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Assessment of Physico-Chemical parameters of the Vanivilasa Sagara Reservoir, Chitradurga District, Karnataka

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Abstract

One of the most crucial and common elements in the environment is water. All life on Earth depends on water for its survival and development. Only Earth has over 70% water on it at this time. Minerals and nutrients abound in water, which is vital to human life. The physical and chemical biology of a reservoir determines the quality of the water, which encompasses all elements of the water that affect its application. The main objective of this study is to know the physic-chemical parameters of the Vanivilasa Sagara reservoir which provides water to many of the surrounding regions such as cities, towns, and villages which are primarily dry regions of the Deccan area of central Karnataka.The present study was performed at Vanivilasa Sagara Reservoir. Water samples were estimated for the physicochemical parameters, by selecting the three sites from April 2022 to March 2023. The important physicochemical parameters like Temperature, pH, DO, CO_2, Total hardness, Total alkalinity, Electrical Conductivity, Transparency, and Temperature were analyzed according to APHA. The present investigation showed that temperature, pH, Total Hardness, Total Alkalinity, and Chloride, were within the permissible limit at all three different sites. Also, the Physico-chemical parameters of Vanivilasa Sagara reservoir showed that water quality is free from pollution. Hence, this reservoir water is considered non-polluted and suggests that it is suitable for irrigation, pisciculture, and other purposes.

Key words : Physico-chemical Parameters**,** Vanivilasa Sagara reservoir, Unpolluted.

Water is one of the most significant and prevalent elements in the environment[8]. Water is necessary for the existence and growth of every living being on Earth.

Currently, only Earth is a planet with almost 70% water. Water is essential to human life and is rich in minerals and nutrients. Approximately 97% of all water on Earth is saltwater, found in seas, oceans, and saline groundwater. Approximately 2.5–2.75% of the water is fresh, of which 1.75–2% of it is frozen as ice, snow, and glaciers, while the remaining 0.5–0.75% is fresh groundwater[12]. Water contamination is a significant global issue nowadays. The majority of India's major rivers and dams have this catastrophic problem. Due to changes in lifestyles, economic development, and population growth, water pollution is getting worse every day and posing a serious threat to human health as well as to other organisms[3].

Aquifers, reservoirs, rivers, lakes, oceans, and groundwater are a few types of water bodies. Water contamination arises from the mixing of pollutants with various water bodies[14]. Contaminants originate from four main sources: industrial activities, sewage discharges, agricultural practices, and rainwater runoff from towns and cities. Surface water pollution and groundwater pollution are the two categories of water contamination. Contaminated water used for drinking or irrigation can cause a number of problems, such as the destruction of the aquatic ecosystems and the spread of illness and infections[15].

The physical and chemical biology of a reservoir determines the quality of the water, which encompasses all elements of the water that affect its application[13]. A precise understanding of the condition, productivity, and sustainability of a specific water body can be obtained by evaluating the physico-chemical characteristics of the water[16]. Variations in temperature, transparency, and chemical components of water, such as phosphate, nitrate, and dissolved oxygen, can provide crucial information about the quality of the water and its sources, as well as how they affect the functions and biodiversity of the reservoir[4,10].

Therefore, the present study evaluates the physic-chemical parameters of the Vanivilasa Sagara reservoir which provides water to many of the surrounding regions such as cities, towns, and villages which are primarily dry regions of the Deccan area of central Karnataka.

Study Area :

The present study was performed at "Vanivilasa Sagara Reservoir", popularly known as "Marikanive" located at Marikanive village, Hiriyur Taluk, Chitradurga District, Karnataka. Vanivilasa Sagara reservoir provides water to many of the surrounding regions such as cities, towns, and villages which are primarily dry regions of the Deccan area of central Karnataka. It is 621.0 meters in height and 405.40 meters (1330 feet) long with an area of 8640 hectares. The dam has a longitude of 750 01I 00" E and a latitude of 130 20I 00" N. The reservoir has a gross storage capacity of 30 TMC, a live storage capacity of 28.13 TMC, and a dead storage capacity of 1.87 TMC. The water samples were collected from the reservoir in the morning hours between 07 a.m. to 10 a.m. in polythene bottles regularly for every month.

Estimation of Physico-chemical properties of water :

To estimate the physic-chemical

parameters, water samples were collected monthly from the Vanivilasa Sagara reservoir. The water quality is analyzed by selecting the three sites. One is at the Outlet of the reservoir, the second is at the Inlet of the reservoir, Third is at the Dam site. The important physic-chemical parameters like pH, DO, CO_2, total hardness, total alkalinity, electrical Conductivity, transparency and temperature were analyzed according to APHA (1998).

Statistical analysis :

One way ANOVA with Tukey HSD statistics was calculated for water quality parameters by using astatsa.com statistical package.

The present study has been conducted in three different regions of the Vanivilasa Sagara reservoir namely the Outlet of the reservoir, the Inlet of the reservoir, and the dam site. The physico-chemical properties of the reservoir have been analyzed every month from April 2022 to March 2023. The findings are shown in Table-1 to 3.

Temperature :

It was observed that the water temperature was minimum in winterand maximum duringsummer in all the 3 collection sites. The maximum water temperature was 30.2 degrees in May 2023 at the dam site and the minimum water temperature was 24.4 at the Inlet of the Reservoir. The temperature was low in winter and high in summer Because of the low water level and clear environment in the summer, the water temperature was high. The average monthly variation in the surface water temperature of the three sites is represented in Figure 1. The temperature of the water collected from 3 different sites ranges from 24.4 to 30.2.

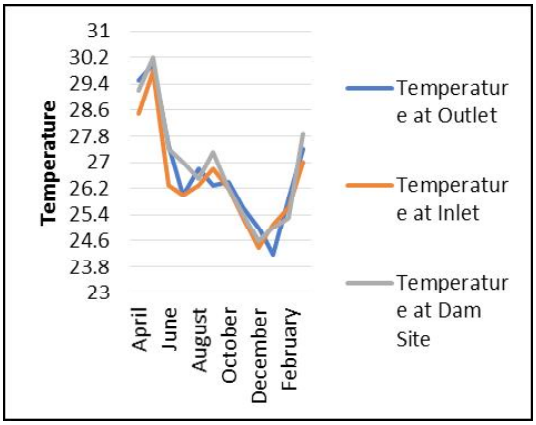

Fig. 1. Surface water temperature at 3 different sites of Vanivilasa Sagara reservoir.

pH :

The pH ranges from 0 to 14. It is reported that pure water has a pH of 7, making it neutral. Water that has a pH of below 7.0 is classified as acidic, whereas water that has a pH of higher than 7.0 is classified as basic or alkaline. During our study, the pH ranged from 6.6-8.4 at the outlet 6.2-8.4 at the inlet, and 6.6-8.2 at the dam site of the reservoir. Minimum pH was observed in the inlet of the reservoir in Feb 2022 and maximum pH was observed in April 2023 at the outlet of the reservoir (Figure 2). There was no significant difference in pH throughout the study period, which was in accordance with the previous studies[1,2,6,9].

Dissolved Oxygen :

One of the most crucial factors in determining the quality of water is dissolved

Table-1. physico-chemical properties of water at the Outlet of the reservoir from April 2022-March 2023

Month	Water Parameters							
	Tempe-rature (^{O}C)	P^{H}	Dissolved Oxygen (mg/L)	CO_2 (mg/L)	Total Hardness as $CaCo_3$ (mg/L)	Total alkalinity As $CaCo_3$ (mg/L)	Electric Conduc-tivity (µs/cm)	Trans-parency (NTU)
Apr-22	29.5	8.3	4.2	1.8	123.3	224	416	104
May-22	30.0	8.0	4.6	1.6	120.1	216	420	120
Jun-22	27.5	7.8	5.0	1.4	118.0	212	356	60
July 22	26.0	7.1	6.5	1.2	115.3	210	340	75
Aug-22	26.8	6.8	6.8	1.8	118.6	230	336	98
Sept-22	26.3	6.7	7.5	2.2	125.8	220	310	123
Oct-22	26.4	7.1	7.6	2.4	122.9	226	300	150
Nov-22	25.6	6.8	7.8	2.7	113.8	224	280	130
Dec-22	25.0	7.2	8.5	3.1	115.4	221	294	97
Jan-23	24.2	7.0	7.5	2.4	118.4	218	326	170
Feb-23	25.9	6.6	5.9	2.0	120.0	216	320	135
Mar-23	27.4	7.2	4.0	2.2	121.1	228	340	117

Table-2. physico-chemical properties of water at the Inlet of the Reservoir, from April 2022-March 2023

Month	Water Parameters							
	Tempe-rature (^{O}C)	P^{H}	Dissolved Oxygen (mg/L)	CO_2 (mg/L)	Total Hardness as $CaCo_3$ (mg/L)	Total alkalinity As $CaCo_3$ (mg/L)	Electric Conduc-tivity (µs/cm)	Trans-parency (NTU)
Apr-22	28.5	8.4	4.0	1.9	125.3	225	412	103
May-22	29.8	8.1	4.3	1.5	122.1	210	410	118
Jun-22	26.3	7.7	5.2	1.4	115.0	208	346	65
July 22	26.0	7.0	6.3	1.0	118.3	210	330	70
Aug-22	26.3	6.6	6.5	1.4	111.6	220	350	100
Sept-22	26.8	6.8	7.3	2.0	120.8	225	320	125
Oct-22	26.2	7.3	7.4	2.3	123.9	227	310	145
Nov-22	25.3	6.5	7.7	2.5	115.8	223	285	132
Dec-22	24.4	7.1	8.0	3.0	112.4	220	295	95
Jan-23	25.1	7.4	7.6	2.7	110.4	218	329	160
Feb-23	25.6	6.2	6.0	2.2	123.0	214	325	145
Mar-23	27.0	7.0	4.2	2.3	124.1	225	330	112

Table-3. physico-chemical properties of water at the Dam site, from April 2022-March 2023

Month	Water Parameters							
	Tempe-rature (^{O}C)	P^{H}	Dissolved Oxygen (mg/L)	CO_2 (mg/L)	Total Hardness as $CaCo_3$ (mg/L)	Total alkalinity As $CaCo_3$ (mg/L)	Electric Conduc-tivity (µs/cm)	Trans-parency (NTU)
Apr-22	29.2	8.2	4.3	2.0	127.3	220	442	123
May-22	30.2	8.1	4.5	1.	123.1	218	420	122
Jun-22	27.4	7.7	5.2	1.4	120.1	214	355	69
July 22	27.0	7.3	6.3	1.2	115.3	211	342	73
Aug-22	26.5	6.9	6.6	1.8	118.6	228	338	100
Sept-22	27.3	6.6	7.3	2.0	123.4	223	323	122
Oct-22	26.2	7.0	7.7	2.3	129.9	222	310	140
Nov-22	25.4	6.7	7.6	2.5	117.3	225	285	128
Dec-22	24.6	7.1	8.0	3.3	112.1	220	292	95
Jan-23	25.0	7.4	7.0	2.5	116.4	218	320	180
Feb-23	25.3	6.8	5.6	2.0	122.0	214	322	145
Mar-23	27.9	7.0	4.3	2.0	123.2	217	330	120

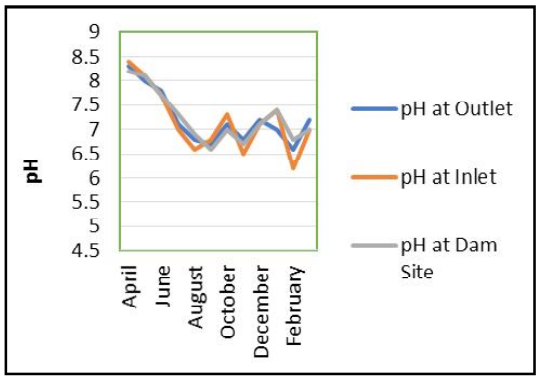

Fig. 2. Graphical data of pH of water at 3 different sites of Vanivilasa Sagara reservoir.

oxygen, which is necessary to maintain the biotic forms in the water. A crucial indicator for assessing the ecological health, productivity, and quality of water is dissolved oxygen in the reservoirs.

This is because it plays a crucial role in biological and chemical processes. In our study maximum dissolved oxygen was recorded in the winter season and minimum was recorded in the summer season in all the 3 different collection sites. The highest DO was recorded in the Outlet of the Reservoir *i.e.* 8.5 (Figure 3). Similar results were reported by Indur and Kishore[6] and Gujjar[5] in their respective studies but in contrast, the studies by Abhilash & Mahadevaswamy[1]; Babu Yogitha S *et al.*,[2] and Murthuzasab *et al.*,[9] reported highest level in summer.

Free CO_2 :

Most aquatic ecosystems produce carbon dioxide as an end product of the breakdown of organic carbon, and variations

in this gas are frequent indicators of net ecosystem metabolism. In all three dam sites highest free CO_2 was recorded in December and it ranges from 1.0 to 3.3 (Figure 4). a study by Murthuzasab et al.,(2010) reported free CO_2 range from 4.4 to 39.6 mg/L. Seasonal variation was common for free carbon dioxide.

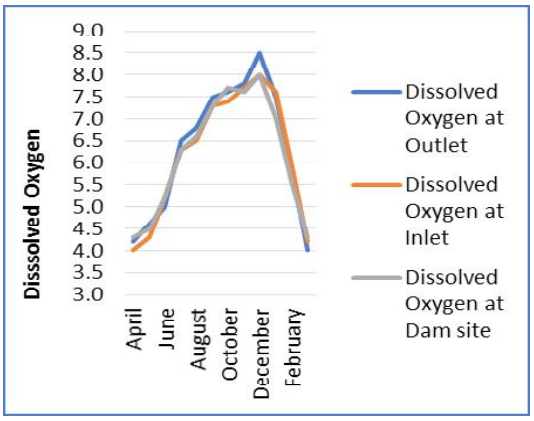

Fig. 3. Graphical representation of Dissolved oxygen of water at 3 different sites of Vanivilasa Sagara reservoir.

Total Hardness :

The quality of water known as total hardness raises the boiling point of water and inhibits soap from lathering. Water hardness is mostly determined by the concentration of calcium or magnesium salts or both. Our study reported total hardness from 113.8 to 125.8 at the outlet of the reservoir, 111.6 to 125.3 at the inlet of the reservoir, and 115.3 to 127.3 at the dam site (Figure 5). Our results are similar to the study conducted by another researcher in different reservoirs in Karnataka[2,5]. Based on hardness measurements Kannan[7] classified water into three groups: "mild (0–60 mg/L), moderately hard (61–120 mg/L), hard (121–160 mg/L), and very hard (more than 180 mg/L)[11]. Our study results showed that Vanivilasa Sagara reservoir water is moderately hard.

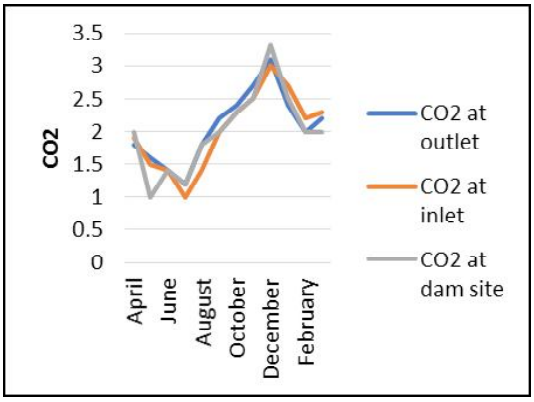

Fig. 4. Graphical representation of free CO_2 of water collected at 3 different sites of Vanivilasa Sagara reservoir.

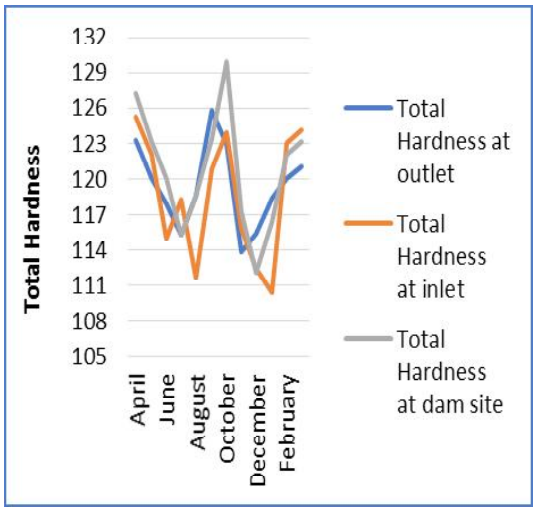

Fig. 5. Graphical representation of Total hardness of water at 3 different sites of Vanivilasa Sagara reservoir.

Total alkalinity :

Water's ability to neutralize a strong acid is measured by its alkalinity. The concentration of carbonate and hydroxide is

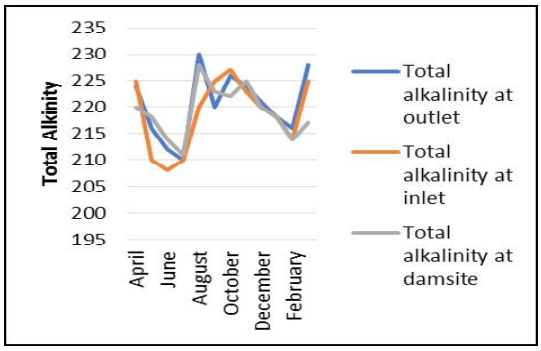

Fig 6. Graphical representation of Total Alkalinity of water at 3 different sites of Vanivilasa Sagara reservoir.

the main factor determining the alkalinity of surface water. silicates, phosphates, borate, and other bases also have some significant role. The maximum alkalinity values were recorded during the summer season, while lower values were observed in the monsoon season. The highest values (230.0mg/L) are recorded from the water sample at the outlet of the reservoir (Figure 6). These higher values may associated with the rate of phytoplankton growth during the rainy season. Level of alkalinity level was ranged from 208 mg/L to 230 mg/L. This is similar tothe findings of Babu *et al.*,[2] in Bangalore Lake.

Electric conductivity :

The ability of water to transmit electric current and a measurement of the total amount of dissolved salts or ions is known as electrical conductivity. The electric conductivity of Vanivilasa Sagara Reservoir ranges from 280-420 at the Outlet of the Reservoir, 285-410 at the Inlet of the Reservoir, and 285-442 at the Dam site. Electric conductivity was highest in the summer season and low in winter (Figure 7). Seasonal changes in conductivity, particularly in lakes with minimal water inflow, are mostly caused by temperature and evaporation[1].

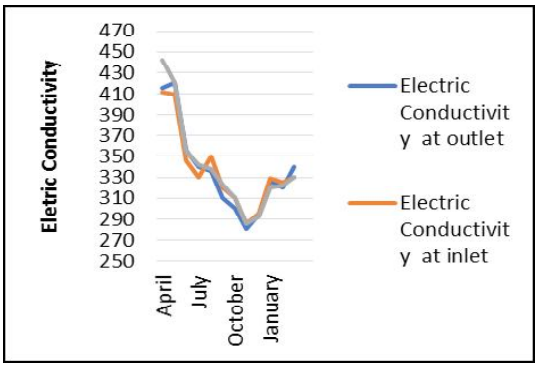

Fig. 7. Graphical representation of Electric conductivity of water at 3 different sites of Vanivilasa Sagara reservoir.

Transparency :

Transparency is the clarity of the water. Transparency of water collected from different study sites of Vanivilasa Sagara Reservoir ranges from 60-170 at the Outlet of the Reservoir, 69-180 at the Inlet of the Reservoir, and 65-150 at the Dam site. Transparency was low in the rainy season (Figure 8).

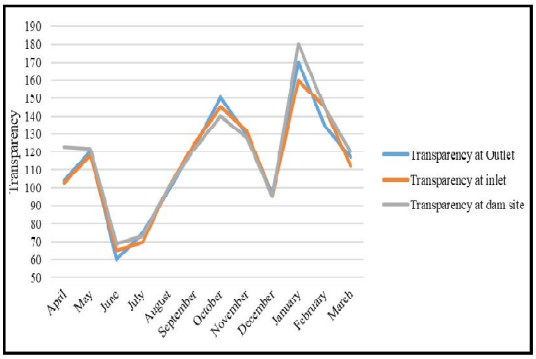

Fig. 8. Transparency of water collected at 3 different sites of Vanivilasa Sagara reservoir.

One-way ANOVA with Post-hoc Tukey HSD with Scheffe, Bonferroni and Holm multiple comparison tests :

The results are depicted in Tables-4 to 9. The p-value corresponding to the F-statistic of one-way ANOVA is lower than 0.05, suggesting that the one or more parameters are significantly different.

As per Tukey HSD test the p-value subsequent to the F-statistic of one-way ANOVA is lower than 0.01 which strongly suggests that one or more pairs of treatments are significantly different.

Table-4. Descriptive statistics of independent water parameters

Treatment	A (Temp., pH)	B (DO, CO_2)	C (TH, Total Alk.)	D (EC, Transparency)	Pooled Total
Observations	72	72	72	72	288
Sum	1,219.4000	297.8000	12,204.1000	16,121.0000	30,04-63000
Mean	16.9361	4.1361	169.5014	226.7361	104.3174
Sum of squares	27,164.8400	1,684.4800	2,250,183.9700	4,681,819.0000	6,961,101.2900
Sample variance	97.3654	5.6721	2,557.3551	13,807.7743	13,312.9214
Sample std. Dev.	9.8674	2.3817	50.5703	117.5065	115.4683
Std. Dev. Of mean	1.1629	0.2807	5.9598	13.8483	6.8040

Table-5. One-way ANOVA of independent parameters

Source	Sum of squares	DF	Mean square	F statistic	P-value
Treat-ment	2,657,309.2651	3	885,769.7550	215.1472	1.1102e-16
Error	1,169,239.7482	284	4,117.0414		
Total	3,826,549.0133	287			

Table-6. Tukey HSD datas

Treat-ments pair	Tukey HSDq statistic	Tukey HSD p-value	Tukey HSD inference
A vs B	1.6927	0.6139797	insignificant
A vs C	20.1757	0.0010053	** p<0.01
A vs D	27.7446	0.0010053	** p<0.01
B vs C	21.8684	0.0010053	** p<0.01
B vs D	29.4374	0.0010053	** p<0.01
C vs D	7.5689	0.0010053	** p<0.01

Table-7. Scheffe data results

Treat-ments pair	Scheffé t-statistic	Scheffé p-value	Scheffé inference
A vs B	1.1969	0.6981561	insignificant
A vs C	14.2664	1.1102e-16	** p<0.01
A vs D	19.6184	1.1102e-16	** p<0.01
B vs C	15.4633	1.1102e-16	** p<0.01
B vs D	20.8154	1.1102e-16	** p<0.01
C vs D	5.3520	5.0019e-06	** p<0.01

Table-8. Bonferroni and Holm data: all parameters simultaneously compared

Treat-ments pair	Bonferroni and holmt-statistic	Bonferronip-value	Bonferroni infere-nce	Holm p-value	Holm-infere-nce
A vs B	1.1969	1.3939930	insignificant	0.2323322	insignificant
A vs C	14.2664	0.0000e+00	** p<0.01	0.0000e+00	** p<0.01
A vs D	19.6184	0.0000e+00	** p<0.01	0.0000e+00	** p<0.01
B vs C	15.4633	0.0000e+00	** p<0.01	0.0000e+00	** p<0.01
B vs D	20.8154	0.0000e+00	** p<0.01	0.0000e+00	** p<0.01
C vs D	5.3520	1.0769e-06	** p<0.01	3.5896e-07	** p<0.01

Table-9. Bonferroni and Holm data: parameters relative to A simultaneously compared

Treatments pair	Bonferroni and holmt-statistic	p-value	Bonferroni inference	Holm p-value	Holm-inference
A vs B	1.1969	0.6969965	insignificant	0.2323322	insignificant
A vs C	14.2664	0.0000e+00	** p<0.01	0.0000e+00	** p<0.01
A vs D	19.6184	0.0000e+00	** p<0.01	0.0000e+00	** p<0.01

Our study showed that Physico-chemical parameters of Vanivilasa Sagara reservoir water is good quality and also free from pollution. This work was performed by taking important parameters like Temperature, pH, Total Alkalinity, Dissolved Oxygen, Total Hardness, etc., from April 2022 to March 2023. In our investigation, temperature, pH, Total Hardness, Total Alkalinity, etc., were within the permissible limit as per the standard. Hence, this reservoir water is considered non-polluted and suggests that it is suitable for irrigation, pisciculture, and other purposes.

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