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The study dissolved oxygen, chemical oxygen demand and biological oxygen demand in lakes of Bangalore, garden city of India

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Abstract
Oxygen Supports life, the dissolved oxygen content varies with dissolved salts the dissolved oxygen, BOD and COD determines the flora and fauna in the habitat. This paper hurl radiance on Biological oxygen demand in important lakes of Bangalore. Water samples from three different prominent lakes was collected for about two years at various seasons and analyzed for dissolved oxygen, chemical oxygen demand and biological oxygen demand.

Keywords: Bangalore, dissolved oxygen, chemical oxygen demand and biological oxygen demand

Introduction
Though water can exist in all the three forms namely solid, liquid and gas, most water on earth is found in the liquid form. Water in its liquid state is made up of groups of molecules associated together by linkages between the two hydrogen atoms of one water molecule and the oxygen atom of an adjacent water molecule. This is known as hydrogen bonding. This unique bonding that imparts special properties to water making it an essential component of life. It is the basic transport medium for nutrients and waste products in life processes. It also has the capacity to absorb heat without substantial rise in temperature. Hence, there are no sudden changes in temperature, especially in large bodies. This property protects aquatic organisms from instantaneous shock (Kumar and Ravindranath, 1998) [1].
Fresh water lakes are very vital resources for any country (Reddy, 1984) [2]. Eutrophic lakes initiate as nutrient deficient, hence unproductive. Detritus free systems develop with increasing amount of nutrients, thus leading to the productive systems with considerable amount of organic materials.
Lakes have a complex and fragile ecosystem as they do not have a self-cleaning ability and therefore readily accumulate pollutants. The increasing anthropogenic influences in recent years, in and around aquatic systems and their catchment areas have contributed to a large extent to their accelerated eutrophication.
Aging of lake eutrophication creates robust growth of planktons exspecialey the floating plants covers the water thus not allowing oxygen to diffuse into the water naturaly this results in decress in water content and starvation of aquatic animals due to lack of water thus leading to the death of this animal addition further organic nutrient into the water thus making the water habitat unfit for habitation in this regard the dossloved oxygen, chemical oxygen demand and biological oxygen demand is estimated.

Study Area
Bangalore City in Karnataka State of India lies between 12°44' and 13°14'N latitude and 77°25' to 77°47'E longitude and at a mean altitude of 921m above mean sea level (MSL).
The climate of the district enjoys an agreeable temperature range from the highest mean maximum of 33°C in April to lowest of 14°C in January. It has two rainy seasons from June to September and October to November coming one after the other but with opposite wind regime, corresponding to south-west and north-east monsoons. The mean monthly relative humidity is lowest in the month of March (44%) and high during the month of June to October, being between 80 to 85% on an average. The mean annual rainfall is 859.6 mm and the mean number of rainy days is about 57. Bangalore receives 54% of the total rainfall in the Southwest monsoon period with a rainfall of 496 mm and 34 rainy days, whereas the Northeast monsoon contributes a mean rainfall of 241 mm and mean rainy days being 14 (Kamath, 1990) [3].

Material and Methods
Dissolved Oxygen
A number of factors may affect the accuracy of precision of dissolved oxygen measurements. Winkler's iodometric method was used for the measurement of dissolved oxygen. The basic principle of Winkier's method is estimation of DO. It has been modified to remove nitrate interference by adding solution azide along with alkali-iodide.
When the manganous sulphate is added to the solution contain; sodium or potassium hydroxide, manganous hydroxide is formed which is oxidized by the dissolved oxygen of the sample to basic manganic oxi-hydroxide. On addition of concentrated H2SO4, the basic manganic oxi-hydroxide forms manganic sulphate which further reacts with iodide liberating iodine equivalent to that of DO originally present in the sample. The liberated iodine is titrated with standard solution of sodium thiosulphate using starch indicator (APHA, 2000).

Chemical Oxygen Demand
The Chemical Oxygen Demand (COD) is used as a measure

of oxygen equivalent of organic matter content of a sample that is susceptible to oxidation by a strong chemical oxidant. For samples from a specific source, COD can be related empirically to biological oxygen demand, organic carbon or organic matter. The test is useful for monitoring and control after correlation has been established. Chemical oxygen demand was estimated by Open Reflux method (APHA, 2000).

The sample was refluxed in strong acid solution with a known excess of potassium di-chromate ($K_2Cr_20_7$). After digestion, the remaining unreduced $K_2Cr_20_7$ was titrated with standard ferrous ammonium sulphate to determine the amount of $K_2Cr_20_7$ consumed and the oxidizable organic matter was calculated in terms of oxygen equivalent. Silver sulphate (AgSO4) was added as a catalyst to promote oxidation of certain compoundssuch as straight chain aliphatic compounds and mercuric sulphate (H was added to eliminate the interference due to chloride.

5ml of potassium-di-chromate was taken in a reflux flask and 15mi concentrated sulphuric acid was added with few crystals of silver sulphate and mercury sulphate with 10ml of an aliquot sample. The mixture was refluxed for 2 hrs at around 150°C temperature. After cooling it was titrated against ferrous ammonium sulphate (0.05N) using ferroin indicator. The end point of the titration is blue green to reddish brown.

Biological Oxygen Demand

The biological oxygen demand (BOD) is an empirical test in which standardized laboratory procedures are used to determine the relative oxygen requirements of water and waste water. A number of factors may affect the accuracy and precision of BOD measurements. For instance, soluble and floatable solids, oxidation of reduced ions and sulphur compounds, lack of mixing etc. The BOD test is dependent on dissolved oxygen available in the incubated sample. Therefore, it is necessary to dilute the sample before incubation, to bring the oxygen demand and supply into appropriate balance.

Biological oxygen demand was estimated by Winkler's method (APHA 2000). The basic principle of Winkler's method is estimation of dissolved oxygen uptake at 27°C temperature under incubation for 3 days. It has been modified to remove nitrate interference by adding sodium azide along with alkali-iodide.

Required volume of water was aerated with supply of clean compressed air in a suitable container and to this was added 1ml of phosphate buffer, 1ml of Magnesium Sulphate ($MgSO_4$), 1ml of Calcium Chloride ($CaCI_2$) and 1ml of Ferric Chloride ($FeCI_3$) solution per one liter aerated water and mixed thoroughly. This dilution water was prepared just before use.

Aliquot sample in duplicate was taken in 300 ml BOD bottles and diluted with water. One bottle was incubated at 27°C for 3 days. To the other bottle, 2 ml of Manganous Sulphate ($MnSO_4$) solution was added followed by the addition of 2 ml of alkali-iodide azide solution. The precipitate was allowed to settle, then carefully the stopper was removed and 2 ml concentrated H2SO4 was added by the sides of the bottle. Re-stopped and mixed by inverting several times until dissolution is complete.

Take 200 ml from the BOD bottle into conical flask was titrated against 0.025N Sodium Thiosulphate (Na_2S2O3) using starch as indicator. The end point of the titration is blue color to colorless.

Result and Discussion

Dissolved Oxygen

Dissolved oxygen was 4.29 mg/l at station 'A' and 6.0 at station 'B' from Nov 03 to Oct 04 in the samples collected near Hebbal lake. Similar values were found from Nov 04 to Oct 05. Similarly, in the samples collected near Muninagara lake dissolved oxygen was 5.7 mg/l at station 'A' and 7.2 mg/l at station 'B' from Nov 03 to Oct 04. The values in the samples collected from Nov 04 to Oct 05 are not statistically different from the previous year.

Dissolved oxygen in the samples collected at station 'A' was nil while it was as much as 3.84 mg/l at station 'B' from Nov 04 to Oct 05 near Yelahanka lake. Similar values are found from Nov 03 to Oct 04.

Table 1: Variations in Dissolved Oxygen at the studied lakes

Month & Year	Lakes					
	Hebbal		Muninagara		Yelahanka	
	Station		Station		Station	
	'A'	B[1]	'A'	B'	'A'	[1]B'
Nov 03	5.1	6.8	5.5	8.0	0.0	3.2
Dec 03	5.5	7.2	6.5	8.2	—	4.0
Jan 04	5.2	6.9	6.3	8.2	—	3.7
Feb 04	5.0	6.6	6.3	8.0	—	3.3
Mar 04	4.8	6.0	6.0	7.5	—	3.1
Apr 04	4.0	5.5	5.8	7.2	—	3.0
May 04	2.8	4.8	4.8	6.8	—	2.5
Jun 04	2.5	4.6	4.0	5.8	—	2.5
Jul 04	2.5	4.6	4.0	5.8	—	2.5
Aug 04	3.8	5.5	5.5	6.5	—	3.5
Sep 04	4.8	6.5	5.8	6.8	0.8	4.2
Oct 04	5.0	6.8	6.2	7.5	0.5	4.0
Year Average	4.3+ 0.99	6.0+ 0.89	5.7+ 0.799	7.22+ 0.858	—	3.3+ 0.54
Nov 04	5.6	7.3	7.2	8.5	—	3.8
Dec 04	6.0	7.7	7.0	8.7	—	4.5
Jan 05	5.7	7.4	6.8	8.7	—	4.2
Feb 05	5.5	7.1	6.8	8.5	—	3.8
Mar 05	5.3	6.5	6.5	8.0	—	3.6
Apr 05	4.5	6.0	6.3	7.7	—	3.5
May 05	3.3	5.3	5.3	7.3	—	3.0
Jun 05	3.0	5.1	4.5	6.3	—	3.0
Jul 05	3.5	5.3	5.7	6.7	—	3.5
Aug 05	4.3	6.6	6.0	7.0	—	4.0
Sep 05	5.3	7.0	6.3	7.3	1.0	4.7
Oct 05	5.5	7.3	6.7	8.0	0.5	4.5
Year Average	4.79+ 0.99	6.5+ 0.89	6.24+ 0.73	7.7+ 0.77	0.0	3.84+ 0.54

Chemical Oxygen Demand

The mean chemical oxygen demand was 127.3 at station 'A' and 77.4 mg/l at station 'B' from Nov. '03 to Oct 04 in samples collected near Hebbal lake. Similarly, the average COD showed a decreased value of 117.3 mg/l atstation 'A' and 63.3 mg/l station 'B' from Nov 04 to Oct 05. However, in the samples collected near Muninagara lake, COD was as little as 43.4 mg/l at station 'A' which was found further low of 31.9

mg/l at station 'B' from Nov 03 to Oct 04. Similar values were found from Nov 04 to Oct 05 which averaged to 38.4 mg/l at station 'A' and 26.9 mg/l at station 'B' in samples collected near Muninagara lake.

Chemical oxygen demand in the samples collected near Yelahanka lake was the highest of 162.8 mg/l at station 'A' and 104 mg/l at station B' from Nov 04 to Oct 05. Similarly, the COD was very high of 172.8 mg/l at station 'A' and 114.1 mg/l at station 'B'.

Table 2: Variations in Chemical Oxygen Demand at the studied lakes

	Lakes					
Month &	Hebbal		Muninagara		Yelahanka	
year	Station		Station		Station	
	A	'B'	'A'	'B'	'A'	'B'
Nov 03	125	80	35	**27**	165	110
Dec 03	130	84	42	28	170	115
Jan 04	135	83	42	30	175	118
Feb 04	140	82	44	30	180	120
Mar 04	142	88	48	34	185	120
Apr 04	148	95	49	34	190	122
May 04	158	98	62	48	190	126
Jun 04	155	96	68	52	192	129
Jul 04	135	78	52	40	182	125
Aug 04	110	65	30	22	160	102
Sep 04	75	40	24	18	140	92
Oct 04	75	40	25	20	145	90
Year Average	127.3+ 26.5	77.4+ 10.9	43.4+ 13.1	31.9+ 10.1	172.8+ 16.7	114.1 + 12.5
Nov 04	115	70	30	22	155	100
Dec 04	120	74	37	23	160	165
Jan 05	125	73	37	25	165	108
Feb 05	130	72	39	25	170	110
Mar 05	130	78	43	29	175	110
Apr 05	138	85	44	29	180	112
May 05	148	88	57	43	180	116
Jun 05	145	86	63	47	182	119
Jul 05	125	68	47	35	172	115
Aug 05	100	55	25	17	150	92
Sep 05	65	30	19	13	130	82
Oct 05	65	30	20	15	135	80
Year Average	117.3+ 26.5	63.3+ 22.3	38.4+ 13.1	26.9+ 10.1	162.8+ 16.7	104.0+ 12.5

Biological Oxygen Demand

The biological oxygen demand (BOD) varied depending on the season and other physico-chemical factors in each point at three different tested lakes. BOD was high at station 'A' than at station 'B'. For instance in the samples collected at station 'A' the BOD was 31.1 mg/l with a variation of as high as 11.4 mg/l; while it was as low as 14.0 mg/l with a variation of 5.9 mg/l at station 'B' from Nov 03 to Oct 04 near Hebbal lake. Similarly, BOD was high of 26.1 mg/l with a standard deviation of 11.4 mg/l at station 'A' as against 9.2 mg/l with standard deviation of 5.6 mg/l at station 'B' during Nov 04 to Oct 05 near Hebbal lake.

Biological oxygen demand was as low as 3.3 mg/l at station 'A' and 2.3 at station 'B' from Nov 03 to Oct 04 near Muninagara lake. Similarly the BOD was 2.4 mg/l only at station 'A' and 1.8 mg/l at station 'B' during Nov' 04 to Oct 05. Eventhough the BOD during this period in Muninagara lake was low, but it was clear that the demand for oxygen was more at station A' than at station'B'.

The BOD was highest of 67.8 mg/l with standard deviation of 14.6 mg/l at station 'A' and 25 mg/l with standard deviation of 6.3 mg/l at station B' respectively in the samples collected near Yelahanka lake. It could be seen that highest BOD was in the samples collected near Yelahanka lake and lower at Hebbal lake and the lowest at Muninagara lake. Perhaps, the BOD may depend on the breeding of mosquitoes.

Table 3: Variations in Biological Oxygen Demand at the studied lakes

Month & Year	Lakes					
	Hebbal		Muninagara		YELAHANKA	
	Station		Station		Station	
	'A'	'B'	'A'	'B'	'A'	'B'
Nov03	30	12	03.0	02.0	68	35
Dec 03	30	14	03.5	02.0	71	34
Jan 04	32	14	03.2	02.5	71	32
FebO4	38	12	03.2	02.8	81	32
Mar 04	38	16	03.5	03.0	84	33
Apr 04	40	18	03.5	03.0	88	33
May 04	45	20	04.5	03.8	88	34
Jun 04	45	28	06.0	04.5	87	35
JulO4	32	14	03.5	03.0	80	34
Aug 04	26	09	02.2	01.8	65	22
SepO4	09	06	02.0	01.5	45	18
Oct04	09	06	02.0	01.5	45	18
Year Average	31.1 + 11.4	14.0+ 5.9	3.3+ 1.1	2.3+ 0.89	72.8+ 14.4	30.0+ 6.3
Nov04	25	07	02.0	01.5	63	30
Dec 04	25	09	02.5	01.5	66	29
Jan 05	27	09	02.5	01.5	66	27
FebO5	33	07	02.2	01.8	76	27
Mar 05	33	11	02.5	02.0	79	28
Apr 05	35	13	02.5	02.0	83	28
May 05	40	15	03.5	02.8	83	29
Jun 05	40	23	05.0	03.5	83	30
JulO5	27	09	02.5	02.0	75	29
Aug 05	21	04	01.5	01.0	60	17
SepO5	04	02	01.0	01.0	40	13
Oct05	04	02	01.5	01.0	40	13
Year Average	26.1 + 11.4	9.2+ 5.6	2.4+ 0.99	1.8+ 0.72	67.8+ 14.6	25.0+ 6.3

There was significant change in dissloved oxygen, chemical oxygen demand and biological oxygen demand in the all the habitat which resulted in diverse flora and fauna study in relation with different habitat at different geographical area is necessary to place in record a detail hypothesis on flora and fauna.

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