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Estimation of calcium, magnesium, sulphates, ammonical nitrogen, nitrates, phosphates and heavy metals in water samples of lakes of Bangalore

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Abstract
Mineral salts content in water plays a significant role in determining the flora and fauna of that water body it helps in determining the age of the water body. Study was conduct in three prominent lakes of Bangalore. In the study conducted it showed the variation of calcium from 175.2+ 36.6 to 210.5+ 42.9 over a period of two years, Magnesium showed an variation of 113.5+ 15.2 to 213.9+ 26.5.All other nutrient too showed a sever variation.

Keywords: nitrates, eutrophication, aging of lakes, magnesium and phosphates

Introduction
Water is the most common yet the most precious resource on earth without which there would be no life on earth (Kumar and Ravindranath, 1998) [1]. It is an important factor which controls the limits of distribution of terrestrial animals (Allee *et al.*, 1949) [2]. It is the most vital resource for the life molecule to survive. It possesses a number of physical and chemical properties that help the molecule to act as best suited medium for the life activities. Most of the bio-chemical reactions that occur in the metabolism and growth of the living cells involves water; hence it has been referred to as a universal solvent. It has played a predominant role in governing the distribution of animals.
The quality of water bodies is influenced by physico-chemical environment. These factors determine the ecological conditions and also predict the nutrient status of the water. In India, water pollution is a major problem. Most of the water bodies around industrial and urban centers receive large amount of effluents either partially treated or untreated, thus affecting the quality of water. Most of the lentic water bodies are polluted due to urbanization, industrial growth and other man made problems.
Evaluation of effects due to water pollution involves physical, chemical and biological analysis. Physical and chemical parameters give information related to the time sampling, indicating levels and sources of various pollutants. The biotic and abiotic factors of aquatic ecosystem affect the life.
So this research paper attempts to briefs Calcium, Magnesium, Sulphates, Ammonical Nitrogen, Nitrates, Phosphates and Heavy metals in water samples of lakes of Bangalore.

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
Hydrological samplings were conducted in the selected three lakes at monthly intervals throughout the period of study (Nov 2003 to Oct 2005). The monthly rainfall data was obtained from Indian Meteorological Department, Bangalore and calculated for average values. The atmospheric and ambient water temperatures were recorded at the time of sampling. Water samples were collected from surface at monthly intervals in polythene cans (size 2 Its.) between 7 and 9 a.m. for a period of two years from Nov 03 to Oct 05. The samples were analyzed in the laboratory on the same day for various physico-chemical parameters.

Calcium
The presence of calcium is from passage of water through or over deposits of limestone, dolomite and gypsum. Calcium contributes to the total hardness of water. Calcium was estimated by EDTA titrimetric method (APHA, 2000).
To 50 ml or an aliquot volume and diluted to about 50 ml with distilled water, 2 ml of 4% Sodium hydroxide (NaOH) was added and then titrated against 0.02N EDTA using murexide as indicator.

Magnesium
Magnesium is an essential element in chlorophyll and in red blood cells. It is an important contributor to the hardness of

water. Magnesium was estimated by calculation method (APHA, 2000). It is estimated as the difference between hardness and calcium as Calcium Carbonate ($CaCO_3$).

Sulphate

Sulphate is widely distributed in nature and may be present in natural waters in concentrations ranging from few to a thousand milligrams per liter. Mining drainage wastes may contribute large amounts of sulphate through pyrite oxidation. In the presence of organic matter certain bacteria may reduce sulphate to sulphur.

Sulphate was estimated by Turbidimetric method (APHA, 200: Sulphate ion (SO''^{2}_{4}) is precipitated in an acetic acid medium with barium chloride ($BaCI_2$) so as to form barium sulphate ($BaSO_4$) crystals of uniform size.

Turbidity is the measure of the scattering of light in all directions by undissolved substances. Nephelometers determine the ratio of the intensity of scattered light at right angles to the main light path. This scattered light intensity is proportional to the concentration of the suspension.

100 ml of sample was taken with 5ml of conditioning reagent and was rotated on a magnetic stirrer for about 3 to 4 minutes. While stirring, a spoonful of barium chloride crystals were added. After stirring period ended, solution was poured into sample container of Nephlometer and turbidity measured.

Ammonical nitrogen

The nitrogen present in saline constituents is called ammonical nitrogen. Ammonia is produced by the microbiological activity on organic nitrogenous matter. It appears in ground as well as surface waters. Ammonical nitrogen was estimated by titrimetric method (NH_3-N concentration greater than 5 mg/L) (APHA, 2000).

The sample was buffered to pH 9.5 with borate buffer to decrease hydrolysis of cyanates and organic nitrogen compounds. It is distilled into a solution of boric acid and titrated against standard sulphuric acid.

Suitable volume of sample was taken in distillation flask and diluted to 200 ml. If necessary, the diluted sample was neutralised by using 1N NaOH of H_2SO_4. 10 ml of borate buffer was added and the pH adjusted to 9.5 using 6N NaOH. The flask was placed in its proper position in distillation apparatus and turned on to collect the distillate to about 100 ml in 10 ml boric acid. The volume was noted down and the distillate was titrated with 0.02N H2SO4 using mixed indicator. End point shows dark green to pale lavender color. A blank was carried through all above steps.

Nitrate

Synthetic fertilizer wastes contain enormous quantities of nitrates. Nitrates are the end products of the aerobic stabilization of organic nitrogen.

The basic reaction between nitrates and 1,2.4 phenol-di-sulphonic acid produces 6-nitro 1.2.4 phenol-di-sulphonic acid which upon conversion to alkaline salt yields yellow colored solution. Nitrate was measured by phenol di-sulphonic acid method.

Suitable quantity of well mixed sample was taken in glass dish and evaporated in water bath. 2 ml of phenol-di-sulphonic acid was added to ensure complete dissolution of the residue. To this 50% Sodium hydroxide (NaOH) was added till the red litmus changed to blue, filtered and made upto 50 ml in Nessler's tube. A blank was prepared by treating 50 ml distilled water in the same manner as sample. Read absorbance on a spectrophotometer was read at 450 nm.

Phosphate

Phosphate occurs in natural waters and in waste waters in various forms. They are commonly classified as orthophosphates, condensed phosphates and organically bound phosphates. These various forms of phosphorous may occur in soluble form or in particulate form. Phosphate was estimated by stannous chloride method (APHA, 2000).

Molybdophosphoric acid is formed and reduced by stannous chloride to intensely colored molybdenum blue. This method is more sensitive.

Positive interference is caused by silica and arsenate only if the sample is heated. Negative interference is caused by arsenate, fluoride, thorium, bismuth, sulfide, thiosulphate, thiocynate etc.

50ml or portion diluted to 50 ml of water sample was taken in Nessler's tube and to this 2 ml of ammonium molybdate and 2 to 4 drops of stannous chloride was added. Similarly, standards were prepared with distilled water. The blue colour developed was read on a spectrophotometer at 690 nm.

Heavy metals

The effect of metals in water and waste water range from beneficial to troublesome to dangerously toxic depending on their concentration in waters. Determination of total metal content in water was carried out by digestion with triacidic mixture followed by estimation with atomic absorption spectrophotometer.

Results and Discussion

Calcium

The mean calcium of 175.2 mg/l was recorded at station 'A' and 139.2 mg/l at station 'B' from Nov 03 to Oct 04. It was 146.8 mg/l at station 'A' and 111.5 mg/l at station 'B' from Nov 04 to Oct 05 in the samples collected near Hebbal lake.

Lower amount of calcium with a mean value of 42.2 mg/l was found at station 'A' and 34.4 mg/l at station 'B' from Nov 03 to Oct 04 in the samples collected at Muninagara lake. Such lower values were also found from Nov 04 to Oct 05 in Muninagara lake with a mean value of 32.1 mg/l at station 'A' and 24.0 mg/l at station 'B'.

Higher amount of calcium with a mean value of 339.0 mg/l was found at station 'A' and 240.5 mg/l at station 'B' from Nov 03 to Oct 04 and 309.8 mg/l and 210.5 mg/l from Nov 04 to Oct 05 in the samples collected near Yelahanka lake.

Table 1: Variations in Calcium at the studied lakes

Month & year	Lakes					
	Hebbal		Muninagara		Yelahanka	
	Station		Station		Station	
	'A'	B'	'A'	'B'	•A[1]	'B'
Nov03	158	115	38	30	330	250
Dec 03	167	130	40	30	335	253
Jan 04	174	142	42	32	350	256
FebO4	170	135	41	35	362	262
Mar 04	182	148	45	37	374	268
Apr 04	212	170	48	43	386	266
May 04	225	186	52	45	394	275
JunO4	225	182	52	45	393	278
JulO4	205	160	43	38	386	264
Aug 04	162	125	34	28	328	210
SepO4	110	85	35	24	212	152
Oct04	112	92	36	26	395	222
Year Average	175.2+ 36.6	139.2+ 31.0	42.2+ 5.9	34.4+ 6.4	339.0+ 60.0	240.5+ 42.9
Nov04	128	85	28	20	300	220
Dec 04	137	100	30	20	305	375
Jan 05	144	112	32	22	320	226
FebO5	140	105	31	25	332	232
Mar 05	152	118	35	27	344	238
Apr 05	182	140	38	33	356	236
May 05	195	156	42	35	364	245
Jun 05	195	152	42	35	363	248
JulO5	175	130	33	28	356	234
Aug 05	132	95	24	18	298	180
SepO5	80	55	25	10	182	122
Oct05	92	60	26	16	188	122
Year Average	146.8+ 33.7	111.5+ 27.9	32.1 + 5.9	24.0+ 7.5	309.8+ 60.2	210.5+ 42.9

Magnesium

The mean magnesium value of 113.5 mg/l at station 'A' and 87.6 mg/l at station 'B' was found from Nov 03 to Oct 04 and it was 101.6 mg/l at station 'A' and 77.9 mg/l at station 'B' from Nov 04 to Oct 05 in the samples collected near Hebbal lake.

Lower values of magnesium was found with a value of 25.0 mg/l at station 'A' and 22.3 mg/l at station 'B' from Nov 03 to Oct 04 and still lower values of 15 mg/l at station 'A' and 13.4 mg/l at station 'B' in the samples collected near Muninagara lake. However, highest values of 213.9 mg/l at station 'A' and 137.8 mg/l at station 'B' were recorded from Nov 04 to Oct 05 and in the next year of investigation magnesium was as much as223.9 mg/l at station 'A' and 149.2 mg/l at station 'B' from Nov 03 to Oct 04 in the samples collected near Yelahanka lake.

Table 2: Variations in Magnesium at the studied lakes

Month & year	Lakes					
	Hebbal		Muninagara		YELAHANKA	
	Station		Station		Station	
	'A'	'B'	'A'	'B'	'A'	"B'
Nov03	102	75	24	20	245	160
Dec 03	112	78	25	22	245	162
Jan 04	112	73	24	23	232	160
FebO4	132	95	27	23	223	158
Mar 04	133	102	25	26	221	157
Apr 04	123	110	34	27	224	158
May 04	127	109	32	27	256	167
Jun 04	135	112	34	28	255	200
JulO4	97	90	33	27	229	158
Aug 04	102	85	17	14	212	172
SepO4	92	63	12	14	168	068
Oct04	96	60	13	16	177	070
Year Average	113.5+ 15.2	87.6+ 17.5	25.0+ 6.1	22.3+ 4.96	223.9+ 26.5	149.2+ 37.6
Nov04	98	65	14	10	235	150
Dec 04	102	68	15	12	235	152
Jan 05	102	63	14	13	222	150

FebO5	122	85	17	13	213	148
Mar 05	123	92	15	16	211	147
Apr 05	113	100	24	27	214	148
May 05	117	99	22	17	246	167
Jun 05	115	102	24	18	245	160
JulO5	87	80	23	17	219	148
Aug 05	92	75	07	04	202	162
SepO5	72	53	02	08	158	58
Oct05	76	52	03	06	167	60
Year Average	101.6+ 16.4	77.9+ 17.3	15.0+ 7.4	13.4+ 5.95	213.9+ 26.5	137.8+ 35.9

Sulphate

The total amount of sulphate was 36.2 mg/l at station 'A' and 26.3 mg/l at station 'B' from Nov 03 to Oct 04 and 27.2 at station 'A' and 17.5 mg/lat station 'B' from Nov 04 to Oct 05 in the samples collected near Hebballake.

The total amount of sulphate was 16.0 mg/l at station 'A' and 13.5 mg/l at station B' from Nov 03 to Oct 04 and 11.6 mg/l at station 'A' and 8.3 mg/l at station 'B' from Nov 04 to Oct 05 in the samples collected near Muninagara lake.

The total amount of sulphate was 53.4 mg/l at station A' and 37.4 mg/l at station 'B' from Nov 03 to Oct 04 and 43.4 mg/l at station A and 27.4 mg/l at station 'B' from Nov 04 to Oct 05 in the samples collected near Yelahanka lake.

Table 3: Variations in Sulphates at the studied lakes

	Lakes					
Month & year	**Hebbal Station**		**Muninagara Station**		**Yelahanka Station**	
	'A'	**'B'**	**'A'**	**'B'**	**'A'**	**'B'**
Nov03	36	23	14	12	42	35
Dec 03	34	25	16	12	46	38
Jan 04	39	28	14	12	55	40
FebO4	41	30	16	14	60	42
Mar 04	43	33	19	16	62	42
Apr 04	46	35	22	18	65	43
May 04	48	40	22	18	65	44
Jun 04	46	40	23	19	65	45
JulO4	34	29	19	15	62	39
AugO4	28	21	12	10	52	35
SepO4	20	11	08	08	32	22
Oct04	20	12	08	08	35	24
Year Average	36.2+ 9.2	26.3+ 9.2	16.0+ 4.9	13.5+ 3.6	53.4+ 11.5	37.4+ 7.1
Nov04	26	13	09	07	32	25
Dec 04	24	15	11	07	36	28
Jan 05	29	18	09	07	45	30
FebO5	31	20	11	09	50	32
Mar 05	33	23	14	11	52	32
Apr 05	36	25	17	13	55	33
May 05	38	30	17	13	55	34
Jun 05	36	30	17	14	55	35
JulO5	24	19	14	10	52	29
AugO5	18	11	07	05	42	25
SepO5	10	02	03	02	22	12
Oct05	10	02	03	02	25	14
Year Average	27.2+ 9.1	17.5+ 8.9	11.6+ 4.8	8.3+ 3.9	43.4+ 11.5	27.4+ 7.1

Ammonical Nitrogen

The mean amount of ammonical nitrogen was 22.3 mg/l at station 'A' and 8.2 mg/l at station 'B' from Nov 03 to Oct 04 and 18.3 mg/l at station 'A' and 5.6 mg/l at station 'B' from Nov 04 to Oct 05 in the samples collected near Hebbal lake.

The mean total ammonical nitrogen was 39.6 mg/l at station 'A' and 22.0 mg/l at station 'B' from Nov 03 to Oct 04 and 38.2 mg/l at station 'A' and 20.8 mg/l at station 'B' from Nov 04 to Oct 05 in the samples collected near Yelahanka lake.

The mean total ammonical nitrogen was 7.6 mg/l at station 'A' and 0.97 mg/l at station 'B' from Nov 03 to Oct 04 and 6.6 mg/l at station 'A' and 0.37 mg/l at station 'B' from Nov 04 to Oct 05 in the samples collected near Muninagara lake.

Table 4: Variations in Ammonical Nitrogen at the studied lakes

Month & year	**Lakes**					
	Hebbal Station		**Muninagara Station**		**YELAHANKA Station**	
	'A'	**B[1]**	**'A'**	**'B'**	**'A'**	**'B'**
Nov03	12	2	3	0.3	35	22
Dec 03	13	4	5	0.5	38	22
Jan 04	15	5	5	0.5	40	22
FebO4	18	4	6	0.8	42	23
Mar 04	23	8	8	0.8	42	22
Apr 04	28	12	10	1.2	45	23
May 04	36	18	12	1.8	48	25
Jun 04	42	20	16	3.0	48	26
JulO4	32	15	12	2.0	44	21
Aug 04	25	10	8	0.8	36	21
SepO4	12	ND	3.5	ND	28	18
Oct04	12	ND	3.8	Nil	30	20
Year Average	22.3± 9.9	8.2± 5.5	7.6± 3.9	0.97+ 0.74	39.6± 5.5	22.0± 1.9
Nov04	8	1	2	0.1	31	18
Dec 04	9	0.5	4	Nil	37	21
Jan 05	11	1	4	0.1	39	21
FebO5	14	2	5	0.1	41	22
Mar 05	19	4	7	0.1	40	20
Apr 05	24	8	9	0.1	44	22
May 05	32	14	11	0.8	47	24
Jun 05	38	16	15	2.0	47	25
JulO5	28	11	10	1.0	43	20
Aug 05	21	6	7	0.1	25	20
SepO5	8	2	2.5	Nil	27	17
Oct05	8	2	2.8	Nil	29	19
Year Average	18.3± 9.9	5.6± 5.2	6.6± 3.8	0.37± 0.55	38.2± 6.4	20.8± 2.2

Nitrate

The mean amount of nitrate was 1.1 mg/l at station 'A' and 0.43 mg/l at station 'B' from Nov 03 to Oct 04 and 1.55 mg/l at station 'A' and 0.93 mg/l at station 'B' from Nov 04 to Oct 05 in the samples collected near Hebbal lake.

The mean total nitrate was 0.89 mg/l at station 'A' and 0.63

mg/l at station 'B' from Nov 03 to Oct 04 and 1.38 mg/l at station 'A' and 1.0 mg/l at station 'B' from Nov 04 to Oct 05 in the samples collected near Yelahanka lake.

The mean total nitrate was 0.48 mg/l at station 'A' and 0.33 mg/l at station 'B' from Nov 03 to Oct 04 and 0.98 mg/l at station 'A' and 0.8 mg/l at station 'B' from Nov 04 to Oct 05 in the samples collected near Muninagara lake.

Table 5: Variations in Nitrate at the studied lakes

Month & Year	Lakes					
	Hebbal Station		Muninagara Station		YELAHANKA Station	
	'A'	'B'	'A'	'B'	'A'	'B'
Nov03	1.5	0.5	0.5	0.3	1.2	0.7
Dec 03	1.3	0.4	0.5	0.3	1.0	0.6
Jan 04	1.2	0.4	0.5	0.3	1.1	0.6
Feb04	1.0	0.3	0.4	0.3	0.9	0.6
Mar 04	0.8	0.2	0.4	0.2	0.8	0.5
Apr 04	0.5	0.1	0.3	0.1	0.8	0.5
May 04	0.2	Nil	0.2	0.1	0.6	0.4
Jun 04	Nil	Nil	Nil	Nil	0.5	0.3
JulO4	1.0	0.5	0.4	0.3	0.6	0.5
Aug 04	1.5	0.8	0.6	0.4	0.9	0.8
SepO4	1.8	1.0	1.0	0.8	1.2	1.0
Oct04	1.8	1.0	1.0	0.8	1.0	1.0
Year Average	1.1± 0.47	0.43± 0.08	0.48+ 0.24	0.33± 0.21	0.89± 0.22	0.63+ 1.78
Nov04	2.0	1.0	1.0	0.8	1.7	1.2
Dec 04	1.8	0.9	1.0	0.8	1.5	1.1
Jan 05	1.7	0.9	1.0	0.8	1.6	1.1
FebO5	1.5	0.8	0.9	0.8	1.4	1.1
Mar 05	1.3	0.7	0.9	0.7	1.3	1.0
Apr 05	1.0	0.6	0.8	0.6	1.3	1.0
May 05	0.7	0.5	0.7	0.6	1.1	0.9
Jun 05	0.5	0.5	0.5	0.2	1.0	0.8
JulO5	1.5	1.0	0.9	0.8	1.1	0.8
Aug 05	2.0	1.3	1.1	0.9	1.4	1.0
SepO5	2.3	1.5	1.5	1.3	1.7	1.2
Oct05	2.3	1.5	1.5	1.3	1.5	0.8
Year Average	1.55± 0.53	0.93± 0.33	0.98± 0.28	0.8+ 0.28	1.38± 0.22	1.0± 0.14

Phosphate

The mean total phosphate was 13.7 mg/l at station 'A' and 7.6 mg/l at station 'B' from Nov 03 to Oct 04 and 17.8 mg/l at station 'A' and 10.6 mg/l at station 'B' from Nov 04 to Oct 05 in the samples collected near Hebbal lake.

The mean total PO_4 is 24.5 mg/l at station 'A' and 19.3 mg/l at station 'B* from Nov 04 to Oct 05 and 20.6 mg/l at station 'A' and 15.5 mg/lat station 'B' from Nov 03 to Oct 04 in the samples collected near Yelahanka lake.

The mean total PO_4 was lower of 5.0 mg/l at station 'A' and 3.0 mg/l at station 'B' from Nov 03 to Oct 04 and 9.6 mg/l at station 'A' and 7.0 mg/l at station 'B' from Nov 04 to Oct 05 in the samples collected near Muninagara lake.

Table 6: Variations in Phosphate at the studied lakes

Month & Year	Lakes					
	Hebbal Station		Muninagara Station		Yelahanka Station	
	'A'	'B'	'A'	'B'	'A'	'B'
Nov03	22	14	06	04	26	18
Dec 03	22	12	06	04	22	17
Jan 04	22	12	06	04	21	15
FebO4	18	10	06	03	19	14
Mar 04	15	06	05	02	19	14
Apr 04	12	04	03	01	65	43
May 04	06	—	02	01	14	10
Jun 04	06	—	01	01	14	09
JulO4	08	02	04	02	18	13
Aug 04	10	06	05	03	22	20
SepO4	12	08	08	06	28	22
Oct04	12	08	08	06	28	22
Year Average	13.7+ 5.8	7.6+ 3.9	5.0+ 2.1	3.0+ 1.7	20.6+ 4.7	15.5+ 4.2
Nov04	26	13	09	07	30	22
Dec 04	26	16	11	07	26	21
Jan 05	26	16	10	08	25	19
FebO5	22	14	10	07	23	18
Mar 05	19	10	09	06	23	18
Apr 05	16	08	07	05	20	16
May 05	38	30	06	05	18	14
Jun 05	10	04	05	05	18	13
Ju!05	24	19	14	10	22	17
Aug 05	04	10	09	07	26	22
SepO5	16	12	12	10	32	26
Oct05	16	12	12	10	32	26
Year Average	17.8+ 5.8	10.6+ 4.8	9.6+ 2.1	7.0+ 1.7	24.5+ 4.7	19.3+ 4.0

Iron

The iron content was 2.6 mg/l at station 'A' and 2.1 mg/l at station 'B' from Nov 03 to Oct 04 and 3.0 mg/l at station 'A' and 2.5 mg/l at station 'B' from Nov 04 to Oct 05 in the samples collected near Hebbal lake.

The mean iron content was 3.1 mg/l at station 'A' and 2.9 mg/l at station 'B' from Nov 03 to Oct 04 and 3.2 mg/l at station 'A' and 2.8 mg/l at station 'B' from Nov 04 to Oct 05 in the samples collected at Muninagara lake.

The mean iron (Fe) content was 3.2 mg/l at station 'B' and 2.7 mg/l at station 'B' from Nov 03 to Oct 04 and 3.6 mg/l at station 'A' and 3.1 mg/l at station 'B' in the samples collected near Yelahanka lake.

Table 7: Variations in Iron at the studied lakes

Month & year	Lakes					
	Hebbal		Muninagara		YELAHANKA	
	Station		Station		Station	
	'A'	'B'	'A'	'B[1]	'A'	'B'
Nov03	2.9	2.5	3.0	2.8	4.0	3.0
Dec 03	3.0	2.5	3.0	2.5	4.0	3.0
Jan 04	3.0	2.5	2.8	2.5	3.0	3.0
FebO4	3.0	2.5	2.5	2.5	3.0	3.0
Mar 04	2.5	2.1	2.3	2.5	2.0	2.0
Apr 04	1.8	1.5	2.0	2.3	2.0	1.0
May 04	0.8	0.8	2.0	1.8	1.0	1.0
Jun 04	0.8	0.8	1.8	1.0	1.0	1.0
JulO4	2.0	1.5	2.5	2.0	3.0	2.0
AugO4	3.0	2.5	5.0	4.5	4.5	4.0
SepO4	4.0	3.0	5.5	5.0	5.5	5.0
Oct04	4.0	3.0	5.0	5.0	5.0	5.0
Year Average	2.6+ 1.0	2.1± 1.1	3.1 + 1.2	2.9± 1.2	3.2± 1.4	2.7± 1.4
Nov04	3.5	2.8	3.5	3.3	4.5	3.5
Dec 04	3.5	3.0	3.5	3.0	4.5	3.5
Jan 05	3.5	3.0	3.3	3.0	3.5	3.2
FebO5	3.5	3.0	3.0	3.0	3.5	2.5
Mar 05	3.0	2.6	2.8	3.0	2.5	2.2
Apr 05	2.3	2.0	2.5	2.8	2.5	1.5
May 05	1.3	1.3	2.5	2.3	1.5	1.5
Jun 05	1.3	1.3	2.3	1.5	1.5	1.2
JulO5	2.5	2.0	3.0	2.5	3.5	2.5
Aug 05	3.5	3.0	5.5	5.0	5.0	4.5
SepO5	4.5	3.5	6.0	5.5	6.0	5.5
Oct05	4.5	3.5	5.5	5.0	5.5	5.0
Year Average	3.0± 0.99	2.5± 0.74	3.2± 0.79	2.8+ 0.85	3.6± 1.4	3.1± 1.4

Zinc

The mean total amount of zinc present in the samples near Hebbal lake was 0.6 mg/l at station 'A' and 0.35 mg/l at station 'B' from Nov 03 to Oct 04. Similarly the zinc content during the subsequent year of investigation from Nov 04 to Oct 05 was 0.94 mg/l at station 'A' and 0.658 mg/l at station 'B'.

The mean total amount of zinc was 0.39 mg/l at station 'A' and 0.29 mg/l at station 'B' from Nov 03 to Oct 04 and 0.65 mg/l at station 'A' and 0.55 mg/l at station 'B' from Nov 04 to Oct 05 in the samples collected near Muninagara lake.

The total mean zinc content was 0.358 mg/l at station 'A' and 0.24 mg/l at station 'B' from Nov 03 to Oct 04 and 0.66 mg/l at station 'A' and 0.49mg/l at station B from Nov 04 to Oct 05 in the samples collected near Yelahanka lake.

Table 8: Variations in Zinc at the studied lakes

Month & Year	Lakes					
	Hebbal		Muninagara		YELAHANKA	
	Station		Station		Station	
	'A'	[l]'B'	'A'	'B'	'A'	'B'
Nov03	1.0	0.5	0.5	0.4	0.3	0.1
Dec 03	1.0	0.4	0.5	0.2	0.3	0.1
Jan 04	0.8	0.4	0.4	0.2	0.3	0.2
FebO4	0.8	0.3	0.4	0.2	0.3	0.1
Mar 04	0.6	0.2	0.3	0.1	0.2	0.1
Apr 04	0.2	ND	0.2	ND	0.2	0.1
May 04	ND	ND	ND	ND	0.1	0.1
Jun 04	ND	ND	ND	ND	0.1	0.1
JulO4	0.5	0.3	ND	ND	0.3	0.2
Aug 04	0.8	0.6	0.6	0.6	0.5	0.5
Sep04	1.0	0.8	0.8	0.8	0.8	0.7
Oct04	1.0	0.8	0.8	0.8	0.8	0.6
Year Average	0.6+ 0.2	0.35± 0.18	0.39± 0.19	0.29+ 0.23	0.36± 0.23	0.24± 0.55

Nov04	1.3	0.8	0.8	0.7	0.6	0.4
Dec 04	1.3	0.7	0.8	0.5	0.6	0.4
Jan 05	1.1	0.7	0.7	0.5	0.6	0.5
FebO5	1.1	0.6	0.7	0.5	0.6	0.4
Mar 05	0.9	0.5	0.6	0.4	0.7	0.4
Apr 05	0.5	0.3	0.5	0.3	0.5	0.4
May 05	0.3	0.3	0.3	0.3	0.5	0.4
Jun 05	0.3	0.3	ND	ND	0.4	0.3
JulO5	0.8	0.6	0.5	0.5	0.6	0.4
Aug 05	1.1	0.9	0.9	0.9	0.8	0.6
SepO5	1.3	1.1	1.2	1.0	1.1	0.8
Oct05	1.3	1.1	1.1	1.0	1.1	0.9
Year Average	0.94± 0.37	0.66± 0.25	0.65± 0.26	0.55± 0.24	0.66± 0.22	0.49± 0.18

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