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PHYSICO-CHEMICAL ANALYSIS OF WATER QUALITY OF GAURALA LAKE OF BHADRAWATI WITH RESPECT TO SEASONAL VARIATIONS DISTRICT CHANDRAPUR, MAHARASHTRA, INDIA.

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ABSTRACT

The present research analyses the physico-chemical characteristics of Gaurala Lake in Bhadrawati, Dist. Chandrapur, Maharashtra, India. The Gaurala lake water sample was studied monthly and seasonally at five different sites (G1-G5) from September 2023 to August 2024. The water samples were examined for 22 different parameters of physico-chemical like Colour, Water Temperature, Transparency, Atmospheric Temperature, Turbidity, Conductivity, Total Solids (TS), Total Soluble Solid (TSS), Dissolved Oxygen (DO), Total Dissolved Solid (TDS), Conductivity, Biological Oxygen Demand (BOD), pH, Free CO_2, Total Hardness, Chemical Oxygen Demand (COD), Magnesium,Chloride, Total Phosphorous, Nitrate, Calcium, Sulphate and Total Alkalinity. The values of physico-chemical analysis showed variation in different seasons. The physico-chemical analysis is important to study the quality of water and to preserve the health and balance of both abiotic and biotic components of the aquatic environment. The study revealed that the fluctuation of physico-chemical parameters is due to the change in water status during three different seasons.

INTRODUCTION

Water is necessary for every living organism's survival.Lakes preserve the natural equilibrium of plants and animals, and their interactions regulate the climate in the area and restore groundwater(Edmondson, 1959)[7]. Unfortunately, the lakes are getting polluted daily due to increased anthropogenic activity such as fishing and cattle bathing. People who alsoperform religious rituals and throw in the lakes, celebrating festivals like Ganeshotsav and Durga Pooja, despite the effects of pollution on the aquatic environment.The Idols made up of Plaster of Paris (POP), Plastic and painted withchemical paints are immersed in lakes that leak toxic compounds which contain heavy metals like lead and mercury. This increases acidity, TDS (total dissolved solids), and heavy metal levels in the water and harms aquatic flora and fauna (Kulkarni, 2023)[16].

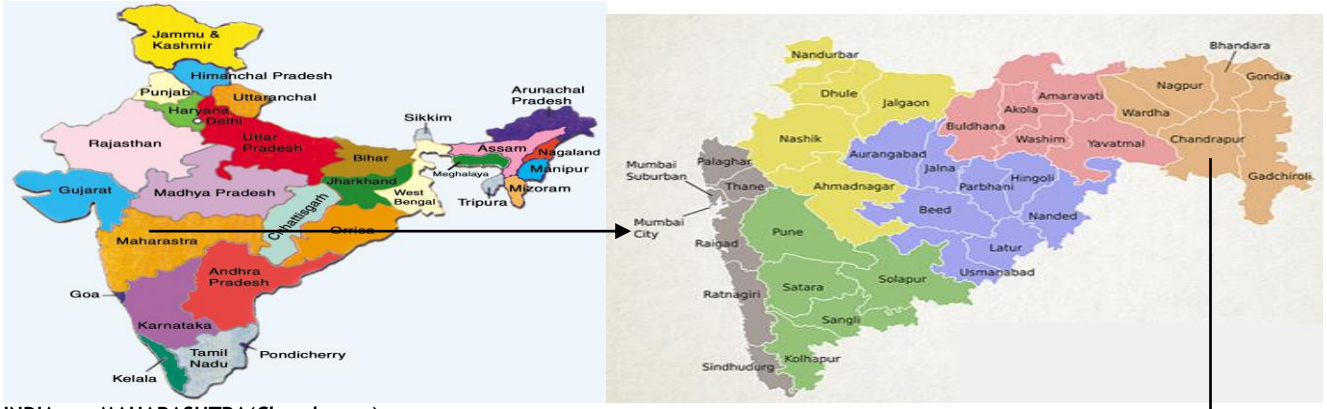
The GauralaLake is located on the way to the Railway station nearthe Ganesh temple and Gaurala Park in the Bhadrawati district of Chandrapur, Maharashtra, India. This lake is beautiful and useful for fishing and Singhada cultivation. This lake gets water from rain water in the monsoon. Neglecting the beauty and importance of this lake, people are throwing garbage, templewaste,flowers and ritual waste. In Ganeshotsav, people immersetheidols of Lord Ganesh in the lake, which pollutes the water and harms the aquatic flora and fauna. For lakes to remain healthy, the awareness of aquatic importance should be conducted,andthe water's physical, chemical, and biological characteristics must be properly balanced. The structure and function of lakes in terms of their habitat could be better understood through physico-chemical research.Physico-chemical research is important to know the exact status of the lake because changes in physico-chemical parameters frequently harm organisms, reducing their traits and productivity.The freshwater ecology can be preserved by regular monitoring of water quality measurements.

Material and Method

Study Area

Bhadrawatiislocated in the District Chandrapur, Maharashtra, India. Bhadrawatitown lies 26 km from Chandrapur city,spanning 20 km^2 (8 sq mi), between Latitude $20^0$06'35" N and Longitude $79^0$7'2" E.TheGauralaLakeislocated near the Ganesh Mandir in Gaurala locality on the way to Bhadrawati (Bhandak) Railway Station Road, between the longitude 79.112453 and latitude 20.089351 above the mean sea level 226.33_+16.The Gaurala

Lakeis a perennial water body.During the monsoon season, rainwater provides the primary supply of water. The lake is mostly used for washing, bathing, fishingandSinghada cultivation.



INDIA MAHARASHTRA(Chandrapur)

GauralaLakeCHANDRAPUR (Bhadrawati)

Sample Collection and Analysis

Samples of water were collected in bottles of 5-litre capacity for physico-chemical analysisearlymorningbetween8:30 am to 10:30 am, from five different sitesG1-G5monthly during September 2023 to August 2024. These five different sites are G-1 East Side near the main road to the railway station road this side is less polluted, G-2 West Side close to Ganesh Temple, this side is less polluted, G-3 North Side Road to Ganesh Temple and Gaurala Park, this side is moderately polluted due to Idols which are immersed here and rituals waste of Temples thrown here. G-4 South Side is farfromtheRailway quarter compound wall, and this side is less polluted. G-5 Centre of the lake,whereSinghada is cultivated and less polluted. The polluted site is G-3 due to Ganesh Temple waste, and during the Ganesh Festival, Idols are immersed here. Water samples were analysed at the sitein the lab by using the Standard MethodAPHA(2012)[2] and Maiti (2011)[12].Thephysico-chemical parameters include physical and chemical parameters.The following physicochemical parameters have been investigated to evaluate the quality of the water.

Physical parameters: Colour noted by visual observation, Atmospheric Temperature and Water Temperature measured in ^{0}C by Calibrated mercury thermometer, Transparency measured by the Secchi disc, Turbidity measured in NTU by Nephelometer, Conductivity measured in µmhos/cm, by a Conductivity meter (EUTECH CON700), Total Soluble Solid (TSS), Total Solid (TS), and Total Dissolved Solids (TDS) measured in mg/l by evaporation method and pH measured by pH meter.

Chemical parameters: Chemical Oxygen Demand (COD),Dissolved oxygen (DO) Biological Oxygen Demand (BOD)mg/l, Free Carbon dioxide (CO_2), MagnesiumHardness,Total Alkalinity,CalciumHardness,Total Hardness,Sulphate, Phosphate, Chloride&Nitrate were analysed monthly.

Results and Discussion

The Gaurala Lake'sphysico-chemical analysis studied under three different seasons, monsoon, winter and summer during September 2023 to August 2024.

The water colour of Gaurala Lake changes from slightly yellow to muddy.In winter, the water is slightly yellow due to the growth of phytoplankton, while during the rainy season, the water of Gaurala Lake gets muddy because surface running water is mixed in the lake. Atmospheric temperature ranged between 22.5 ^{0}Cto 35.5 ^{0}C while the water temperature ranged from 19 ^{0}C to 31 ^{0}C, minimum temperature noted in winter in December,whilemaximum temperature noted in summer in May. The transparency ranged between 11.5 to 48 NTU, maximum transparency noted in January,minimum transparency noted in August. Turbidity ranged between 2.5 to 14.7NTU,maximum turbidity noted in monsoon in Augustdue to surface running water,whileminimum turbidity noted in winter in October.Thesame result noted by Al-Dawoodi (2019)[14] in Baghdad Island Lake. Conductivity ranged from 301to 872 µmhos/cm; the higher conductivity noted in summer in May, while the lower conductivity noted in September. Total Dissolved

Solids ranged between 152 to 502 mg/l;maximum TDS noted in May,whileminimum TDS noted in September. Total Soluble Solids ranged between 4.2 to 22 mg/l,maximum TSS noted in monsoon in August,whileminimum TSS noted in winter in October. Total Solids ranged between 290.30 to 418.75 mg/l,maximum TS noted in Julyandminimum TS noted in September. pH fluctuated between 7.38 to 8.33,maximum pH noted in winter whileminimum pH noted in monsoon, due to algal growth in winter maximum value of pH and minimum in monsoon due to rain surface water and organic-inorganic ions mixing in the water, Similar result was observed by Kumar et al (2006)[10] in Khoh Lake, Garhwal Himalayas. Dissolved Oxygen varies between 5.1 to 6.7 mg/l,maximum DO is recorded in winter,whileminimum DO is recorded in summer. BOD ranged between 4.02 to 8.12mg/l;minimum BOD noted in January; maximum BOD noted in summer in May. COD ranged between 9.8 to 26 mg/l;maximum COD was noted in summer,whileminimum COD noted in winter in January. Free CO_2 ranged between 2.04 to 4.53 mg/l,maximum CO_2noted in monsoon andminimum CO_2noted in winter. Total Alkalinity ranged between 162 to 312 mg/l;maximum alkalinity noted in July (2024),whileminimum alkalinity noted in September (2023). Total hardness ranged between 105 to 326 mg/l;maximum total Hardness noted in May,whileminimum total Hardness noted in September. Calcium ranged between 69.5 to 174 mg/l;minimum calcium noted in September,whilemaximum Calcium noted in May. Magnesium ranged between 7.86 to 40.02 mg/l;maximum Magnesium notedin Maywhileminimum Magnesium noted in September. Chloride ranged between 14 to 41 mg/l;maximum Chloride noted in Mayminimum Chloride noted in September. Phosphate among 0.11 to 0.175 mg/l;highestPhosphate noted in July due to rainwater leaching the surface and increasedphosphate,minimum phosphate noted in October. Sulphate ranged between 8.1 to 27.1 mg/l;maximum sulphate noted in July whileminimum sulphate noted in September. Nitrate ranged between 2.05 to 4.16 mg/l;maximum nitrate noted in May while the lowest nitrate noted in September (Table-1). The result is also expressed in the bar diagram (Fig.1-11).

Many workers have researchedphysico-chemical parameters,such as M. Shiji et al. (2016)[11]studied water quality assessment in Kavvayi Lake and reported that the lake was influenced with anthropogenic action like unscientific tourism and pollution. Borkar and Deshmukh (2018)[5] studied the annual variation in Mul Lake. Deshpande (2019)[6]observedrare combination with six different ecosystems. The biodiversity of Lonar Lake is enormous, and researchers have more opportunities to specialise hydrobiology and biodiversity.Minki Kumari (2020)[13] investigated the limnological characteristics which can promote fish production and fisheries in Kanjha Lake, Purnea, Bihar. Khune et al. (2021)[9], shows that we can control the appropriateness of water for fishing, drinking and irrigation by using physico-chemical parameters.

Table 1- Seasonal variation of physico-chemical parameters of Gaurala Lake at Site (G-1 to G-5) during September 2023- August 2024.

	Winter					Summer					Monsoon				
	G-1	G-2	G-3	G-4	G-5	G-1	G-2	G-3	G-4	G-5	G-1	G-2	G-3	G-4	G-5
Atm. Temp.	21.75 ± 2.75	21.75 ± 2.75	21.75 ± 2.75	21.75 ± 2.75	21.75 ± 2.75	36.25 ± 2.99	36.25 ± 2.99	36.25 ± 2.99	36.25 ± 2.99	36.25 ± 2.99	31.5 ± 3.42	31.5 ± 3.42	31.5 ± 3.42	31.5 ± 3.42	31.5 ± 3.42
Water Temp.	19.13 ± 1.31	19.28 ± 1.89	19.19 ± 1.93	19.13 ± 2.03	18.75 ± 2.07	30.75 ± 2.14	30.94 ± 2.39	31.04 ± 2.37	30.63 ± 2.56	30.38 ± 2.06	27.21 ± 4.04	27.5 ± 4.34	27.48 ± 4.23	27.3 ± 4.3	26.28 ± 5.3
Tran.	37.13 ± 2.53	36.23 ± 2.61	34.6 ± 3	39.75 ± 3.5	42 ± 6.06	25 ± 2.58	26.1 ± 2.7	25.23 ± 3.15	23.73 ± 0.98	24.5 ± 1.29	16.25 ± 5.97	14.53 ± 2.55	15.5 ± 2.08	15.75 ± 2.63	17.75 ± 2.22
Turb.	4.08 ± 0.88	3.7 ± 0.81	4.83 ± 13	3.68 ± 0.9	3.75 ± 0.87	6.73 ± 1.05	5.83 ± 0.81	8 ± 1.46	6.2 ± 1.02	5.55 ± 0.7	8.38 ± 3.92	8.48 ± 4.02	10.2 ± 5.03	9.75 ± 1.98	8.2 ± 3.62
Cond.	556 ± 50.09	556.25 ± 41.89	569.25 ± 49.51	561.25 ± 49.72	547 ± 46.01	577.5 ± 33.97	559.75 ± 25	634.75 ± 158.52	559 ± 30.69	553 ± 22.7	562.5 ± 172.22	532.5 ± 150.46	542.75 ± 146.78	538.75 ± 148.69	532.5 ± 154.35
TDS	323.25 ± 36.28	282.75 ± 76.21	339 ± 39.41	319.25 ± 33.56	304.5 ± 35.3	332.5 ± 18.38	330.75 ± 14.43	381.5 ± 80.75	335 ± 23.11	332.25 ± 14.15	311 ± 89.18	317 ± 90.51	320.5 ± 92.97	305 ± 87.55	302 ± 100.04
TSS	6.58 ± 1.28	6.4 ± 1.56	7 ± 1.41	6.65 ± 1.44	6.25 ± 1.39	11.13 ± 1.9	11 ± 2.1	11.5 ± 1.91	11.03 ± 2.03	10.68 ± 1.91	15.15 ± 6.94	15.58 ± 6.91	16 ± 7.12	15.68 ± 7.6	15.55 ± 7.48
TS	329.83 ± 36.99	289.15 ± 77.77	341 ± 32.49	325.9 ± 34.66	310.75 ± 36.43	343.63 ± 20.2	341.75 ± 16.49	357.75 ± 14.66	346.03 ± 25.01	342.93 ± 16.01	326.15 ± 95.51	332.58 ± 96.82	335 ± 98.29	320.68 ± 94.51	317.55 ± 107.07
pH	8.05 ± 0.06	0.15	7.88 ± 0.1	8.08 ± 0.1	8.13 ± 0.13	7.98 ± 0.05	7.95 ± 0.13	7.78 ± 0.17	8.03 ± 0.15	8 ± 0.16	7.75 ± 0.21	7.78 ± 0.13	7.75 ± 0.31	7.73 ± 0.17	7.83 ± 0.21
DO	6.2 ± 0.08	6.23 ± 0.15	5.75 ± 0.13	6.4 ± 0.18	6.25 ± 0.13	5.78 ± 0.13	5.85 ± 0.31	5.4 ± 0.08	5.88 ± 0.36	6.03 ± 0.46	5.65 ± 0.13	5.48 ± 0.17	5.48 ± 0.45	5.55 ± 0.13	5.63 ± 0.15
BOD	4.3 ± 0.21	4.29 ± 0.12	4.66 ± 0.09	4.45 ± 0.16	4.35 ± 0.15	5.44 ± 1.64	5.36 ± 1.65	5.69 ± 1.69	5.38 ± 1.58	5.34 ± 1.5	5.6 ± 0.72	5.63 ± 0.73	6.11 ± 0.9	5.64 ± 0.72	5.58 ± 0.85
COD	12.53 ± 1	10.6 ± 0.61	14 ± 0.82	12.1 ± 2.59	11.68 ± 1.49	15.53 ± 2.73	15.05 ± 2.36	16.25 ± 2.63	14.75 ± 1.95	13.23 ± 2.24	17.53 ± 3.25	16.85 ± 3.02	20 ± 4.32	17.8 ± 5.31	16.2 ± 4.41
CO2	2.17 ±	2.04 ± 0.8	2.2 ± 0.88	2.15 ± 0.9	2.13 ±	3.6 ± 0.1	3.03 ±	3.25 ± 1.04	2.82 ±	2.28 ±	4.32 ±	4.34 ±	4.42 ± 1.04	4.34 ± 0.88	2.22 ± 0.81

	0.86				0.78		0.96		0.92	0.13	0.95	0.85			
Alka.	212.5 ± 19.49	216.7 5 ± 18.43	198.2 5 ± 25.26	219.2 5 ± 17.67	221.7 5 ± 18.4	230.7 5 ± 7.63	242.2 5 ± 12.04	226.7 5 ± 6.85	235.5 ± 10.34	245 ± 10.98	253.5 ± 33.64	265 ± 36.37	240 ± 24.25	262.7 5 ± 38.82	244.7 5 ± 72.15
Hard .	211.7 5 ± 17.46	208.5 ± 20.53	221 ± 20.94	204.7 5 ± 25.2	180.5 ± 14.98	262.2 5 ± 23.5	255 ± 16.89	279 ± 35.92	260.5 ± 19.89	250.2 5 ± 9.98	213.2 5 ± 70.57	209.7 5 ± 69.96	222 ± 71.24	216.2 5 ± 67.1	203 ± 62.98
Calci -um	138.5 8 ± 15.26	136.1 8 ± 12.59	143 ± 15.36	129.4 3 ± 13.52	122.1 3 ± 11.2	143.3 8 ± 18.32	154.6 5 ± 4.33	156.5 ± 4.43	152.4 5 ± 4.13	140.5 ± 7.48	141.9 5 ± 46.02	139.9 1 ± 45.01	143.5 ± 46.69	138.0 3 ± 44.06	132.7 3 ± 42.21
Mag.	17.85 ± 1.87	17.65 ± 2.08	19.03 ± 1.44	18.38 ± 3	14.24 ± 2.07	29.01 ± 1.31	24.48 ± 3.08	29.89 ± 7.69	26.36 42 ± 3.98	26.77 9 ± 1.17	17.4 ± 6.08	17.04 ± 6.23	19.15 ± 5.99	19.09 ± 5.63	17.15 ± 5.31
Chlo.	29.58 ± 3.09	29.28 ± 4.2	32.75 ± 3.2	28.82 ± 4.54	28.9 ± 2.61	31.91 ± 0.69	31.9 ± 0.22	36.25 ± 1.5	31.95 ± 0.7	30.53 ± 0.3	28.53 ± 8.21	28.7 ± 8.4	33.25 ± 11.15	28.35 ± 8.92	26.93 ± 8.62
Phos .	0.12 ± 0.06	0.12 ± 0.06	0.13 ± 0.06	0.12 ± 0.06	0.12 ± 0.06	0.15 ± 0	0.15 ± 0.01	0.17 ± 0.01	0.16 ± 0.01	0.15 ± 0.01	0.15 ± 0.01	0.12 ± 0.07	0.17 ± 0.01	0.16 ± 0.01	0.15 ± 0.01
Sulp h.	18.9 ± 2.77	20.15 ± 3.04	20.8 ± 3.14	19.15 ± 2.74	16.33 ± 1.81	21 ± 0.8	21.4 ± 0.98	23.4 ± 1.4	21.5 ± 0.8	20.1 ± 0.5	19.38 ± 7.52	19.7 ± 7.34	21.68 ± 8.29	19.95 ± 7.37	18.3 ± 6.83
Nitra .	3.18 ± 0.53	3.03 ± 0.36	2.05 ± 0.01	2.95 ± 0.24	3.05 ± 0.26	3.95 ± 0.64	3.79 ± 0.42	2.35 ± 0.57	3.93 ± 0.4	3.63 ± 0.5	3.63 ± 0.99	3.17 ± 0.55	3.2 ± 0.78	2.83 ± 0.64	3.4 ± 0.8

(All parameters in mg/l except Atm. Temp, Water Temp. = ^{0}C, Transparency and Turbidity = cm, Conductivity = µmhos/cm, pH.)

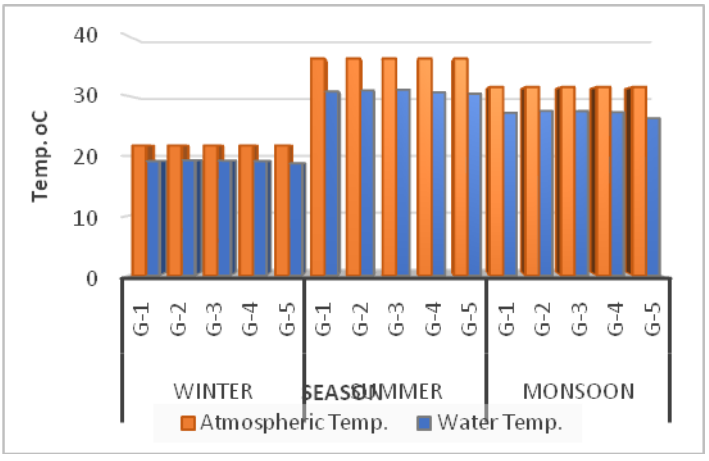


Fig. 1- Seasonal value of Atmospheric temperature and water temperature of Gaurala lake.

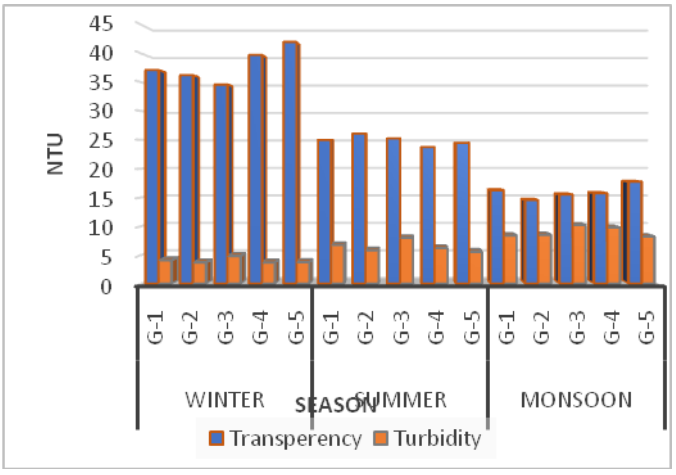


Fig. 2-Seasonal value of Transperency and Turbidity of Gaurala lake.

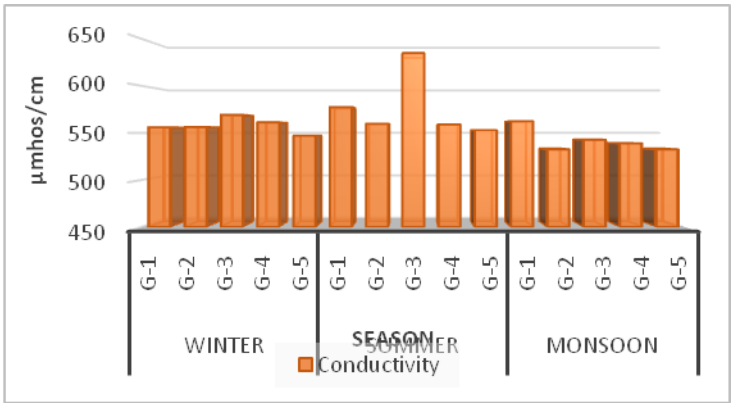


Fig. 3- Seasonal value of Conductivity of Gaurala lake.

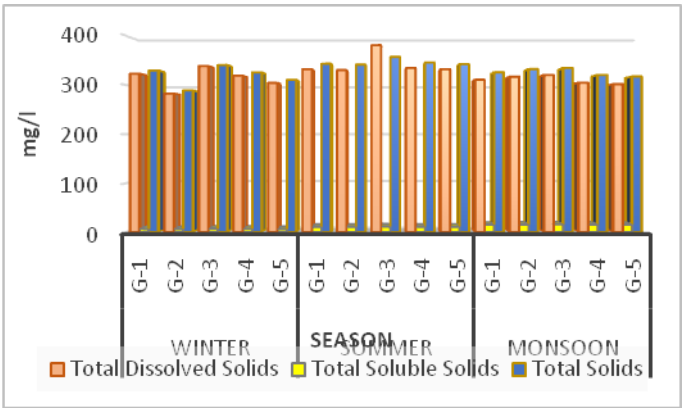


Fig. 4- Seasonal value of TDS, TSS and TS of Gaurala lake.

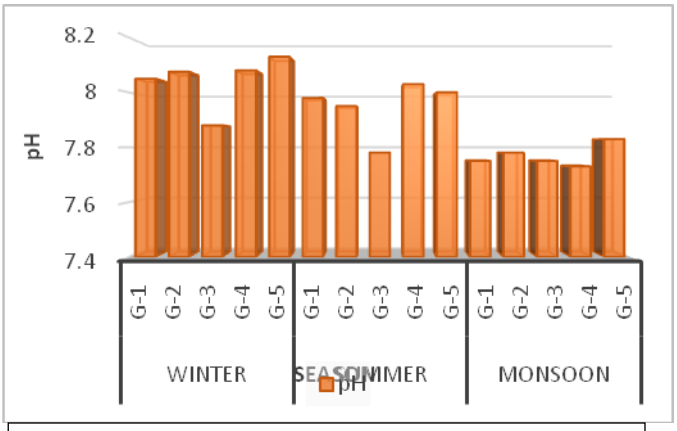


Fig. 5- Seasonal value of pH of Gaurala lake.

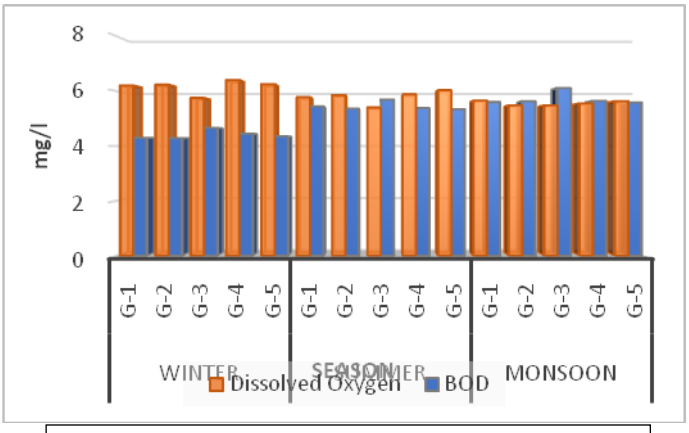


Fig. 6- Seasonal value of DO and BOD of Gaurala lake

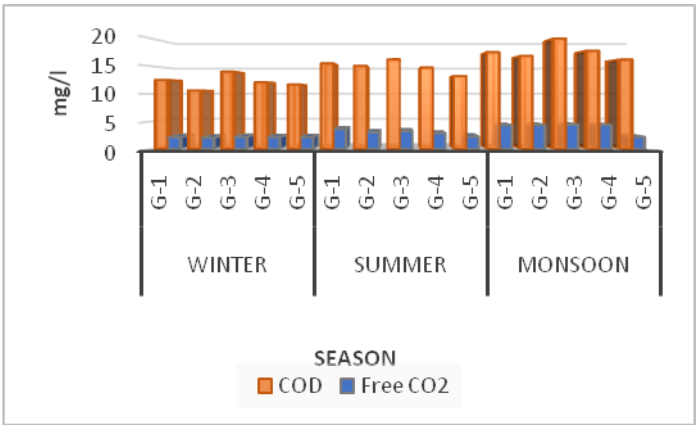


Fig. 7- Seasonal value of COD and Free CO_2 of Gaurala lake.

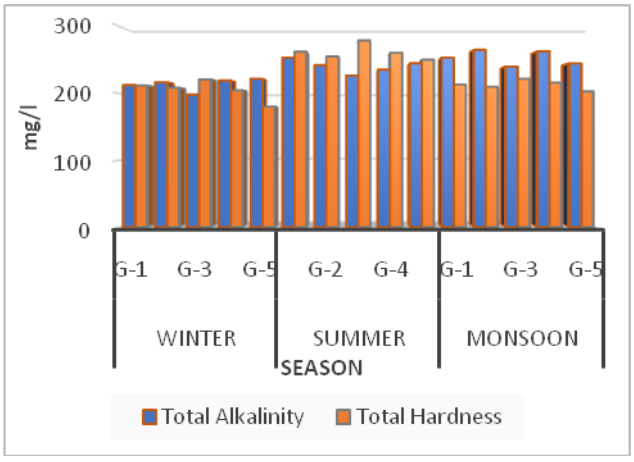


Fig. 8- Seasonal value of Alkalinity and Hardness of Gaurala lake. Seasonal value of COD and Free CO_2 of Gaurala lake.

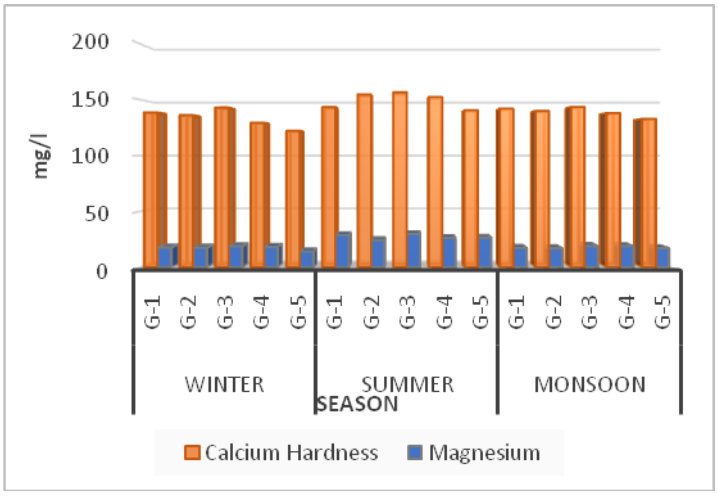


Fig. 9- Seasonal value of Calcium and Magnesium of Gaurala lake

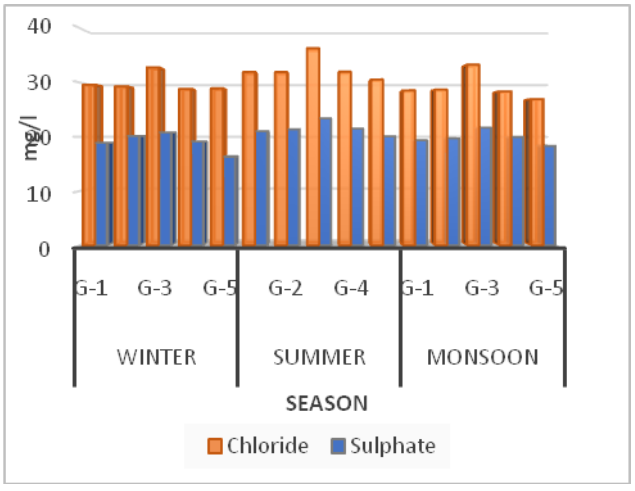


Fig. 10- Seasonal value of Chloride and Sulphate of Gaurala lake

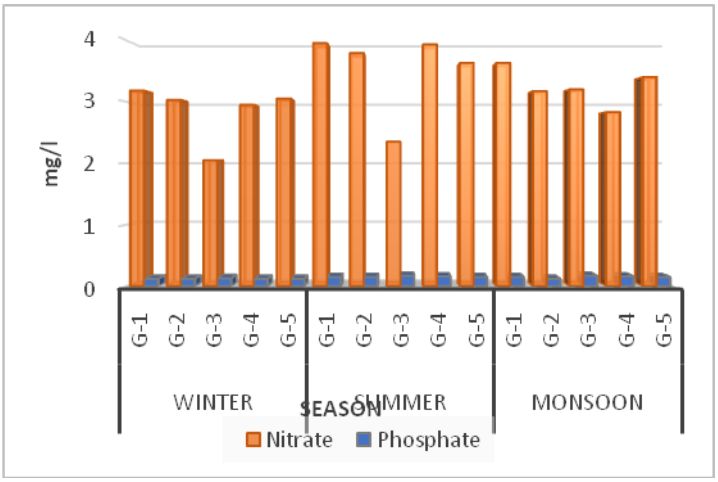


Fig. 11- Seasonal value of Chloride and Sulphate of Gaurala lake

According to Pimpalshende et al. (2022)[3], the surrounding factors have an important impact on the physico-chemical conditions and fluctuate depending on the climate. Kamble et al. (2023)[8] observed that the good water quality index rating is suitable for aquatic life, recreational activities, and human use. Shivshankar and Alvandi (2024)[15]revealed that Seasonal fluctuations in temperature, conductivity, total suspended solid, turbidity, and pH show notable variations in the ponds. A. R. Deborah et al.(2025)[1] observed the potability of water for drinking during the rainy season of Tirupattur. The analysed water is free from harmful bacteria like enteric coliform, which is dangerous for human health and may cause many waterborne illness. John(2025)[4] revealed a high level of pollutants, which gives a negative impact on water quality, aquatic organism health and human health.

CONCLUSION

The water quality of Gaurala Lake was analyzed by using physicochemical parameters. The selected sampling sites like G-1, G-2, G-4 and G-5 were silent zone. However, the G-3 site is mildly polluted by anthropogenic activity. The obtained values were within the permissible limit of WHO[17], BIS and ICMR except for Conductivity, TDS, DO, COD, Total Alkalinity and Calcium Hardness in summer due to a decrease in water level due to evaporation. This study recommends minimising the anthropogenic activities surrounding the Lake and maintaining the lake.

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