Takht sagar	T5	Lower hatchery bandh	26	17	212	72	58	15
6	Takht sagar	T6	Near to tapu	26	16	902	72	58	12
7	Takht sagar	T7	Near the fall	26	17	934	72	58	33
8	Takht sagar	T8	Near the bridge	26	17	974	74	58	28
9	Kaylana	K1	Pumping station 1	26	18	006	72	58	41
10	Kaylana	K2	Pumping station 2	26	18	035	72	58	35
11	Kaylana	K3	Hathi canal, b/c	26	19	183	72	58	27
12	Kaylana	K4	Inlet, a/c	26	19	14.2	72	58	31
13	Kaylana	K5	Near to tapu	26	18	121	72	58	35
14	Kaylana	K6	Left bank of lake (forest chowki)	26	18	061	72	58	26
15	Kaylana	K7	Right bank of lake	26	18	066	72	58	39

For analyzing various WQP, water samples has been collected at certain seasonal interval during the study period by using clean 1L-polyethylene bottle at preselected point of the lakes. The thorough analysis was carried out for the different WQP such as temperature, pH, dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), chlorophyll a, nitrate, total phosphate (TP), turbidity, total dissolved solid (TDS), electrical conductivity (EC), fecal coliform (FC). For measuring water temperature LCD portable digital multistem thermometer was used having the range of –50°C to 150°C, similarly for measuring pH and EC were determined by the digital pH meter and conductivity

meter respectively. TDS were accessed by digital TDS meter and the results were express in ppm or mg/l. In order to measure NO_3-N, TP, EC, BOD, chlorophyll a, COD, the samples were taken in standard bottle of 500 ml capacity to laboratory to perform the test within 24 hours. The standard method was used for assessing the physico-chemical parameters [22]. Before conducting the test the samples were kept in refrigerator at 4^0C.

3. Results and discussions

The sample K1 to K7 and T1 to T8 are from inlet and outlet which mainly depends on the depth of the lake. The results reflects that the temperature ranges from 28.7–31.8°C during the period of sampling, while the pH remains between 7.4 - 8.2 that is within the prescribed limits for the WQ class 'B'(6.5 – 8.5). The DO varies from 5.5 – 12.29 mg/l, which fulfills the prescribed value (6 mg/l or more) of well oxygenated water. The turbidity is in the interval of 24.5 – 26.7 mg/l, which is pretty higher than the prescribed limit of 10 mg/l, indicating the bathing WQ 'B' which has slightly more sediments/ silts [23].The WQP such as pH, BOD, DO, Turbidity, TP and NO3-N has been taken from figure 1, whereas TDS, Conductivity and FC has been taken from Figure 2.

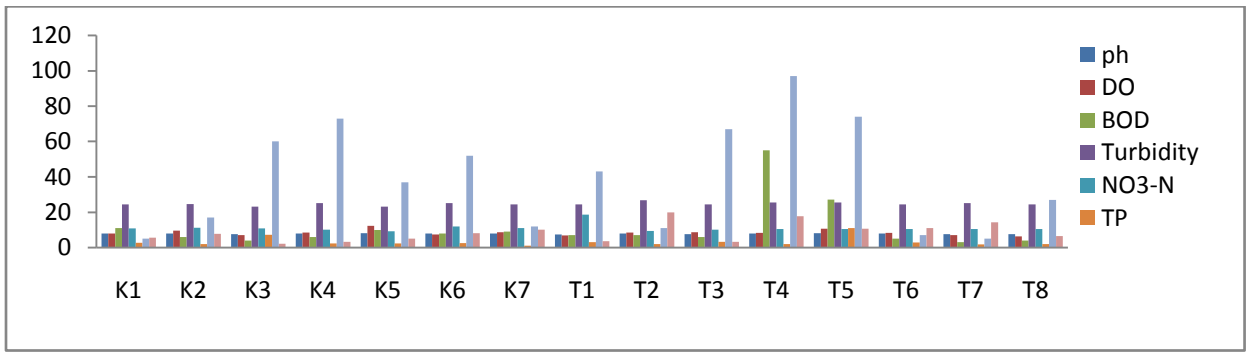

Figure 1: *WQ data of Kaylana and Takht Sagar Lake, Jodhpur*

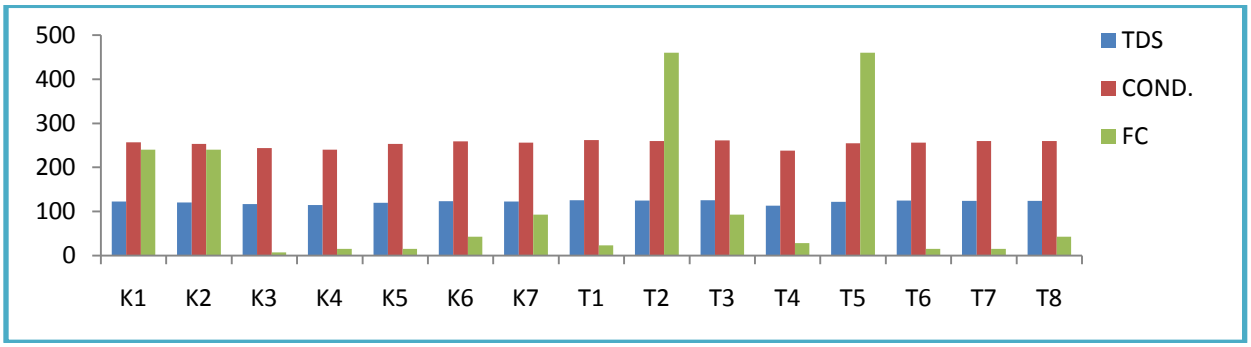

Figure 2: *WQ data of Kaylana and* Takht Sagar *Lake, Jodhpur*

NO_3-N ranges from 9.1 – 18.65 mg/l with highest content found at T2 (near the pump house) of the order of 18.65 mg/l and the lowest content has been found at T3 i.e. near Sidhnath temple of the order of 9.1 mg/l. This may be primarily attributed to the anthropogenic activities comprising agriculture/ artificial forest, uses of synthetic nitrogen fertilizers, which might have mixed to the lake through run-offs. The TP ranges from 1.99 –11.99 mg/l, with highest value at station T4 (11.99 mg/l). This is mainly due to the hatchery, where lot of waste is coming from the catchment in the form of human wastes due to open defecation and animal wastes of grazing animals. The BOD ranges from 3 – 55 mg/l, which is quite higher than the prescribed limit of bathing water quality. The conductivity ranges from 238 - 260 µS/cm for which no limit has been prescribed in specifications. The FC ranges from 7 to 460 MPN/100ml, which is pretty below than the standard limits of class 'B' water quality (500 or less). The enhancement in FC from T2 – T5 and further from KI - K2 is mainly attributed to the increase in the amount of human wastes. These data concludes that WQ at all well mixed locations except the stagnant water is an indicator of WQ of class 'B', that can be used for bathing purposes [23].The water is pumped to the physical treatment plant where from supply of drinking water is fulfilled for Jodhpur city. The TSI of lake at various

locations was assessed using the data of TP, Chlorophyll, Secchi depth and by using the equations for TSI. The Carlson's TSI can be computed using the following equations [24 & 25]:

TSI = 14.42 * ln [TP] + 4.15 (in µg/l) **(1)**

TSI = 30.6 + 9.81 ln [Chlor-a] (in µg/l) **(2)**

TSI - S = 60 - 14.41 * ln [SD] (in meters) **(3)**

Average TSI = [TSI (P) + TSI (CHL 'a') + TSI (SD)]/3 **(4)**

Where: TP: total phosphorus, Chlor-a: chlorophyll 'a' and SD: sechhi depth. Carlson's TSI was calculated for various ranges, which has been shown in Table 2.

Table 2: *Details of Carlson's Trophic State Index [25]*

TSI Values	Trophic status	Characteristics
<30	Oligotrophic	Clear water, oxygen throughout the year in the hypolimnion
30-40	Oligotrophic	A lake will still reveal oligotrophy, but some shallower lakes will become anoxic during summer season
40-50	Mesotrophic	Water reasonably clear, but increasing probability of anoxia during summer season
50-60	Eutrophic	Lower boundary of classical eutroph : Decrease transparency
60-70	Eutrophic	Dominance of blue-green algae, algal scum probable, extensive macrophytes problems
70-80	Eutrophic	Heavy algal blooms possible throughout the summer, often hypereutrophic
>80	Eutrophic	Algal scum, summer fish kils, few macrophytes

From the above table the lower value (< 30) of TSI indicates the pristine WQ having abundant availability of oxygen in the lake, where as the higher value (> 80) of TSI indicates the poor WQ in which only few macrophytes could survive. For in depth analysis TSI of Kaylana and Takht Sagar Lake ware calculated at different locations from K1 to K7 and T1 to T8 which gives, the exact status of lake at that point as shown in Table 3.

Table 3: *Trophic State Index of Kaylana and* Takht Sagar *Lake*

S. No.	Location	Calculated TSI Range	Status of Lake
1.	K1	40-50	Mesotrophy
2.	K2	60-70	Eutrophy
3.	K3	15-30	Slightly oligotrophy
4.	K4	15-30	Slightly oligotrophy
5.	K5	30-40	Slightly mesotrophy
6.	K6	40-50	Mesotrophy
7.	K7	40-50	Mesotrophy
8.	T1	30-40	Slightly mesotrophy
9.	T2	50-60	Slightly eutrophy
10.	T3	30-40	Slightly mesotrophy
11.	T4	60-70	Eutrophy
12.	T5	50-60	Slightly eutrophy
13.	T6	30-40	Slightly mesotrophy
14.	T7	15-30	Slightly oligotrophy
15.	T8	30-40	Slightly mesotrophy

The above table leads to the conclusion that the TSI of Kaylana as well as Takhat Sagar Lakes falls in the mesotrophy category, it means both the lakes are in the process of intermediate level of productivity. These lakes are primarily having clear water, with their beds submerged in aquatic plants and medium level of nutrients. The level of the pH and DO of the lake water satisfy the minimum WQ criteria prescribed for bathing purpose, but the level of BOD and FC are quite high.

4. Conclusions

It is concluded that out of 11 WQP measured; only five parameters viz, pH, DO, BOD and FC and chlorophyll 'a' are found as the major stressors leaving an impact on higher than the permissible limits for human use. Thus, the water becomes suitable for bathing and irrigation, which can be easily, improved using various conservation measures comprising of landscape development, management of solid wastes in and around lake. Moreover, both the lakes are in mesotrophic state with respect to its TSI. It indicates that it has received the nutrients from surrounding; as a result the lake has developed the tendency to allow the growth of vegetation in stagnant water only. The findings clearly indicate, that the lakes are polluted and mesotrophic in nature, because of discharge of sewage and other anthropogenic activities. All the above impacts have resulted in further deterioration of water quality of Kaylana and Takht Sagar Lake.

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