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WATER QUALITY OF THREE PONDS OF CHITTAGONG UNIVERSITY CAMPUS USING WATER QUALITY INDEX

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Abstract: *This investigation is done to determine water quality of three ponds in the Chittagong University campus using eleven physicochemical factors (temperature, Secchi depth, conductivity, pH, DO, BOD, free* CO_2*, calcium, TDS, total hardness and alkalinity), to find out the Water Quality Index (WQI) for human uses. WQI was determined using "Weighted Arithmetic Water Quality Index method which was found to be 130.08 for Pond 1, hence unsuitable for drinking, where as for Pond 2 and pond 3 WQI were 98.07 and 102.18 respectively, hence very poor but suitable for drinking after treatment. Pond 2 was less used by the local residence and was less polluted. Pond 1 was extensively used for bathing and house hold washing, while Pond 3 was moderately used, hence found to be moderate to highly pollute respectively. To keep the pond water in good condition mass domestic use should be controlled, draining of surrounding organic matter should be stopped in pond 1 and pond 2 and also digging is necessary to remove the bottom deposits which should be continued at five years interval.*

Keywords: Physicochemical parameters, Water quality, WQI-"Weighted Arithmetic Index Method", Chittagong University Campus ponds.

INTRODUCTION

From time immemorial man-made and natural water reservoirs like ponds have been playing a vital role for keeping all living beings alive by providing water for drinking and also for other purposes such as bathing, washing and fish culture. Bangladesh is a small but densely populated country with vast natural water resources like ponds, wet lands, rivers and reservoirs. Among these water bodies role of pond in the daily life of mass peoples in rural areas is tremendous. There is no village in Bangladesh without the existence of some ponds. Earlier, ponds were also found in urban areas which are now disappearing due to urbanization. Chittagong University (CU) is the largest university in Bangladesh situated in the hilly area of Hathazari Upazilla, 25 km North of Chittagong city, established in November 1966 with an area of 1754 acres, where some manmade lentic and natural lotic water bodies i.e. lake, marshy lands, hilly stream and ponds are present. Since the inception of Chittagong University (CU) in 1966 due to insufficient supply of underground water, there was need for pond water for different uses like bathing, household washing, cooking etc. by the general staffs. There was also need of a pond for water polo and swimming competition for the students. Keeping this in mind, three ponds were excavated in different locations of the CU campus. These three ponds are used in different levels, one for vigorous domestic use, one for moderate domestic use and the other one for swimming and water polo and very less use for domestic purposes. Hence, it is essential to check the deteriorating level of the water quality of the three ponds to determine how far the ponds are usable and whether the pond water is suitable for human use.

Since the last few decades, in general the water quality status is determined by the WQI, which is used for surface and ground water quality determination throughout the globe (Samantray *et al.* 2009; Sharma and Kansal 2011; Tyagi *et al.* 2013; Bhutiani *et al.* 2014; Yadav *et al.* 2015;

Kaviarasan *et al.* 2016). Major objective of the WQI method is to know the quality of the water source by clear and exploitable information from some important water quality data. Till now, four different methods are found for water quality estimation, such as “Canadian Council of Ministries of the Environment Water Quality Index (CCMEWQI), National Sanitation Foundation Water Quality Index (NSFWQI), Oregon Water Quality Index (OWQI) and Weighted Arithmetic Water Quality Index (WAWQI)” methods (Chandra *et al.* 2017). WQI is generally applied to compare the quality of different water bodies of a particular region which gives an idea to the users regarding the quality of water.

WQI provides an index value of the quality of different water bodies, obtained by using some physicochemical parameters as a result of which the quality of water and its usefulness (drinking, irrigation, fishing etc.) will be known to the users (Abbasi, 2002). In Bangladesh and India some research are done on the quality determination of water by WQI (Chatterjee and Raziuddin, 2002; Samantray *et al.* 2009; Islam *et al.* 2011; Chowdhury *et al.* 2012; Balan *et al.* 2012; Jagadeeswari and Ramesh, 2012; Bhutiani *et al.* 2014; Dash *et al.* 2015). Although there are large numbers of ponds present in Bangladesh but their quality status by WQI is not yet studied much. Considering human health concern, the water quality of three excavated big ponds in Chittagong University campus was studied to know their status in respect to drinking and other purposes which was not done earlier. This study might aware the users and also will help the authority to maintain the quality of water in good condition by some rules and regulations.

Materials and Methods

On the basis of level of use three ponds situated in Chittagong University (CU) campus (Latitude 22° 4710021′ and Longitude 91°7884693′) namely Pond 1(Shova Colony Pukur highly used) situated in the west of CU North campus, Pond 2 (Gol Pukur-less used) situated in the west of South campus and Pond 3 (Jib Biggan Anushad Pukur-modarately used) situated in the south of Biological Science Faculty locally called Jib Biggan Anushad were selected to determine the water quality by WQI using eleven physicochemical parameters. All three ponds are manmade and located in the three sites of the CU Campus within a triangle. Each pond was about 2 to 3 km away from another pond (Fig. 1).The three studied ponds are briefly described below.

Pond 1 (Shova Colony Pukur): This is about 25 years old manmade pond (Latitude 22° 483778´ and Longitude 91° 79082´) located in North-West side of the CU Campus and near to north side of CU central playground, about 1.7 km northerly from CU Zero Point (Fig. 1). The pond was rectangular in shape, covered 838 m^2 area with an average depth 3.1 m. The pond was located about 2.3 km north from Pond 2 and about 4.2 km north from Pond 3. The pond was in the middle of the Shova Colony. Colony residents (about 100) used the water of this pond for various purposes (bathing, cloth and utensil washing, house hold washings, fish culture etc.). Most of the surface area of the pond remained under shade of the trees present on the dyke of the pond, thus sun light could not directly fall on the water surface. Leaves fell in the pond at all the times. Bottom of the pond was muddy. It is a perennial pond with fluctuation of water level during winter and rainy season. The pond water was dense greenish color due to high algal bloom. Except for some floating water hyacinth and some planted rooted littoral plants locally called "*Pati-Patha"*(English name Murta, scientific name: *Schumannianthus dichotomus*), no other plants were observed. As the pond bank and its adjacent area was in the same level, so there was an easy access of surrounding wastes and used water to the pond during rainy season hence polluting the pond water.

Pond 2 (Gol Pukur): This is a round shaped perennial pond (Latitude 22° 466205´ and Longitude 91° 792128´) with an area of 1288 m^2, constructed during 1970mainly for swimming, water polo, other recreational purposes and also for bathing during water scarcity in the teachers quarters. Later on fish culture was introduced. Now some young people and few road side people were found to use this pond for bathing and farmers (vegetables carriers on shoulder) use it for washing their vegetables before taking to different markets. Two big trees and some coconut trees were found on the bank of the pond. Except few scattered littoral rooted plants, no floating plants were present. This is a highly deep pond with an average depth of 5 meters. The water was transparent. Pond bottom was sandy. Due to high and well-constructed dyke no surrounding waste materials could enter the pond during rainy time. So, there was little chance of contamination of water of this pond. During rainy season excess water was found to be removed through a well fitted big out-let pipe. This pond was located in South campus, south westerly near to South campus teachers' quarter and west of South campus mosque (Fig. 1) and about 700 meters south-westerly from the campus Zero Point. The distance of this pond was about 2.3 km from Pond 1 and about 1.9 km from Pond 3.

Pond 3 (Jib Biggan Anushad Pukur/Biological Science Faculty Pond): This rectangular perennial pond (Latitude 22° 466197′and Longitude 91° 781166′) covered an area of 2632 m^2 with an average depth 4.2 m, which was excavated during 2006 for using in the construction work of Biological Science faculty as well as for the various uses of the building construction workers. Later on fish culture was introduced. No big trees were found on the bank of the pond. An outlet was found in the dyke to drain the over level excess water during rainy season. A small colony of university employees was found near this pond. They used this pond for bathing, house hold washing etc. Road side peoples also used this pond for bathing. Farmers usually used this pond water for washing their vegetables before carrying to the market for selling. The pond bottom was muddy. Dyke height was not higher than the surrounding land, so, there was an easy excess of waste loaded surrounding water into the pond during rainy season. The pond water was medium transparent. Some littoral vegetation along with some planted rooted littoral plants locally called "*Pati Patha"*,Murta (*Schumannianthus dichotomus*) were found in the south and west littoral zones of the pond. Floating plant locally called "Topa Pana" (*Pistia sp.*) was seen occasionally. The pond was about 200 m south of CU Biological Science faculty, one km southwest of CU Zero Point, about 1.9 km west of Pond 2 and about 4.2 km southwest of Pond 1 (Fig. 1).

Sampling Period and sample collection

Monthly water samples from sub-surface level were collected in sampling bottles of 500 ml capacity for two years period from January 2017 to December 2018 from the three experimental ponds at regular monthly intervals.

Water Quality parameters and WQI

Eleven parameters of water were used to find out the WQI. Five of the parameters (water temperature, secchi depth, conductivity, pH, TDS) were recorded in the sampling stations immediately after collection of samples, and after necessary preservation rest six parameters ["DO, BOD, freeCO_2, Ca++, total hardness (TH) and alkalinity (AL)"] were measured in the Departmental Laboratory. Temperature was recorded by a general mercury Centigrade thermometer, Secchi depth by a 20 cm diameter Secchi disc, conductivity by a digital pocket Conductivity meter (EC 4DIGIT, HM Digital, China), pH by a pocket pH meter (pHepHANNA Instruments, Italy), and TDS by a digital TDS meter (DiST 2, HANNA Instruments, Italy). DO, BOD, free CO_2,Ca++, TH and AL were detected following 'APHA' (2012).

Procedure of WQI determination

"Weighted Arithmetic Water Quality Index (WAWQI) method" (Horton 1965 and Brown *et al.* 1972)was followed to determine the WQI. Eleven water parameters (temperature, Secchi depth, pH, conductivity, TDS, DO, BOD, free CO_2, Ca++, TH and AL) were utilized for transforming these values into the single index value of WQI. Interpretation and comparison was done with the index level of standards of drinking water quality, recommended by WHO(1992),BIS(1983) and ICMR(1975).

WQI is calculated following "Weighted Arithmetic Index method of Brown *et al.*(1972)" as mentioned below: WQI $= \sum_{n=1}^{n} qn * Wn / \sum_{n=1}^{n} Wn$

"q_n is the Quality rating for the n^{th} water quality parameter"

"Wn is the Unit weight for n^{th} parameters"

Sub Index Quality Rating (q_n) is calculated as follows:

q_n= 100[(Vn - Vio) / (Sn - Vio)]

Where,

q_n = Quality rating for the n^{th} water quality parameter

Vn = Estimated value of the n^{th} parameter at a given sampling station.

Sn = Standard permissible value of n^{th} parameter

Vio = Ideal value of n^{th} parameter in pure water.

"Viois taken as zero for drinking water except for pH = 7.0 and dissolved Oxygen =14.6mg/l (Tripaty and Sahu, 2005)".

"Calculation of Unit Weight (Wn)"

Wn is calculated from following relation:

Wn = K/Sn

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Here, Wn is the Unit weight for n^{th} parameters, Sn is the Standard value for n^{th} parameters, and K is the Constant for proportionality

Table 1 shows the classification of WQI level and status of water quality

Table1. Water Quality Index level and water quality status based on Weighted Arithmetic Index WQI method (source: Brown *et al.* 1972; Chatterjee and Raziuddin, 2002)

Water Quality Index Level	**Water Quality Status**
0-25	Excellent
26-50	Good
51-75	Poor
76-100	Very Poor
>100	Unsuitable for Drinking

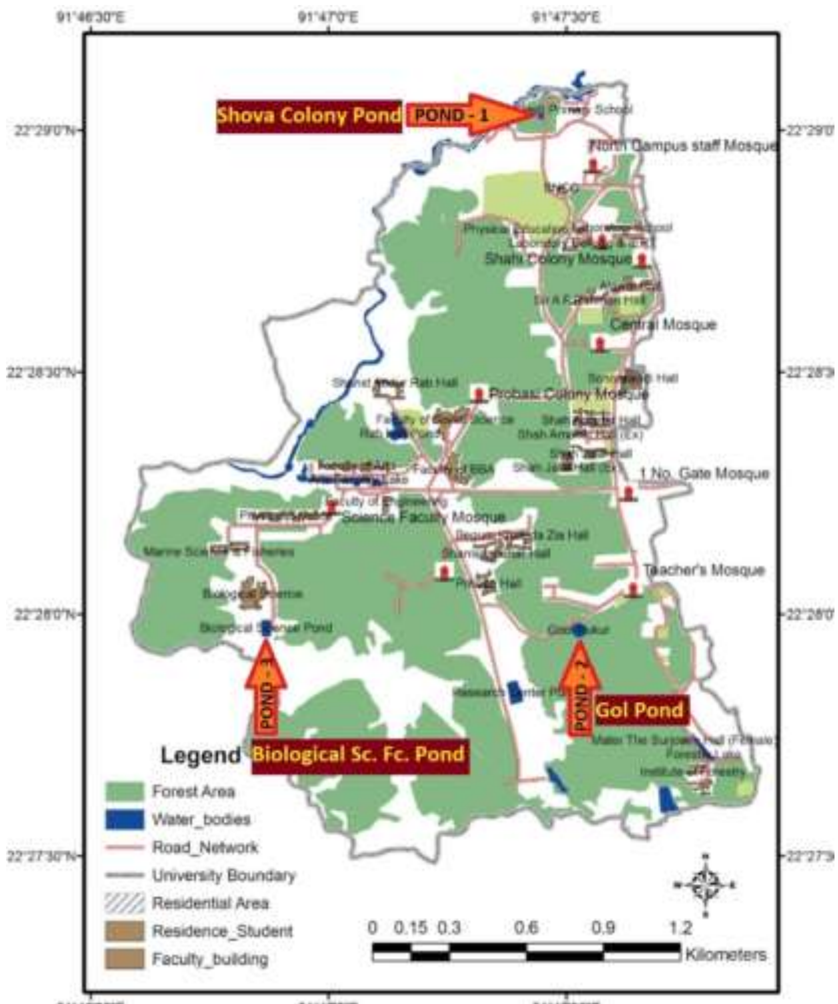

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Figure 1. Map showing location of three studied ponds (Pond 1: Shova Colony Pukur, Pond2: Gol Pukur and Pond3: Jib Biggan Anushad Pukur) in the Chittagong University campus. All the three ponds were in a triangle.

RESULTS AND DISCUSSION

Water quality index (WQI) gives brief indication of large number of water quality parameters into a single term (for example; excellent, good, poor, bad, unsuitable for drinking etc.) on the basis of WQI range level value for easy reporting to the concerned users (Hulya, 2009). This will help for taking safety measures. WQI is used to compare the quality of water of different water bodies in a particular region and it gives an idea regarding the quality of water to the people. For water quality management, the indices are the most effective means for informing the concerned authority (Jagadeeswari and Ramesh, 2012).

Tables 2,3 and 4show the minimum, maximum, range and mean values (with standard deviation) of 11 physicochemical parameters and WQI of the three experimental ponds of Chittagong University campus of 24 months samples.

Temperature: During 24 months study period water temperature varied between18-31^{0}C (mean 26.94±3.89^{0}C), 20-32^{0}C (mean 27.94±3.64^{0}C) and 20-33^{0}C (mean 28.08±3.34^{0}C) in ponds 1, 2and 3 respectively (Tables 2-4). Water temperature was found to remain in normal condition and was found to be within standard limit (Tables 2-4). In some other water bodies of Bangladesh, a maximum difference of 10.4 ^{0}C and temperature variation between 23.8-34.2^{0}Cwas noticed (Chowdhury *et al.* 2012). In some Indian ponds water temperature varied from 26.7^{0}C to 32.7 ^{0}C (Ashok *et al*.2015).

Secchi depth: Secchi depth or Water transparency varied from 14-72 cm (mean 46.69±13.78 cm), 20.5-85 cm (64.98±14.65 cm) and 16-75 cm (39.96±12.01 cm) in the ponds 1,2 and 3 respectively (Tables 2-4). Although among the three ponds mean transparency was lowest in Pond 3 but generally lowest transparency was found in Pond 1 due to mass use and thus was responsible for contamination which increased the turbidity. Except Pond 3, transparency of the other two ponds was more than standard limit (Tables 2-4).

Conductivity: Electrical conductivity varied from 180-423 µS/cm (mean 278.92±69.40 µS/cm), 22-85 µS/cm (mean 43.83±14.51 µS/cm) and 44-154 µS/cm (mean108.79±34.11 µS/cm) in ponds 1,2 and 3 respectively (Tables 2-4). Highest conductivity was recorded in Pond 1 which might be due to the presence of more electrolytes which happened due to excessive use of this pond water for different purposes by the surrounding peoples as well as entrance of waste materials in the pond. Conductivity of water of Pond 1 was found to be more than standard limit and indicated eutrophic nature of water and was highly contaminated than the other two ponds (Tables 2-4).

TDS: Total dissolved solids varied from 0.01-0.23 ppt (mean 0.13±0.049 ppt), 0.00-0.02 ppt (0.01±0.006 ppt) and 0.01-0.07 ppt (0.04±0.017 ppt) in ponds 1,2 and 3 respectively (Tables 2-4). TDS was directly related to conductivity. Like conductivity, TDS indicated the low amount of electrolytes in the studied water bodies except pond 1, where a little bit high TDS was noticed due to mass use of water by local residence for different purposes.

pH: Purity of water for various uses is indicated by pH. During 24 months study period the pH varied from 6.7-7.8 (mean 7.25±0.29), 6.1-8.4 (7.48±0.55) and 6.4-7.9 (7.23±0.32) in ponds1,2 and 3 respectively (Tables 2-4).The pH varied between a little acidic to high alkaline. However, when mean of 24 months was considered, water of the three ponds showed good alkaline condition. In different water bodies similar results were recorded by many authors (Ambasht, 1971; Petre, 1975; Patra and Azadi, 1985; Swarnalatha & Narasingarao, 1993; Sinha, 1995; and

Sayeswara *et al*. 2011). The observed range of pH was found to be suitable for fish culture. The suitable range of pH was recorded as 6.7 and 9.5by Santhosh and Singh (2007). Although acidic to alkaline pH existed in all the three ponds but overall pH was alkaline and thus was not harmful for different uses and fish culture and was also within the standard level (Tables 2-4).

Dissolved Oxygen (DO): The DO level of any water body is important for the survival and distribution of aquatic organisms. The dissolved oxygen (in mg/L) varied from 0.9-8.2 (mean 4.06±1.99l), 4.4-16.5 (mean 9.39±3.20) and 4.4-14.1 (7.73±2.76) in the ponds 1, 2 and 3 respectively (Tables 2-4). Minimum DO in Pond 1 was due to high rate of contamination occurring due to addition of contaminating agents during different uses of pond water as well as inflow of water from the surroundings carrying sediments during rainy season. This agreed with the findings of Shukla (2016) in Mohan Ram pond, Shahdol District, Madhya Pradesh, India. Water Quality Index value is very much dependent on DO. DO level is related to clearness of water. Clear water shows more DO than unclear water (Kumar &Dua, 2009). Except Pond 1, the DO level was higher than standard level (Tables 2-4) in the other two ponds and thus was found to be suitable for different uses.

Biochemical Oxygen Demand (BOD): Amount of organic load in a water body is indicated by BOD level (Yogendra & Puttaiah, 2008). BOD also indicates the amount of DO required by aerobic organisms to break down organic material in water over time. When DO level increases then BOD level decreases due to consumption of oxygen by bacteria. During 24 months of study period BOD varied from 0.4-8.2 (mean 3.46±2.16mg/l) in Pond 1, 0.3-12.3 mg/l (4.52±2.57 mg/l) in Pond 2 and 0.5-9.7 mg/l (4.77±2.50 mg/l) in Pond 3(Tables 2-4). Pond 1 was found to be more contaminated with organic loads than ponds 2 and 3, which is supported by lower BOD values of the water of the ponds. Similar organic waste laden contamination was found in urban water bodyof India (Yogendra & Puttaiah, 2008). The BOD values of ponds 2 and 3 were slightly below the standard limit (Tables 3 & 4).

Free Carbon-dioxide: Free-CO_2 level is one of the major factors controlling water eutrophication. The free-CO_2 varied from 8.99-26.97 mg/l (15.02±5.53 mg/l), 2.00-16.98 mg/l

(9.66±4.73 mg/l) and 4.99-19.98 mg/l (10.20±4.12 mg/l) in the ponds 1, 2 and 3 respectively (Tables 2-4). Presence of high amount of free CO_2 in Pond 1 indicated the presence of high amount of decomposing materials, which was also supported by the standard value of free CO_2 and thus indicated the eutrophic nature of that water body. The free CO_2 values of the water of the other two ponds were also above the standard value, indicating presence of decomposed organic matter.

Calcium (Ca^{++}): During the study period, calcium varied from 9.46-32.68 mg/l (mean 17.85±4.77mg/l), 1.72-18.92 mg/l (7.17±3.47 mg/l) and 5.16-30.96 mg/l (11.57±6.81 mg/l) in the ponds 1, 2 and 3 respectively(Tables 2-4).Differences in Calcium might be due to the calcium deficient soil surrounding the ponds. However, Calcium values of the water of the three ponds were far below the standard value (Tables 2-4) indicating the low level of calcium in this geographical region.

Total Hardness (TH): Total hardness ranged from 31-110 mg/l (mean 55.63±15.97mg/l), 4-69 mg/l (22.04±17.41 mg/l) and 15-56 mg/l (39.04±11.65 mg/l) in the ponds 1, 2 and 3 respectively(Tables 2-4). This difference of TH values amongst the ponds was perhaps due to variation ofuses of soaps in domestic washing and bathing and fluctuations of user's numbers in different ponds. Kiran (2010) using the hardness values categorized the water quality "as soft (0-75 mg/l), moderately hard (75-150 mg/l), hard (150- 300 mg/l) and above 300 mg/l as very hard". From the above observations, the water of all the three ponds appeared as soft, but the calculated WQI values for the three ponds were far below the standard value (Tables 2-4).

Alkalinity (AL): The values of alkalinity ranged from 42-98 mg/l (mean 63.92±16.64mg/l), 40-82 mg/l (53.83±11.43 mg/l) and 42-92 mg/l (58.13±13.41 mg/l) in the ponds 1, 2 and 3 respectively (Tables 2-4). Alkalinity values of the three ponds were almost half of the standard value (Tables 2-4).

Water Quality Index (WQI):

In this study, WQI of three ponds using “weighted arithmetic WQI method” was 130.08 in pond 1, 98.07 in Pond 2 and 102.18 in Pond 3 (Figure 2, Tables 2-4). According to the water quality rating, using “weighted arithmetic WQI method” (Table 1), water of all the three ponds indicated very poor quality. More or less similar results were also observed by Yogendra and Puttaiah (2008) and Chandra *et al.* (2017) for different water bodies in India. Among the three studied ponds, Pond 1 was more polluted than the other two ponds. The bottom of the Pond 1 was muddy. The water of this pond was polluted due to multiple uses by the surrounding people of the colony who discharge their household wastes into it. Pond 3 was also polluted and the WQI value indicated unsuitable for drinking because the surrounding colony peoples also used this pond for different purposes. The farmers who work in the surrounding fields take a bath, washes their agricultural products and hence contaminating the water. The value of water quality index of Pond 2 is less than the other two ponds. The bottom of the pond is mostly sandy and also had less human interference and utilization. The water quality rating obtained by means of calculating WQI indicates that the overall nature of the three ponds was organically polluted but as per WQI the water of Pond 1 was highly polluted and unsuitable for drinking where as Pond 2 and Pond 3 was less polluted not harmful for human domestic uses.

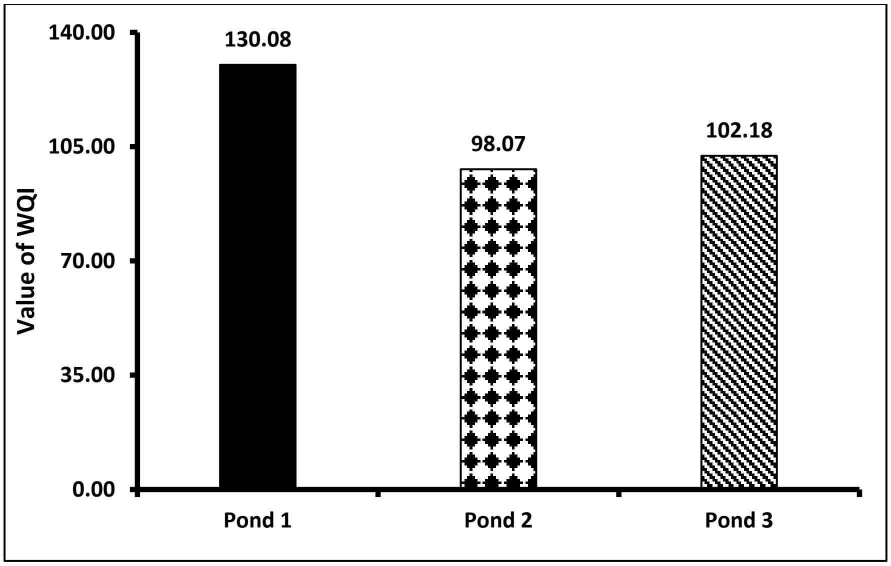

Fig. 2. Water Quality Index (WQI) of the three experimental Ponds (1, 2 and 3) at CU campus during 2017-2018.

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Table 2.Mean±SD and range values of 11 physicochemical water quality parameters, Standard values and Water Quality Index (WQI) of Pond 1 recorded for 24 months (from January 2017 to December 2018).

Parameters	Observed Values(V_n) [Mean ±SD (Range)]	Recommended Standard Values (S_n)	'Recommended Agency' of Standard Values	'Unit Weights' (W_n)	'Quality Rating' (q_n)	'$W_n \times q_n$'	WQI = $\Sigma(W_n \times q_n)/\Sigma W_n$
Temperature (^0C)	26.94±3.89 (18-31)	30	Santhosh & Singh, 2007	0.0413	89.8000	3.7124	130.08
Secchi depth (cm)	46.69±13.78 (14-72)	40	Santhosh & Singh, 2007	0.0310	116.7250	3.6191	
Conductivity (µS/cm)	278.92±69.40 (180-423)	300	ICMR, 1975	0.0041	92.9733	0.3844	
pH	7.25±0.29 (6.7-7.8)	6.5-8.5	ICMR, 1975/BIS, 1983	0.1459	16.6667	2.4318	
DO (mg/l)	4.06±1.99 (0.9-8.2)	5	ICMR, 1975/BIS, 1983	0.2480	109.7917	27.2330	
BOD (mg/l)	3.46±2.16 (0.4-8.2)	5	ICMR, 1975	0.2480	69.2000	17.1645	
free CO_2 (mg/l)	15.02±5.53 (8.99-26.97)	5	Santhosh & Singh, 2007	0.2480	300.4000	74.5119	
Calcium (mg/l)	17.85±4.77 (9.46-32.68)	75	ICMR, 1975/BIS, 1983	0.0165	23.8000	0.3936	
TDS (ppt)	0.13±0.049 (0.01-0.23)	500	ICMR, 1975/BIS, 1983	0.0025	0.0263	0.0001	
TH (mg/l)	55.63±15.97 (31-110)	300	ICMR, 1975/BIS, 1983	0.0041	18.5433	0.0767	
Alkalinity (mg/l	63.92±16.64 (42-98)	120	ICMR, 1975	0.0103	53.2667	0.5505	
				ΣW_n = 1.00		**$\Sigma(W_n \times q_n)$ =130.08**	

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Table 3.Mean±SD and range values of 11 physicochemical water quality parameters, Standard values and Water Quality Index (WQI) of Pond 2recorded for 24 months (from January 2017 to December 2018).

Parameter	**Observed Values(V_n) [Mean ±SD (Range)]**	**Standard Values (S_n)**	**'Recommen-ded Agency' of Standard Values**	**'Unit Weights' (W_n)**	**'Quality Rating' (q_n)**	**'$W_n \times q_n$'**	**WQI = $\Sigma(W_n \times q_n)/\Sigma W_n$**
Temperature (^{0}C)	27.94±3.64 (20-32)	30	Santhosh & Singh, 2007	0.0413	93.1333	3.8502	**98.07**
Secchi depth (cm)	64.98±14.65 (20.5-85)	40	Santhosh & Singh, 2007	0.0310	162.4500	5.0368	
Conductivity (μS/cm)	43.83±14.51 (22-85)	300	ICMR, 1975	0.0041	14.6100	0.0604	
pH	7.48±0.55 (6.1-8.4)	6.5-8.5	ICMR, 1975/BIS, 1983	0.1459	32.0000	4.6690	
DO (mg/L)	9.39±3.20 (4.4-16.5)	5	ICMR, 1975/BIS, 1983	0.2480	54.2708	13.4615	
BOD (mg/l)	4.52±2.57 (0.3-12.3)	5	ICMR, 1975	0.2480	90.4000	22.4230	
fCO2 (mg/l)	9.66±4.73 (2-16.98)	5	Santhosh & Singh, 2007	0.2480	193.2000	47.9218	
Calcium (mg/l)	7.17±3.47 (1.72-18.92)	75	ICMR, 1975/BIS, 1983	0.0165	9.5600	0.1581	
TDS (ppt)	0.01±0.006 (0-0.02)	500	ICMR, 1975/BIS, 1983	0.0025	0.0019	0.000005	
TH (mg/l)	22.04±17.41 (4-69)	300	ICMR, 1975/BIS, 1983	0.0041	7.3467	0.0304	
Alkalinity (mg/l)	53.83±11.43 (40-82)	120	ICMR, 1975	0.0103	44.8583	0.4636	
				ΣW_n = 1.00		**$\Sigma(W_n \times q_n)$ = 98.07**	

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Table 4.Mean±SD and range values of 11 physicochemical waterquality parameters, Standard values and Water Quality Index (WQI) of Pond 3recorded for 24 months (from January 2017 to December 2018).

Parameter	**Observed Values(V_n) [Mean ±SD (Range)]**	**Standard Values (S_n)**	**'Recommended Agency' of Standard Values**	**'Unit Weights' (W_n)**	**'Quality Rating' (q_n)**	**'$W_n \times q_n$'**	**WQI = $\Sigma(W_n \times q_n)/\Sigma W_n$**
Temperature (^{0}C)	28.08± 3.34 (20-33)	30	Santhosh & Singh, 2007	0.0413	93.6000	3.8695	
Secchi depth (cm)	39.96±12.01 (16-75)	40	Santhosh & Singh, 2007	0.0310	99.9000	3.0974	
Conduct. (µS/cm)	108.79±34.11 (44-154)	300	ICMR, 1975	0.0041	36.2633	0.1499	
pH	7.23±0.32 (6.4-7.9)	6.5-8.5	ICMR, 1975/BIS, 1983	0.1459	15.3333	2.2372	
DO (mg/l)	7.73±2.76 (4.4-14.1)	5	ICMR, 1975/BIS, 1983	0.2480	71.5625	17.7505	
BOD (mg/l)	4.77±2.50 (0.5-9.7)	5	ICMR, 1975	0.2480	95.4000	23.6632	
fCO2 (mg/l)	10.20±4.12 (4.99-19.98)	5	Santhosh & Singh, 2007	0.2480	204.0000	50.6007	**102.18**
Calcium (mg/l)	11.57±6.81 (5.16-30.96)	75	ICMR, 1975/BIS, 1983	0.0165	15.4267	0.2551	
TDS (ppt)	0.04±0.017 (0.01-0.07)	500	ICMR, 1975/BIS, 1983	0.0025	0.0088	0.00002	
TH (mg/l)	39.04±11.65 (15-56)	300	ICMR, 1975/BIS, 1983	0.0041	13.0133	0.0538	
Alkalinity (mg/l)	58.13±13.41 (42-92)	120	ICMR, 1975	0.0103	48.4417	0.5006	
				ΣW_n = 1.00		**$\Sigma(W_n \times q_n)$ = 102.18**	

CONCLUSION

For Assessment and management of water quality of any water body, WQI is very useful tool. This study concludes that water of the three ponds was not fit for drinking purpose. Ponds 1 and 3 is currently used by surrounding colony people for bathing, washing clothes and cooking utensils, fishing, discharging household wastes and surrounding runoff etc. Most of the time dissolved oxygen level was extremely low in pond 1 indicating high contamination due to pollution occurred by human interference. Level of DO is the controlling factor of WQI. To keep pond water in good condition discharging household wastes, high use of detergent and surrounding runoff should be stopped by creating health concern awareness among the users. So, it is very important for continuous monitoring of the physicochemical parameters and treatment process of the water as well as digging the pond at regular 5 years interval, if it has to be used for drinking (after proper treatment) and domestic purposes.

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