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Research Article

Research on Physico-Chemical Parameters and Their Correlation, Coefficient of a Fresh Water Lake

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Abstract

The purpose of this research was to assess the present state of the lake's physicochemical characteristics in the Karimnagar district of India. Physicochemical parameters including water temperature, pH, turbidity, TDS, THD, chlorides, phosphate, nitrates, dissolved oxygen, and biological oxygen demand were monitored for a year, from January 2020 to December 2020. Each parameter was considered monthly. This water is safe for use in household and agricultural irrigation applications, according to the findings, as its physicochemical characteristics are within the acceptable range. Results from the correlation coefficient showed both positive and negative relationships.

Keywords: Freshwater; Physico-chemical parameter; Upper Manair Dam lake; Correlation coefficient.

Introduction

Many aquatic organisms, including those that are in risk of extinction, rely on the food and shelter that wetlands offer [1]. The health of a body of water is closely correlated with its water quality, hence the water quality of an ecosystem tells us a lot about the resources that ecosystem has for sustaining life . Therefore, it is crucial to regulate the aquatic environment's water quality properly. For human needs such as drinking, irrigation, washing, and industrial processes, water is an essential natural resource [2]. Numerous physicochemical criteria and biological traits determine the quality of water supplies. Water quality declined due to human activities such as agriculture, urbanization, residential sewage, etc., in the watershed region, as well as seasonal influences on physicochemical characteristics. Mathematical relationships for comparing physicochemical characteristics have been developed using statistical correlation [3]. The current research aims to investigate the physico-chemical characteristics that make up upper Manair dam Lake's water quality, how these parameters fluctuate throughout the year, and what relationships exist between them.

Materials and Methods

Study area

The Upper Manair Dam is an existing medium irrigation project located in Narmal Village, Gambhiraopet Mandal, Rajanna Sircilla district, Telangana. Coordinates 18°16′13″N 78°32′40″E
It was constructed across the Manair River by the Nizam and began construction in 1943, with the dam opening in 1950. The dam is intended to irrigate an ayacut of 13,086 acres, benefiting 16 villages in Gambhiraopet, Yellareddypeta, and Mustabad mandals. Total capacity 62,387,

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000 m^3 (50,578 acre·ft) Active capacity 61,439,000 m^3 (49,809 acre·ft) Surface area 15.3 km^2 (5.9 sq mi).

Materials & Methods

Five different sites were selected for collection of samples. The samples were collected in sterilized polythene bottles of one liters capacity. Monitoring was done during January 2020 to December 2020 in monsoon season (July to October), winter season (November to February) and summer season (March to June). For unstable parameters like pH, temperature, Electrical Conductivity (EC) and Dissolved Oxygen (DO) were measured on the station. Samples were brought to the laboratory for analysis of other physico-chemical parameters like sodium, total alkalinity, total hardness, calcium, magnesium, chlorides, sulphate, nitrate, phosphate and Biochemical Oxygen Demand (BOD) were analyzed according to the standard methods described in the literature [4-6].

Statistical analysis

The correlation between various physico-chemical parameters of water samples were analyzed statistically conducting Pearson correlation analysis with the help of SPSS software (20.0).

Results and Discussion

Physico-chemical parameters (Mean ± S.D) of Upper Manair Dam lake obtained during the present investigation (January 2020 to December 2020), is presented in Table 1.

Water temperature

Water temperature recorded as minimum value of 17°C and maximum of 31°C during the study period In the present investigation, minimum water temperature was obtained during winter season and maximum during summer. Water temperature shows high significant positive relationship ($p<0.01$ level) with pH ($r=0.608$), alkalinity ($r=0.971$), total hardness ($r=0.998$) and calcium ($r=0.893$) whereas electrical conductivity ($r= -0.129$), dissolved oxygen ($r= -0.596$), nitrate ($r= -0.886$), phosphate ($r= -0.682$) and biological oxygen demand ($r= -0.495$) were show negative relationship ($p<0.05$ level).

Electrical conductivity

The electrical conductivity of upper Manair dam Lake ranges from the 3.13 to 4.89 Ω/cm (Table 1). The maximum EC was reported during monsoon season 4.89 Ω/cm and the minimum was reported during winter 3.13 Ω/cm. Electrical conductivity shows high significant positive relationship ($p<0.01$ level) with turbidity ($r=0.968$), total dissolved solids ($r=0.997$), pH ($r=0.709$), sodium ($r=0.97$) and phosphate ($r=0.814$) whereas calcium ($r= -0.562$), magnesium ($r=-0.998$), dissolved oxygen ($r= -0.719$), chloride ($r= -0.995$) and biological oxygen demand ($r= -0.798$) were show negative relationship ($p<0.05$ level).[7]

Turbidity

The turbidity value of the upper Manair dam Lake was noted between 11 to 18 NTU (Table 1). The maximum turbidity was reported in monsoon season 18 NTU and minimum turbidity was found during winter 11 NTU. Turbidity shows high significant positive relationship ($p<0.01$ level) with total dissolved solids ($r=0.984$), pH ($r=0.709$), sodium ($r=0.978$) and phosphate ($r=0.814$) whereas magnesium ($r=-0.953$), dissolved oxygen ($r= -0.87$), chloride ($r= -0.939$), nitrate ($r=-0.568$) and biological oxygen demand ($r= -0.798$) were show negative relationship ($p<0.05$ level).

Total Dissolved Solids (TDS)

Total dissolved solids recorded from the upper Manair dam Lake ranges between 1489 to 1842 mg/L. The maximum TDS in monsoon season 1842 mg/L and TDS values lower during winter season 1489 mg/L. Total dissolved solids shows high significant positive relationship ($p<0.01$ level) with pH ($r= 0.759$), sodium ($r= 0.986$) and phosphate ($r= 0.768$) whereas calcium ($r= -0.499$), magnesium ($r=$

−0.991), dissolved oxygen (r= −0.697), chloride (r= −0.985) and biological oxygen demand (r= −0.84) were show negative relationship (p<0.05 level).[8]

pH

The pH values of samples collecting from the upper Manair dam Lake range from 7.5 – 8.7 which showed acidic water whole year (Table 1). The maximum pH noted during monsoon 8.7 and minimum pH observed during winter 8.2. pH shows high significant positive relationship (p<0.01 level) with alkalinity (r=0.779), total hardness (r=0.654) and sodium (r=0.858) whereas magnesium (r= −0.668), dissolved oxygen (r= −0.985), chloride (r= −0.636), nitrate (r= −0.906) and biological oxygen demand (r= −0.991) were show negative relationship (p<0.05 level).

Alkalinity

Alkalinity value ranged between 179-223 mg/L for Upper Manair Dam Lake (Table 1). The maximum value of alkalinity was reported during summer 274 mg/L and minimum alkalinity was during winter season 194 mg/L. Alkalinity shows high significant positive relationship (p<0.01 level) with total hardness (r=0.984) and calcium (r=0.76) whereas dissolved oxygen (r= −0.77), nitrate (r= −0.971) and biological oxygen demand (r= −0.687) were show negative relationship (p<0.05 level).[9]

Total hardness

Total Hardness of water collected from the Upper Manair Dam Lake ranges between 246 to 320 mg/L (Table 1). The maximum amount of total hardness in the water was recorded during summer season 320 mg/L and the minimum amount of total hardness was recorded during winter season 246 mg/L. Total hardness shows high significant positive relationship (p<0.01 level) with calcium (r=0.76) whereas dissolved oxygen (r= −0.642), nitrate (r= −0.912), phosphate (r= −0.637) and biological oxygen demand (r= −0.545) were show negative relationship (p<0.05 level).[10]

Table 1: Average with standard error values of physico-chemical parameters of Upper Manair Dam Lake

Average with standard error values of physico-chemical parameters at Upper Manair Dam Lake (2020)					**W.H.O. standards for drinking water (Annual Max.) in 1998**
Sr. No.	**Parameters**	**Year 2020**			
		Monsoon	**Winter**	**Summer**	
1	Temperature (°C)	20 ± 1.63	17 ± 0.74	31 ± 0.87	30-32
2	Electrical conductivity (Ω/cm)	4.89 ± 0.45	3.13 ± 0.47	3.48 ± 0.69	500
3	Turbidity (NTU)	18 ± 0.33	11 ± 0.16	14 ± 0.15	5
4	Total Dissolve Solid (mg/L)	1842 ± 79.14	1489 ± 0.42	1584 ± 57.63	259-500
5	pH	8.7 ± 0.07	7.5 ± 0.13	8.6 ± 0.42	6.5-8.5
6	Alkalinity (mg/L)	198 ± 7.32	179 ± 3.8	223 ± 3.42	100
7	Total Hardness (mg/L)	266 ± 3.88	246 ± 7.64	320 ± 7.13	200
8	Calcium (mg/L)	43 ± 1.36	54 ± 6.47	84 ± 3.47	75
9	Magnesium (mg/L)	31 ± 1.65	38 ± 5.69	37 ± 0.93	150
10	Dissolved Oxygen (mg/L)	3.36 ± 0.84	5.17 ± .39	3.54 ± 0.47	7.5
11	Chloride (mg/L)	49 ± 0.69	79 ± 5.47	76 ± 4.13	200
12	Sodium (mg/L)	59 ± 0.69	40 ± 3.23	48 ± 2.52	200
13	Nitrate (mg/L)	8.22 ± 0.72	9.01 ± 0.53	7.78 ± 0.84	11
14	Phosphate (mg/L)	0.77 ± 0.15	0.48 ± 0.38	0.27 ± 0.23	0.5
15	Biochemical Oxygen Demand (mg/L)	1.21 ± 0.24	1.80 ± 0.98	1.34 ± 0.77	6.9

Calcium

The analysis of calcium revealed a range of between 43 to 84 (Table 1). The maximum amount of calcium recorded in water during summer season 84 mg/L and the minimum amount of calcium in

water was recorded during monsoon season 43 mg/L. Calcium shows high significant positive relationship ($p<0.01$ level) with magnesium ($r=0.608$) and chloride ($r=0.64$) whereas nitrate ($r= -0.583$) and phosphate ($r= -0.938$) were show negative relationship ($p<0.05$ level

Magnesium

The amount of magnesium recorded in the water ranges between 31 to 38 mg/L (Table 1). The maximum amount of magnesium in the water was recorded during winter season 38 mg/L where as the minimum value was recorded during monsoon season 31 mg/L. Magnesium shows high significant positive relationship ($p<0.01$ level) with dissolved oxygen ($r=0.679$), chloride ($r=0.999$) and biological oxygen demand ($r=0.763$) whereas nitrate ($r= -0.955$) and phosphate ($r= -0.845$) were show negative relationship ($p<0.05$ level).

Dissolve oxygen

The amount of dissolved oxygen recorded in the water ranges between 3.36 to 5.17 mg/L (Table 1). The maximum amount of dissolved oxygen recorded during winter season 5.17 mg/L whereas the minimum dissolved recorded during monsoon season 3.36. Dissolved oxygen shows high significant positive relationship ($p<0.01$ level) with chloride ($r=0.648$), nitrate ($r=0.9$) and biological oxygen demand ($r=0.993$) whereas sodium ($r= -0.866$) was show negative relationship ($p<0.05$ level).[11]

Chloride

Chloride concentration in Upper Manair Dam Lake lies between 49 to 79 mg/L (Table 1). The maximum chloride reported in winter season 89 mg/L and the minimum value of chloride recorded during monsoon season 49 mg/L. Chloride shows high significant positive relationship ($p<0.01$ level) with biological oxygen demand ($r=0.735$) whereas sodium ($r= -0.942$) and phosphate ($r= -0.867$) were show negative relationship ($p<0.05$ level).

Sodium

The amount of sodium recorded in the water of Upper Manair Dam Lake ranges between 40 to 59 mg/L (Table 1). The maximum amount of sodium was recorded during monsoon season 59 mg/L and the minimum amount was recorded during winter season 40 mg/L. Sodium shows high significant positive relationship ($p<0.01$ level) with phosphate ($r=0.649$) whereas nitrate ($r= -0.561$) and biological oxygen demand ($r= -0.92$) were show negative relationship ($p<0.05$ level).

Nitrate

The amount of Nitrate recorded in the water of Upper Manair Dam Lake ranges between 7.78 to 9.01 mg/L (Table 1). The maximum amount of nitrate was recorded during winter season 9.01 and the minimum amount of nitrate in water was recorded during summer season 7.5 mg/L. Nitrate shows high significant positive relationship ($p<0.01$ level) with biological oxygen demand ($r=0.841$).

Phosphate

Phosphate recorded in the water of Upper Manair Dam Lake ranges between 0.27 to 0.77 mg/L (Table 1). The maximum amount of phosphate recorded during monsoon season 0.77 mg/L and the minimum amount phosphate was recorded during summer season 0.27 mg/L.

Biochemical Oxygen Demand (BOD)

The biochemical oxygen demand (BOD) reported from Upper Manair Dam Lake was ranges from 1.21 to 1.80 mg/L (Table 1). The maximum demand of oxygen in the water was recorded during winter season 1.80 mg/L and the minimum demand was recorded during monsoon season 1.21 mg/L. In the present study the correlation coefficient (r) between every parameter pairs in computed by taking the average values as shown in Table 1. Correlation coefficient (r) between any two parameters, x and y is calculated for parameter such as water temperature, pH, turbidity, total dissolved solids, total hardness, chloride, phosphate, nitrate, dissolved oxygen and biological oxygen demand of the Upper

Manair Dam Lake. The degree of line association between any two of the water quality parameters as measured by the simple correlation coefficient (r) is presented in Table 2. The comparison of various physico-chemical parameters deduced from Upper Manair Dam Lake allowed us to study the pollution status of this water body. Quantities such as turbidity, total dissolved solids, alkalinity, pH, hardness and phosphate contents are significantly high.[11-12].

Table 2: Correlation Coefficient (r) of various physico-chemical parameters studied from Upper Manair Dam Lake.

Correlation Coefficient (r) of various physico-chemical parameters studied from Upper Manair Dam Lake															
	Tem	**EC**	**Tur**	**TDS**	**pH**	**Alk**	**TH**	**Ca**	**Mg**	**DO**	**Cl**	**NA**	**NO_3**	**PO_4**	**BOD**
Tem	1	-0.129	0.122	-0.056	0.608	0.971	0.998	0.893	0.185	-0.596	0.226	0.114	-0.886	-0.682	-0.495
EC	-0.129	1	0.968	0.997	0.709	0.11	-0.07	-0.562	-0.998	-0.719	-0.995	0.97	-0.345	0.814	-0.798
Tur	0.122	0.968	1	0.984	0.862	0.355	0.181	-0.338	-0.953	-0.87	-0.939	0.978	-0.568	0.643	-0.923
TDS	-0.056	0.997	0.984	1	0.759	0.183	0.004	-0.499	-0.991	-0.769	-0.985	0.986	-0.413	0.768	-0.84
pH	0.608	0.709	0.862	0.759	1	0.779	0.654	0.185	-0.668	-0.985	-0.636	0.858	-0.906	0.167	-0.991
Alkal	0.971	0.11	0.355	0.183	0.779	1	0.984	0.76	-0.054	-0.77	-0.012	0.347	-0.971	-0.488	-0.687
TH	0.998	-0.07	0.181	0.004	0.654	0.984	1	0.865	0.127	-0.642	0.168	0.173	-0.912	-0.637	-0.545
Ca	0.893	-0.562	-0.338	-0.499	0.185	0.76	0.865	1	0.608	-0.17	0.64	-0.346	-0.583	-0.938	-0.05
Mg	0.185	-0.998	-0.953	-0.991	-0.668	-0.054	0.127	0.608	1	0.679	0.999	-0.955	0.291	-0.845	0.763
DO	-0.596	-0.719	-0.87	-0.769	-0.985	-0.77	-0.642	-0.17	0.679	1	0.648	-0.866	0.9	-0.181	0.993
Cl	0.226	-0.995	-0.939	-0.985	-0.636	-0.012	0.168	0.64	0.999	0.648	1	-0.942	0.251	-0.867	0.735
Na	0.114	0.97	0.978	0.986	0.858	0.347	0.173	-0.346	-0.955	-0.866	-0.942	1	-0.561	0.649	-0.92
NO_3	-0.886	-0.345	-0.568	-0.413	-0.906	-0.971	-0.912	-0.583	0.291	0.9	0.251	-0.561	1	0.265	0.841
PO_4	-0.682	0.814	0.643	0.768	0.167	-0.488	-0.637	-0.938	-0.845	-0.181	-0.867	0.649	0.265	1	-0.299
BOD	-0.495	-0.798	-0.923	-0.84	-0.991	-0.687	-0.545	-0.05	0.763	0.993	0.735	-0.92	0.841	-0.299	1

Conclusion

Fluctuations in various physico-chemical parameters were observed during monsoon, winter and summer seasons. The study shows that the water of Upper Manair Dam Lake exhibits high concentration of turbidity, total dissolved solids, alkalinity, total hardness, calcium and phosphate due to addition of detergents and soup by washing clothes surround the lake which directly released into the lake and also evaporation of water which make the water more concentrated during summer season. Other physic-chemical parameters were within desirable limits suggest by WHO [12]. The correlation coefficient indicates positive and negative correlation of physico-chemical parameters with each other. This study may be helpful in sustainable management of the lake.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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