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Investigations of Water Quality of Chikkere Water Body, Sira, Tumkur District

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Abstract

Water is considered as unique natural resource. It has a fundamental importance in the life of organisms. Lentic water is used for drinking, domestic purpose. Hence, lentic water body quality depends on physico-chemical parameters and biotic factors. Investigations on water quality of Chikkere water body of Sira conducted from February 2020 by collecting water samples on monthly basis for analysis of physico-chemical parameters like temperature, pH, EC, Turbidity, DO, TDS, Total hardness, Calcium, Magnesium, Total alkalinity, Chloride and BOD. The present investigations were carried out and the results revealed that except turbidity most of the physico-chemical parameters were within the permissible limits. Data subjected for statistical analysis for correlation and also done principal component analysis.

The quality of surface water is a very sensitive issue and it is a great environmental concern worldwide. It is critical for long-term economic development, social welfare and environmental sustainability. In recent years. there has been an increase in awareness and concern about water pollution across the globe[5]. Safe and affordable water is essential for public health. It is used for drinking, food production, domestic use, and recreational purposes. Access to improved water supplies and sanitation, along with better management of water resources, plays a crucial role in developing countries by impacting on communities' well-being and on national development plans[19,20,32].

Rivers and freshwater lakes are very important multi-usage components since they are the source of drinking water, agriculture, fishery, and energy generation[8]. These sources, especially in developing countries, are endangered to a wide range of pollutants caused by diffuse nonpoint (such as agricultural land, urban development and atmosphere) and point (such as discharges of sewage and industrial waste) sources which are difficult to be monitored, evaluated, and controlled. The pollution of drinking water sources is gradually increasing, due to limited financial capabilities and poor infrastructure, which force communities to directly consume water from farm wells, springs, and rainwater stores without prior treatment[3,22,25].

There has been much attention from local governments, governmental organizations, and NGOs but the burden is still primarily in developing countries[15]. Regular water quality assessment would help water resource managers, environmental health officers, and the whole community to better understand and correlate seasonal variability and drinking water quality. Thus, some multivariate statistical techniques have been used to assist the monitoring of water quality, formulating a rapid response to aquatic pollution. Among these. the Principal Component Analysis (PCA) is an analytical methodology used commonly in the scIentific community as it allows reducing the dimensionality of a data set.

Every month samples were collected from four different stations (Fig. 1) from Chikkere water body. It is a perennial water body which is located at Sira, Tumakuru district, along the national highway N0. 4 at an elevation of 662 meters from mean sea level. which falls under 13^0 75' 25" N Latitude and 76^0 90' 70" E Longitude Water samples collected for the purpose of estimation of various parameters, were brought to the laboratory and subjected to analysis immediately.

Standards methods for estimation of water and waste water 22nd Edition, (2012) (APHA, AWWA)[30] were referred for estimation of parameters viz., total dissolved solids, pH, electrical conductivity, dissolved oxygen, total alkalinity, total hardness, calcium, magnesium, chloride and BOD.

The study carried out for the period of two years and values presented in the Table 1. The most of the parameters are within the permissible limit. Some results like turbidity and pH show that the water is polluted by sewage discharge and agriculture runoff are mainly the reason for pollution.

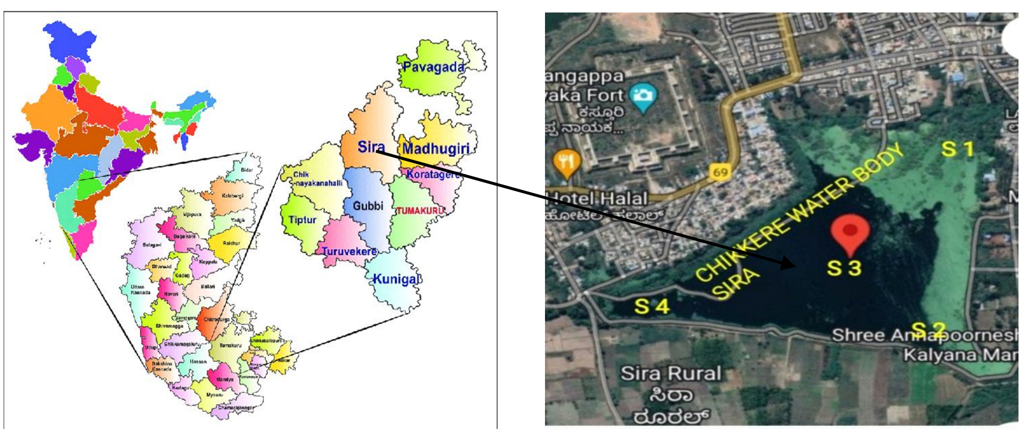

Fig. 1. Map showing the Chikkere water body of Sira

Table-1. Monthly variations of physic-chemical parameters of Chikkere water body, Sira

Months	AT	WT	Turbidity	TDS	TSS	EC	pH	DO	TA	TH	Ca	Mg	Cl	BOD
Feb. 2020	24.2	22.1	48	657	70	2056	8.1	2.2	456	356	262	132	310	38
Mar. 2020	24.8	23.2	70	858	68	2104	8.2	1.9	414	374	236	138	290	26
Apr. 2020	24.9	23.4	76	1152	62	2290	8.2	2.5	432	382	228	162	286	32
May 2020	25.1	22.5	86	1107	54	2112	7.9	2.8	398	390	204	144	272	20
June 2020	23.2	21.1	46	1052	48	2012	8.3	2.1	406	278	174	128	232	14
July. 2020	24.1	22.2	38	1058	38	1806	8.5	3.6	382	284	182	126	254	18
Aug. 2020	24.5	22.1	42	978	42	1502	8.9	3.5	372	298	168	138	262	20
Sep. 2020	24.7	22.3	56	896	36	1608	8.9	3.2	360	356	138	152	256	18
Oct. 2020	22.1	20.2	32	454	29	828	8.3	4.9	191	156	144	88	135	8
Nov. 2020	22.3	20.1	25	568	38	960	8.2	5.2	199	198	138	96	156	10
Dec. 2020	22.5	20.2	26	785	24	1502	8.1	5.8	209	280	152	86	180	18
Jan. 2021	22.7	21.2	78	1005	61	2055	7.3	2.2	424	366	222	92	271	31
Feb. 2021	23.1	22.1	81	1006	62	2070	8.0	2.0	432	366	207	147	274	31
Mar. 2021	24.2	23.1	88	1002	62	2098	8.1	1.8	429	364	203	143	266	32
Apr. 2021	24.8	22.3	71	1046	62	2085	8.6	1.6	426	362	201	138	265	32
May 2021	25.3	23.1	90	1136	18	1825	7.8	2.0	512	352	185	140	252	27
Jun. 2021	24.4	22.2	20	989	07	1578	8.2	3.7	442	303	159	136	258	14
July. 2021	24.7	22.3	25	895	83	1478	8.6	4.1	307	295	155	136	234	11
Aug. 2021	23.5	22.1	40	1095	26	1670	8.9	3.8	370	378	196	182	266	25
Sep. 2021	23.3	22.2	56	1002	32	1526	9.3	3.0	354	420	158	136	272	19
Oct. 2021	23.1	22.1	14	550	11	714	8.3	4.8	398	187	105	82	105	12
Nov. 2021	22.9	22.1	15	434	6	616	8.0	5.7	201	173	95	77	79	3
Dec. 2021	22.8	21.1	15	406	23	647	7.9	6.5	181	154	92	62	65	4
Jan. 2022	22.5	21.2	42	615	14	929	7.2	4.9	358	294	160	135	138	17

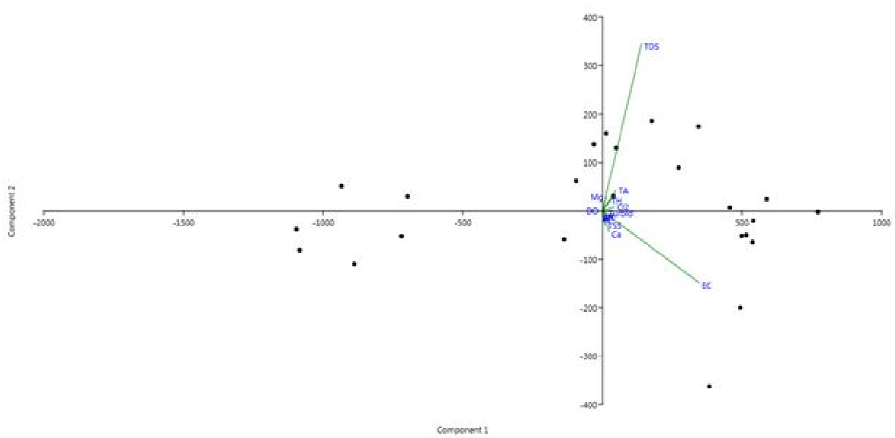

Fig. 2. Principal Component Analysis (PCA) of the Physicochemical parameters of Chikkere water body.

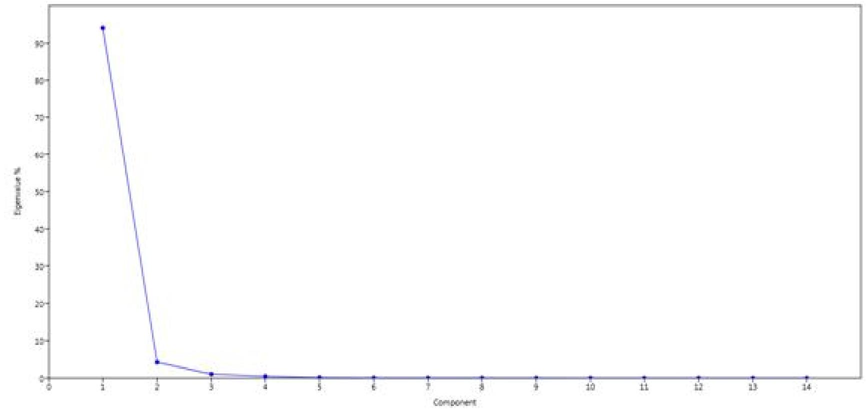

Fig. 3. Scree plots of the (percentage variance) eigen values during study period

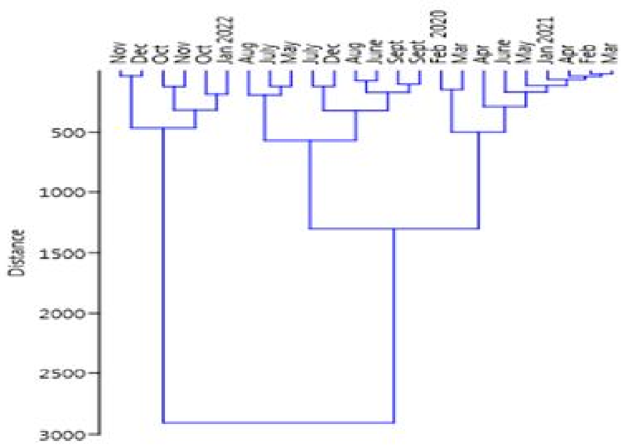

Fig. 4. Cluster analysis of Physicochemical parameters of Chikkere water body by Ward's method

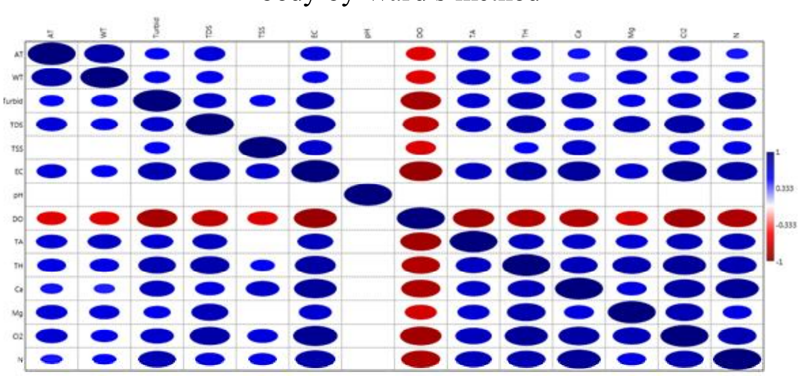

Table 2. Statistical linear correlation analysis of Physico chemical parameters of Chikkere water body.

Table-3. Showing the positive correlation with the physicochemical parameters

Parameter	Positively correlated with
AT	WT, TDS, EC TA, TH, Mg Cl_2
WT	AT, TA, TH, mg, Cl_2
Tur	TDS, EC, TH, Cl_2, DOD
TDS	AT, EC, TH Cl_2
TSS	EC, Ca, Cl_2
DO	Turbidity, EC, TA,TH, Ca, Cl_2, BOD
TA	TDS, EC, Cl_2, BOD
TH	Turbidity, DO, EC, Cl_2, BOD
Ca	Turbidity, EC, DO, TH, Cl_2, BOD
Mg	TDS, TH, Cl_2
Cl_2	AT, turbidity, TDS, Do, EC, TH, BOD
BOD	Turbidity, EC, DO, Ca, Cl_2

In the present study average values of water quality parameters obtained monthly basis during February 2020 to January 2022 is depicted in table-1. Surface water temperature is an important factor in any aquatic environments affecting biological processes, in this study Atmospheric temperature varied from highest 25.1^{O}C and 25.2^{O}C in the May 2020 and 2021 lowest values recorded 21.1^{O}C and 22.9^{O}C October 2020 and November 2021 respectively. The higher concentration must be due to the presence of cloudy weather according to (Uyeno,1966) long rains responsible for following temperature during south west monsoon and north east monsoon season. Water temperature highest recorded 23.4^{O}C and 23.1^{O}C in the month of April 2020 and May 2021respectively. Similarly lowest values 20.1^{O}C in November 2020 and 21.1^{O}C in December 2021. Temperature fluctuation in water are influenced considerably by meteorological factors such as air temperature, humidity, winds and solar radiations. Munawar[18] reported direct relationship between bright sunshine and air temperature. Similar pattern of changes in the air and water temperature was reported by Sathe *et al.*,[24].

pH of any aqueous system is suggestive of its acid-base equilibrium achieved by various dissolved compounds in it. pH of water is a master variable because many reactions that control water quality are pH dependent. The pH values ranged from 7.3 to 8.9 in the year 2020-21. Similarly 7.2 to 9.3 in the year 2021-22. Maximum values observed during monsoon season might be due to increased photosynthetic activity. The decrease in pH during winter could be due to decreased photosynthetic activity[4].

pH remained alkaline throughout the study period. Annual fluctuations are small indicating good buffering capacity. Higher pH is normally associated with Photosynthetic activity in water (King, 1970). The increase and decrease in summer and monsoon respectively have been reported from a number of lakes of Australia Ferell *et al.*, (1979) tropical India (Rao *et al*., 1964). The high pH in summer observed in present investigations may be due to increased Photosynthesis. The photosynthetic assimilation of dissolved inorganic carbon can increase pH [11]. Milind *et al.*,[16] have reported the similar results on seasonal variation of physic-chemical parameters in Perennial tank of Talsande, Maharashtra.

Dissolved oxygen (D.O) is the prime important critical factor in natural waters both as regulator of metabolic processes of biota and as a vital indicator of water quality, ecological and trophic status of a reservoir. This is due to its importance as a respiratory gas, and its significant role in both chemical and biological reactions of an ecosystem. The values of Dissolved oxygen values varied from 41.9 mg/l in February 2020 to 5.8 mg/l in December in 2020 and 1.6 mg/l in April 2021 to 6.5 mg/l in the month of December-2021. From these findings it is seen that, highest dissolved oxygen concentrations were observed during north east monsoon season. These highest values can be attributed to high rate of photosynthetic activity that might have resulted in the liberation of oxygen as a by-product. Lowest oxygen concentrations were observed in summer season, then oxygen levels slightly increased and this might be due to cumulative effect of wind generated turbulence, resultant mixing coupled with rainfall during this period Chalapathi *et al.,*[4].

Alkalinity of water is its capacity to neutralize acids. Weathering of rocks is the potential source of it and it imparts buffering capacity to water, there by helps in stabilizing the pH of water. Total alkalinity values obtained higher 456 mg/l in October 2020 and 512mg/l in May 2021 and lower values in 191 mg/l in October 2020 and 181 mg/l in the month of December 2021 respectively. The higher alkalinity in summer may be attributed to increased rate of decomposition, during which carbon dioxide is liberated which reacts with water to form HCO_3 increasing the total alkalinity in summer. The observed summer higher values compared to monsoon and winter seasons might have resulted from the effect of pH on the relative proportions of different forms (CO_2, HCO_3- and $CO_{3\text{-}2}$) of inorganic carbon. Slightly higher values of alkalinity were observed during summer as was observed in case of pH. Similar type of observations was made by Harshey *et al.,*[9], Kaur *et al.,*[10], Manjare *et al.,*[14], Simpi *et al.,*[27], Lubal *et al.,*[12].

The high pH values during dry season may be due to high photosynthesis of micro and macro vegetation, shifting the equilibrium towards alkaline side (Trivedi, 1989) or due to low water levels and concentration of nutrients in water.

The principle ions causing hardness in water are the divalent cations, especially calcium and magnesium in case of surface waters. Dissolution of limestone is the primary source of these ions in water. The total hardness values ranged from 390 mg/l in the month of May 2020 and minimum 156 mg/l in the month of October 2020 and subsequently higher values obtained 420 mg/l in Sept 2020 and lowest 154 mg/l in the month of December 2021, respectively. The values of Calcium highest values 262 mg/l and 207 mg/l in February 2020 and 2021 respectively and lowest values 138 mg/l in November 2020 and 92 mg/l ion December 2021 respectively. Similarly Magnesium values recorded higher 162 mg/l during April 2020 and 182 mg/l in August in 2021 respectively, likewise lower concentration was 88 mg/l in Oct 2020 and 92 in December 2021 respectively.

Higher values of total hardness during summer season can be attributed to decrease in water volume and increased rate of evaporation, Saify *et al.,*[23] have also recorded higher hardness in summer and lower in winter.

The total dissolved solids were more during 1152 mg/l in April 2020 and 1136 mg/l in May 2021 summer and monsoon season and lower values 454 mg/l in October 2020 and 406 mg/l in December 2021 recorded in Northeast monsoon season. And total suspended solids were also higher 70 mg/l in February 2020 and 83 mg/l in July 2021. Like wise lower values recorded 29 mg/l and 6 mg/l during October 2020 and November 2021 respectively.

Chlorides occur naturally in waters. Discharge of sewage contributes to chlorides there by their concentration serves as an indicator of pollution by sewage. The chloride has been recorded highest 310 mg/l and 274 mg/l in the month of February 2020 and 2021 respectively, similarly lowest 135 mg/l and 65 mg/l in the month of October 2020 and December 2021 respectively. Higher values of chlorides were observed during summer and monsoon samplings compared to winter. Higher values of summer could be attributed to high rate of evaporation, which might have resulted in increase in their concentration, while high values observed in monsoon samplings might be due to the entry of runoff including sewage from the catchment area. A similar observation has been made by Shastry *et.al*.,[26] and Sinha[28]. Such condition was also observed by Swarnalatha and Rao[29] reported raise of chlorides may be due to increased summer temperature and evapo-transpiration.

The turbidity values maximum observed highest 86 mg/l and 90 mg/l during May 2020 and 2021. Lower values has been recorded 25 mg/l in November 2020 and 14 October 2021. Araoye (2009) had also reported that high flood results in increased turbidity and this reduces dissolved oxygen.

Similarly Electrical conductivity was observed higher 2290 April 2020 and 2098 in March 2021 respectively and lower values observed 828 in October 2020 and 616 in November 2021. Similar observation made by Yogendra and Puttaiah (2008). The higher conductivity observed during dry season in the reservoir may be due to the evaporation of water in dry season due to high temperatures. When water temperature increases, so will conductivity. For every 1°C increase, conductivity values can increase 2-4% [17].

Bio-chemical oxygen demand is a parameter to assess the organic load in a water body. Biological Oxygen Demand observed highest 38 mg/l in February 2020 and 32 mg/l April 2021 respectively and 8mg/l in October 2020 and 3mg/l in November 2021 respectively. This is similar to the findings of Mahar[13], who suggested the reason for the high BOD was due the depletion of oxygen in the water during decomposition in dry season. Many researchers have recorded higher BOD values in polluted water. The BOD concentration ranged between 32 mg/1 to 33 mg/1 indicating the fact that the water body is eutrophic. Seasonally, it was high during summer, being in conformity with the observation of Chatterjee[6].

Fig. 2 shows the principal components (PCs) and their eigenvalues and the percentage of variance of each PC. Figure 3. Shows the scree plot of the eigen values for each component. yielding 14 PCs eigenvalues > 1. adding 72% of the total variance in the dataset. The Scree Plot shows a marked change of slope from the first to the second eigen value because PC1 is responsible for 93.9% of the water quality variation in the Chikkere. PC2 is responsible for 4.1 %. PC3 is 1.4 and rest all less than 1.and Fig. 4 and Table 2 depicts the positive correlations with variables.

Hitherto studies reveals that physico-chemical parameters like dissolved oxygen, high bio-chemical oxygen demand and low dissolved concentration concentrations indicate the mixed status of waterbody. A relatively higher concentration of turbidity, chlorides and TDS also indicate the unsuitability of water for domestic use. The principal component analysis was presented as an important tool to explain the variance of the data set of interrelated variables through a smaller set of independent variables principal components analysis has been instrumental in minimizing the eclipse effect giving an accurate answer to the assessment of water. Though many of the parameters are with in permissible limit, the overall assessment of the water quality of a waterbody is a not good for drinking and domestic purpose. However further studies are required on the continuous monitoring of this Chikkere water body.

Conflicts of Interest :

We authors have no conflict of interest

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