



A STUDIES ON PHYSICO-CHEMICAL PARAMETERS TO ASSESS WATER QUALITY OF PAVANA RIVER IN PUNE, MAHARASHTRA.

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ABSTRACT: Water is most important natural resource essential for survival of life. Only 0.3 % of fresh water is available for human use. Water is one of the important abiotic factor of the environment. The Pavana River is a one of important river in the pune district The Water of this river is used for drinking in Maval Tahsil , Pimpri –Chinchwad Municipal Corporation lift the water from Ravet bundh for drinking ,Water of river is used for irrigation and for industrial use. The present study is for assessment of water qualities by analysis of physico-chemical parameters.. The study was for knowing physico-chemical parameters of Pavana river water for two years i.e. from August 2016 to July 2018. The parameters like WT, TDS, DO, BOD, COD, Alkalinity, Cl, SO₄, PO₄ .Ca, Mg has been studied. Physico- chemical parameters helps to decide quality of water utilized for drinking, irrigation or industrial and fishery purpose.

Key words: - Pavana river, Lonavala, Physico-chemical parameters.

INTRODUCTION:

Water is most important factor for survival of life, growth and development of aquatic life.. The sources of fresh water are rivers, lakes, streams, glaciers and dams. For drinking purpose water is used from above sources .Therefore quality of drinking water must be checked by physico-chemical parameters. The water quality is also asses for irrigation, domestic and industrial use. The present study is revealed with Pawana River. The river originates from 6 Km south of Lonavala from the Western Ghats, and flows a total of nearly 60 kilometres to meet Mula river in Pune City The river flows at 18°41'36"N 73°37'15"E in pune district. The river is reported to be severely polluted from Ravet bridge to Dapodi. Physico-chemical parameters are the prime consideration to assess the quality of water, helpful in understanding the complex interaction between the climatic and biological process in the water (J.Arun Raj, et al)

Because of increase in urbanization and industrialization surface water get polluted. Accumulation of silt, discharge of untreated industrial waste water, anthropogenic activities and sewage water are the major factors of pollution of the river. Farmer uses chemical pesticide and fertilizers on the crop for better yield (Rajmohan and Elango, 2005). But these fertilizers and pesticides can be washed through the soil by rain, to end up in rivers and has made the river water unfit for consumption (Begum and Harikrishna, 2008) . Examples of such pollutants include cyanide, zinc, lead, copper, cadmium and mercury. These substances may enter the water in such high concentrations that fishes and other animals are died. Sometimes the pollutants enter a food chain and accumulate until they reach toxic levels, eventually killing birds, fish and mammals. More than 3,500 industrial units discharges 40 million litres a day (MLD) of untreated effluents into Pavana River. In 1840s

over a hundred species of fishes were recorded in the river. Today barely 40 are left. The level of dissolved oxygen at various places in Pawana is virtually negligible, threatening aquatic life. The situation has worsened by the unchecked growth of water hyacinth, which blocks out sunlight from penetrating the water. (Economic Times Feb.24, 2012). The nature and distribution of flora and fauna in a water body is mainly controlled by the fluctuations in the physico-chemical characteristics of water.

MATERIALS AND METHODS:

Study Area: Pavana river is study area The Pavana river originates near from Lonavala of Maval and flows nearly 60 kilometres to meet Mula river in Pune City .Three sites of river are selected i.e.Pavananagar just near to Pavana dam where water is released from the dam ,Ravet bundh from where PCMC lift water for drinking and Sangavi .

Water samples were collected in every month in the morning between 8:00 a.m. to 10:00 a.m. in the clean one litre plastic container. The temperature and PH is measured in the field with mercury thermometer and PH paper respectively. But PH is measured in Laboratory by PH Meter. While some water is fixed for oxygen estimation. The water samples were brought for further analysis in the laboratory. The water parameters are analysed according to the methods described by APHA(2005), Goel and Trivedi (1984) and WHO guidelines for drinking water ,titrimetric method for total alkalinity, EDTA titrimetric method for total hardness, DO by Winkler's method. For BOD water is incubated and Winkler's method is used. The transparency of water was measured by using Sacchi disc at the sites.

RESULT & DISCUSSION:

Water Temperature : The water temperature plays important role in the life processes of

aquatic organisms .The average minimum temperature was noted as 23.27 ± 0.15 °c in August 2016 and 23.50 ± 0.10 °c in January 2018 .The maximum average temperature 28.23 ± 0.15 °c in May 2017 and 29.67 ± 0.53 °c in May 2018. The temperature increases due to more solar radiation in May . Trivedi and Goel (1988) reported higher temperature in March and lower in November in satara district.

Total Dissolved Solids: It measures quantity of solid materials dissolved in the water . The high TDS amount is harmful to life . The average minimum TDS was present in the October 2016 i.e. 100 ± 36.6 mg/l and in January 2017 i.e 102 ± 68.79 mg/l . And maximum values were 272.33 ± 287.33 mg/l in the month of May 2017 and 219.33 ± 231.6 mg/l in month of February 2018 . The more TDS in July is due mu to mud or sand (Gupta et al 1999) Due to excess TDS light rays poorly reaches to the bottom . Water is not suitable when TDS is more than 500 mg/l .(WHO) .

Turbidity : Natural water becomes turbid because of clay,phytoplankton or organic matter (Sarwade and Kamble 2014) . In the more turbid water light penetration is poor .(N.Gupta et al 2017) The average minimum turbidity was recorded as 4.11 ± 3.47 NTU in May 2017 and 4.35 ± 1.13 in March 2017 . The average maximum turbidity was 16.33 ± 1.61 NTU recorded in August 2016 and 10.70 ± 7.01 NTU in August . Fawaz Al-Badaii et al (2013) noted the highest value was 206.7 NTU It indicates turbidity increases in monsoon due to silt , suspended particles etc (WHO 2.5 NTU). The high turbidity hampers life in the water and deteriorates water quality.(Verma et al 1984) .

Water Transparency : Water transparency and turbidity correlated to each other. If water is more turbid , transparency is less . It affect penetration of light to bottom of lentic water system. And turbidity affect trophic level of aquatic ecosystem .The minimum average transparency observed in

August 2016 and August 2017 as 20.07 ± 1.01 cm and 20.03 ± 1.48 cm. respectively. The average maximum transparency observed in May 2017 and May 2018 as 34.57 ± 1.18 cm. and 34.43 ± 2.11 cm. respectively. (Manjare et al, 2010).

PH: PH is a - log of H^+ ion concentration, Acceptable values of drinking water ranges from 6.5 to 8.5 (WHO). It determines acidity or alkalinity. PH is measured by paper strip and PH-meter. The minimum average PH was observed in May 2017 as 6.91 ± 0.63 and in August 2017 as 6.56 ± 0.63 . While average maximum PH was 8.18 ± 0.28 in February 2017 and 7.90 ± 0.63 in July 2017. Kamboj et al (2016) noted 8.53 PH at Ganga river. The above values indicates that, water of Pawana river has acceptable PH. pH greatly affects biological activity. (Nure Jannat, et al, 2019)

Dissolved Oxygen: DO in the water arises from atmosphere due to wind action and photosynthetic activity of aquatic flora. Less DO adversely affect aquatic life and also causes anaerobic process (Cox, 2003). DO is required for metabolism of aquatic organisms and affect productivity. The average minimum DO values of Pavana river water was 3.40 ± 0.20 mg/l in May 2017 and 2.87 ± 0.15 mg/l in March 2018. And average maximum values are 6.30 ± 0.56 mg/l in March 2017 and 5.73 ± 0.15 mg/l in May 2018. Gidde (2018) noted. the value of DO is decreased near Aditya Birla hospital it may be due to the mixing of Padamji Paper mill waste on the u/s side of Birla Hospital and there is gradual reduction in DO from d/s side of Pimrigaon and absolutely 0.0 at harris bridge Dapodi due to the confluence of Pawana river in Mula River The river shows minimum values (<7) in Sangavi, therefore water is polluted. More DO quantity indicates good quality of water while low quantity indicates water pollution. DO is useful pollution index of water quality. (Ruby Pande, et al. 2014).

Biochemical Oxygen Demand: BOD is quantity of oxygen used by microbes to decompose organic matter in the water. The average minimum BOD was noted as 10.10 ± 0.10 mg/l in August 2016 and 14.33 ± 0.95 mg/l September 2017. While average maximum BOD was 41.43 ± 0.51 mg/l in April 2017 and 39.50 ± 1.32 mg/l in March 2018. Maximum BOD was observed in summer for both the years. The amount of BOD ranges from 3.0 mg/l to 6.0 mg/l is optimal for normal activities of fishes (Bhatnagar and Devi, 2013). All observed values of BOD were very high due to sewage and pollutant. Higher quantity of BOD is harmful to aquatic life because oxygen level depleted rapidly (P. B. Sirsat and A.H. Kamble, 2020)

Chemical Oxygen Demand: Amount of oxygen required for chemical oxidation of organic material in the water. The organic waste pollution is indicated by COD (King et al, 2003). COD correlated with pollution level. The average minimum COD was recorded as 12.60 ± 0.56 mg/l in August 2016 and $32.23.19$ mg/l in November 2016. While average maximum COD was noted as 136.67 ± 102.75 mg/l in May 2017 and 106.81 ± 132.71 mg/l in June 2018. The increased amount of COD observed in May and June. COD and BOD are more in urban streams (Berhanu Zawude Bakure, et al, 2020). All the readings are very high and degree of pollution is high.

Free Carbon Dioxide; Low amount of CO_2 is essential for photosynthesis of flora. Pollution load increases with increase in CO_2 . During present study the average minimum amount of CO_2 was 1.46 ± 0.42 mg/l in the August 2016 and 8.92 ± 8.49 mg/l in April 2018. While average maximum amount of CO_2 was 24.09 ± 16.82 mg/l in April 2017 and 42.50 ± 32.76 mg/l August 2017. Maximum values noted by D.M. Joshi et al (2009) in Ganga river. The value noted in Pavana river were increased above acceptable level i.e. 10 mg/l.

Total Hardness : It is effect of dissolved minerals in the water. Hardness is the property of water which prevents the lather formation with soap and increases the boiling points of water. (S.D. Jadhav ,2020) Ca^{++} and Mg^{++} causes hardness of water . Water having hardness 0-60 mg/l is considered s soft water, hardness above 120 mg/l is considered as hard water . The average minimum values were 38.10 ± 10.77 mg/l in November 2016 and 74.91 ± 62.18 mg/l in February 2017. And average maximum values were 115.01 ± 89.25 in December 2016 and 122.87 ± 87.56 mg/l in August 2017 . If hard water is used for washing it produces scum or white precipitate.(S. N. Patil ,et al , 2021) Average maximum values are close to 120mg/l therefore Pavana water at Sangavi is moderately hard water .

Total Alkalinity : Alkalinity is capacity of water to neutralize strong acid . The alkalinity is caused by presence of salts of carbonates , bicarbonates and hydroxide compound of calcium , sodium and potassium.(V. A. Patil et al ,2014) . The average minimum alkalinity of Pawana river water were 78.74 ± 80.66 mg/l in Novmber 2016 and 52.11 ± 37.06 mg/l in May 2017. And average maximum alkalinity were 128.55 ± 69.88 mg//l in August 2017 and 119.87 ± 89.9 mg/l in January 2018 . The alkalinity of Kaveri river was found to be 172 mg/L and 189mg/L.This also is very high according to WHO (Anima Upadhyay , 2014) . These values are higher according WHO (75) within limits according toBIS(200),Water is hard and poluuted .

Chloride : In the water chloride arises from sewage effluents . High quantity of chloride(< 200Mg/l) indicate pollution and makes water salty . The average minimum amount of Chloride were noted 24.75 ± 25.94 mg/l in May 2017 and 23.48 ± 21.08 mg/l in August 2017 .While average maximum Chloride values were noted as 73.20 ± 66.80 mg/l in February 2017 and 86.04 ± 110.41 mg/L in June 2018 .

Chavdanshive (2013) noted chloride values between minimum of 38.5696mg/litre and maximum was 60.48mg/litre in monsoon and summer respectively. Water from rock side contains high chloride (F.O.Abulude et al ,2006).The chloride value of Pavana river water are below acceptable level(250 mg/l) .

Nitrate: Biodegradation of nitrogenous compounds by bacteria is source of nitrates. Nitrite is oxidized form of nitrogen which is one of the source of plant nutrients. High concentration of nitrates is useful in irrigation but their entry into water resources increase the growth of nuisance algae, macrophytes and trigger eutrophication and pollution (Kidu Mezgebe et al ,2015) The average minimum amount of Nitrite were recorded as 0.31 ± 0.12 mg/l in September 2016 and 1.68 ± 1.08 mg/l in March 2018 .And average maximum values were recorded as 8.18 ± 0.77 mg/l in July 2017 and 7.99 ± 0.20 mg/l in July 2018 . The observed values are very low as Indian standard value i.e. is 45 mg/l .Therefore in Pawana river water trace amount of nitrite are present . . Nitrate can reach surface water as a consequence of agricultural activity from wastewater disposal.(Patil S.V. et al ,2020)

Sulphate : The sulphate occurs naturally in water as a result of leaching from gypsum and other common rock.. The average minimum values were 1.57 ± 0.29 mg/l in September 2016 and 7.64 ± 6.81 mg/l in April 2018 .While maximum average values were recorded as 16.39 ± 11.17 mg/l in December 2016 and 18.41 ± 14.29 in December 2017 . The maximum values were observed in winter season . The value of sulphate concentration ranged within 2.5- 3.28 mg/l observed in Pravara river(D.V. Aware 2013) These values of Pavana river does not exceeds the permissible limit .(WHO -250 m/l).

Phosphate : Phosphate is one of the nutrient factor for plants and phytoplanktons . Because of agricultural runoff phosphate is added in

water .Pavana river water shows minimum average quantity of phosphate were 0.16 ± 0.17 mg/l in August 2016 and 0.36 ± 0.54 mg/l in November 2017 . While average maximum values i.e. 1.97 ± 1.70 mg/l in June 2017 and 2.26 ± 2 mg/l in August 2017 . The nitrite, silicate and phosphate were found to be higher in vegetation area.(P. Raja et al ,2008)

Bicarbonate: The average minimum amount of bicarbonate were 76.20 ± 82.18 mg/l in April 2017 and 52.11 ± 0.06 mg/l May 2018 . While average maximum amount of bicarbonate were found in September 2016 i.e. 90.44 ± 87.15 mg/l and in February 2018 i.e. 95.89 ± 93.08 mg/l. The minimum amount was recorded in the summer season while maximum quantity recorded in September and February. The bicarbonates are derived from soil and carbonate or silicate minerals by carbonic acid (Fella H. C; et al,2013)

Calcium : Calcium is released in the water from mineral rock weathering and from organic matter. Ca^{++} is One of micronutrient for many Organisms . During present study the average minimum amount of calcium were noted as 14.82 ± 8.15 mg/l in March 2017 and 15.12 ± 15.47 mg/l in May 2018 .While average maximum amount of Calcium were recorded as 26.18 ± 19.13 in June 2017 and 27.67 ± 19.28 mg/l in August 2017 . Jadhav recorded Ca value as 292.3 mg/l in Krishna river(2020) .The minimum amount were observed in summer season and maximum amount in rainy season because water run off with mineral. All Calcium values were within acceptable limits.(WHO-75 mg/l)

Magnesium : Magnesium is important element for growth of chlorophyll and hence growth of phytoplankton. Magnesium is present with calcium in all type of water . These Ca and Mg affects hardness of water . The average minimum values were noted as 7.35 ± 5.33 mg/l in May 2017 and 4.10 ± 2.47 mg/l in May 2018. The

average maximum values of Mg^{++} noted as 11.67 ± 9.52 mg/l in June 2017 and 13.44 ± 10.18 mg/l in December 2018. The minimum amount recorded in May. While maximum amount recorded in June and December. Jadhav recorded Mg value as 23 mg/l in Krishna river satara (2020). But all the values are below WHO standard (30 mg/l).

CONCLUSION

The main objective was to study different physico-chemical parameters of Pavana river. These parameters were considered for assessment of water quality of Pawana River during years August 2016 to July 2018. The analysed physico-chemical parameters were compared with WHO standard limits and it was observed that some physico-chemical parameters were in the permissible limits. And some parameters were above WHO standard. Therefore water of Pawana River is not suitable for drinking, irrigation and for other uses. At Sangavi, water was polluted and in this water growth of phytoplankton, zooplankton, fishes, etc. poorly took place.

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Table 1. Monthly variation in physico-chemical parameters of Pawana River from 2016 to 2017

PARAMETRS	WT OC	TDS mg/l	TURB NTU	WTr cm	PH	DO mg/l	BOD mg/l	COD mg/l	CO2 mg/l	TH mg/l	TA mg/l	Cl mg/l	NO3 mg/l	SO4 mg/l	PO4 mg/l	BC mg/l	Ca mg/l	Mg/l
Aug-16	23.27 ±0.15	148.00 ±2.0	16.33 ±1.61	20.07 ±1.01	7.93 ±0.06	4.93 ±0.21	10.10 ±0.10	12.60 ±0.56	1.46 ±0.42	106.93 ±28.87	128.55 ±69.88	37.63 ±26.53	0.42 ±0.22	6.36 ±1.08	0.16 ±0.17	87.17 ±71.90	25.52 ±16.72	9.80 ±2.21
SEP	26.07 ±0.12	204.00 ±204.12	5.70 ±5.47	22.53 ±0.61	7.03 ±0.13	4.87 ±1.58	11.67 ±1.46	24.96 ±20.28	15.22 ±17.48	101.33 ±81.28	90.02 ±87.64	26.78 ±30.26	0.31 ±0.12	1.57 ±0.29	0.89 ±1.41	90.44 ±87.15	25.53 ±22.99	8.68 ±5.66
OCT	26.47 ±0.06	100.00 ±36.06	7.18 ±1.93	27.50 ±2.02	7.05 ±0.09	4.47 ±0.15	21.33 ±1.10	50.97 ±5.66	7.77 ±3.14	105.05 ±66.88	83.51 ±81.34	54.12 ±57.88	0.34 ±0.02	12.23 ±7.73	0.33 ±0.26	81.69 ±75.86	23.46 ±20.59	11.48 ±10.46
NOV	27.43 ±0.25	193.33 ±220.99	8.19 ±8.38	28.20 ±1.91	7.44 ±0.51	5.47 ±0.12	15.50 ±0.44	29.95 ±22.38	16.93 ±21.09	38.10 ±10.77	78.74 ±80.66	35.18 ±31.82	0.33 ±0.08	13.33 ±11.91	0.47 ±0.00	78.73 ±80.64	19.04 ±19.85	10.67 ±10.60
DEC	24.40 ±0.10	105.33 ±65.43	7.07 ±0.81	30.37 ±2.69	7.69 ±0.52	4.67 ±0.59	28.27 ±0.91	54.30 ±7.81	19.97 ±20.27	115.01 ±89.25	93.36 ±73.47	59.10 ±57.32	2.05 ±2.58	16.39 ±11.17	0.21 ±0.22	78.07 ±79.70	19.91 ±17.80	10.85 ±9.56
JAN	23.47 ±0.06	104.67 ±70.22	7.53 ±0.76	27.35 ±1.63	8.07 ±0.25	4.33 ±0.45	30.43 ±0.59	66.17 ±42.12	21.71 ±15.17	75.37 ±32.14	111.32 ±114.70	67.39 ±67.49	1.71 ±1.75	14.00 ±9.76	0.22 ±0.19	79.20 ±73.51	19.97 ±18.41	8.89 ±8.59
FEB	26.43 ±0.12	128.00 ±64.90	7.53 ±0.84	26.87 ±1.40	8.18 ±0.28	3.90 ±0.36	33.31 ±1.07	66.74 ±38.61	24.00 ±20.64	88.27 ±42.76	116.11 ±83.81	73.20 ±66.80	1.04 ±0.84	15.19 ±9.68	0.85 ±0.81	82.76 ±84.68	19.49 ±16.63	11.41 ±9.73
MAR	27.43 ±0.15	215.33 ±229.70	8.86 ±8.39	32.63 ±1.99	6.91 ±0.63	6.30 ±0.56	41.20 ±1.05	46.70 ±15.81	23.69 ±23.88	85.80 ±79.79	90.44 ±91.47	28.25 ±29.15	0.92 ±0.41	8.47 ±7.80	3.22±	89.34 ±92.46	14.82 ±8.15	9.34 ±9.19
APRIL	28.23 ±0.15	269.67 ±286.95	6.15 ±3.59	33.60 ±0.96	7.66 ±0.68	3.60 ±0.10	41.43 ±0.51	41.10 ±22.32	24.09 ±16.82	87.41 ±71.65	83.87 ±89.06	39.40 ±23.20	4.89 ±1.69	7.61 ±5.88	0.89 ±1.02	76.20 ±82.18	21.28 ±19.32	8.75 ±6.44
MAY	28.23 ±0.15	272.33 ±287.24	4.11 ±3.47	34.57 ±1.18	7.25 ±0.08	3.40 ±0.20	29.20 ±0.95	136.67 ±102.75	17.51 ±11.55	84.89 ±70.36	89.43 ±88.94	24.75 ±25.94	5.25 ±0.57	11.69 ±14.28	1.03 ±1.67	89.86 ±88.52	20.03 ±18.03	7.35 ±5.33
JUN	27.50 ±0.10	170.67 ±96.55	4.33 ±1.07	28.80 ±0.72	7.89 ±0.91	3.80 ±0.20	29.03 ±0.91	119.44 ±112.21	19.33 ±12.07	77.52 ±51.25	94.76 ±85.16	60.48 ±69.31	6.55 ±0.53	14.48 ±13.91	1.97 ±1.70	87.13 ±94.11	26.18 ±19.13	11.67 ±9.52
JUL	24.67 ±0.06	172.33 ±101.91	9.92 ±1.98	25.87 ±0.51	7.41 ±0.61	4.47 ±0.15	27.73 ±0.71	64.80 ±36.97	20.12 ±12.24	114.25 ±83.71	120.39 ±97.23	38.50 ±34.83	8.18 ±0.77	14.76 ±14.42	1.46 ±0.97	90.14 ±93.44	25.73 ±18.37	9.25 ±7.99

Abbreviations: WT- Water temperature; TDS- Total Dissolved Solid ; TURB-Turbidity ; WTr- Water transparency; pH- Potential of hydrogen ion; DO- Dissolved oxygen; BOD-Biochemical Oxygen Demand ;COD-Chemical Oxygen Demand;CO₂ – Carbon Dioxide; TH- Total hardness; TA- Total alkalinity ; Cl- Chloride; NO₃⁻- Nitrate; SO₄- Sulphate, PO₄-Phosphate ; BC-Bicarbonate ; Ca- Calcium ; Mg- Magnesium

Table. 2. Monthly variation in physico-chemical parameters of Pawana River from 2017 To 2018

PARAMETRS	WT OC	TDS mg/l	TURB NTU	WTr cm	PH	DO mg/l	BOD mg/l	COD mg/l	CO2 mg/l	TH mg/l	TA mg/l	Cl mg/l	NO3 mg/l	SO4 mg/l	PO4 mg/l	BC mg/l	Ca mg/l	Mg/l
Aug-16	24.30 ±0.10	178.00 ±123.98	10.70 ±7.01	20.03 ±1.48	6.56 ±0.63	4.30 ±1.84	22.67 ±9.02	41.56 ±50.25	42.50 ±32.76	122.87 ±87.56	83.54 ±102.68	23.48 ±21.08	7.21 ±6.09	16.13 ±17.24	2.26 ±2.00	83.50 ±102.71	27.67 ±19.28	10.79 ±6.95
SEP	25.40 ±0.10	162.00 ±130.68	7.43 ±3.39	21.37 ±0.78	7.33 ±0.73	4.90 ±0.10	14.33 ±0.95	32.65 ±22.23	36.18 ±19.79	108.19 ±83.92	93.78 ±87.91	56.35 ±66.48	7.12 ±7.54	13.75 ±15.44	1.08 ±1.22	86.25 ±83.26	24.37 ±21.51	9.39 ±7.62
OCT	26.53 ±0.06	134.00 ±86.53	7.05 ±1.13	27.20 ±0.62	7.30 ±0.70	4.33 ±0.15	19.03 ±5.31	53.36 ±5.69	25.71 ±12.86	106.55 ±70.29	85.77 ±82.53	64.66 ±68.97	4.52 ±3.60	16.18 ±16.40	0.94 ±0.89	84.01 ±79.50	25.28 ±22.50	11.12 ±8.65
NOV	27.10 ±0.10	120.67 ±79.0	6.54 ±3.15	28.47 ±2.39	7.34 ±0.67	4.47 ±0.49	34.27 ±1.82	32.12 ±23.19	18.35 ±9.70	114.13 ±86.06	88.75 ±91.68	46.19 ±35.58	3.38 ±2.44	14.99 ±14.54	0.36 ±0.54	80.60 ±82.28	20.89 ±19.81	12.52 ±9.08
DEC	24.30 ±0.10	109.33 ±67.0	6.42 ±0.35	30.27 ±1.86	7.22 ±0.61	3.23 ±0.15	31.83 ±1.45	58.69 ±11.49	18.71 ±10.18	114.82 ±86.06	108.91 ±87.48	67.56 ±72.18	2.83 ±3.21	18.41 ±14.29	0.58 ±0.56	79.21 ±79.49	21.19 ±18.93	13.44 ±10.18
JAN	23.50 ±0.10	102.00 ±68.79	7.17 ±0.45	28.23 ±2.18	7.35 ±0.64	2.97 ±0.06	33.23 ±0.35	66.85 ±40.34	18.19 ±13.69	86.73 ±45.83	119.87 ±89.19	72.25 ±72.12	2.14 ±1.68	14.64 ±12.36	0.69 ±0.47	77.92 ±77.13	22.34 ±20.47	12.29 ±9.37
FEB	27.10 ±0.10	219.33 ±231.16	6.78 ±4.82	27.73 ±1.62	7.26 ±0.57	3.33 ±1.77	27.87 ±6.65	92.26 ±31.54	25.15 ±33.05	74.91 ±62.18	95.74 ±94.13	25.91 ±23.79	2.05 ±1.56	10.72 ±13.26	1.20 ±1.21	95.89 ±93.98	17.56 ±16.94	5.58 ±4.22
MAR	27.60 ±0.17	218.67 ±233.46	4.35 ±1.13	30.30 ±2.57	7.70 ±0.61	2.87 ±0.15	39.50 ±1.32	87.23 ±67.56	13.60 ±8.86	82.10 ±71.64	92.10 ±88.78	26.80 ±22.55	1.68 ±1.08	10.33 ±9.16	1.33 ±1.45	91.90 ±91.40	18.83 ±17.05	9.92 ±7.15
APRIL	28.13 ±0.12	207.67 ±179.66	4.92 ±1.60	32.20 ±1.74	7.37 ±0.83	4.97 ±1.43	31.83 ±0.97	76.55 ±61.16	8.92 ±8.49	86.83 ±75.89	81.47 ±85.64	38.70 ±23.82	4.13 ±1.38	7.64 ±6.81	1.42 ±1.28	78.44 ±83.52	20.58 ±17.03	9.55 ±9.79
MAY	29.67 ±1.53	187.33 ±192.93	9.35 ±8.38	34.43 ±2.15	7.24 ±0.22	5.73 ±0.15	26.33 ±1.53	62.79 ±78.0	11.72 ±6.62	80.35 ±76.49	52.11 ±37.06	26.70 ±26.39	5.64 ±0.24	7.70 ±9.77	0.65 ±1.03	52.11 ±17.06	15.12 ±15.47	4.10 ±2.47
JUN	27.43 ±0.06	158.00 ±98.31	5.44 ±0.66	27.50 ±0.62	7.44 ±0.62	3.60 ±0.53	15.20 ±2.04	106.81 ±132.71	13.61 ±6.65	79.54 ±55.47	86.45 ±74.03	86.04 ±110.41	6.06 ±0.04	13.66 ±13.84	1.82 ±1.45	84.69 ±92.11	17.74 ±14.32	10.15 ±8.53
JUL	24.63 ±0.15	167.33 ±107.43	10.17 ±2.68	23.10 ±2.26	7.90 ±0.63	2.96 ±0.06	30.57 ±0.71	58.73 ±45.24	14.65 ±7.33	117.99 ±86.17	117.21 ±94.90	78.68 ±98.53	7.99 ±0.20	14.67 ±15.35	1.19 ±0.74	87.38 ±92.23	26.73 ±18.00	11.76 ±7.94

Abbreviations: WT- Water temperature; TDS- Total Dissolved Solid ; TURB-Turbidity ; WTr- Water transparency; pH- Potential of hydrogen ion; DO- Dissolved oxygen; BOD-Biochemical Oxygen Demand ;COD-Chemical Oxygen Demand;CO₂– Carbon Dioxide; TH- Total hardness; TA- Total alkalinity ; Cl- Chloride; NO₃⁻- Nitrate; SO₄⁻- Sulphate, PO₄⁻-Phosphate ; BC-Bicarbonate ; Ca- Calcium ; Mg- Magnesium