

Research Paper

**EVALUATION OF PHYSICO-CHEMICAL PROPERTY - CARBON DIOXIDE,
DISSOLVED OXYGEN AND TOTAL DISSOLVED SOLID CONTENTS IN THE
WATER OF CHILIKA LAGOON**

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Abstract

Wetlands are receiving much international attention during past few decades with the better understanding of their values and functions. Wetland science is emerging as an unique discipline encompassing the terrestrial and aquatic ecology i.e. hydrology, limnology and engineering. The quality of surface water of Chilika lagoon with respect to physico-chemical parameters was investigated. The present investigation on evaluation of water quality such as carbon dioxide, dissolved oxygen and total dissolved solid contents of Chilika Lagoon will primarily address the changing characteristics and will be a step for formulating an action plan for integrating ecological, social and economical dimensions to promote sustainable development of the lagoon. The variables that are related to pollution sources showed differences. For the study of physico-chemical properties of water, the samples were collected monthly for a period of 2 years from July 2011 to June 2013 from six different sampling stations which spread over all the ecological sectors. Collection of samples was made from the predetermined stations of the water body by holding the polythene bottle (5 L. capacities). The samples were brought to the laboratory for analysis. At the spot of the sampling sites, the temperature of water was recorded. The water samples were analyzed in the laboratory by standard methods (APHA, 2004). The water samples were then filtered and were used for the measurement. Among the stations, Palur canal shows the highest value i.e. $8.05 \pm 0.07 \text{ mg l}^{-1}$ of carbon dioxide during winter season and Balugaon shows the lowest value i.e. $3.65 \pm 0.41 \text{ mg l}^{-1}$ of carbon dioxide during summer season. Among the stations Bhusandapur nail shows the highest dissolved oxygen value i.e. $13.60 \pm 0.89 \text{ mg l}^{-1}$ in summer season and Kalupada Ghat shows the lowest dissolved oxygen value i.e. $6.25 \pm 1.01 \text{ mg l}^{-1}$ in winter season respectively. Among the stations, Palur Canal shows the highest total dissolved solid i.e. $33113.83 \pm 443.7 \text{ mg l}^{-1}$ in the summer season and Bhusandapur nail showed the lowest value i.e. $6886.33 \pm 258.0 \text{ mg l}^{-1}$ in summer season.

Key words: Chilika Lagoon, Brackish water, Carbon dioxide, Dissolved Oxygen, Total Dissolved Solid contents.

INTRODUCTION

Trisal and Zutshi (1985) [1] were of opinion that, studies on wetlands of India are relatively recent and much is not known about their distribution, structure, function, ecological status and management needs. According to Mahajan (1982) [2], wetlands have received considerable attention in recent years and attempts have been made to evaluate the wetlands, their comparative worth and significance from the ecological, hydro biological, economic, meteorological and educational view points. The ecology, management and research needs of the wetland ecosystems of the Indian subcontinent had been deliberated in a regional meeting of the National Man and Biosphere (MAB) committee of central and south Asian countries. (Trisal and Zutshi, 1985) [3]. In Hudson River, Raymond and coworkers (1997) [4] reported that CO₂ in surface water averaged 1125 ±403 (SD) μ atm, while the atmosphere average 416±68 μ atm. Atekwana *et al* (2003) [5]. studied on dissolved inorganic carbon in a subtropical riverine estuary, Southwest Florida, USA and of opinion that, the DIC model was able to describe sea water mixing in the estuary as DIC changed in concentration between values measured in river water at the tidal front to the most seaward station. Billen *et al* (2001) [6] showed that, oxygenation of the fluvial sector below pairs has increased considerably owing to improved waste water treatment, but a large part of the estuary remain completely anoxic during the spring and summer months. Chandrasekhar and coworkers (2003)[7]. studied the Bellandur Lake, Bangalore with opinion that, the addition of effluents from urbanized Bangalore city has changed the characteristics of the lake from an ecologically healthy lake to an artificial reservoir of domestic sewage and industrial effluents. DO range from 3.8-6.3 mg l⁻¹, BOD from 89-99 mg/L by absorption of pollutants by aquatic flora. Dissolved oxygen (12.6 mg l⁻¹) increased steadily with increased rainfall and highest in late August. (Jha and Barat, 2003) [8].. In Chesa peake Bay Christman and Dauer (2003) [9]. found that, due to low dissolved oxygen and sediment contamination effect the benthic sites are under degradation. Hambright and coworkers (1998) [10] studied a subtropical wetland lake, Agmon Hula valley (Israel) and reported that, heavy influence of stream and drainage inflows promote high pH, alkalinity, conductivity and Total dissolved solid which promote nutrient cycling algal and macrophytic production and ultimately strongly affect lake water quality. Lane and Coworkers (1999) [11] studied on Breton sound estuary and reported that, spring and summer water quality transects indicated rapid reduction of total suspended sediment concentration as directed Mississippi River water entered the estuary suggesting near complete assimilation of these constituents by the ecosystems. Rajyalaxmi and coworkers (1989) [12] studied the soil and water characteristics of confined brackish water ponds of Chilika lake Fringe Area.

MATERIALS & METHODS

Sampling strategies:

For the study of physico-chemical properties of water, the samples were collected monthly for a period of 2 years from July 2011 to June 2013 from six different sampling stations which spread over all the ecological sectors. With the global positioning system (GPS) the exact longitude and latitude of each station was determined (Table-1). Collection of samples was made from the predetermined stations of the water body by holding the polythene bottle (5 L. capacities) and usually from one foot below the water surface, plunging it there to avoid atmospheric contamination and bubbling. The bubbles were then turned until the neck pointed slightly upwards and completely filled. During filling up the bottles they were kept horizontally forward in the direction away from the hand. When filled, the bottles were raised and the stoppers were replaced while the bottles were inside the water. Above all, scrupulous care was taken to obtain a sample that was representative of the respective water body and to avoid accidental contamination of the sample during collection.

To reach all the stations a flat bottom wooden boat was used. From each station, samples and field notes were collected in respect of various parameters like carbon dioxide, dissolved oxygen and total dissolved solid of water. The samples were brought to the laboratory by keeping inside the dark wooden boxes for analysis of the parameters.

Analytical methods:

The water samples were analyzed in the laboratory standard methods (APHA, 2004) [13]. Immediately after returning to the laboratory, the water samples were then filtered through Whatman No.2 filter paper into clean glass bottles.

CO₂ can be determined by titrimetric method. The free CO₂ react with sodium carbonate or sodium hydroxide to form sodium bicarbonate. The completion of the reaction is indicated by the development of the pink colour characteristic of phenolphthalein indicator.

Dissolved oxygen is measured by the azide modified Iodometric method. Dissolved oxygen (DO) levels in natural lakes and different water reservoirs depend on the physical, chemical and biochemical activities in the water body. The analysis for DO is a key test in water pollution and waste treatment process control. This process is based on the addition of divalent manganese solution, followed by strong alkali, to the sample in a glass Stoppard bottle. DO rapidly oxidize an equivalent amount of the dispersed divalent manganous hydroxide precipitate to hydroxides of higher valency states. In the presence of iodide ions in an acidic solution, the oxidized manganese reverts to the divalent state, with the liberation of iodine equivalent to the original DO content. The iodine is then titrated with a standard solution of thiosulphate. The titration end point can be detected visually, with a starch indicator. To the sample collected in a bottle, 1 ml MnSO₄ solution was added followed by 1 ml alkali-iodide-azide reagent. After settlement of the precipitate 1.0 ml conc. H₂SO₄ was added. Then the volume corresponding to 200 ml original sample titrated against after correction for sample loss by displacement with reagents. Then it was titrated with 0.025 M Na₂S₂O₃ solution to a pale straw colour. A few drops of starch solution were added to continue titration to first disappearance of the blue colour.

Calculation:- $1\text{ml } 0.025\text{ M Na}_2\text{S}_2\text{O}_3 = 1\text{ mg DO/L}$

Total dissolved solid (TDS) was estimated by the gravimetric method in which a well-mixed sample was filtered through a standard glass fiber filter, and the filtrate was evaporated to dryness in a weighed dish and dried to constant weight at 180°C. The increase in dish weight represents the total dissolved solids. The apparatus required are the glass-fiber filter disks, filtration apparatus, solution flask and drying oven.

Calculation:
$$\text{mg TDS/L} = \frac{(A-B) \times 1000}{\text{Sample volume, ml}}$$

Where A= weight of dried residue + dish, mg

B= weight of dish, mg.

Table-- 1. Longitude and Latitude of the stations selected in Chilika Lagoon

| Sl.No | Name of Stations | Longitude | Latitude |
|-------|------------------|-----------|----------|
| 1 | Bhusandpur | 85°.47' | 19°.83' |
| 2 | Kalupada Ghat | 85°.42' | 19°.86' |
| 3 | Balugaon | 85°.22' | 19°.67' |
| 4 | Barkul | 85°.18' | 19°.66' |
| 5 | Rambha | 85°.13' | 19°.53' |
| 6 | Palur Canel | 85°.17' | 19°.49' |

RESULTS

Due to large volume of data collected over the two years from July, 2011 to June, 2013, instead of giving the raw data obtained, only the monthly means with their standard errors were given in Table-5 & 6). The results presented in this section are stationed, seasonal and annual means of various physicochemical and biological parameters along with their standard errors.

The results of the variables of physico-chemical parameters of water i.e. water pH, acidity, alkalinity etc. were examined and presented here.

During the two years of investigation, the carbon dioxide content varied from $3.99 \pm 0.03 \text{ mg l}^{-1}$ (June) to $7.85 \pm 0.06 \text{ mg l}^{-1}$ (January) during the 1st year and from $3.01 \pm 0.03 \text{ mg l}^{-1}$ (June) to $6.85 \pm 0.06 \text{ mg l}^{-1}$ (January) during the 2nd year. The seasonal means of both the years are $6.35 \pm 0.05 \text{ mg l}^{-1}$ in rainy, $7.71 \pm 0.03 \text{ mg l}^{-1}$ in winter and $4.93 \pm 0.11 \text{ mg l}^{-1}$ in summers during 2011-12 and $5.35 \pm 0.05 \text{ mg l}^{-1}$ in rainy, $6.66 \pm 0.04 \text{ mg l}^{-1}$ in winter and $3.93 \pm 0.11 \text{ mg l}^{-1}$ in summer during the year 2012-13. The annual means of carbon dioxide content were $6.33 \pm 0.09 \text{ mg l}^{-1}$ during the 1st year and $5.32 \pm 0.09 \text{ mg l}^{-1}$ during the 2nd year respectively. Among the stations, Palur canal shows the highest value i.e. $8.05 \pm 0.07 \text{ mg l}^{-1}$ of carbon dioxide during winter season and Balugaon shows the lowest value i.e. $3.65 \pm 0.41 \text{ mg l}^{-1}$ of carbon dioxide during summer season. (Table-2).

The maximum contents of dissolved oxygen were $9.66 \pm 0.55 \text{ mg l}^{-1}$ and $9.28 \pm 0.56 \text{ mg l}^{-1}$ in the months of June and May of the first and second year respectively. The monthly minimum values of the dissolved oxygen were $6.58 \pm 0.34 \text{ mg l}^{-1}$ and $5.92 \pm 0.34 \text{ mg l}^{-1}$ in the month of November in the first and second year respectively. The seasonal means of both the years recorded were $8.45 \pm 0.14 \text{ mg l}^{-1}$ in rainy, $7.91 \pm 0.20 \text{ mg l}^{-1}$ in winter and $9.48 \pm 0.24 \text{ mg l}^{-1}$ in summer in 2011-12 and $8.61 \pm 0.13 \text{ mg l}^{-1}$ in rainy, $7.31 \pm 0.21 \text{ mg l}^{-1}$ in winter and $9.32 \pm 0.26 \text{ mg l}^{-1}$ in summer in 2012-13 respectively. The annual means of dissolved oxygen were $8.61 \pm 0.12 \text{ mg l}^{-1}$ in 2011-12 and $8.42 \pm 0.13 \text{ mg l}^{-1}$ in 2012-13 respectively. Among the stations Bhusandapur nail shows the highest dissolved oxygen value i.e. $13.60 \pm 0.89 \text{ mg l}^{-1}$ in summer season and Kalupada Ghat shows the lowest dissolved oxygen value i.e. $6.25 \pm 1.01 \text{ mg l}^{-1}$ in winter season respectively. (Table-3).

In 2011-12 the monthly highest value of total dissolved solid was $19607.6 \pm 2501.5 \text{ mg l}^{-1}$ in the month of October and that of the year 2012-13 was $17316.2 \pm 2071.1 \text{ mg l}^{-1}$ in the month of September. The minimum values were recorded $11545.0 \pm 631.8 \text{ mg l}^{-1}$ in the December in 2011-12 and $11881.8 \pm 1027.3 \text{ mg l}^{-1}$ in the month of August in 2012-13 respectively. The seasonal means of both the years recorded were $14922.8 \pm 923.09 \text{ mg l}^{-1}$ in rainy, $12925.8 \pm 346.26 \text{ mg l}^{-1}$ in winter and $16385.8 \pm 936.10 \text{ mg l}^{-1}$ in summer in 2011-12 and $14779.5 \pm 861.19 \text{ mg l}^{-1}$ rainy, 14616.1 ± 587.8 in winter and 17247.0 ± 996.70 in summer in the year 2012-13 respectively. The annual means of Total dissolved solid were $14744.8 \pm 461.31 \text{ mg l}^{-1}$ in 2011-12 and $15547.56 \pm 458.56 \text{ mg l}^{-1}$ in 2012-13 respectively. Among the stations, Palur Canal shows the highest total dissolved solid i.e. $33113.83 \pm 443.7 \text{ mg l}^{-1}$ in the summer season and Busandapur nail showed the lowest value i.e. $6886.33 \pm 258.0 \text{ mg l}^{-1}$ in summer season (Table-4).

DISCUSSIONS

In a seasonal cycle water quality parameters change in any kind of lentic water body since the water contains a variety of substances which vary both qualitatively and quantitatively. However, the number of factors –physical, chemical and biological parameters greatly influencing the water body changes the water quality to a greater extent and ultimately affects the biological phenomena. During the recent years, wetlands have attracted the attention of scientists and the experts to understand and study its values and functions. The unique ecosystem of Chilika lagoon has been a centre of attraction for a number of workers who have done pioneering and commendable work on various aspects of the lagoon. However, there have been conspicuous alternations in regard of physico-chemical parameters of water and sediments and biological parameters after opening of the new mouth in Chilika. During the present study, extensive survey was carried out for presenting the effect of new mouth on the physico-chemical and biological parameters leading to see the correlation among the biotic and abiotic factors of Chilika lagoon.

CO₂ is negatively correlated with water temperature indicating that, during the summer season, this content is decreased due to more photosynthesis due to more growth of aquatic plants increasing productivity of lake with more CO₂ utilization in the process of photosynthesis, as per example in tables-32,35 and 36 (Atekwana *et al.*, 2003) [14].

Dissolved oxygen is an important parameter to indicate the level of water quality / pollution of a water body and has been found to be negatively correlated with BOD and CO₂ and positively with alkalinity. The relationship between DO with BOD and CO₂ is well known. With increase of

pollution, the BOD load due to microorganisms is increased and in the process due to oxygen consumption by the microorganisms, the oxygen content is decreased. This process also increases CO₂ content. Probably alkalinity of the specific pollutants in the water provides favourable conditions for the growth and degradation ability of the microorganisms leading to more oxygen demand and in terms of increase BOD (Chandrasekhar and coworkers, 2003) [15].

TDS is positively correlated with chloride and water temperature. During summer season, the water volume decreases due to little improve of fresh water by the rivers and evaporation of surface water. In such situation, the total dissolved solids are not diluted and thus their content increases (Hambright and coworkers, 1998) [16].

Table- 2. Station, season and yearly mean with standard error of carbon dioxide (CO₂) (mg/l) of Chilika water during 2011-13.

| Stations↓ | 2011-12 | | | 2012-13 | | |
|---------------|---------------|---------------|---------------|---------------|---------------|---------------|
| Seasons→ | Rainy | Winter | Summer | Rainy | Winter | Summer |
| ST1 | 6.60 ±0.13 | 8.00 ±0.05 | 5.20 ±0.44 | 5.60 ±0.18 | 7.00 ±0.04 | 4.20 ±0.29 |
| ST2 | 6.40 ±0.18 | 7.70 ±0.05 | 5.00 ±0.40 | 5.40 ±0.22 | 6.70 ±0.04 | 4.00 ±0.36 |
| ST3 | 6.20 ±0.22 | 7.45 ±0.04 | 4.65 ±0.29 | 5.20 ±0.22 | 6.45 ±0.03 | 3.65 ±0.41 |
| ST4 | 6.30 ±0.22 | 7.55 ±0.04 | 4.90 ±0.36 | 5.30 ±0.18 | 6.55 ±0.07 | 3.90 ±0.36 |
| ST5 | 6.50 ±0.18 | 7.90 ±0.03 | 5.10 ±0.40 | 5.50 ±0.16 | 6.90 ±0.44 | 4.10 ±0.40 |
| ST6 | 6.50 ±0.16 | 8.05 ±0.07 | 5.20 ±0.13 | 5.50 ±0.05 | 7.05 ±0.40 | 4.20 ±0.40 |
| Seasonal Mean | 6.35 ±0.05 | 7.71 ±0.03 | 4.93 ±0.11 | 5.35 ±0.05 | 6.66 ±0.04 | 3.93 ±0.11 |
| Year mean | 6.33 ±0.09 | | | 5.32 ±0.09 | | |

Table- 3. Station, season and yearly mean with standard error of dissolved oxygen (mg/l) of Chilika water during 2011-13.

| Stations↓ | 2011-12 | | | 2012-13 | | |
|---------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Seasons→ | Rainy | Winter | Summer | Rainy | Winter | Summer |
| ST1 | 9.10 ±0.928 | 7.51 ±1.030 | 13.56 ±0.746 | 9.16 ±0.890 | 7.14 ±1.033 | 13.60 ±0.890 |
| ST2 | 7.61 ±0.289 | 6.78 ±0.966 | 7.60 ±0.139 | 7.71 ±0.251 | 6.25 ±1.014 | 7.16 ±0.196 |
| ST3 | 8.76 ±0.329 | 8.41 ±0.441 | 8.76 ±0.080 | 8.71 ±0.218 | 7.78 ±0.400 | 8.46 ±0.174 |
| ST4 | 8.08 ±0.305 | 7.15 ±0.773 | 8.78 ±0.111 | 7.80 ±0.465 | 6.71 ±0.795 | 8.65 ±0.145 |
| ST5 | 8.41 ±0.403 | 8.91 ±0.571 | 9.21 ±0.192 | 8.88 ±0.190 | 8.30 ±0.569 | 9.41 ±0.290 |
| ST6 | 8.61 ±0.361 | 7.78 ±0.595 | 8.75 ±0.188 | 8.63 ±0.217 | 7.35 ±0.598 | 8.38 ±0.111 |
| Seasonal Mean | 8.456 ±0.141 | 7.915 ±0.208 | 9.486 ±0.243 | 8.619 ±0.130 | 7.315 ±0.217 | 9.329 ±0.262 |
| Year mean | 8.619 ±0.124 | | | 8.421 ±0.133 | | |

Table- 4. Station, season and yearly mean with standard error of total dissolved solid (mg/l) of Chilika water during 2011-13.

| Stations↓ | 2011-12 | | | 2012-13 | | |
|---------------|---------------------|---------------------|--------------------|---------------------|---------------------|--------------------|
| Seasons→ | Rainy | Winter | Summer | Rainy | Winter | Summer |
| ST1 | 7036.83 ±815.5 | 15176.66 ±444.4 | 8358.33 ±171.0 | 7479.00 ±823.9 | 16081.33 ±573.3 | 6886.33 ±258.0 |
| ST2 | 10240.33 ±312.7 | 13375.16 ±497.8 | 10761.00 ±202.3 | 10415.33 ±636.0 | 13884.50 ±455.4 | 11289.50 ±260.2 |
| ST3 | 12689.33 ±149.6 | 12006.00 ±673.7 | 13312.66 ±192.8 | 13171.66 ±357.5 | 12715.33 ±787.7 | 13336.50 ±363.1 |
| ST4 | 15048.16 ±1445.1 | 9261.50 ±1396.4 | 18227.50 ±187.1 | 15645.00 ±1365.1 | 10461.00 ±1075.7 | 19335.16 ±476.3 |
| ST5 | 14111.16 ±1771.0 | 14992.83 ±1539.7 | 18455.00 ±340.1 | 15308.50 ±1741.6 | 16343.00 ±1543.1 | 19523.66 ±257.9 |
| ST6 | 25478.50 ±2379.2 | 12746.66 ±476.6 | 21202.83 ±796.0 | 27697.50 ±2879.8 | 18212.83 ±4104.9 | 33113.83 ±443.7 |
| Seasonal Mean | 14922.8 ±923.09 | 12925.8 ±346.26 | 16385.8 ±936.10 | 14779.5 ±861.19 | 14616.1 ±587.89 | 17247.0 ±996.70 |
| Year mean | 14744.83 ±461.31 | | | 15547.56 ±485.56 | | |

Table- 5. The monthly means of physico-chemical parameters of water of Chilika lagoon during 2011-12

| Param eters | July | Aug ust | Septe mber | Octo ber | Nov e. | Dece . | Janu ary | Febr uary | Mar ch | Apri l | May | June |
|-------------------------------|----------------------------|----------------------------|----------------------------|----------------------------|---------------------------|---------------------------|---------------------------|---------------------------|----------------------------|----------------------------|----------------------------|----------------------------|
| CO ₂ (mg/L) | 6.02 ±0.0 5 | 5.88 ±0.0 6 | 6.83 ±0.03 | 6.68 ±0.0 3 | 7.70 ±0.0 5 | 7.56 ±0.0 6 | 7.85 ±0.0 6 | 7.72 ±0.0 6 | 5.87 ±0.0 7 | 5.73 ±0.0 8 | 4.15 ±0.0 3 | 3.99 ±0.0 3 |
| DO (mg/L) | 8.78 ±0.2 69 | 8.73 ±0.2 77 | 8.08 ±0.28 4 | 8.22 ±0.2 88 | 6.58 ±0.3 45 | 6.63 ±0.3 46 | 9.21 ±0.2 22 | 9.22 ±0.1 97 | 9.28 ±0.4 22 | 9.38 ±0.4 32 | 9.61 ±0.5 57 | 9.66 ±0.5 54 |
| TDS (mg/L) | 118 84.7 ±10 26.7 | 118 83.2 ±10 26.6 | 16315 .6 ±1837 .7 | 196 07.6 ±25 01.5 | 115 48.0 ±63 1.8 | 115 45.0 ±63 1.8 | 143 04.8 ±61 5.5 | 1430 5.2 ±614 .9 | 161 05.5 ±18 59.4 | 161 07.5 ±18 59.4 | 166 66.8 ±19 62.8 | 166 63.6 ±19 62.8 |

Table- 6. The monthly means of physico-chemical parameters of water of Chilika lagoon during 2012-13

| Param eters | July | Aug ust | Septe mber | Octo ber | Nov e. | Dece . | Janu ary | Febr uary | Mar ch | Apri l | May | June |
|-------------------------------|----------------------------|----------------------------|----------------------------|----------------------------|---------------------------|---------------------------|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|
| CO ₂ (mg/L) | 5.02 ±0.0 5 | 4.88 ±0.0 6 | 5.83 ±0.03 | 5.68 ±0.0 4 | 6.70 ±0.0 5 | 6.55 ±0.0 6 | 6.85 ±0.0 6 | 6.53 ±0.1 2 | 4.87 ±0.0 7 | 4.71 ±0.0 8 | 3.15 ±0.0 3 | 3.01 ±0.0 3 |
| DO (mg/L) | 8.41 ±0.2 9 | 8.85 ±0.2 5 | 8.55 ±0.25 | 8.65 ±0.2 5 | 5.92 ±0.3 4 | 6.08 ±0.3 4 | 8.57 ±0.2 8 | 8.66 ±0.2 6 | 9.30 ±0.5 1 | 9.43 ±0.5 0 | 9.28 ±0.5 6 | 9.28 ±0.5 5 |
| TDS (mg/L) | 126 05.1 ±11 07.8 | 118 81.8 ±10 27.3 | 17316 .2 ±2071 .1 | 173 14.7 ±20 71.0 | 127 05.1 ±60 6.6 | 127 02.2 ±60 6.6 | 165 27.8 ±14 45.1 | 1652 9.3 ±144 5.2 | 172 22.5 ±20 78.8 | 172 24.4 ±20 78.8 | 172 72.4 ±19 94.1 | 172 68.7 ±19 94.0 |

CONCLUSIONS

The variables that are related to pollution sources show differences and they do not seem to be related to the climatic variation. Although TDS show similar trends, however, in others like CO₂, vary remarkably. Bhusandpur nali shows the highest DO level whereas Kalupada ghat shows the lowest DO level. The stations in between these two based on DO the ranking from the least polluted to the most polluted could be 1). Rambha, 2). Balugaon, 3). Palur canal, 4). Barakul. CO₂ content increases from summer to winter. The controlling factor in the value of dissolved oxygen was not the temperature alone but also the abundance of algal growth resulting liberation of oxygen. The oxygen content varies greatly and it depends largely on the intensity of illumination for which in the clear sky period the oxygen content was comparatively high. Highest value of total dissolved solid was found in the month of October and September in the 1st and 2nd year respectively. The minimum values found in December and August in 1st and 2nd year, respectively.

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