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Estimation of Physico-chemical Parameters in Katral and Bharamasagara Lake of Chitradurga District

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KEYWORDS

Bharamasagara Lake; Chitradurga; Katral lake; Physiochemical parameters; Water quality.

ABSTRACT:

As water is an essential survival factor for living things and development. This study evaluates the water parameters of Katral Lake and Baramasagara Lake in Chitradurga district of Karnataka. The current study aims to understand the parameters viz., Temperature (water and air), pH, turbidity, conductivity, colour, total solid, total suspended solids, TDS, alkalinity, hardness, calcium, sulphate, nitrate phosphate, DO, BOD, COD, magnesium are all desirable and indicate that the water is safe to drink. By monitoring water quality parameters and evaluating the overall state of the ecosystem, phytoplankton serves as an essential indicator of environmental health and reflects changes in H2O quality. The analysis method used in accordance with the water quality to examine the public consumption, recreation, and other uses in order to determine the various physico-chemical parameters and the water quality index. According to water parameters we calculate the different seasons of standard deviation & Karl Pearson Correlation coefficient. This study examines the effect of domestic activities and environmental factors influence on the lake's water quality.

Introduction

As a universal solvent, water can dissolve a wide range of materials, including both organic and inorganic molecules. This exceptional quality of water can be attributed to the impossibility of consuming water in its purest form. In general, the component of water that is present at the ideal level for the proper growth of plants and animals is referred to as water quality. The physicochemical properties of the water body determine the productivity of aquatic species, which require a healthy habitat and sufficient nutrients for growth (1). The freshwater resource's quality is deteriorating more quickly, creating a worldwide issue. Freshwater lakes are a country's greatest asset, and a system's biological and physical characteristics determine the health of its aquatic ecosystem. The biological and chemical elements are connected and dependent upon one another. The species composition, abundance, productivity, physiological conditions, and native population of aquatic organisms are all impacted by the quality of the water (2). Minerals, vitamins, amino acids, proteins, omega-3 essential fatty acids, antioxidants, carotenoids, phytonutrients, chlorophyll, trace minerals, and phytochemicals are all abundant in phytoplankton. Marine biogeochemistry and ecological stability depend heavily on phytoplankton biodiversity (3).

Water, which makes up around 71% of the Earth's surface, is a vital natural resource that is necessary for all life. It is essential to chemical, biological, and ecological processes. Through processes like evaporation, condensation, and precipitation, water cycles through the environment in three different states: liquid, solid (ice), and gas (vapor). Drinking, agriculture, industry, and energy production are just a few of the uses for it. Both environmental equilibrium and human health depend on clean water (4). Due to improper sewage and waste disposal methods, ground water in the surrounding area becomes contaminated, which contaminates lake water. Degradation of eutrophication causes significant harm to the lake's environment. This could happen as a result of improper water management planning. Water quality can be maintained by reducing pollution by timely monitoring and appropriate management of water bodies.

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The insect community nearby is impacted by the physicochemical characteristics of the lake water (5).

Several studies on physico-chemical characteristics of lakes and reservoirs, as well as ponds have been done in India. reported the water quality of the Ganga River at Allahabad, where the results revealed that all criteria were over allowable limits and unfit for human consumption but suitable for irrigation. explored the Yamuna River's water quality index. examined the contributions of sewage to the chemistry of the Varuna River and discovered that the DO and transparency of the river water decreased and the temperature, pH, alkalinity, BOD, COD, chlorides, phosphates, nitrates, and heavy metals increased. Analogous physical-chemical investigations of Lathiahwa Talab, Gopalganj and Bhadohi resulted in nearly zero DO, high pH, alkalinity, hardness, TSS, TDS, COD, and excessive chromium values (5.7 mg/l > standard limit), which prohibited them from fish production. noted two ponds in Patna had physico-chemical characteristics and water quality characteristics which proved to be conducive to some species (6). Since an organism interacts directly with its ecosystem, many scientists have instead employed biological rather than physic-chemical indicators to detect changes in behavioral or pathological responses, population dynamics, environmental contamination, and consequences (7).

Numerous incidences of typhoid, diarrhea, and other water-borne illnesses have been documented as a result of drinking tainted water. Many researchers have conducted studies to evaluate the quality of water. These days, more people die of tainted water than cancer, AIDS, war, terrorism, or accidents. The physico-chemical attributes of water fluctuate seasonally, and the human-induced practices of the catchment site, including its dwellings sewage, urbanization, and agriculture, contribute to the degradation of water quality (8). However, several investigations have investigated the quality of river water using the parameter level. Nine of the indicators ranged within the FAO standard limit for irrigation and beyond the WHO limits for drinking according to a study exploring the pollution effects related to the physico-chemical parameters of the African Elala River. There is another study that evaluated physico-chemical and bacteriological investigation in the river Cauvery of Kollegal stretch in Karnataka. And, it was indicated by the pH, conductance, alkalinity and hardness, DO, BOD and COD levels of the results, indicate the absence of major organic pollution sources and that the water in the river was uncontaminated (9).

Materials and Methods

Study Area

Katral Lake

Katral Lake is one of the beautiful lake, located near to the Chitradurga city, Karnataka, India. It is situated close to the national highway, which attracts more visitors for its environment. Its approximate coordinates are 14.28056°N latitude and 76.31963°E longitude. The lake is popular for the bird watchers since it harbours various bird species *viz*., painted storks and egrets. The Katral lake has been disturbed with the anthropogenic influence and the water quality is being altered seasonally. Monthly collection of the water samples was done and the quality of the water is analysed for some of the essential water parameters. The collected water was estimated for algal identification using light microscopy and taxonomic keys. The statistical correlation between the algal diversity and environmental parameters was carried out.

Bharamasagara Lake

Bharamasagara Lake is a historic reservoir located in the village of Bharamasagara, with in the Chitradurga district of Karnataka, India.

The lake plays a crucial role in local agriculture, providing irrigation to surrounding farmlands. In recent years, water from the Tungabhadra River, sourced via the Rajanahalli Lift Irrigation Project, has been used to replenish the reservoir. This initiative not only fills Bharamasagara Lake but also supplies water to 42 nearby village lakes, enhancing the region's irrigation capabilities. The lake's approximate coordinates are Latitude: 14°22'24.96" N and Longitude: 76°11'59.28" E. Bharamasagara Lake, like many other water bodies in India, faces several environmental and human-induced challenges. Some of the important threats to the lake involve fluctuation in the water level, silt and sediment formation, pollution and contamination, encroachment and urban sprawling, loss in the biodiversity, etc. Hence this lake attracts a significant attention towards the study to draw appropriate mitigation measures.

Water Sample Collection & Analysis

Water samples are collected in sterile polytene bottle of 2 Ltr capacities every month. The samples are collected at morning time in order to maintain unibrity for a period of 2 year Jan-2021 to Dec-2022 and examined the several

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parameters. The temp and pH were recorded at the time of sample collection with the help of thermometer and pH paper and later confirmed in the laboratory using digital pH meter. The Physico-Chemical characteristics of the lake. water like Total hardness, DO, BOD, COD, TDS, Conductivity, Total solid, Total suspended solid, Total alkalinity, Acidity, Chloride, Sulphate, Nitrate, Phosphate, Magnesium were determined every month in laboratory as per standard methods suggested (10,11). Physico chemical parameters of the water, This water parameters of the above said lakes were analysed periodically.

Results

Physico-chemical parameters and their analysis

The physico-chemical parameters recorded from the study sites over a period of 2 years and at different seasons were represented in tables 3 and 4. The average values were represented along with the standard deviation calculated among the two study sites.

Table 1 reveals the average values of physico-chemical parameters recorded in Bharamasagara lake over a period of 2 years. The seasonal data is also been represented in the same table. Table 2 represents the average values of water parameters recorded in Katral lake over a period of 2 years. The seasonal data is also been represented in the same table.

The physico chemical parameters were subjected to Karl Pearson correlation coefficient estimation to understand the relation between the parameters recorded in the study sites. Table 3 and 4 represents the Karl Pearson correlation coefficient calculated for Physico-chemico parameters of Bharamasagara and Katral lakes respectively. The table 3 represents the correlation coefficient calculated among the physico-chemical parameters recorded in Bharamasagara lake.

Table 1. Physico-chemical parameters recorded during 2023 – 25 at Bharamasagara lake.

Parameters	**2023 - 25**		**Premonsoon**		**Monsoon**		**Postmonsoon**	
	Mean ± SD		**Mean ± SD**		**Mean ± SD**		**Mean ± SD**	
Colour Hazen Unit	<5.0		<5.0		<5.0		<5.0	
Turbidity, NTU	0.43	0.123	0.40	0.141	0.50	0.082	0.40	0.141
pH	8.26	0.684	8.12	0.300	8.92	0.745	7.74	0.310
Conductivity µs/cm	1135.17	520.008	1566.75	419.985	1101.25	431.759	737.50	409.823
Total Solids mg/l	626.67	280.073	901.50	101.092	579.50	197.352	399.00	256.249
Total Suspended Solids, mg/l	3.33	1.371	2.50	0.577	4.00	0.816	3.50	2.082
Total Dissolved solids mg/l	620.25	282.658	898.75	102.011	566.50	203.667	395.50	257.771
Total Alkalinity	151.67	72.561	210.00	42.230	147.50	48.734	97.50	81.701
Total Hardness	271.27	83.186	322.75	62.434	303.45	46.718	187.60	71.020
Calcium	46.98	17.488	66.05	14.806	41.40	8.349	33.50	7.984
Total Acidity	10.33	4.509	14.00	13.110	5.90	0.358	8.00	2.828
Chloride	174.38	64.736	194.65	56.708	223.65	14.407	104.85	41.382
Sulphate	29.21	8.191	30.40	10.481	34.03	4.321	23.20	6.043
Nitrate	12.97	6.480	13.70	5.377	18.50	1.732	6.70	5.303
Phosphate	0.09	0.138	0.20	0.257	0.04	0.017	0.05	0.022
Dissolved Oxygen	3.68	0.931	3.20	0.678	3.33	0.222	4.50	1.140

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BOD	9.32	5.512	9.20	6.171	5.00	2.160	13.75	4.193
COD	45.33	22.713	46.00	26.432	26.00	13.663	64.00	6.532
Magnesium	37.52	13.180	38.23	6.404	49.13	7.468	25.20	12.551
Air Temperature	29.58	2.234	31.25	2.500	27.50	1.291	30.00	0.816
Water Temperature	24.50	4.011	27.50	2.380	22.25	1.708	23.75	5.560

Table 2. Physico-chemical parameters recorded during 2023 – 25 at Katral lake.

Tests	**2023 - 25**		**Premonsoon**		**Monsoon**		**Postmonsoon**	
	Mean ± SD		**Mean ± SD**		**Mean ± SD**		**Mean ± SD**	
Colour Hazen Unit	<5.0		<5.0		<5.0		<5.0	
Turbidity, NTU	0.28	0.119	0.33	0.126	0.30	0.141	0.23	0.096
pH	8.12	0.642	8.05	0.677	8.64	0.585	7.69	0.313
Conductivity µs/cm	814.75	450.031	1275.50	311.663	578.50	294.280	590.25	366.326
Total Solids mg/l	484.91	268.717	745.75	82.867	306.50	164.699	375.00	303.643
Total Suspended Solids, mg/l	2.83	1.193	1.75	0.500	4.00	0.816	2.75	0.957
Total Dissolved solids mg/l	460.25	267.915	744.00	83.090	302.50	164.393	334.25	259.918
Total Alkalinity as CaCO3, mg/l	147.50	77.709	217.50	22.546	135.00	63.770	90.00	80.104
Total Hardness as C_aCO_3, mg/l	190.74	84.122	276.70	34.578	155.10	64.878	140.43	74.975
Calcium as Ca, mg/l	37.18	15.748	55.25	10.302	26.70	8.009	29.60	8.983
Total Acidity mg/l	4.33	8.466	8.18	13.550	0.90	0.000	3.90	3.934
Chloride as Cl, mg/l	99.37	41.059	130.80	3.335	98.53	47.650	68.78	36.517
Sulphate as SO4, mg/l	24.81	8.256	31.78	5.055	26.20	4.249	16.45	6.775
Nitrate as NO_3, mg/l	11.55	4.712	14.43	2.755	13.50	3.109	6.73	4.124
Phosphate as PO4, mg/l	0.04	0.007	0.04	0.005	0.05	0.000	0.05	0.010
Dissolved Oxygen mg/l	3.63	1.025	3.20	1.117	3.10	0.258	4.58	0.854
BOD (3 days@ 27^0 C), mg/l	6.76	3.761	6.78	4.167	5.00	0.816	8.50	5.066
COD, mg/l	32.67	14.253	34.00	20.000	26.00	7.659	38.00	13.663
Magnesium as Mg, mg/l	23.63	12.436	33.38	5.966	21.48	11.677	16.05	13.626
Air Temperature	28.92	2.746	28.00	2.449	28.00	2.160	30.75	3.202
Water Temperature	25.58	2.778	24.75	2.754	25.00	2.828	27.00	2.944

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Table 3. Karl Pearson Correlation coefficient calculated for Physico-chemico parameters of Bharamasagara lake.

	Turbidity	**pH**	**Conductivity**	**Total_solids**	**Total_suspended-**	**Total_dissolved-**	**Total_alkalinit-**	**Total_hardness**	**Calcium**	**Total_acidity**	**Chloride**	**Sulphate**	**Nitrate**	**Phosphate**	**Dissolved_oxygen**	**BOD**	**COD**	**Magnesium**	**Air_temp.**
Turbidity	1																		
pH	0.111	1																	
Conductivity	-0.384	0.049	1																
Total_solids	-0.433	0.132	0.931	1															
Total_suspended_solids	**0.683**	0.074	-0.429	**-0.503**	1														
Total_dissolved_solids	-0.439	0.134	**0.929**	**0.999**	**-0.509**	1													
Total_alkalinity	-0.48	0.391	**0.731**	**0.883**	**-0.591**	**0.89**	1												
Total_hardness	-0.391	**0.527**	**0.753**	**0.846**	-0.35	**0.837**	**0.811**	1											
Calcium	-0.444	0.158	**0.758**	**0.889**	-0.412	**0.89**	**0.785**	**0.827**	1										
Total_acidity	0.089	-0.325	0.065	0.096	-0.392	0.102	0.047	-0.231	-0.138	1									
Chloride	-0.187	**0.673**	**0.506**	**0.579**	-0.146	**0.563**	**0.64**	**0.877**	**0.579**	-0.475	1								
Sulphate	0.156	**0.641**	0.242	0.352	0.101	0.347	0.425	**0.612**	0.468	-0.306	**0.676**	1							
Nitrate	-0.019	**0.78**	0.414	0.492	-0.041	0.48	**0.578**	**0.804**	0.482	-0.332	**0.881**	**0.859**	1						
Phosphate	-0.306	0.274	-0.438	0.306	-0.485	-0.372	-0.432	-0.302	-0.467	-0.251	0.031	0.064	0.041	1					
Dissolved_oxygen	-0.254	-0.342	-0.193	-0.215	-0.32	-0.211	-0.151	-0.39	-0.454	**0.679**	**-0.51**	-0.402	-0.347	-0.188	1				
Bod	-0.105	-0.411	-0.089	-0.054	-0.239	-0.038	-0.065	-0.382	-0.186	**0.822**	**-0.683**	-0.317	-0.445	0.034	**-0.8**	1			
Cod	0.035	-0.454	-0.146	-0.124	-0.062	-0.104	-0.182	-0.458	-0.157	**0.707**	**-0.769**	-0.255	**-0.51**	0.218	**-0.605**	**0.945**	1		
Magnesium	-0.248	**0.719**	**0.531**	**0.57**	-0.209	**0.557**	**0.614**	**0.878**	0.458	-0.253	**0.893**	**0.565**	**0.857**	-0.479	-0.24	-0.45	**-0.592**	1	
Air_temperature	-0.143	-0.498	-0.003	0.205	-0.129	0.206	0.204	-0.101	0.282	0.181	-0.171	-0.206	-0.298	-0.246	**-0.634**	0.218	0.205	-0.409	1
Water_temperat	-0.313	0.002	0.483	**0.628**	-	**0.636**	**0.662**	0.379	**0.533**	0.27	0.20	0.12	0.168	-0.487	**-0.523**	0.32	0.22	0.13	**0.61**

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ure					0.231					7	2	2				1	4	9	**4**

Note: The values represented in Bold letters indicates the significant values.

Table 4. Karl Pearson Correlation coefficient calculated for Physico-chemico parameters of Katral lake

	Turbidity	**pH**	**Conductivity**	**Total_suspended_solids**	**Total_dissolved_solids**	**Total_alkalinity**	**Total_hardness**	**Calcium**	**Total_acidity**	**Chloride**	**Sulphate**	**Nitrate**	**Phosphate**	**Dissolved_oxygen**	**BOD**	**COD**	**Magnesium**	**Air_temp.**
Turbidity	1																	
pH	0.128	1																
Conductivity	0.319	**-0.076**	1															
Total_suspended_solids	0.17	**0.502**	**-0.608**	1														
Total_dissolved_solids	0.325	-0.036	**0.958**	**-0.655**	1													
Total_alkalinity	0.426	0.351	**0.819**	-0.358	**0.899**	1												
Total_hardness	0.383	0.065	**0.969**	**-0.537**	**0.972**	**0.924**	1											
Calcium	0.281	-0.102	**0.895**	**-0.64**	**0.858**	**0.737**	**0.899**	1										
Total_acidity	**0.514**	**-0.627**	0.469	-0.311	0.406	0.22	0.444	**0.525**	1									
Chloride	0.387	0.427	**0.813**	-0.245	**0.827**	**0.937**	**0.901**	**0.724**	0.185	1								
Sulphate	0.497	**0.539**	**0.517**	-0.028	**0.562**	**0.752**	**0.63**	**0.58**	0.064	**0.718**	1							
Nitrate	0.449	**0.732**	0.394	0.202	0.449	**0.725**	**0.521**	0.368	-0.149	**0.682**	**0.914**	1						
Phosphate	-0.306	0.274	-0.438	0.306	-0.485	-0.372	-0.432	-0.302	-0.467	-0.251	0.031	0.064	1					

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Dissolved oxygen	0.1	**-0.644**	0.068	-0.227	0.047	-0.185	-0.009	-0.007	**0.525**	-0.24	**-0.553**	**-0.623**	**-0.788**	1				
Bod	0.306	-0.36	0.354	-0.259	0.409	0.289	0.365	0.32	**0.575**	0.193	-0.026	-0.111	**0.934**	**-0.775**	1			
Cod	0.178	-0.298	0.375	-0.207	0.376	0.3	0.42	0.492	**0.629**	0.289	0.067	-0.072	**0.718**	**-0.611**	**0.862**	1		
Magnesium	0.411	0.184	**0.894**	-0.379	**0.926**	**0.942**	**0.943**	**0.701**	0.327	**0.915**	**0.588**	**0.572**	-0.479	-0.006	0.36	0.32	1	
Air_temp.	0.19	-0.507	0.023	-0.005	0.015	-0.203	-0.095	-0.216	0.272	-0.304	-0.3	-0.305	**-0.546**	**-0.653**	0.463	0.15	0.011	1
Water_temp.	0.196	-0.492	0.099	0.005	0.057	-0.169	-0.034	-0.177	0.307	-0.217	-0.244	-0.27	-0.487	**-0.582**	0.409	0.118	0.08	**0.972**

Note: The values represented in bold letters indicates the significant values

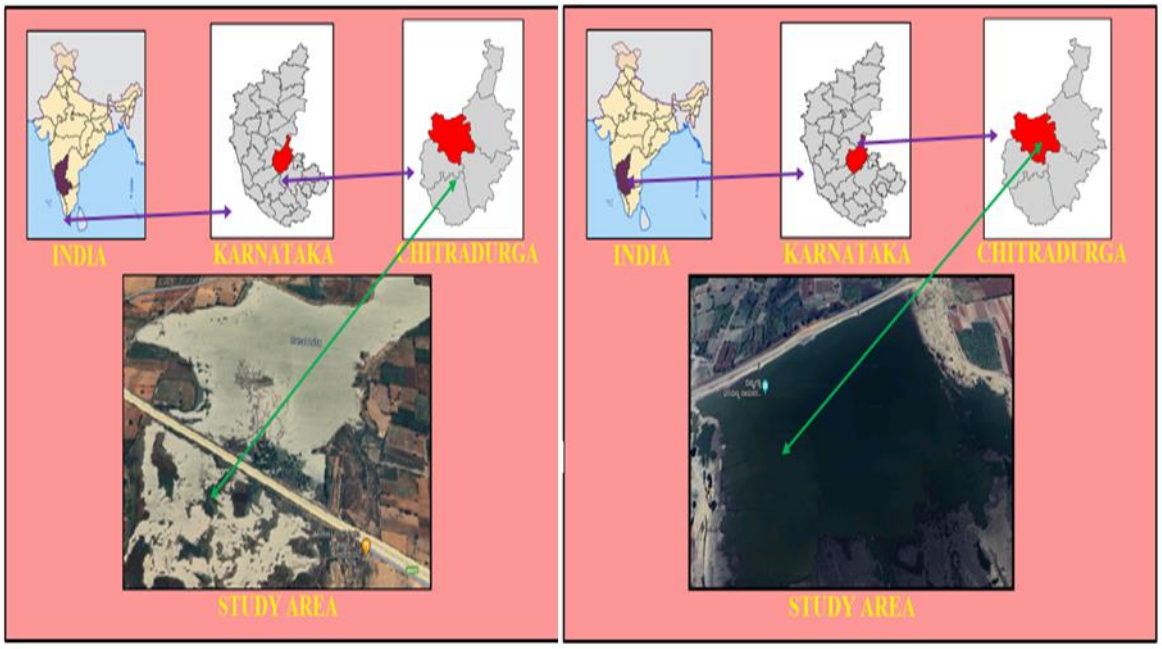

Fig. 1. Map showing 2 ponds of Study area

Discussion

Table 1 & 2 Physico-chemical parameters recorded during 2023 – 25 at Bharamasagara lake & Katral lake. Table 1 reveals the average values of physico-chemical parameters recorded in Bharamasagara lake over a period of 2 years. The seasonal data is also been represented in the same table. Color is the only constant across the year and was found to be low even at fewer than 5 Hazen units for any season as well. Bharamasagara lake turbidity was observed to be 0.43 NTU and similar average values were recorded across all seasons. Water pH was slightly acidic across the year and in the post monsoon, it was found to be close to neutral pH. In this study, pH was varied to be higher during the monsoon season and less fluctuation was recorded during the pre and post monsoon season. Collectively, we observed that the pH was non-constant

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across the study period. The condition of the conductivity of the water was high in the premonsoon season and higher in the whole study period, and the variation of the parameter was more observed during the whole study time period than in the seasonal one. The total solids in the water, recorded, are high during the premonsoon season & low in postmonsoon season. In the same pattern, the total suspended solids in water samples of Bharamasagara lake were high during monsoon and followed by postmonsoon season. Overall data of the study period have been reflected during the premonsoon season as reflected by total dissolved solids. The parameter fluctuation, however, occurs more much during the premonsoon season than any other seasons. High alkalinity was found for premonsoon season and low for postmonsoon season. For the postmonsoon season, the parameter fluctuated high, and for the premonsoon season, it was low. Just like total alkalinity, the total hardness and calcium did a similar with the fluctuation of parameters in different period. In the pre and post monsoon seasons, total acid values for the Bharamasagara lake was mostly high, with the highest variation due to dilution factors: however, the total of those variables was low in the monsoon seasons. Chloride concentration also trended approximately with the total acidity, also demonstrated in the water. The concentrations of sulphate, nitrates and phosphate, also had the similar trend, while the variation in the monsoon season was higher compared to other seasons but the variation/standard deviation values were lower. Dissolved oxygen plays a key role for the sustainable growth of any lake or water body. Dissolved oxygen concentration was lower in all the seasons, but had a slightly high value in the post monsoon season, which indicates that biological and oxygen requirements have higher concentrations. The magnesium concentration was highest in monsoon season and the lowest in postmonsoon season. The average air temperature of the lake region was measured during the time of the study. This has been noted as high in the premonsoon and postmonsoon seasons and low during monsoon season.

Overall also the value was low as mentioned in the table 3. The water temperature was recorded high in the premonsoon season while in monsoon season the value was less. All the above values clearly interprets that there is a greater variation in the values of the physico-chemical parameters across the seasons during the study period. In Bharamasagara lake, the concentrations of the physico-chemical parameters were recorded high during the pre and postmonsoon seasons, while low in the monsoon season. Meanwhile the variation, the standard deviation was recorded high during the monsoon season, but not as compared to the other seasons. Table 3 clearly depicts these values and their deviations in different seasons.

Table 2 represents the average values of water parameters recorded in Katral lake over a period of 2 years. The seasonal data is also been represented in the same table. Even under a low temperature, color is the constant throughout the year, reaching no more than 5 Hazen units along the seasons and is similar to Bharamasagara lake. They found that the turbidity in Katral lake was at 0.28 NTU and the average was similar in all seasons. These values are found to be less than Bharamasagara lake. The pH of the water was only slightly acidic throughout the year in a sense, and was found near neutral pH in the postmonsoon season. Here the pH exhibited high variability in the monsoon season, while lesser variation was found in the pre and post-monsoon season. In general, the pH did not remain constant across the period of study. The conductivity of the water was high in the premonsoon season, and the variability of the parameter was more throughout the whole study time than on a seasonal basis. The total solids of water are reported and showed high solids during the premonsoon season and a low total solids observed in postmonsoon. The total suspended solids in Katral lake water samples are very high in monsoon and followed by postmonsoon seasons. Total dissolved solids represent more in premonsoon season followed by overall data for the study period. But the fluctuation of the parameter was found more in the premonsoon season than in any other seasons. The higher values of alkalinity were found during the premonsoon season, while less in the post monsoon season. The parameter fluctuated high in postmonsoon season and low in premonsoon season. In the case of total hardness, as well as with the total alkalinity, the same trend is observed in calcium and hardness, with the fluctuation of parameters between the seasons being similar. The total acid values of Katral lake were found high at the pre and post monsoon seasons and showed the maximum variation but low at monsoon season because of dilution factors. Similarly, as a trend, the chloride concentration stored in the water also showed a similar trend as that of the total acidity. Sulphate, nitrates and phosphate concentrations also showed similar trends, however in monsoon season it was high but lower concentrations while in other seasons, concentrations were higher but

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variations/standard deviation values were smaller. Obtaining dissolved oxygen is one of the essential components of any lake or bodies of water. Dissolved oxygen concentration was observed to be less in all seasons, although high in post monsoon season, and also biological and oxygen demands were recorded significantly more than the rest of the season. Magnesium concentration was also high in pre monsoon season, and lowest in the post monsoon season. Air temperature of the lake area was measured for the study period. This value has recorded high levels during the pre-monsoon and post-monsoon seasons and low levels during the monsoon season. Generally, the value was low as mentioned in the table 2. The water temperature was recorded high in the pre monsoon season while in monsoon season the value was less. All the above values clearly interprets that there is a greater variation in the values of the physico-chemical parameters across the seasons during the study period. In Katral lake, the concentrations of the physico-chemical parameters were recorded high during the pre and postmonsoon seasons, while low in the monsoon season. Meanwhile the variation, the standard deviation was recorded high during the monsoon season, but not as compared to the other seasons. Table 2 clearly depicts these values and their deviations in different seasons.

The physico chemical parameters were subjected to Karl Pearson correlation coefficient estimation to understand the relation between the parameters recorded in the study sites. Table 3 and 4 represents the Karl Pearson correlation coefficient calculated for Physico-chemico parameters of Bharamasagara and Katral lakes respectively. The Karl Pearson correlation coefficient was calculated among the physico-chemical parameters recorded during the study period at the two different study sites ie., Bharamasagara lake and Katral lake. This is to understand the dependency of the parameters observed in the study sites. The correlation coefficient values which are above 0.5 were found to be more significant either positive or negative correlation.

The table 3 represents the correlation coefficient calculated among the physico-chemical parameters recorded in Bharamasagara lake. Turbidity values show a strongly positive correlation with the total suspended solids, while the water pH shows a significant positive correlation with total hardness, chlorides, sulphates, nitrates and magnesium. The conductivity of Bharamasagara lake water was detected to be significantly positively correlated with the total suspended solids, total alkalinity, total hardness, calcium, chlorides and magnesium concentrations. The total solids have had a significant negative correlation with total suspended solids and a positive correlation with total dissolved solids, total alkalinity, total hardness, calcium, chloride, magnesium and water temperature. Concurrently, total suspended solids have shown a significant negative correlation with total dissolved solids and total alkalinity concentrations. The total dissolved solids have shown a significant positive correlation with total alkalinity, total hardness, calcium, chloride, magnesium concentrations and water temperature. The total alkalinity measured during the study period in Bharamasagara lake water is found to be significantly positively correlated with total hardness as well as calcium, chloride, nitrates, magnesium concentrations and water temperature. The total hardness was significantly positively correlated to calcium, chloride, sulphates, nitrates and magnesium concentrations. The calcium recorded in Bharamasagara lake showed significant positive correlation with chloride and water temperatures recorded during the study period. The total acidity also showed a significant positive correlation with dissolved oxygen, BOD and COD values. However, the chloride concentration has shown a significant positive correlation with sulphates, nitrates and magnesium concentrations whereas it has a negative correlation with dissolved oxygen, BOD and COD values. The sulphates recorded in Bharamasagara lake showed a significant positive correlation with nitrates and magnesium. Nitrate concentration has also shown significant positive correlation with magnesium and negative correlation with COD concentration. The dissolved oxygen concentration exhibited a significant negative correlation with BOD, COD, air and water temperatures. BOD shows a significant positive correlation with the values of COD recorded in Bharamasagara lake water. COD showed a significant negative correlation with magnesium values, while air temperature displayed a significant positive correlation with the recorded values of water temperature in the study area.

The table 4 represents the correlation coefficient calculated among the physico-chemical parameters recorded in Katral lake. The turbidity have showed significant positive correlation with the total acidity, while the water pH have showed the positive significant correlation with the total suspended solids, sulphates and nitrates and negative significant correlation with

conductivity, total acidity and the dissolved oxygen concentrations. The conductivity of the water at Katral lake was found to be negatively correlated with the total suspended solids, while positively correlated with total dissolved solids, total alkalinity, total hardness, calcium concentration, chlorides, sulphates and magnesium concentrations. Meanwhile the total suspended solids, have represented the significant negative correlation with the total dissolved solids, total hardness and the calcium concentrations. The total dissolved solids have represented the significant positive correlation with the total alkalinity, total hardness, calcium, chloride, sulphates and the magnesium concentrations. The concentration of the total alkalinity recorded during the study period in Katral lake waters was found to be significant positive correlated with the total hardness, calcium, chloride, sulphates, nitrates and the magnesium concentrations. The total hardness in turn showed significant positive correlation with the calcium, chloride, sulphates, nitrates and the magnesium concentrations. Calcium concentration recorded in Katral lake was exhibited significant positive correlation with the total acidity, chloride, sulphates and the magnesium concentrations, while the total acidity with dissolved oxygen, BOD and COD values. The concentration of the chloride has showed significant positive correlation with the sulphates, nitrates and the magnesium concentrations. The sulphates recorded in the Katral lake exhibited the significant positive correlation with the nitrates and magnesium, while negative correlation with the dissolved oxygen recorded during the study period. The nitrate concentration have showed significant positive correlation with the magnesium and negative with the dissolved oxygen concentration. The phosphate concentration exhibited the significant negative correlation with the dissolved oxygen and air temperature, while negative correlation with the BOD and COD values. The dissolved oxygen concentration exhibited the significant negative correlation with the BOD, COD, air and water temperatures. BOD represents the significant positive correlation with the values of COD recorded in Katral lake water, while the air temperature exhibited the significant positive correlation with the values of water temperature recorded in the study area.

Conclusion

The majority of the parameters were found to be within the WHO permissible limits, according to the analysis of physico-chemical parameters on Bharamasagara and Katral Lake. The analysis of the water physico-chemical parameters revealed seasonal variations over the course of the study. The findings show that the lake water is suitable for domestic use, irrigation, and water sustainability.

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Authors' Contributions

AMP Prepared the Original Draft, Methodology and Software, Supervision, Editing and Review were done by PNT. All Authors read and approved the final manuscript.

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