Section: Research Paper

Water Quality Index of Freshwater Water Body With Reference to Water Quality Parameters from Punjab (INDIA)

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Abstract

Monitoring of various water parameters of pond water and its fluctuations are useful not only to assess the natural conditions for various purpose such as fish farming, domestic purposes, but also be cautions to environmental damages. Water Quality Index is a method that enables an easier interpretation of the monitoring data. The present study was undertaken to determine the water quality of pond situated in Mansa district, Punjab during June, 2017 to May, 2018. Eight physico-chemical water parameters were evaluated from different selected sites of pond (S1 to S8). Different physico-chemical water parameters were analysed seasonally by following the standard methods given in APHA (2012) and Trivedi and Goel (1984). The values of WQI of different sites observed as S1:143.3, S2:103.8, S3:142.6, S4:127.2, S5:75.6, S6:68.5, S7:56.1 and S8:62.4 which indicate very poor water quality at site S5, poor water quality at site S6, S7 and S8 and unsuitable as S1, S2, S3 and S4 sites. This represents the water quality is highly unsuitable for commercial purpose and can be used for irrigation, industrial purpose and fish culture for suitable fish species.

Key words: Fish culture, Physico-chemical parameters, Pond, Water quality, Water pollution, WQI.

Introduction

Water act as a prime source for the environment development, while development of the environment directly depends upon quality of water. Living components of the pond are totally dependent upon water to breathe, feed and grow, excrete wastes, maintain a salt balance and reproduce[1](Das, 2019). As population explosion leads to rapidity of urbanization, large-scale industrialization, economic development and environmental concerns, that suppresses the water quality and impose threat and physiological stress to the biotic communities. Due to imprudent loading of nutrients results into increase the productivity rate, which consequently in eutrophication and population density and diversity of aquatic

organisms affected critically. Moreover, the effects of low water quality on human health can also be observed. The water pollution problem is one such destruction that has taken the attention of scientists all-round the globe[2] (Mishra *et al.* 2015).

So, assessment with physico-chemical characteristics of water is the major factor, which provides the information regarding the quality of water. To know about the quality of water, various aspects regarding physicochemical parameters are required to study, which alternatively informed us about the state of a water body and its abiotic and biotic components. Each parameter including color, odor, temperature, pH, DO, BOD, TDS, EC, transparency, acidity, alkalinity and hardness, have specific standard value, above or below that value, water is unfit to the use for the various purposes such as agriculture, fish culture, insect development, industrial use etc[3,4,5] (Boyd, 1990; James, 2000; Kiran, 2010) . The major aim of this work is to study the current scenario about the effects of discharge on the water quality of pond and how the contaminants are changing the water quality. Pond habitats can easily be manipulated by controlling the water characteristics for an optimum environment that improve the water quality. Moreover, Water quality and portability of different sites has been evaluated by analysing the physicochemical parameters, correlation coefficient and by estimating WQI. Thus, the aim of the present research was to investigate the water quality of selected pond by analysing the physico-chemical characteristics, comparing the analyzed water quality index values with the standard values, and also observed that the pond water is suitable or not for various purposes.

Materials and Methods

Study Area

Punjab “The land of five rivers” is a state, occupied 50,362 sq. km area situated in northwest end of India (Fig. 1). It extends 29”30’N to 32”32’N latitudes and 73”55’E to 76”50’E longitudes. The state of Punjab is situated in the Indo-Gangnetic alluvial plains, also called as great plain. This area is at the edge of the ‘Thar’ desert, which is one of the largest deserts of north.

Mansa, a Punjab state district situated in Southern part India with latitude 29° 32’N to 30° 12’N and longitude 75 °10’E to 75° 46’E. Mansa District (Fig. 2) is located in the southern part of Punjab State and covers an area of 2,171 sq. This area is irrigated by network of canals (e.g., Sirhind canal and Bhakra canal). The present study was carried on village pond (situated in village Burj Harike; Fig. 3) during the period June, 2017 to May, 2018. This natural village pond is used for various commercial purposes like drainage, run off, bathing

and washing. GPS reading was taken to know the latitude and longitude of each sampling pond.

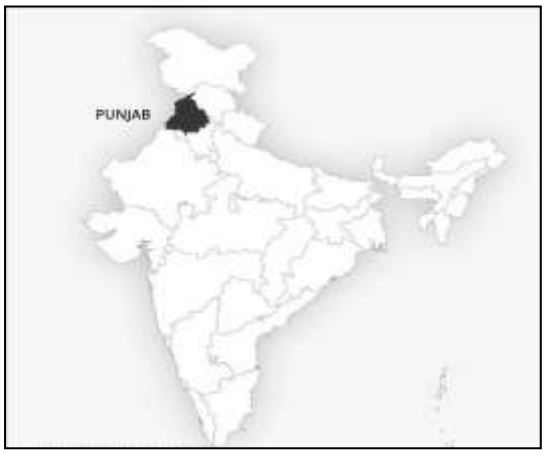

Fig.1 Location of Punjab in India

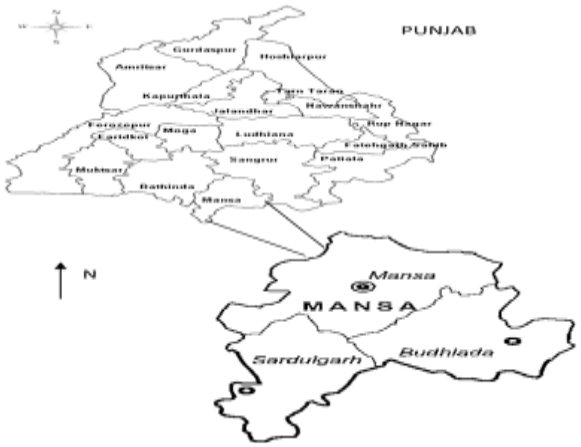

Fig.2 Location map of Mansa district of Punjab

Collection of Water Samples

Total eight different sites were selected in the pond named as S1 to S8, to analyze the water quality index. Different physico-chemical water parameters were analysed seasonally (such as pH (portable digital pH meter (HM DIGITAL-pH80 Hydrotester), total dissolved solids (TDS meter), dissolved oxygen (Winkler's method), hardness, total alkalinity, electrical conductivity,) by following the standard methods given in[6] APHA (2012) and (nitrate and phosphate) by[7] Trivedi and Goel (1984). Physico-chemical parameters such as hardness, total alkalinity (TA), nitrate and phosphate were determined separately in the laboratory. Dissolved oxygen of water was fixed on the spot and brought to laboratory for further titrations. Other physico-chemical parameters including pH, TDS and EC were measured by respective field tools.

Fig. 3 Selected Pond in Burj Harike, District Mansa

RESULTS AND DISCUSSION

Analysis of Physico-chemical Water Parameters and Relationships

The water parameters under report were studied from eight selected sample sites (S1 to S8) of the selected pond during the study period. Various water parameters fluctuations and their relationships have been observed and given in Table.1 and 2. Annually maximum value of pH was observed at site S1, S2, S3 and S4 as compared other four selected sites which may be attributed the high disturbance of various anthropogenic activities. It must be pointed out that these high values of pH lie beyond the permissible limits. Electrical conductance ranged from 705to 1572 µS cm^{-1}, maximum values of conductance were observed at sites S1, S3 and S4 as compared to other selected sites due to high pollution load by runoff and agricultural and industrial effluents.

Total dissolved solids varied between 544 mg/l to 1466 mg/l found maximum at sites S1, S3 and S4 and minimum at other selected sites. These maximum values indicate the high pollution due to influx of various materials. Dissolved oxygen varied from 4.3 to 8.5 mg/l during the study period. Minimum value of dissolved oxygen observed at sites S1, S2, S3 and S4, as compared to sites S5, S6, S7 and S8 due to high pollution load. Total alkalinity ranged between 122 to 321 mg/l, observed maximum at sites S1, S2, S3 and S4, as compared to sites S5, S6, S7 and S8. Hardness of water observed between 110 to 353 mg/l and maximum values were recorded at sites S3, S2, S1 and S4. Nitrates of water varied from 0.117 to 0.181 mg/l and maximum values were observed at all the sites except sites S4, S7 and S8. Phosphate ranged between 0.256 to 0.669 mg/l and peak values were recorded at sites S1, S2, S4 and S5. The values of nitrates and phosphates were recorded very low from permissible limit.

Correlation between Physico-chemical Water Parameters

Pearson Correlation (r) of different water parameters has calculated at different selected sites during the study period (Table.2) and significant fluctuations has been recorded. As pH, and Total dissolved solids showed the positive correlation with the different selected water parameters except dissolved oxygen (r = -0.89). Electrical conductance showed positive correlation with all except dissolved oxygen (r = -0.88) and nitrates (r = -0.04). Dissolved oxygen positively correlated with nitrates (r = 0.02) and negatively correlated with other parameters. Hardness showed negative correlation with dissolved oxygen (r = -0.53), nitrates

(r = -0.31) and phosphates (r = -0.26). Nitrates positively correlated with all except electrical conductance (r = -0.04) and hardness (r = -0.31), whereas phosphates showed positive correlation with all except dissolved oxygen (r = -0.38) and hardness (r = -0.26). It may be pointed here that the level of this earlier observation of[8,9,10,11,12,13] Ganai (2011), Kaur (2013), Sharma (2007, 2010), Modi (2015) and Verma (2015).

Water Quality Index Calculations

The values of water parameters were calculated by following standard methods, then the means values were compared with standard of drinking water recommended by[14,15] WHO and ISI and ICMR. For the calculations of WQI following expression is used: -

$WQI = q_i w_i$

Where q_i (water quality rating) $100 \times (V_a - V_i)/ (V_s - V_i)$

Where V_a actual value present in the water sample,

V_i ideal value (0 for all parameters except pH and DO which are 7.0 and 14.6 mg/L, respectively).

V_s standard value.

W_i (Unit weight) = K/Sn

Where K (constant), Sn standard value

Water Quality Index

Water quality index of nine water parameters of pond is observed as S1 143.3, S2 103.8, S3 142.6, S4 127.2, S5 75.6, S6 68.5, S7 56.1 and S8 62.4 (Table 5). The observed values indicate the WQI ranged between very poor water quality at site S5, poor water quality at site S6, S7 and S8 and unsuitable as S1, S2, S3 and S4 sites (Table 6). Calculated values of different water parameters are compared with standard values of WHO, ICMR and ISI. (Table 3 and 4) and fluctuations are observed. According to Central Pollution Control Board has classified fresh waters into five different classes (A, B, C, D, and E) suitable for various purposes (Table 6). On the basis of this, the selected sites are categorised under the D and E class.

Conclusions

The overall picture, which emerges based on the present investigations, is that the pond under report is highly disturbed by anthropogenic activities, eutrophic and unorganised attributed to discharge of effluents directly into water. According to WQI, the water is unsafe for commercial purposes, highly polluted but can be used for irrigation and industrial purpose. Therefore, necessary steps should be taken to improve the water quality and these steps should be implemented in such a way that they not only to bring economic benefit but also conserve environmental quality. The present study recommended some proper steps to be undertaken at the investigated ponds to maintain and improve the water quality for various beneficial purposes that water quality of pond should be monitored regularly and discharge of effluents into pond should be regulated according the Pollution Control Board to control pollution. Needless to emphasize that these observations from the baseline information for similar future studies and for management of pond fisheries in this area, which is not vogue in this area.

Acknowledgments

The author thanks the Akal University, Talwandi Sabo for financial assistance and providing permission of collection-cum-survey tours to Mansa district, Punjab.

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Table 1. Variations in annual mean values of different physico-chemical parameters at selected sites (S1-S8) from June, 2017 to May, 2018.

S. No.	Water parameters	S1	S2	S3	S4	S5	S6	S7	S8
1	pH	8.7	8.1	8.3	8.1	7.6	7.5	7.8	7.2
2	EC (µS cm^{-1})	1558	988	1572	1470	779	721	767	705
3	TDS (mg/l)	1217	923	1466	1140	728	623	553	544
4	DO (mg/l)	4.3	5.4	5.8	5.3	8.5	8.2	8.5	8.4
5	Total alkalinity (mg/l)	321	277	275	236	175	150	130	122
6	Hardness (mg/l)	163	167	353	282	126	110	172	113
7	Nitrate (mg/l)	0.166	0.146	0.151	0.117	0.181	0.166	0.122	0.129
8	Phosphate (mg/l)	0.699	0.510	0.256	0.518	0.665	0.440	0.301	0.265

Table 2. Correlation of different physico-chemical parameters at selected sites (S1-S8) from June, 2017 to May, 2018.

	pH	EC	TDS	DO	TA	Hardness	Nitrate	Phosphate
pH	1	0.876875	0.840758	-0.89698	0.922429	0.561207	0.100852	0.401375
EC		1	0.961029	-0.88145	0.851634	0.781194	-0.04728	0.214129
TDS			1	-0.84361	0.877622	0.819924	0.781194	0.174047
DO				1	-0.95196	-0.53679	0.02803	-0.38331

TA					**1**	**0.511601**	**0.224843**	**0.45953**
Hardness						**1**	**-0.3162**	**-0.26912**
Nitrate							**1**	**0.571987**
Phosphate								**1**

Table 3.Water quality standards, recommending agency and unit weights.

Water parameter	Standard value	Ideal value	weight	Observed value	Unit weight (w_n)	Quality rating (q_n)	w_nq_n
pH	**8.5**	**7**	**2**	**8.7**	**0.08**	**113.3**	**9.06**
EC	**300**	**0**	**3**	**1558**	**0.12**	**531.7**	**63.8**
TDS	**500**	**0**	**3**	**1217**	**0.12**	**243.4**	**29.2**
DO	**5**	**14.6**	**4**	**4.3**	**0.16**	**107.2**	**17.1**
TA	**120**	**0**	**2**	**321**	**0.08**	**267.5**	**21.4**
Hardness	**300**	**0**	**1**	**163**	**0.04**	**54.3**	**2.17**
Nitrate	**45**	**0**	**5**	**0.166**	**0.2**	**0.36**	**0.07**
Phosphate	**25**	**0**	**5**	**0.699**	**0.2**	**2.79**	**0.55**
			25		$\sum w_n=1$	$\sum q_n=$ **1320.5**	$\sum q_nw_{n=}$ **143.3**

Table 4. Water quality standards.

Parameters	WHO	ICMR	ISI
pH	**6.5-8.5**	**7-8.5**	**8.5**
EC	**1000**	**300**	**300**
TDS	**500**	**500**	**-**
DO	**5**	**-**	**3**
TA	**120**	**-**	**-**
Hardness	**500**	**300**	**300**
Nitrate	**50-100**	**20-100**	**50-100**
Phosphate	**0.1-1**	**-**	**0.5-1**

Table 5. Calculated water quality index[16] (Chatterji and Raziuddin, 2002).

SITES	CALCULATED WATER QUALITY INDEX	REMARKS	FEASIBLE USAGE
S1	143.3	Unsuitable	Treatment before use
S2	103.8	Unsuitable	Treatment before use
S3	142.6	Unsuitable	Treatment before use
S4	127.2	Unsuitable	Treatment before use
S5	75.6	Very poor water quality	Irrigation
S6	68.5	Poor water quality	Industrial and irrigation
S7	56.1	Poor water quality	Industrial and irrigation
S8	62.4	Poor water quality	Industrial and irrigation

Table 6. Water quality criteria for different uses (http://117.252.14.242/rbis/india_information/water%20quality%20standards.htm).

Designated-best-use	Class of water	Criteria
Drinking water source without conventional treatment but after disinfection	A	Total coliforms MPN/100 ml shall be 50 or less pH between 6.5 and 8.5 Dissolved oxygen 6 mg/l or more Biochemical oxygen demand 5 days 20◦C 2 mg/l or less
Outdoor bathing (organized)	B	Total coliforms MPN/100 ml shall be 500 or less pH between 6.5 and 8.5. Dissolved oxygen 5 mg/l or more Biochemical oxygen demand 5 days

		20◦C 3 mg/l or less
Drinking water source after conventional treatment and disinfection	**C**	**Total coliforms MPN/100 ml shall be 5,000 or less pH between 6 and 9.Dissolved oxygen 4 mg/l or more Biochemical oxygen demand 5 days 20◦C 3 mg/l or less**
Propagation of wildlife and fisheries	**D**	**pH between 6.5 and 8.5. Dissolved oxygen 4 mg/l or more**
Irrigation, industrial cooling controlled waste disposal	**E**	**pH between 6.0 to 8.5 Electrical conductivity at 25◦C µΩ/cm Max. 2250**
	Below E	**Not meeting A, B, C, D, and E criteria**