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Research Article

Assessment of Physico-Chemical Analysis and Its Correlation with Water Quality of Chikkarasinakere Lake, Karnataka, India

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ABSTRACT

The physico-chemical parameters like color, odour, temperature, electrical conductivity, total hardness, total dissolved solids, alkalinity, calcium, magnesium, chloride, fluoride, phosphate, iron, sulphate, nitrate, dissolved oxygen, biochemical oxygen demand and chemical oxygen demand content of water samples collected from 4 different months of chikkarasinakere lake and its correlation with water quality were analysed. It was observed that there was a significant variation of physico-chemical properties of water sample among 4 months. The values of BOD and COD oscillate more compared to other parameters. PCA and PCM of physico-chemical parameter showed positive and negative principle component between the parameters. In the present study Physico-chemical parameters values such as Alkalinity, Turbidity, Calcium hardness, Magnesium hardness, DO, BOD and COD are above the permissible limit, control of physicochemical parameters in the lake may result in balanced growth of phytoplankton's and reduces the eutrophication.

Key words: Limnology, correlation, water quality, BOD, COD, TDS

[1]INTRODUCTION:

Water is one of the most vital and copious constituent of the ecosystem. All living organisms on the earth need water for their endurance and growth. As of now only earth is the planet having about 70 % of water. But due to increase in human population, industrialization, use of fertilizers in the agriculture and man-made activity it is highly polluted with different harmful contaminants [1]. High levels of pollutants mainly organic matter in river water cause an increase in biological oxygen demand (BOD), chemical oxygen demand (COD), total dissolved solids (TDS) and total suspended solids (TSS). They make water unsuitable for drinking, irrigation or any other use [2]. The quality of ground water depends on various chemical constituents and their concentration, which are mostly derived from the geological data of the particular region. Industrial waste and the municipal solid waste have emerged as one of the leading cause of pollution of surface and ground water. Most of the rivers in the urban areas of the developing countries are the ends of effluents discharged from the industries. Water quality is determined by the physical and chemical limnology of a reservoir and includes all physical, chemical and biological factors of water that influence the beneficial use of the water. Water quality is important in drinking water supply, irrigation, fish production, recreation and other purposes to which the water must have been impounded [3]. The present study was undertaken to assess the physico chemical characteristics and its correlation with water quality of Chikkarasinakere Lake.

The lake is located in Chikkarasinakere Village in Maddur Taluk in Mandya District of Karnataka State, Mandya Division, India (Fig:-1). The satellite image showed the overview of lake (Fig:-1). It is located 18 KM towards East from District head quarters Mandya, 9 KM from Maddur and 92 KM from State capital Bangalore. Elevation is 641 meters above Sea level. It has a catchment area of almost 105 hectares with maximum depth of 10 meters when full. It has three outlets and one inlet. In the current study physico chemical analysis and their correlation with water quality were analysed.

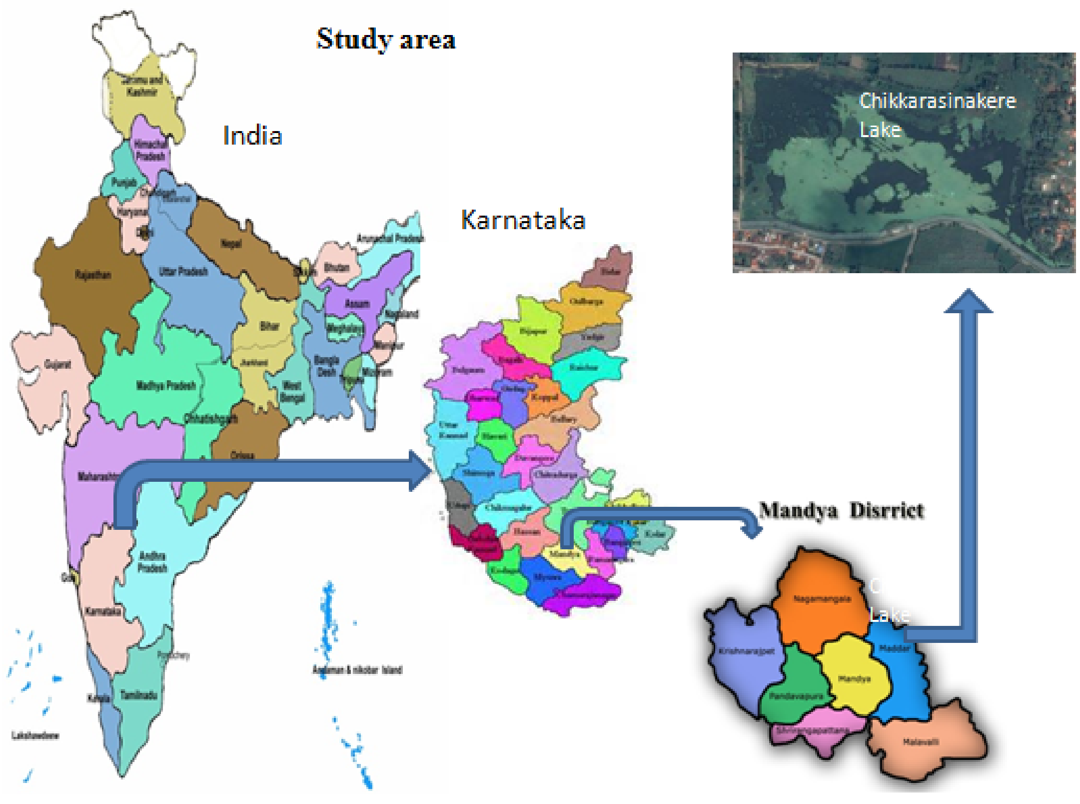

Fig: 1:- Study area map

[2]MATERIALS AND METHODS:

2.1. Collection of water samples: Samples for the estimation of physico-chemical parameters was collected from surface water and deep water at various places of the lakes respectively. Sample was collected at an interval of 30 days as described by [4]. The amount thus sedimented was further reduced to 20ml by centrifugation and on certain occasions when the plankton population was thin it was adjusted to 10 ml or less. These samples were preserved and stored for further analysis. Plastic cans of two liter capacities have been used for collection of lake water sample to analyse the physico and chemical parameters.

2.2.Physico-chemical parameters and their analysis: The different parameters measured are Temperature, pH [5], Electrical conductivity (EC) [6], TDS, COD, BOD, Chloride, Alkalinity, Hardness, Turbidity, Odour, Colour, Sulphate, Nitrate , Calcium, Magnesium, Sodium, Phosphate, Fluoride, Iron. The methods used for determination of physico-chemical parameters are presented in the table 1. The Principal Component analysis and Correlation Co-efficient analysis was done by using PAST and SPSS 10.5 software.

Table 1: Methods used for physico chemical analysis of water sample

SI. No.	Parameters	Methodology
1)	pH	Electrometrical Method
2)	EC	Conductivity Meter
3)	Temperature	Thermometer
4)	Turbidity	Nephelometric Turbidity unit Method
5)	Dissolved Oxygen	Winkler's Iodometric Method
6)	BOD	Winkler's Method
7)	COD	Dichromate Reflux Method
8)	Total Hardness	EDTA Titrimetric Method
9)	Calcium Hardness	EDTA Titrimetric Method
10)	Magnesium Hardness	Calculation Method
11)	Sulphate	Turbidometric Method
12)	Nitrate	Sulphanilamide spectrophotometric Method
13)	Alkalinity	Titrimetric Method
14)	Chloride	Argentometric Method
15)	Phosphate	Vanadomolybdophosphoric Acid Colorimetric Method
16)	Fluoride	Ion selective Electrode Method
17)	Iron	Spectrophotometric Method
18)	TDS	EDTA Titrimetric Method
19)	Colour	Visual Comparison
20)	Odour	Qualitative Human Receptor

[3]RESULTS:

3.1. Physico-chemical Analysis

The Physico-chemical analysis for the month February, March, April and May are represented in the tables 2,3,4 and 5 respectively. The pH of the lake water was in the range 7.58 to 7.80. The highest pH was recorded during the month of May and in other three months showed little variation. The temperature showed variation between 23 ^{0}Cto 34^{0}C. The highest and least temperature was recorded during the month of May and February respectively and in other two months it showed slight variation. The turbidity showed variation between 5.1 NTU to 7.8 NTU. The highest turbidity was recorded during the month of February and April, least during March and medium in May. The EC varied between 258 µs/cm to 408 µs/cm. The highest electric conductivity was recorded during the months February and May, least in March and medium during April. The total hardness varied between 148 mg/L to 246 mg/L. The highest total hardness was recorded during the month March, least in May and medium during the months of February and April.

The TDS showed variation between 158 mg/L to 234 mg/L .The maximum and minimum TDS were recorded during the months March, May and April respectively and medium in February. The alkalinity variation was between the130 mg/L to 225 mg/L. The highest and least alkalinity was recorded during the month of March and April respectively and medium during February and May. The calcium hardness varied between 76 mg/L to 126 mg/L. The highest calcium hardness was recorded during the months of March and April, medium in February and least during May. The magnesium hardness varied between 57 mg/L to 141 mg/L. The highest magnesium hardness was recorded during the month of March and slight variation in other three months. The chloride varied between 36 mg/L to 83.3 mg/L. The highest chloride was recorded during the month of March and May, least during April and medium during February. The fluoride variation was between 0.50 mg/L to 0.58 mg/L. The highest fluoride was recorded during the month of March and February and medium during the month of April and May. The phosphate showed variation between 0.218 mg/L to 0.364 mg/L. The highest phosphate was recorded during the month of March, least during April and in other two months, medium concentration of phosphate was present.

The iron showed variation between 0.274 mg/L to 0.368 mg/L. The highest and least iron was recorded during the month of February and April respectively and medium during March and May. The sulphate varied was between 20 mg/L to 48 mg/L. The highest and least sulphate was recorded during the month of March and April respectively and medium in February and May. The nitrite variation was between 2.380 mg/L to 4.603 mg/L. The highest nitrite was recorded during the month of March, least in February and medium during April and May. The DO showed variation between 4.3 mg/L to 7.6 mg/L. The highest DO was recorded during the month of May, least during March and medium during February and April. The BOD showed variation between 14.0 mg/L to 38.0 mg/L. The highest BOD was recorded during the month of April, least in the month of February and medium in March and May. The COD showed variation between 28 mg/L to 70 mg/L. The highest COD was recorded during the month of April, least in the month of February and medium in March and May.

Table 2: Physico-chemical characteristics of Chikkarasinakere in the month of February 2015

Parameters	Sample 1	Sample 2	Sample 3
pH	7.58	7.56	7.58
Odour	objectionable	objectionable	Objectionable
Color	10	10	5
Temperature	24	23	26
Turbidity	7.8	6.7	5.1
Electrical Conductivity	364	329	343
Total Hardness	180	172	168
Total Dissolved Solid	203	198	190
Alkalinity	154	174	164
Calcium Hardness	103	90	110
Magnesium Hardness	77	82	58
Chloride	63	54.98	58
Fluoride	0.56	0.58	0.55
Phosphate	0.364	0.284	0.274
Iron	0.368	0.348	0.324
Sulphate	36	36	28
Nitrate	2.86	2.384	2.640
DO	4.6	4.5	5.1
BOD	26.0	14.4	14.0
COD	36.0	28.0	30.0

All the values are expressed as mg/L, except pH, Temperature ^{0}C, Conductivity as µs/cm and Turbidity (NTU)

Table- 3: Physico-chemical characteristics of Chikkarasinakere in the month of March 2015

Parameters	Sample 1	Sample 2	Sample 3
pH	7.62	7.62	7.61
Odour	objectionable	objectionable	Objectionable
Color	10	15	5
Temperature	25	26	28
Turbidity	7.3	6.9	7.1
Electrical Conductivity	308	262	258
Total Hardness	236	220	246
Total Dissolved Solid	216	220	230
Alkalinity	185	225	206
Calcium Hardness	126	79	116
Magnesium Hardness	110	141	130
Chloride	76	83.307	80
Fluoride	0.54	0.56	0.52
Phosphate	0.286	0.308	0.314
Iron	0.296	0.338	0.314
Sulphate	42	48	40
Nitrate	2.380	4.603	3.964
DO	4.8	4.3	5.3
BOD	32.0	14.8	26.0
COD	42.0	32.0	30.0

All the values are expressed as mg/L, except pH, Temperature ^{0}C, Conductivity as µs/cm and Turbidity (NTU)

Table- 4: Physico-chemical characteristics of Chikkarasinakere in the month of April 2015

Parameters	Sample 1	Sample 2	Sample 3
pH	7.61	7.58	7.60
Odour	objectionable	objectionable	Objectionable
Color	15	10	10
Temperature	32	31.2	33
Turbidity	7.8	7.6	6.8
Electrical Conductivity	324	314	286
Total Hardness	174	188	194
Total Dissolved Solid	164	158	160
Alkalinity	123	130	144
Calcium Hardness	106	131	120
Magnesium Hardness	68	57	74
Chloride	46	36	38
Fluoride	0.52	0.55	0.50
Phosphate	0.286	0.314	0.218
Iron	0.294	0.306	0.274
Sulphate	22	20	30
Nitrate	2.794	2.864	2.804
DO	4.6	4.4	5.4
BOD	38	46	35
COD	70	58	60

All the values are expressed as mg/L, except pH, Temperature ^{0}C, Conductivity as µs/cm and Turbidity (NTU)

Table- 5: Physico-chemical characteristics of Chikkarasinakere in the month of May 2015

Parameters	Sample 1	Sample 2	Sample 3
pH	7.80	7.69	7.69
Odour	objectionable	objectionable	Objectionable
Color	15	10	10
Temperature	33	34	34
Turbidity	6.4	6.6	5.8
Electrical Conductivity	368	408	354
Total Hardness	154	168	148
Total Dissolved Solid	212	234	232
Alkalinity	172	168	194
Calcium Hardness	76	80	76
Magnesium Hardness	78	88	72
Chloride	52	56	48
Fluoride	0.52	0.53	0.54
Phosphate	0.284	0.279	0.308
Iron	0.282	0.284	0.284
Sulphate	32	24	26
Nitrate	2.869	2.870	2.875
DO	4.6	4.8	5.4
BOD	32	30	28
COD	48	50	38

All the values are expressed as mg/L, except pH, Temperature ^{0}C, Conductivity as μs/cm and Turbidity (NTU)

3.2Principle Component Analysis (PCA) of Physico-chemical parameters

The present study data of physico-chemical parameters apply PCA to obtain the graph with various parameters are close (near) to x-axis or y-axis or intermediate. During February, the magnesium hardness get a longest line and very close to y-axis and electrical conductivity very close to x-axis, these two parameters show a positive principle component and calcium hardness lies to the near of y- axis and it got negative principle component (Fig. 2). During March TDS was near to the y- axis and calcium hardness lies in the middle of x and y- axis and these three parameters showed positive principle component. EC is lies between x and y- axis and these two parameters showed the negative principle component. Other parameters plays an intermediate role (Fig. 3). During April, the magnesium hardness lies near to the y -axis and alkalinity lies very close to x axis, these two parameters showed positive principle component. Total hardness was near to the x-axis and showed a positive role. Calcium hardness was close to the y-axis and electric conductivity near to the x- axis, these two parameters showed a negative principle component and other parameters have intermediate role (fig. 4). During May, COD , total hardness and electrical activity near to the x- axis and shows a positive principle component and total dissolved solid and alkalinity lies in the y-axis and got a negative principle component and other parameters are highly intermediate to each other.(Fig:-8.)

3.3. Correlation Co-efficient Matrix

For quantitative analysis Pearson correlation co-efficient was chosen. Correlation is a statistical measure of the inter dependence of two or more random variables. Fundamentally, the value indicates how much of a change in one variable is explained by a change in another. The measurement scales used should be at least interval scales, but other correlation co-efficient are available to handle other types of data. Correlation co efficient can range from

-1.00 to +1.00. The value of -1.00 represents a perfect negative correlation while a value of +1.00 represents a perfect positive correlation. A value of 0.00 represents a lack of correlation.

3.4. Pearson's Correlation Matrix (PCM) for physicochemical parameters

The PCM for the month of February is presented in the Table 6. There are two correlation matrixes. The second cluster of parameter is color it positively correlates with sulphate and sulphate in turn correlates with color and the remaining parameters lack correlation. The PCM for the month of March is presented in the Table 7. The second cluster of parameter is Color is positively correlates with fluoride and negatively correlates with DO and the twelfth cluster of parameter is fluoride is negatively correlates with sulphate and the remaining parameters lack correlation. The PCM for the month of April is presented in the Table 8. There is only one correlation, the fifteenth cluster of parameter sulphate positively correlates with DO and the remaining parameters lack correlation. The PCM for the month of May is presented in the Table 9.

The first cluster of parameter pH correlates with color, temperature and iron. Among this color positively correlates with pH and temperature and iron negatively correlate with pH. The second and third clusters of parameter are color and temperature respectively negatively and positively correlate with iron respectively. The eighth cluster of parameter is alkalinity that negatively correlates with COD. The twelth cluster of parameter is fluoride it negatively correlates with BOD and the thirteenth cluster of parameter is phosphate that negatively correlates with COD and the remaining parameters lack correlation. In summary pH correlates with color, temperature and iron. Color correlates with iron, sulphate, fluoride and DO. Temperature correlates with iron. Alkalinity correlates with COD and fluoride correlates BOD. Phosphate correlates with COD. Sulphate correlates with DO. Fluoride correlates with sulphate. Sulphate correlates with color.

[4]DISCUSSION:

The present investigation revealed the true picture of water quality on the basis of monthly variation. The pH of an ideal fresh water ecosystem should be in the range of 6.5 for the sustenance of life [7]. The pH of lake water ranged between7.58 to 7.80, showed its alkaline nature. The lower pH during other season was evidently due to the increased decomposition under low water depth. High pH value is probably due to the addition of hydroxyl, bicarbonate and carbonate anions. The greater pH may be caused by increase in DO produced as a result of photosynthesis. The acidic pH is a characteristic of oligotrophic lake where as the neutral and alkaline pH are shown by eutrophic and mesotrophic nature of lake, respectively [8]. pH directly depend on the amount of CO_2 present and inversely proportional to the activity of photosynthesis [9]. In all the months studied, alkaline pH was reported and its value was found to be maximum (7.80) during May.

The shallowness of the lake and consequently the volume of water in contact with air, a close relationship exists between atmospheric temperature and air temperature and such that the water is warmer during summer and colder during winter, although the temperature of lake water ranged between 23 ^{0} C to 34 ^{0}C during the period of study. The high temperature of water bodies is the result of low water depth and volume of water which remains in contact with air.

Temperature of the water sharply declined and its features exert control over the occurrence to the organisms and correspondingly a change in the physico-chemical nature of the water occurs. It has a profound effect and is the most important factor in aquatic ecology [10]. The levels of water during various seasons cause fluctuations in water temperature [11] and indicates that temperature has an influence on the oxygen levels [12]. Higher temperature depletes oxygen content of water.

The physico chemical parameters like pH, carbonates, bicarbonates and calcium are interrelated; further bicarbonates fluctuate directly with calcium and change the pH of water [13]. EC is used as an indicator of water quality based on TDS [14]. Generally, EC value was less than 500 µs/cm in the study period and this result is similar to EC value of Iraq inland water [15].On the other hand lower level of turbidity was recorded in May, while the higher level was observed during February. This may be due to the increase of planktonic algal growth [16].

Alkalinity is due to the presence carbonates and bicarbonates of calcium and magnesium discharged from kitchen waste water. Amount of total alkalinity in the lake ranges from 130 mg/L to 225 mg/L. The high value of total alkalinity in the lake may be due to cattle bathing and laundering of clothes [17]. Alkalinity is total measure of the substances in water that have acid neutralizing ability [18]. In the present study the amount of alkalinity is dependent on the nature of materials discharged into the lake.

Chloride that dissolves easily in water is toxic to most aquatic organisms because it reacts quickly with other substances in water [19]. The amount of chloride in all the months was found to be higher. In the present study the maximum and minimum content of chloride was noticed during March and April respectively. The high amount chloride is an indication of anthropogenic pressure on lake. The increased chlorine is generally due to the salts of sodium, potassium and calcium.

Phosphorous is regarded to be of great importance in biological productivity of water. Lakes contain relatively small amount of phosphorous which are subjected to wide variation [4]. [13] considerd that phosphates are less in water free of contamination; while [19]Hutchinson (1957) states that phosphate content increases as a result of sewage contamination. [20] is of the opinion that phosphate is always present in considerable amounts and therefore not to be limiting factor.

Nitrates remain at fairy fixed concentrations and in lakes where nitrate is poor there is lack of organisms that can oxidize free ammonia [21] Oxygen content of water is one of the important factors, and it is very necessary for all living organisms [22]

The DO content of the lake ranged between 4.3- 7.8 mg/L. However BOD and COD values ranged between 14.0 to 38.0 mg/L and 28 to 70 mg/L respectively. Generally, high value of BOD and COD were observed which coincide with a high water temperature and low DO. These results were slightly lower than that reported [23].The depletion of oxygen can result from a number of natural factors but is most a concern as a result of pollution and eutrophication in which plant nutrients enter water source [24].

This is due to heavy amount of organic matter discharged which needs oxygen for decomposition. As such, low dissolved oxygen indicates the biodegradation of organic matter [25]. Likewise, the biochemical oxygen demand also indicates the amount of organic compounds in water as measured by the volume of oxygen required by the bacteria to metabolise it under aerobic condition. For more organic matter, more oxygen is required by bacteria for its decomposition. Physico-chemical parameters values such as Alkalinity, Turbidity, Calcium hardness, Magnesium hardness, DO, BOD and COD are above the permissible limit of WHO-2004.

Table-6 : Pearson's Correlation Matrix for physicochemical parameters of February.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	1	-.500	.756	-.106	.803	.189	-.132	-.866	.939	-.661	.787	-.945	.410	-.052	-.500	.887
2	-.500	1	-.945	.914	.115	.756	.924	.000	-.768	.980	.141	.756	.585	.891	1.000**	-.044
3	.756	-.945	1	-.731	.217	-.500	-.749	-.327	.935	-.991	.191	-.929	-.288	-.693	-.945	.368
4	-.106	.914	-.731	1	.507	.956	1.000*	-.405	-.443	.816	.530	.426	.864	.999*	.914	.365
5	.803	.115	.217	.507	1	.737	.485	-.993	.548	-.084	1.000*	-.564	.873	.553	.115	.987
6	.189	.756	-.500	.956	.737	1	.948	-.655	-.161	.612	.755	.143	.973	.971	.756	.621

7	-.132	.924	-.749	1.000*	.485	.948	1	-.381	-.466	.831	.508	.449	.850	.997	.924	.341
8	-.866	.000	-.327	-.405	-.993	-.655	-.381	1	-.640	.197	-.990	.655	-.811	-.454	.000	-.999*
9	.939	-.768	.935	-.443	.548	-.161	-.466	-.640	1	-.879	.526	-1.000*	.070	-.394	-.768	.673
10	-.661	.980	-.991	.816	-.084	.612	.831	.197	-.879	1	-.057	.870	.414	.784	.980	-.240
11	.787	.141	.191	.530	1.000*	.755	.508	-.990	.526	-.057	1	-.541	.885	.575	.141	.983
12	-.945	.756	-.929	.426	-.564	.143	.449	.655	-1.000*	.870	-.541	1	-.088	.376	.756	-.687
13	.410	.585	-.288	.864	.873	.973	.850	-.811	.070	.414	.885	-.088	1	.890	.585	.785
14	-.052	.891	-.693	.999*	.553	.971	.997	-.454	-.394	.784	.575	.376	.890	1	.891	.415
15	-.500	1.000**	-.945	.914	.115	.756	.924	.000	-.768	.980	.141	.756	.585	.891	1	-.044
16	.887	-.044	.368	.365	.987	.621	.341	-.999*	.673	-.240	.983	-.687	.785	.415	-.044	1
17	.629	-.988	.984	-.840	.041	-.645	-.854	-.156	.858	-.999*	.015	-.849	-.452	-.810	-.988	.198
18	.474	.525	-.218	.825	.906	.954	.810	-.851	.142	.347	.917	-.160	.997*	.854	.525	.827
19	.693	.277	.052	.643	.986	.839	.623	-.961	.402	.082	.990	-.419	.941	.683	.277	.948

1. pH 2. Color 3.Temperature 4.Turbidity 5.Electrical conductivity 6.Total Hardness.7.Total Dissolved Solids 8.Alkalinity 9.Calcium Hardness 10. Magnesium Hardness 11.Chloride 12.Fluoride 13.Phosphate 14. Iron 15.Sulphate 16.Nitrate 17.DO 18.BOD 19.COD. **. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed).

Table 7: Pearson's Correlation Matrix for physicochemical parameters of March

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	1																
2	.866	1															
3	-.945	-.655	1														
4	.000	-.500	-.327	1													
5	.561	.072	-.801	.828	1												
6	-.792	-.991	.549	.610	.060	1											
7	-.961	-.693	.999*	-.277	-.769	.592	1										
8	-.029	.475	.354	-1.000*	-.844	-.587	.305	1									
9	-.315	-.747	-.013	.949	.609	.828	.039	-.940	1								
10	-.165	.350	.479	-.986	-.909	-.471	.432	.991	-.884	1							
11	-.055	.452	.378	-.999*	-.857	-.566	.329	1.000*	-.931	.994	1						
12	.866	**1.000****	-.655	-.500	.072	-.991	-.693	.475	-.747	.350	.452	1					
13	-.666	-.203	.873	-.746	-.991	.072	.847	.765	-.499	.846	.781	-.203	1				
14	.082	.569	.249	-.997	-.779	-.673	.197	.994	-.972	.969	.991	.569	.689	1			
15	.693	.961	-.419	-.721	-.207	-.989	-.466	.700	-.902	.596	.682	.961	.076	.775	1		
16	-.238	.279	.543	-.971	-.938	-.404	.498	.978	-.847	.997*	.983	.279	.883	.948	.535	1	
17	-.866	**-1.000****	.655	.500	-.072	.991	.693	-.475	.747	-.350	-.452	**-1.000****	.203	-.569	-.961	-.279	1
18	-.172	-.641	-.160	.985	.719	.737	-.108	-.980	.989	-.943	-.974	-.641	-.621	-.996	-.829	-.916	.641
19	.629	.156	-.849	.778	.996	-.024	-.820	-.796	.540	-.871	-.811	.156	-.999*	-.723	-.125	-.905	-.156

1. pH 2. Color 3.Temperature 4.Turbidity 5.Electrical conductivity 6.Total Hardness.7.Total Dissolved Solids 8.Alkalinity 9.Calcium Hardness 10.Magnesium Hardness 11.Chloride 12.Fluoride 13.Phosphate 14. Iron15.Sulphate 16.Nitrate 17.DO 18.BOD 19.COD.

**. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed).

Table-8 : Pearson's Correlation Matrix for Physicochemical parameters of April

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	1																
2	.756	1															
3	.605	-.064	1														
4	.000	.655	-.796	1													

5	.066	.703	-.754	.998*	1												
6	-.532	-.956	.353	-.847	-.880	1											
7	.929	.945	.266	.371	.432	-.808	1										
8	-.143	-.756	.702	-.990	-.997*	.914	-.500	1									
9	-.967	-.899	-.381	-.256	-.320	.731	-.993	.392	1								
10	.772	.167	.973	-.636	-.583	.128	.481	.519	-.583	1							
11	.866	.982	.126	.500	.556	-.884	.990	-.619	-.965	.351	1						
12	-.737	-.115	-.984	.676	.625	-.181	-.434	-.564	.539	-.999*	-.300	1					
13	-.460	.234	-.985	.888	.856	-.508	-.097	-.813	.217	-.919	.046	.939	1				
14	-.540	.143	-.997	.842	.804	-.426	-.189	-.756	.306	-.952	-.047	.967	.996	1			
15	.371	-.327	.964	-.929	-.902	.589	.000	.866	-.121	.877	-.143	-.901	-.995	-.982	1		
16	-.980	-.610	-.752	.200	.134	.352	-.836	-.058	.896	-.883	-.749	.857	.628	.697	-.549	1	
17	.371	-.327	.964	-.929	-.902	.589	.000	.866	-.121	.877	-.143	-.901	-.995	-.982	**1.000****	-.549	1
18	-.825	-.254	-.949	.565	.509	-.040	-.556	-.441	.653	-.996	-.432	.990	.881	.921	-.831	.921	-.831
19	.849	.988	.092	.529	.584	-.899	.984	-.645	-.956	.319	.999*	-.268	.080	-.013	-.176	-.726	-.176

1. pH 2. Color 3.Temperature 4.Turbidity 5.Electrical conductivity 6.Total Hardness.7.Total Dissolved Solids 8.Alkalinity 9.Calcium Hardness 10. Magnesium Hardness 11.Chloride 12.Fluoride 13.Phosphate 14. Iron15.Sulphate 16.Nitrate 17.DO 18.BOD 19.COD. **Correlation is significant at the 0.01 level (2-tailed)

Table 9 : Pearson's Correlation Matrix for Physicochemical parameters of May

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	1															
2	**1.000****	1														
3	**-1.000****	-1.000**	1													
4	.277	.277	-.277	1												
5	.541	.541	-.541	-.658	1											
6	-.225	-.225	.225	.874	-.941	1										
7	-.997	-.997	.997	-.197	-.608	.304	1									
8	-.371	-.371	.371	-.995	.580	-.821	.294	1								
9	-.500	-.500	.500	.693	-.999*	.956	.569	-.619	1							
10	-.143	-.143	.143	.911	-.910	.997	.224	-.866	.929	1						
11	.000	.000	.000	.961	-.841	.974	.082	-.929	.866	.990	1					
12	-.866	-.866	.866	-.721	-.048	-.292	.822	.786	.000	-.371	-.500	1				
13	-.354	-.354	.354	-.997	.595	-.832	.276	1.000*	-.633	-.875	-.935	.774	1			
14	**-1.000****	**-1.000****	**1.000****	-.277	-.541	.225	.997	.371	.500	.143	.000	.866	.354	1		
15	.971	.971	-.971	.038	.727	-.452	-.987	-.137	-.693	-.376	-.240	-.721	-.119	-.971	1	
16	-.629	-.629	.629	-.922	.314	-.616	.563	.955	-.359	-.680	-.778	.933	.950	.629	-.423	1
17	-.693	-.693	.693	-.885	.231	-.546	.632	.926	-.277	-.614	-.721	.961	.919	.693	-.500	.996
18	.866	.866	-.866	.721	.048	.292	-.822	-.786	.000	.371	.500	**-1.000****	-.774	-.866	.721	-.933
19	.359	.359	-.359	.996	-.591	.828	-.281	**-1.000****	.629	.872	.933	-.778	**-1.000****	-.359	.125	-.952

1.pH 2. Color 3.Temperature 4.Turbidity 5.Electrical conductivity 6.Total Hardness.7.Total Dissolved Solids 8.Alkalinity 9.Calcium Hardness 10.Magnesium Hardness 11.Chloride 12.Fluoride 13.Phosphate 14. Iron15.Sulphate 16.Nitrate 17.DO 18.BOD 19.COD. **.Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed).

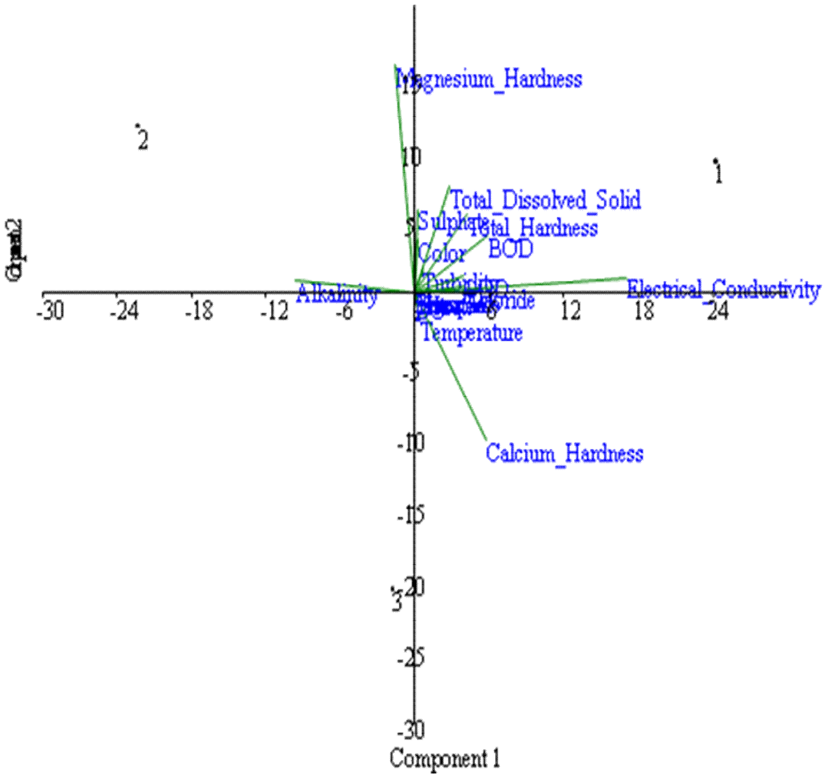

Fig:-2-Principle Component Analysis of February

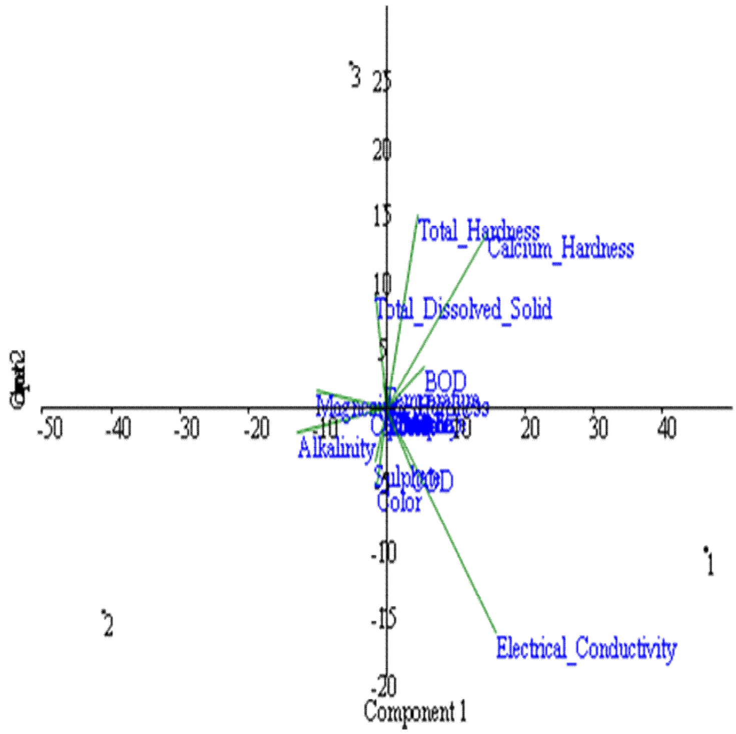

Fig:-3-Principle Component Analysis of March

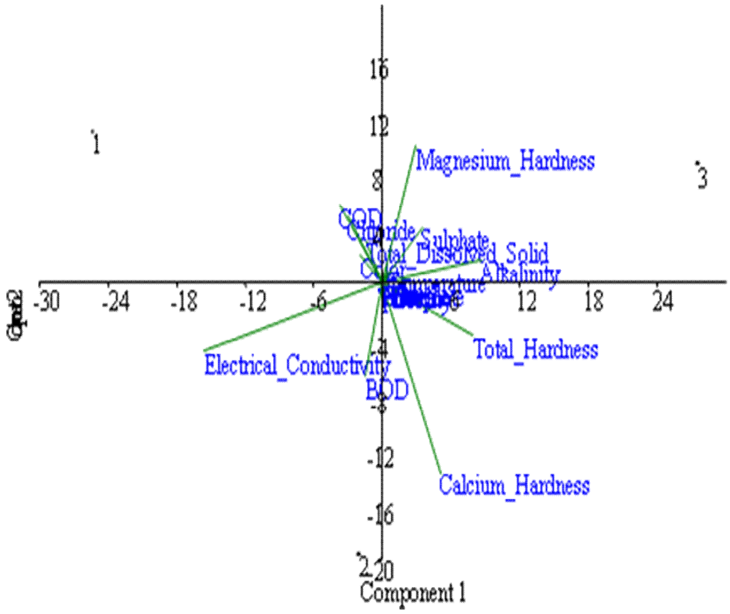

Fig:-4-Principle Component Analysis of April

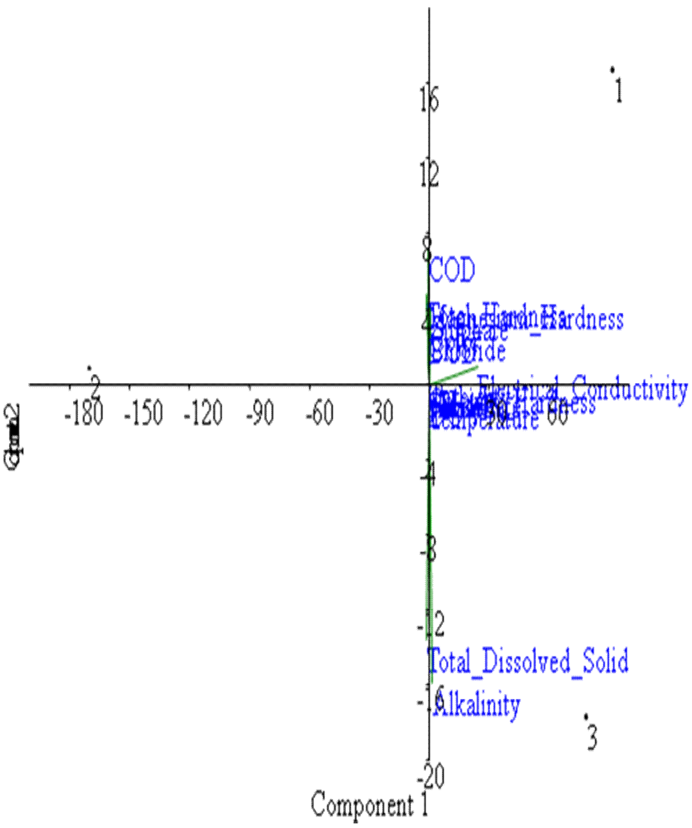

Fig:-5-Principle Component Analysis of May

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