Hydrology
2018; 6(1): 18-31
http://www.sciencepublishinggroup.com/j/hyd
doi: 10.11648/j.hyd.20180601.13
ISSN: 2330-7609 (Print); ISSN: 2330-7617 (Online)

Water Quality Monitoring of Magadi Hill Range Lakes and Reservoirs of India

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To cite this article:
Ramachandra Mohan Muniyellappa. Water Quality Monitoring of Magadi Hill Range Lakes and Reservoirs of India. *Hydrology*. Vol. 6, No. 1, 2018, pp. 18-31. doi: 10.11648/j.hyd.20180601.13

Received: January 5, 2018; **Accepted**: January 12, 2018; **Published**: February 7, 2018

Abstract: Water flows from Magadi hills to Bangalore for about 60 Km, regulates the water quality phenomena through exchange of water. This is the main source of water to caterers drinking, domestic and irrigation purposes of Bangalore City and its sub unbans. Due to improper maintenance and increase papulations of Bangalore City, discharge of sewage water to the Vrishabhavathi river and further this water is flowing back and contaminate the main water bodies which may lead to alter the drinking water quality of Magadi hill range water bodies. Information about water quality monitoring reports and the future project monitoring for these Magadi hill range lakes and reservoirs with special reference to developing countries and its necessary methods/ devices will be reviewed and discussed.

Keywords: Bangalore, Magadi, Hill Range, Water Bodies

1. Introduction

The Bangalore lakes occupy about 4.8% of the cities geographical area (640 sq meters). For Bangalore four valleys i, c, (Virshabavathy, Arkavathy, Hebbal and Koramangala) used to cater water for drinking and irrigation. Due to an increase of population and improper savage management all these valleys are now became a full of savage and not fit for irrigation, domestic are drinking purposes. This could partly relate to the fact that reservoirs are perceived to be low value habitat from a conservation perspective, because the Indian freshwater fish fauna has evolved in rivesrin and floodplain habitats largely in the absence of the large permanent lake systems.

Bangalore city drinking water is mainly from Cauvery River, rain water is due to South West Monsoon brings about one meter of average rainfall over the plains of Magadi hill range lakes and being permanently fed by rain during monsoon Rain, Rains plays an important role in regulating the biological activities of the water bodies. In Bangalore city the monthly rainfall is ranging from 220 – 418.2mm precipitation. Importance of water is well known. It is drawn from natural sources for survival. If water at source is polluted, it is natural that we get polluted water thus causing problems for our survival. It may be mentioned that the water sources are polluted with the idea to improve our living standard or to make our life comfortable but in turn it threatens our very survival. Therefore there is need to study in brief the nature of water pollution so as to enable us to go for prevention.

Water resources are of critical importance to both natural ecosystems and human society development. It is essential and required for maintaining a healthy state of all the animals in sustainable ecosystem. The study of water bodies has gained immense importance in recent years because of their multiple uses for human consumption, agriculture and industry. Thus the demand for water has increased with the increase in human activities and therefore, several of the important concepts in ecology have been developed from studies of the aquatic ecosystems and organisms. Studies of [42], [14], [18], [35] and [46] represent important milestones in the development of the science of ecology.

Freshwater has been of great importance to human beings and other organisms of the environment for sustenance of life and maintaining the balance of the nature, hence “water is the life blood of the earth”. Lakes are becoming very important resources through out the world as they meet basic requirements. Man used water resources for various purposes, such as agriculture, hydropower, industries, municipal supplies, fisheries, recreational use and have put severe strain on the lakes and resulted in deterioration of its quality.

The most important role since ecology determines the habitability and abundance of flora and fauna in different sections [40] though the defilement of water and deterioration of aquatic system is as old civilization however escalating industrialization, urbanization, developmental and agricultural activities have brought irreversible changes in such systems. Unplanned and excessive exploitation and mounting anthropogenic influences in and around aquatic ecosystem have resulted in pollution problems. Lakes being fragile ecosystem are vulnerable to such problems. Pollution caused by a plethora of human activities primarily affects physico-chemical characteristics of water, leading to destructions of community disrupting delicate food webs and deteriorating the lake environment.

Water quality in lakes depends upon natural degradation process of eutrophication. Impacts of human activities, which accelerate eutrophication process by several orders of magnitude then a process that would normally take tens of thousands of years if left to nature. The hastening of eutrophication is an account of waste water discharges and agricultural runoff. The physico-chemical parameters of any lake provide first hand information about water quality characteristics and pollution in lake.

The aquatic ecosystem presents a great contrast to terrestrial ecosystem and aquatic organisms display such a wide range of adaptations that they continue to attract the attention of biologists. Studies on physico-chemical factors influence the aquatic biota [20]. Detailed aspects of physical, chemical and biological characteristics of coastal dune lakes of Eastern Australia [58]. studied basin morphology in relation to chemical and ecological characteristics of lakes [21]. Studies the relationship between phytoplankton composition and physical and chemical variables [25]. On the other hand [29] studied the water chemistry and biology in a shallow lake Pamootis (Greece). studied the species distribution, percentage composition and numerical abundance in north Vembaded Lake [7]

Of late extensive contributions are made in the field of limnology by these authors [15], [16], [49],[55] [62], [43], [53] [2] [24], [6], [49] and [65]

In the early 1990, the work on limnological aspects has been studied by several researchers viz; physico-chemical dimensions of lentic hydrospare of Gaya [45] . Quality of lentic waters of Dharwad district, Karnataka [17]. ecological problems in upper lake of Bhopal [59]. Studied the inter relationship between physico-chemical parameters and phytoplankton in polluted lake Suleker tank of Mandya, Karnataka [44]. monthtly variation in physico-chemical characteristics of a wetland of north Bihar [47]. studied an evaluation of various physico-chemical parameters in surface water of Shahapura lake, Bhopal [56].

[54] studied seasonal variation of physico-chemical parameters of stream in outer Himalayas. [13] investigated the water analysis on Hussainsagar lake of Hyderabad.

studied made by [11] on comparative Limnological investigations of two ponds of Chandraneswar temple in India. Observations of physico-chemical characteristics, and algalblooms, eutrophic conditions of lakes of Udaipura city of Rajasthan made by [12]. Studies of physico-chemical characteristics of Doodhadahri pond of Raipur, Chhattisgarh was made by [31]. Physico-chemical characterization of Kulahalli tank of Davanagere, Karnataka made by [50]. some physico-chemical parameters of Tisgaon lake in Aurangabad, India reported by [60].

The present work focuses on physico-chemical parameters of fresh water bodies of Magadi hill rang .

Study Area:

Magadi hill range area is located 45 km west of Bangalore,(Manchanabele Reservoir) at Latitude 12^{0} 52^{1} 1^{11} N and Longitude 77^{0} 20^{1} 4^{11} E. this water body is also called as Manchanbele, Manchinabele, Manchinbele dam. is build across the river Arkavathi and catering for the irrigation purpose, now it also provide water to the Magadi Town, this Dam. The land which covered for irrigation under this project is called "Thore saalu" because all the villages comes on the two sides of river Arkavathi, in kannada "thore" means river and "saalu" means line.

Manchanbelle reservoir is located on the western side of the Bangalore at a distance of 51 kms. It is located at 12.97° N latitude and 77.23° E longitude with an elevation of 925 metres (3034 feet) from MSL. The reservoir has water spread area of 365 ha. Manchanbele has the highest ratio of catchment to reservoir area (an index of allochthonous input) of 435. The catchment of most of the reservoirs is under forest cover. Manchanabele Reservoir is constructed across the river Arkavathy, a tributary to River Cauvery near Manchanabele village in Magadi Taluk of Bangalore Rural District. The Right and Left bank canals irrigate lands in Magadi and Ramanagaram Taluks. Figure 1. Map showing locations of the Manchanabele reservoir and the sampling sites.

Length of dam: 362.20 Mtr. and height is 28.74 Mtr. with a storage capacity of 34.58 M. Cum. Involving submersion to an extent of 365 Hectares of 4 villages affecting 1350 persons.

Canals: the canal length of Left and Right banks were 52 and 63 Kms. to irrigate 1767 and 2078 Hectares respectively. Since the inflow to the reservoir during the period of six years between 1991 to 1996 was not encouraging, it has been proposed to reduce the lengths of Right Bank Canal to 36 Kms. and Left Bank Canal to 35 Kms. Due to reduction in lengths, the contemplated atchkat has been reduced to 2433 Hectares.

A map of the manchanbele Reservoir basin was used to map out the fifteen sampling sites. The coordinates of these points were estimated from the map and located on the ground using a Global Positioning System (GPS) Owing to the large size, manchanbele Reservoir, and down streams Stream were divided into four stations for sampling purposes. Samples were collected from the reservoir and its feeder streams like Nirmalagiri lake, Bidadi lake, Hemegepura lake, Kagalipura lake, Sulikere lake, Sompura lake, Doddavodeyarhalli lake, Konasandra lake, Kommaghatta lake, Chikkabasti lake, Dalavekere lake, Manchanabele reservoir, Nagadevanahalli lake, Kengeri lake, Mallathahalli lake in the study communities to ascertain the pollutant sources to Magadi hill range lakes/ Reservoir. Figure 2. Map showing locations of the Byramangala reservoir, Vrishabhavathi valley, Arkavathy valley, and the sampling sites.

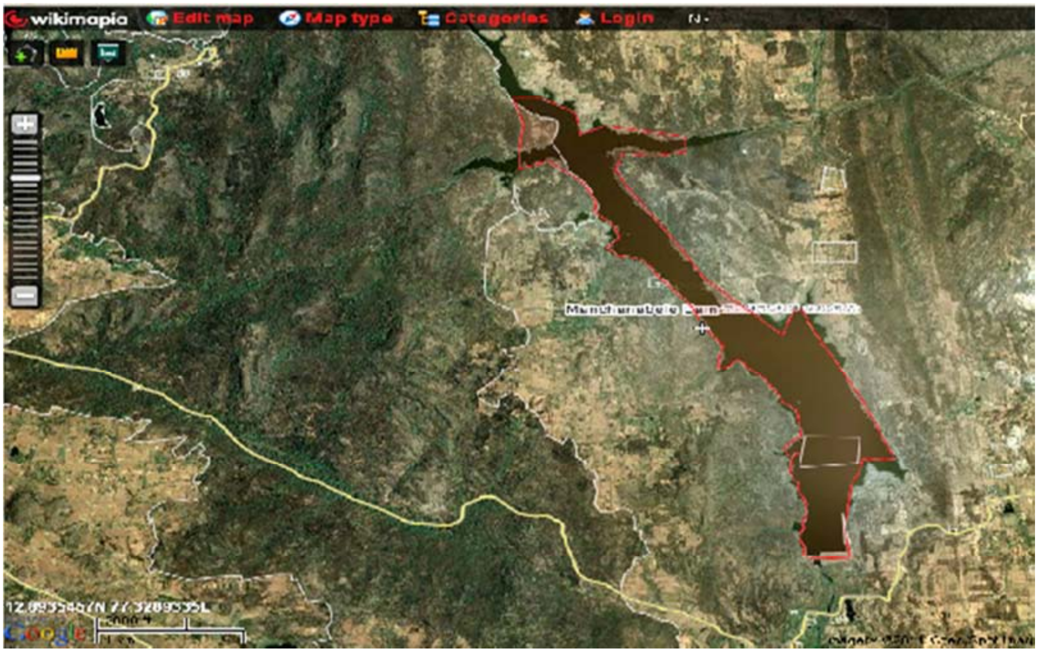
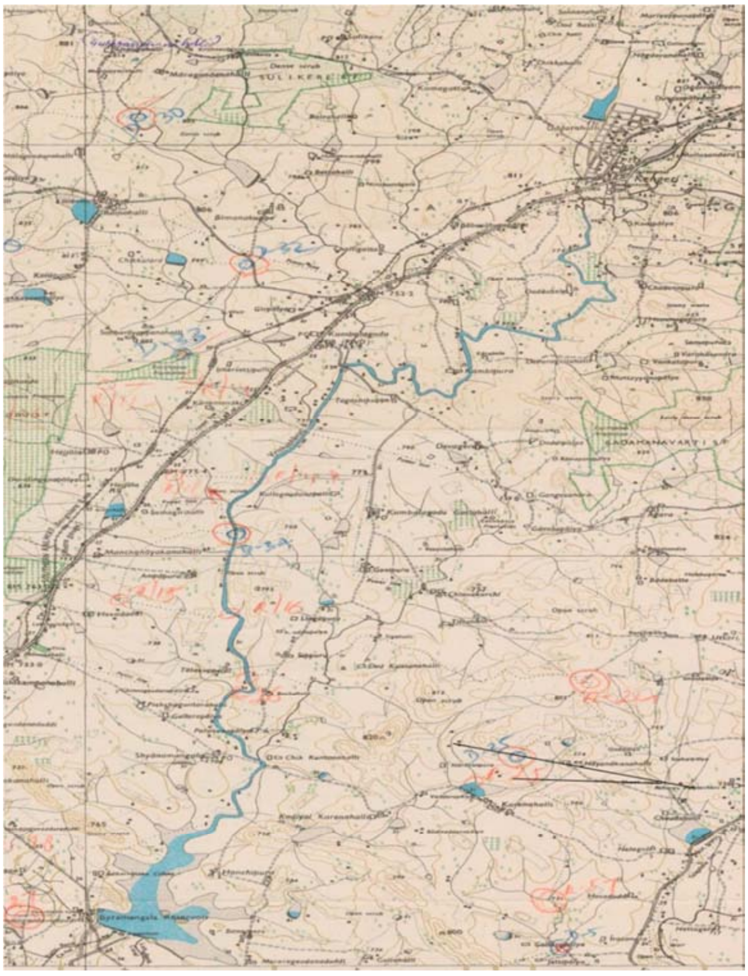


Figure 1. Map showing locations of the Manchanabele reservoir and the sampling sites.



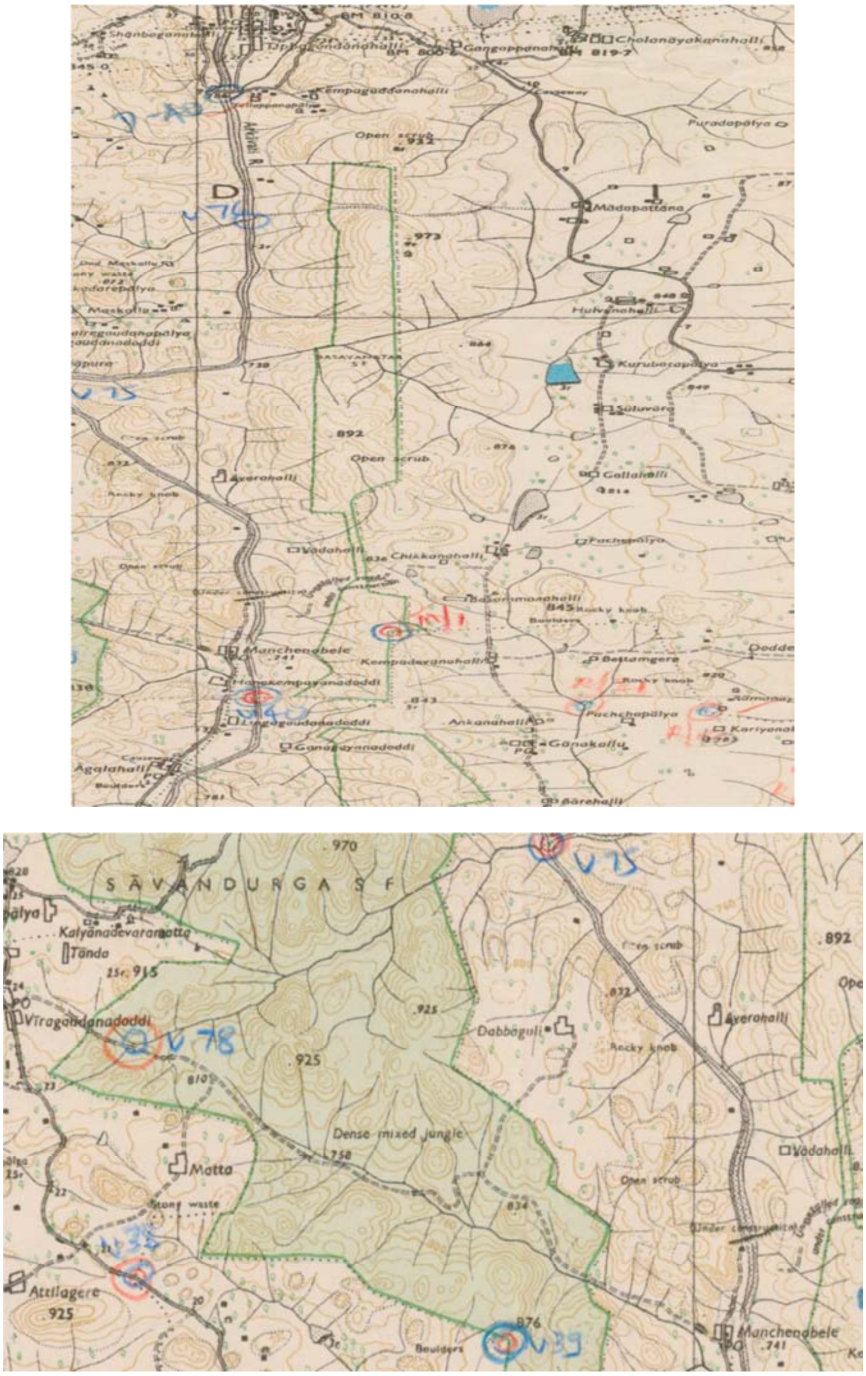


Figure 2. Map showing location of the Byramangala reservoir, Vrishabhavathi vale, Arkavathy vale, and the sampling sites.

2. Materials and Methods

Water samples from the lakes were collected and observed between 08.00 A. M. to 12.00 P. M. throughout the study period. The water samples collected from the lakes in bottles were brought to the laboratory and parameters studied comprised pH, Temperature, TDS, Turbidity, Electrical Conductivity, Total Hardness, Total Alkalinity, Dissolved oxygen, Biological oxygen demand, Chemical oxygen demand, Phosphates, Sulphates, Nitrates and potassium to the laboratory for analysis of parameters studied as per the standard methods described by APHA (1995), Trivedy and Goel P. K. (1986), Mathur R. P. (1999).

3. Results

Average values of magadi hill range water bodies are represented in Table: 1. Monthly variation of physico-chemical parameters of four vales of Bangalore namely Vrishabhavathy, Arkavathy, Hebbal and Koramangala are represented in Table: 2, 3, 4 and 5 respectively. Graphical representation of monthly variation of physico-chemical parameters for Vrishabhavathy, Arkavathy, Hebbal and Koramangala vales are shown in Figure: 3 – 16.

Table 1. *Showing average values of physico-chemical parameters of magadi hill range water bodies.*

Sl. No	Parameters	Units	WHO Standard	NG	B	HP	KP	SK	SP	DV	KS
1.	Water Temp	°C		26.9	28.41	27.8	28.4	25.46	26.78	28.9	28.0
2.	pH		6.5 – 9.2	6.9	7.31	7.3	6.5	7.6	7.35	7.61	7.6
3.	DO	mg/L	5 - 10	4.43	6.5	6.9	8.5	6.99	7.2	6.85	7.8
4.	BOD	mg/L	6.0	4.32	6.0	6.09	4.2	5.5	6.54	6.20	6.2
5.	COD	mg/L	10.0	10.54	16.38	30.53	16.7	25.01	29.83	37.05	16.8
6.	TDS	mg/L	500	283.33	366.66	583.33	100	716.66	450	650	700
7.	Elec Conductivity	Mmhos/cm	1400	442.7	572.91	911.43	156.25	1119.79	703.12	1015.62	1093.75
8.	Alkalinity	mg/L	200 - 600	102.83	77	163.16	62.3	91.66	128.16	109.16	224
9.	Chloride	mg/L	200 – 600	40.65	63.16	97.95	56.4	80.31	90.55	96.91	77
10.	Hardness	mg/L	500	126.41	96.66	190.83	94.3	233.66	97.16	136.66	160

NG – Nirmalagiri lake, B – Bidadi lake, HP - Hemegepura lake, KP – Kagalipura lake, SK – Sulikere lake, SP – Sompura lake, DV – Doddavodeyarhalli lake, KS – Konasandra lake.

Sl. No	Parameters	Units	WHO Standard	KG	CB	DK	MB	NH	K	MT
1.	Water Temp	°C		29.0	30.1	26.8	29.4	27.25	28.4	28.2
2.	pH		6.5 – 9.2	6.9	7.2	7.4	7.9	7.25	7.8	5.9
3.	DO	mg/L	5 - 10	3.25	3.9	6.5	9.1	4.6	7.9	3.25
4.	BOD	mg/L	6.0	7.6	8.6	5.2	5.4	4.61	3.8	18.2
5.	COD	mg/L	10.0	22.4	30.7	20.8	16.8	28.23	4.8	38.8
6.	TDS	mg/L	500	800	900	300	200	633.33	400	500
7.	Elec Conductivity	Mmhos/cm	1400	1250	1406.25	468.75	312.5	989.58	625	781.25
8.	Alkalinity	mg/L	200 - 600	61.66	113	62	57.5	91.16	66	113
9.	Chloride	mg/L	200 – 600	108.33	97.8	39	33	110.43	194	405.83
10.	Hardness	mg/L	500	25	366	186	192	183.66	98	150

KG - Kommaghatta lake, CB - Chikkabasti lake, DK – Dalavekere lake, MB – Manchanabele reservoir, NH – Nagadevanahalli lake, K – Kengeri lake, MT – Mallathahalli lake.

Table 2. *Representing monthly variation of different physico-chemical parameters of vrishabhavathy vale.*

SL. NO.	Parameters	Units	Who Standards	jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec.
1.	pH		6.5 – 9.2	7.8	7.6	8.0	8.2	8.3	8.0	7.9	7.9	8.0	7.7	7.8	7.7
2.	WATER TEMP	°C		23.3	23.0	28.0	29.0	30.0	28.0	27.2	26.0	25.2	24.0	23.0	23.4
3.	TDS	mg/L	500	755.0	748.0	760.0	782.0	783.0	753.0	820.0	920.0	880.0	750.0	753.0	748.0
4.	TURBIDITY	FAU		31.0	32.0	26.0	27.0	28.0	28.0	29.2	30.2	27.0	33.0	34.0	32.0
5.	CONDUCTIVITY	mhos/cm	1400	1263.0	1216.0	1238.0	1200.0	1226.0	1360.0	1420.0	1380.0	1460.0	1310.0	1260.0	1200.0
6.	TOTAL HARDNESS	mg/L	500	373.0	360.0	530.0	475.0	460.0	400.0	360.0	310.0	303.0	268.0	192.0	220.0
7.	ALKALINITY	mg/L	200 - 600	704.0	690.0	670.0	774.0	810.0	760.0	780.0	810.0	780.0	560.0	670.0	610.0
8.	DO	mg/L	5 - 10	4.0	3.8	2.6	2.7	2.3	2.8	3.2	3.8	2.7	3.0	3.0	3.4
9.	BOD	mg/L	6.0	11.3	12.3	20.8	21.3	28.7	17.0	18.2	18.0	19.0	12.0	17.0	19.2
10.	COD	mg/L	10.0	23.0	28.0	61.0	63.0	58.0	48.0	49.0	50.0	52.0	38.0	42.0	40.0
11.	PHOSPHATE	mg/L		6.8	7.2	6.0	5.8	5.9	10.5	13.0	14.0	14.5	8.2	8.0	7.8
12.	SULPHATE	mg/L		26.0	23.0	22.0	23.0	24.0	38.0	32.0	40.0	29.0	27.0	26.0	25.0
13.	NITRATE	mg/L		4.2	4.8	3.2	2.8	2.0	5.7	6.8	5.0	5.2	4.2	4.0	4.4
14.	POTASSIUM	mg/L		18.2	17.8	16.0	17.0	16.0	19.0	23.0	24.0	21.0	20.0	18.0	19.0

Table 3. *Representing monthly variation of different physico-chemical parameters of arkavathy vale.*

SL. NO.	Parameters	Units	Who Standards	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec.
1.	pH		6.5 – 9.2	7.0	7.2	8.0	7.8	7.7	8.0	7.5	7.6	7.4	7.0	7.2	7.0
2.	WATER TEMP	°C		23.8	23.2	26.3	27.0	28.0	25.0	24.8	25.2	25.6	24.0	23.0	24.3
3.	TDS	mg/L	500	1288.0	1264.0	1322.0	1400.0	1374.0	1520.0	1478.0	1388.0	1400.0	1220.0	1270.0	1300.0
4.	TURBIDITY	FAU		172.0	183.0	162.0	170.0	168.0	139.0	140.0	148.0	152.0	172.0	178.0	184.0
5.	CONDUCTIVITY	mhos/cm	1400	2000.0	1978.0	1825.0	1725.0	1698.0	2500.0	1950.0	2300.0	2420.0	1800.0	1750.0	1810.0
6.	TOTAL HARDNESS	mg/L	500	213.0	208.0	234.0	226.0	220.0	175.0	183.0	195.0	164.0	198.0	210.0	195.0

SL. NO.	Parameters	Units	Who Standards	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec.
7.	ALKALINITY	mg/L	200 - 600	223.0	227.0	278.0	293.0	282.0	263.0	251.0	248.0	260.0	238.0	221.0	228.0
8.	DO	mg/L	5 - 10	6.7	7.0	5.2	5.7	5.0	6.2	6.0	5.8	6.4	7.2	7.0	6.4
9.	BOD	mg/L	6.0	3.0	3.2	4.3	4.0	4.2	4.0	4.2	4.0	3.8	3.0	3.8	3.2
10.	COD	mg/L	10.0	33.0	32.0	48.0	47.0	46.0	39.0	36.0	37.0	36.0	32.0	34.0	38.0
11.	PHOSPHATES	mg/L		0.3	0.35	0.2	0.25	0.3	0.3	0.6	0.8	0.7	0.5	0.4	0.35
12.	SULPHATES	mg/L		16.5	17.2	16.2	16.2	17.0	27.0	23.0	22.5	23.2	19.0	18.0	17.2
13.	NITRATES	mg/L		6.2	5.9	6.5	5.8	6.3	9.5	9.0	9.5	8.5	6.0	5.3	5.8
14.	POTASSIUM	mg/L		31.0	29.0	31.0	29.0	28.0	38.0	39.0	42.0	44.0	32.0	33.0	82.0

Table 4. *Representing monthly variation of different physico-chemical parameters of hebbal vale.*

SL. NO.	Parameters	Units	Who Standards	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec.
1.	pH		6.5 – 9.2	7.0	7.1	7.9	7.5	8.0	7.2	7.7	7.1	7.1	7.2	7.1	7.3
2.	WATER TEMP	°C		23.0	22.3	26.0	23.0	24.90	23.0	24.60	22.9	23.0	22.0	22.30	23.3
3.	TDS	mg/L	500	1270.0	1320.0	950.0	870.0	900.0	1470.0	1530.0	1632.0	1538.0	1321.0	1300.0	1283.0
4.	TURBIDITY	FAU		18.0	18.0	12.0	13.0	14.0	12.0	8.0	10.0	8.0	18.0	16.0	18.0
5.	CONDUCTIVITY	mhos/cm	1400	730.0	760.0	650.0	720.0	680.0	1120.0	930.0	850.0	830.0	800.0	760.0	770.0
6.	TOTAL HARDNESS	mg/L	500	370.0	362.0	440.0	430.0	385.0	350.0	363.0	342.0	350.0	380.0	392.0	362.0
7.	ALKALINITY	mg/L	200 - 600	149.0	153.0	192.0	183.0	178.0	157.0	153.0	151.0	160.0	148.0	163.0	140.0
8.	DO	mg/L	5 - 10	5.2	5.8	4.3	4.2	4.0	5.8	5.0	5.0	4.8	4.8	5.0	5.2
9.	BOD	mg/L	6.0	6.2	6.0	13.1	14.0	14.8	9.0	10.2	12.3	10.2	6.6	6.8	6.0
10.	COD	mg/L	10.0	113.0	109.0	172.0	180.0	167.0	157.0	147.0	137.0	130.0	103.0	98.0	112.0
11.	PHOSPHATES	mg/L		0.5	0.6	0.7	0.4	0.3	0.8	0.1	0.9	0.8	0.6	0.5	0.8
12.	SULPHATES	mg/L		11.2	11.6	10.2	8.5	9.0	14.0	17.32	16.0	14.0	11.2	12.2	12.0
13.	NITRATES	mg/L		4.2	4.4	3.8	3.9	3.2	5.2	4.8	4.3	4.5	4.8	4.2	4.0
14.	POTASSIUM	mg/L		3.1	3.2	2.3	3.2	3.3	9.2	8.2	7.2	7.3	3.2	3.9	3.0

Table 5. *Representing monthly variation of different physico-chemical parameters of koramangala vale.*

SL. NO.	Parameters	Units	Who Standards	Jan	Feb	mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec.
1.	pH		6.5 – 9.2	7.6	7.2	7.8	8.0	7.4	7.8	7.1	7.2	8.0	7.5	7.8	7.9
2.	WATER TEMP	°C		29.6	30.2	31.1	31.0	31.2	28.3	27.1	27.2	28.0	30.9	28.0	27.0
3.	TDS	mg/L	500	500	400	400	300	400	300	200	100	200	200	500	500
4.	TURBIDITY	FAU		14	16	18	32	330	43	371	245	22	85	48	43
5.	CONDUCTIVITY	mhos/cm	1400	781.25	625	625	468.75	625	468.75	312.5	156.25	312.5	312.5	781.25	781.25
6.	TOTAL HARDNESS	mg/L	500	182	163	144	116	160	54	90	122	128	168	184	204
7.	ALKALINITY	mg/L	200 - 600	96	87	81	42	62	52	50	54	130	174	176	150
8.	DO	mg/L	5 - 10	3.2	2.9	3.1	2.6	3.9	5.2	4.6	6.5	3.25	7.15	5.2	7.8
9.	BOD	mg/L	6.0	6.1	5.9	5.4	5.2	4.8	4.9	4.2	3.8	6.8	7.0	5.05	6.8
10.	COD	mg/L	10.0	7.4	8.2	6.9	11.2	4.8	4.8	25.6	1.6	1.6	16.0	9.6	20.8
11.	PHOSPHATES	mg/L		0.6	0.53	0.42	0.5	0.61	0.65	0.75	0.83	0.78	0.81	0.62	0.45
12.	SULPHATES	mg/L		11.2	7.8	9.6	8.3	12.5	14.8	16.7	17.5	19.6	18.7	12.3	9.3
13.	NITRATES	mg/L		5.3	5.1	4.3	4.5	5.5	6.2	6.7	6.9	7.2	6.4	3.6	4.5
14.	POTASSIUM	mg/L		8.3	7.6	8.8	9.1	9.6	9.4	6.3	11.6	12.4	8.9	9.6	10.4

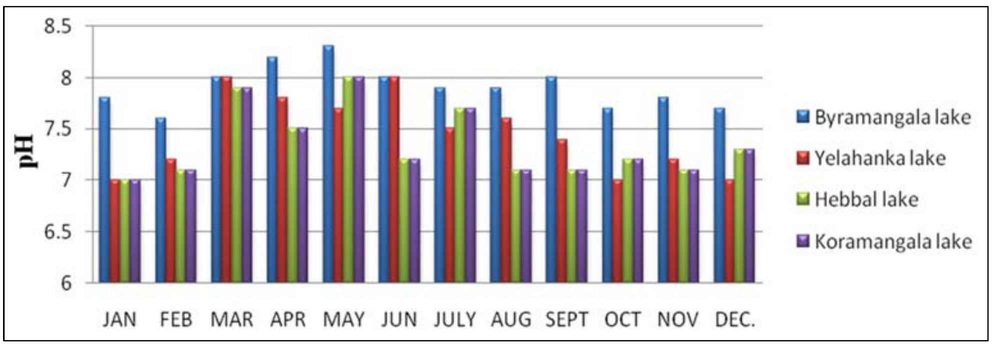


Figure 3. *Showing Monthly Variation of pH in four vales of Bangalore.*

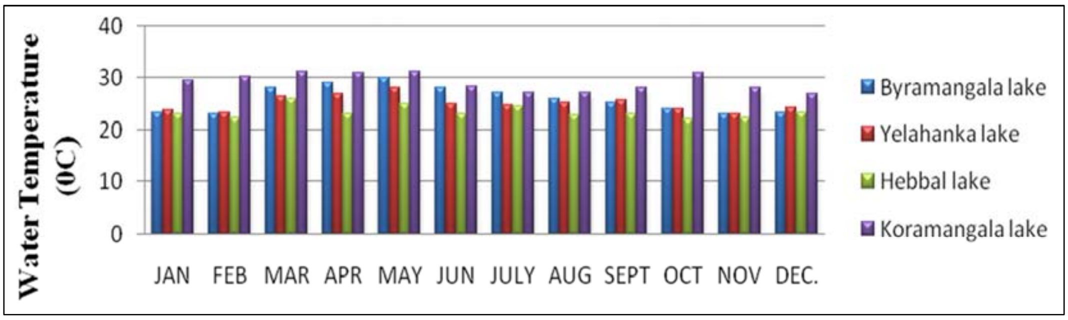


Figure 4. *Showing Monthly Variation of Water Temperature in four vales of Bangalore.*

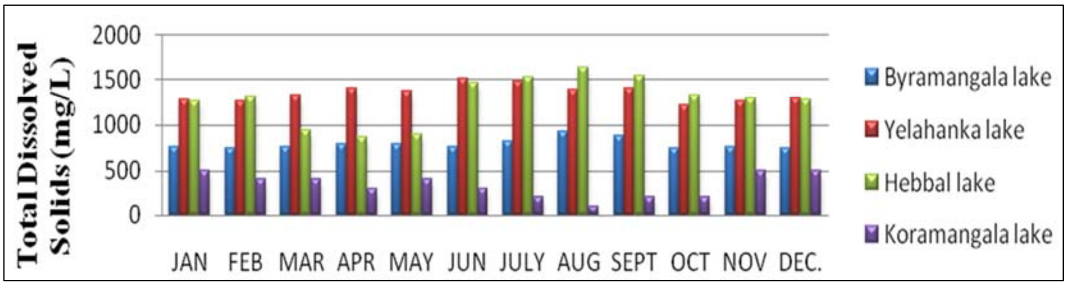


Figure 5. *Showing Monthly Variation of Total Dissolve Solids in four vales of Bangalore.*

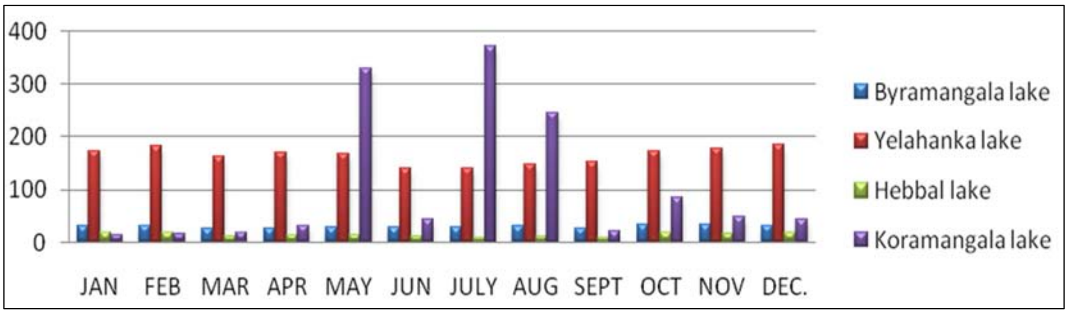


Figure 6. *Showing Monthly Variation of Turbidity in four vales of Bangalor.*

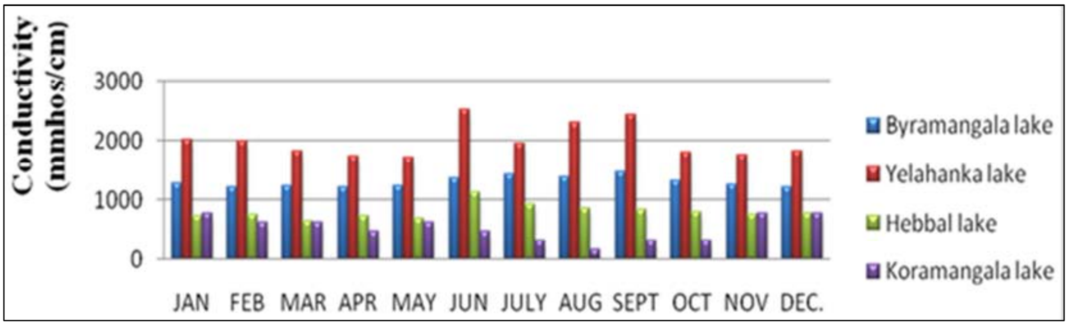


Figure 7. *Showing Monthly Variation of Conductivityin four vales of Bangalore.*

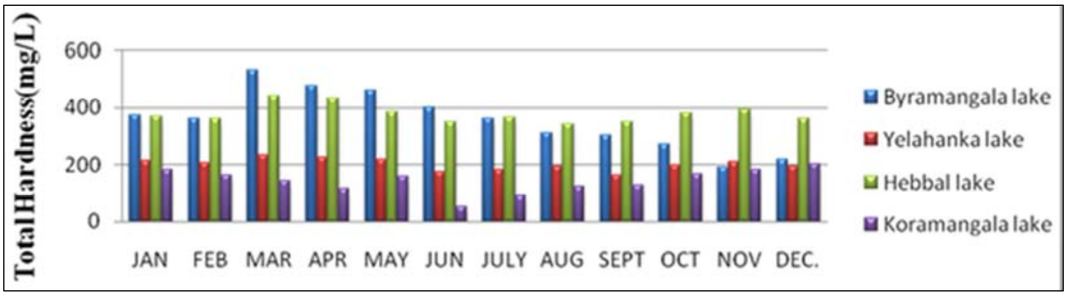


Figure 8. *Showing Monthly Variation of Total Hardness in four vales of Bangalore.*

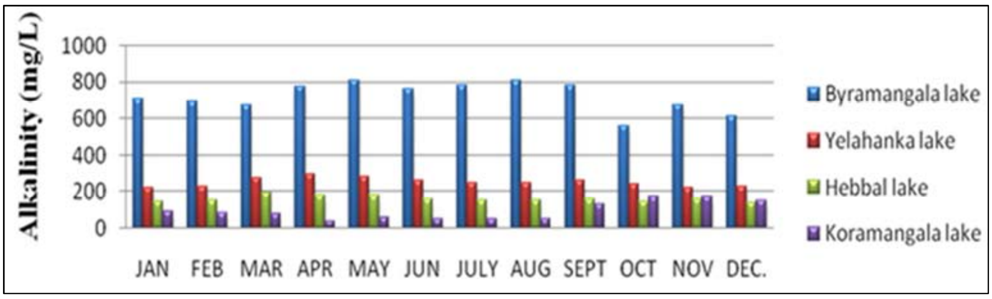


Figure 9. *Showing Monthly Variation of Alkalinity in four vales of Bangalore.*

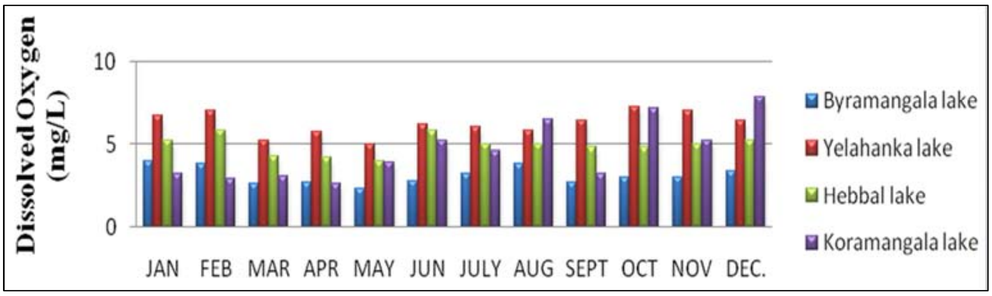


Figure 10. *Showing Monthly Variation of Dissolved Oxygen in four vales of Bangalore.*

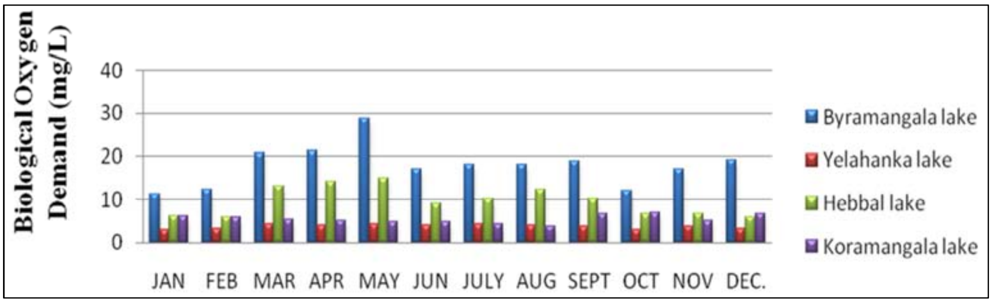


Figure 11. *Showing Monthly Variation of Biological Oxygen Demand in four vales of Bangalore.*

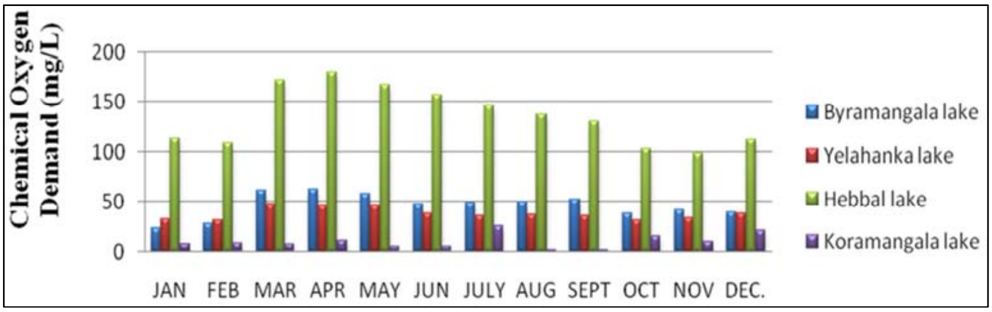


Figure 12. *Showing Monthly Variation of Chemical Oxygen Demand in four vales of Bangalore.*

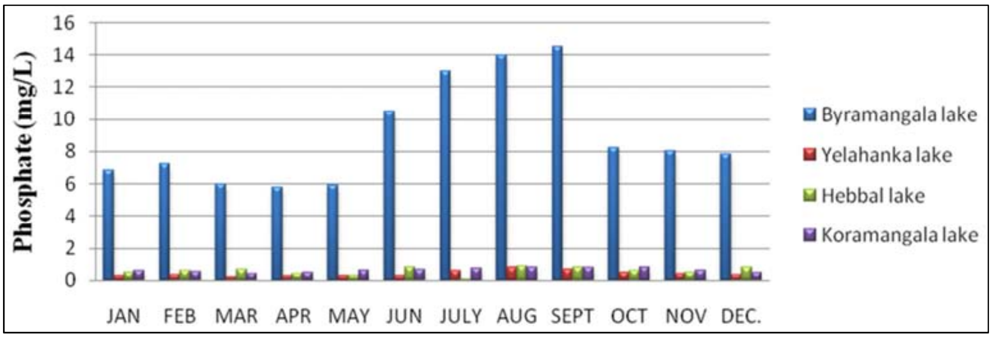


Figure 13. *Showing Monthly Variation of Phosphate in four vales of Bangalore.*

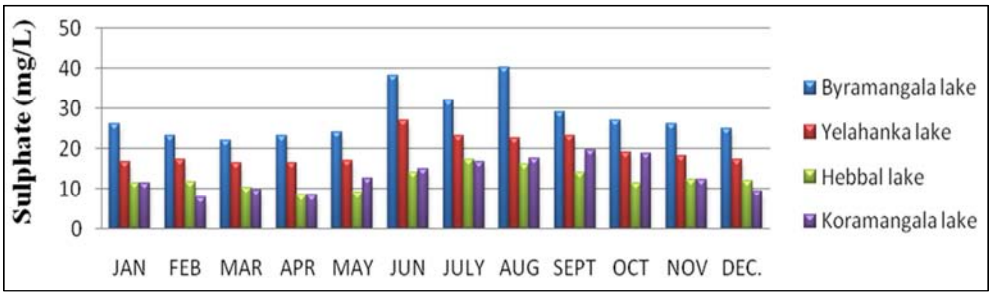


Figure 14. *Showing Monthly Variation of Sulphate in four vales of Bangalore.*

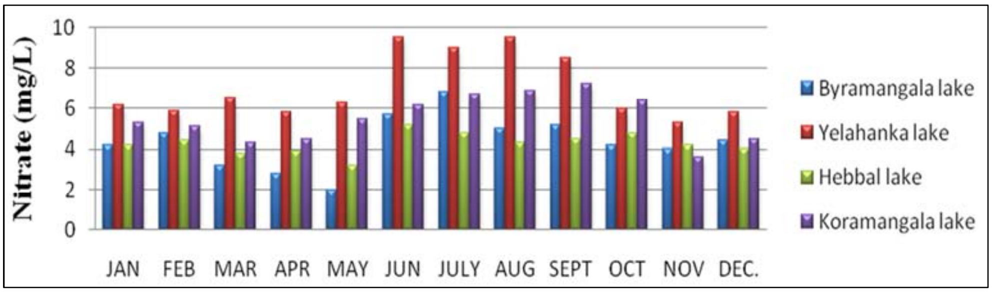


Figure 15. *Showing Monthly Variation of Nitrate in four vales of Bangalore。*

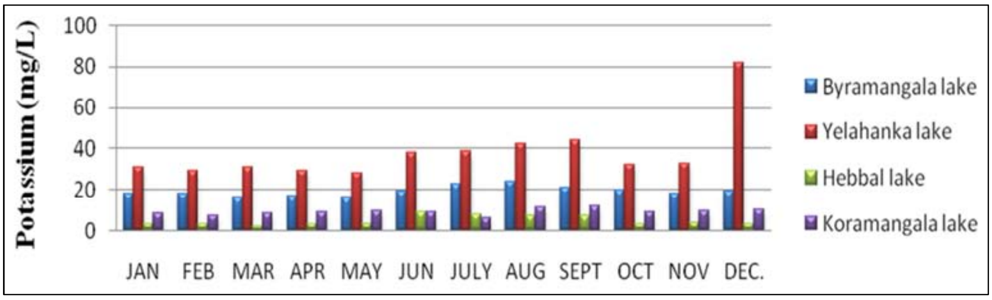


Figure 16. *Showing Monthly Variation of Potassium in four vales of Bangalore.*

4. Discussion

Water is the most vital resource for all kind of life on this planet. It is also the resource which has been adversely affected both qualitatively and quantitatively by all kind of human activities on land and water. The increasing industrialization, urbanization and developmental activity and consequent pollution of water resources have brought acute of water crisis. Today, most of the lakes of world receive millions of litres of sewage, domestic waste, industrial waste water and agricultural runoff containing several kinds of harmful substances.

The pH values varied different lakes as follows: In Byramangala lake recorded 7.6-8.2; Yelahanka lake recorded 7.0-.8.0; Hebbal lake recorded 7.1-7.9 and Koramangala lake recorded 7.2-8.0. the pH was found above 7.0 in all the lakes making them alkaline that may be due to the presence of alkaline substances, detergents as a component of industrial effluents and household sewage. The pH values were mostly within desirable limits prescribed by (ICMR, WHO). A pH range of 6.7 and 8.4 is considered to be safe for aquatic life and to maintain productivity. However, pH below 4.0 and above 9.6 are hazardous to most life forms. pH gives an idea to the to the and intensity of pollution (Verma et al., 1987; [40] that pH is considered a very important single factor which influences aquatic production [57]

Water temperature regulating factor for various physico-chemical as well biological activities in ecosystem. Temperature also affects the concentration of dissolved oxygen and can influence the activity of bacteria and toxic chemicals in water. Temperature values varied in different lakes as follows: Byramangala lake recorded 23.0-30°C; Yelahanka lake recorded 23.0-28°C; Hebbal lake recorded 22-24.9°C and Koramangala lake recorded 27-31.2°C. Moderately high temperature of water has been found to favour the active multiplication of plankton resulting in low transparency. It also exerts profound influence on metabolic and physiological behaviour of aquatic ecosystem [66] It also reflects on the dynamics of living organisms [9] Increase temperature not only reduces oxygen availability, but also increases oxygen demand, a situation that would add to physiological stress of organisms [19] In fresh water ecosystem dissolved solids originate from natural sources and depending upon location. Geological basin of the water body drainage, rainfall, bottom deposits and flowing water.

Total dissolved solids values ranges varied in different lakes as follows: Byramangala lake recorded 748-920 mg/l; Yelahanka lake recorded 122-152 mg/l; Hebbal lake recorded 870-1632 mg/l and Koramangala lake recorded 100-500 mg/l. The values highest recorded in Hebbal lake and lowest recorded in Koramangala lake. The values of and Yelahanka lake are within the permissible limits and Koramangala lake values are below the desirable level, and in Hebbal lake the values recorded are above the permissible limits (ICMR. USEPA). A certain level of these ions in water is necessary for aquatic life; changes in TDS concentration can be harmful because of entry and exit of water into and out of an organism's cell [41]. The high concentration of TDS reduce water clarity, contribute toa decrease in photosynthesis, combine with toxic compounds and heavy metals, and lead to an increase in water temperature. (Kan CRN website). High TDS concentration can produce laxative effects and can give an unpleasant mineral taste to water.

Turbidity of water is actually the expression of optical property in which the light is scattered by the particles present in the water. Turbidity values varied in different lakes as follows: Byramangala lake recorded 26-34 FAU; Yelahanka lake recorded 139-184 FAU; Hebbal lake recorded 8-18 FAU and Koramangala lake recorded 14-371 FAU. The highest values recorded in Yelahanka lake and lowest values recorded in Hebbal lake. All values recorded above are within the permissible limit prescribed by ICMR. Turbidity has been considered as a limiting factor for biological productivity in fresh water []. The sources are mainly the storm water, agricultural run off and effluents from industrial and domestic sectors, which in turn restrict the penetration of light giving rise to reduced photosynthesis and aesthetically unsatisfactory odors [32]. Turbidity in water is caused by suspended matter such as clay, silt, organic matter, plankton and other microscopic organisms that interfere with the passage of light through the water [5]

Conductivity is good and rapid measure of the solids, Conductivity values varied in different lakes as follows: Byramangala lake recorded 1200-1460 mmhos/cm; Yelahanka lake recorded 1750-2500 mmhos/cm; Hebbal lake recorded 650-1120 mmhos/cm and Koramangala lake recorded 312.5-781.25 mmhos/cm. The values are highest recorded in Yelahanka Lake and lowest recorded in Koramangala Lake. The values observed in Yelahanka lake values are very much higher than the prescribed standards limits (1400 mmhos/cm) recommended by W. H. O. Conductivity increases with increasing amount of mobility of ions and also can be used an indicator of water pollution. Higher the values of dissolved solids, greater the amount of ions in water [8]. The conductivity of the common bicarbonate type of lake water is closely proportional to concentrations of the major ions. [28]. High levels of conductivity reflects on the pollution status as well as trophic levels of the aquatic body [51] Conductivity is an easily – obtained parameter that is an good indicator of the amount of dissolved solids in a water and thus can be used to detect contaminants in water.

Hardness is measure of polyvalent cations in water. Hardness generally represents the concentration of calcium and magnesium ions, because these are the most common polyvalent cations. The values of hardness varied in different lakes as follows: Byramangala lake recorded 192-530 mg/l; Yelahanka lake recorded 164-226 mg/l; Hebbal lake recorded 342-440 mg/l and Koramangala lake recorded 54-204 mg/l. The highest recorded in Byramangala lake and lowest recorded in Koramangala Lake. These values all are within the permissible limits of standards by (ICMR, WHO). Water is classified according to its hardness mg/l. as [22]. Water with a total hardness in the range of 0 to 60 mg/l are termed soft; 60-120mg/l moderately hard; from 120 to 180 mg/l hard and above 180mg/l very hard. High values of hardness are probably due to the regular addition of large quantities of sewage, detergents and large scale human use. Water for domestic use should not contains more than 80 mg/l. total hardness. High concentration of TH in water may cause kidney stone and heart disease in humans.

Alkalinity of water is its acid neutralizing capacity. Alkalinity of surface water is primarily a function of carbonate and hydroxide content. The values of alkalinity varied in different lakes as follows: Byramangala lake recorded 610-810 mg/l; Yelahanka lake recorded 221-293 mg/l; Hebbal lake recorded 140-192 mg/l and Koramangala lake recorded 42-176 mg/l. The highest values recorded in Byramangala lake and lowest values recorded in Koramangala Lake. It may be used as important measure to determine the quality of water. The variation in total alkalinity may be due to the seasonal effect, planktonic population, bottom deposits. According [32] high alkalinity values are indicative of the eutrophic nature of the water body. The conditions of the lake when tallied with the higher values of the total alkalinity point towards polluted condition of lakes. The increase of alkalinity content might due to fact that the accidental mixing of amount of industrial substances in low water quality and high evaporation rates. The change in alkalinity might be due to the increased decomposition. Similar observation was also reported by [23]. [8] Explained that the maximum in summer months is due to the result of evaporation. Alkalinity not only helps regulate the pH of water body, but also the metal content.

Disssolved oxygen (DO) is one of the important parameter in water quality assessment. Its presence is essential to maintain variety of forms of biological life in the water and the effects of waste discharges in a water body are largely determined by the oxygen balance of the system. Dissolve oxygen values varied in different lakes as follows: Byramangala lake recorded 2.3-4.0 mg/l; Yelahanka lake recorded 5.0-7.2 mg/l; Hebbal lake recorded 4.0-5.8 mg/l and Koramangala lake recorded 2.9-7.8 mg/l. This change may be due to fluctuation in temperature. Increase in dissolved oxygen is related to decrease in temperature or decrease in dissolved oxygen is possibly because of higher temperature as solubility of O_2 decreases with increase in temperature. The highest DO recorded at during monsoon and post monsoon months may be due to the impact of rain water resulting in aeration [22]. [36], [26] [1] and [37]. The lowest DO values exhibited at summer months as a result of the accumulation of oxygen demanding effluents. Water classifieds for aquatic life should not have DO concentration below 5 mg/l. and very high DO concentration can also be harmful to aquatic life. Fish in waters containing excessive dissolved gases may suffer a condition in which bubbles of oxygen block the flow of blood through blood vessels, causing death. Most of fishes cannot survive at concentration below 3 mg/l. of dissolved oxygen.

The biological oxygen demand (BOD) is the indicator of water pollution. It represents the amount of oxygen required for microbial degradation of organic matter. The standard value of BOD for drinking water is less than 5 mg/l. The values varied in different lakes as follows: Byramangala lake recorded 12.0-28.7 mg/l; Yelahanka lake recorded 3.0-4.3 mg/l; Hebbal lake recorded 6.0-14.8 mg/l and Koramangala lake recorded 4.2-7.0 mg/l. The values highest observed in Byramangala lake, and lowest observed in Yelahanka lake. The observed BOD values are more in Byramangala Lake, Hebbal Lake and Koramangala Lake and less in Ye lahanka lake compared to standard limits of W. H. O. It is also indicated that amount of organic matter in such water is more. This shows that water samples are polluted in Byramangala lake, Hebbal Lkae, Koramangala lake. Therefore, it is required further treatment. BOD, a relative oxygen demand is the amount of oxygen required for the biochemical degradation of organic material and the oxygen used to oxidize in organic material such as sulphides and ferrous ions [5] Chemical oxygen demand (COD) is the amount of oxygen required by the organic substances in the waste to oxidize them by strong chemical oxidant, but it does not suggest whether the waste is degradable basically nor it indicates the rate at which biological oxidation would proceed and hence, the rate at which oxygen would be required in a biological system. However it gives us a reliable parameter for judging the extent of pollution in water. Chemical oxygen demand values varied in different lakes as follows: Byramangala lake recorded 23.0-63.0 mg/; Yelahanka lake recorded 32-48 mg/l; Hebbal lake recorded 98-180 mg/l and Koramangala lake recorded 4.8-25.6 mg/l. The vaues highest in Hebbal lake and lowest recorded in Koramangala lake. Chemical oxygen demand no standard values are prescribed by (WHO, ICMR). As a result the high value of COD values higher even then acontituous monitoring is necessary so that the direct disposal of organic matter into the lakes should be strictly prohibited. Pollution that is largely determinedby the various organic and inorganic materials [34]

Phosphates generally considered as a key nutrient in the productivity. It is necessary for the fertility of fresh waters. The phosphate values varied in different lakes as follows: Byramangala lake recorded 5.8-14.5 mg/l; Yelahanka lake recorded 0.2-0.8 mg/l; Hebbal lake recorded 0.1-0.9 mg/l and Koramangala lake recorded 0.42-0.83 mg/l. It is an essential metabolic element which normally occurs in low concentration in natural aquatic ecosystem and hence often acts as a limiting factor for primarily production which leads to a change in the biological characteristics of the receiving water body. Phosphate emphasized that weathering of phosphorous bearing rocks, leaching of the soils of the catchment area by rain, cattle dung and might soils are the main sources of the phosphorous to natural waters [27]. The classification proposed on the basis of phosphorous contents, the Yelahanka lake, Hebbal lake and Koramangala are under eutrophic condition. [62] and [48] established the importance of phosphate as a nutrient element in the growth of microscopic algae and is responsible for the maintains of the lakes productivity.

Sulphate usually occur in natural waters. They contribute to the permanent hardness. Sources of sulphates are mainly sulphate rocks such as`calcium sulphate and sulphur minerals such as pyrities and also due to air and water pollution sulphate contribute to the total solids content and in a reduce and anaerobic condition produce hydrogen sulphide, which gives a rotten eggodour to the water. The sulphates values varied in different lakes as follows: Byramangala lake recorded 22.0-38.0 mg/l; Yelahanka lake recorded 16.2-27.0 mg/l; Hebbal lake recorded 9.0-17.32 mg/l and Koramangala lake recorded 7.8-19.6 mg/l. The highest values observed in Byramangala lake and lowest values observedin Koramangala lake. All the lakes observed with in the desirable limits of (ICMR). The high concentrations of sulphates have been reported from the lake waters and high concentration of sulphates stimulus the action of sulphur reducing bacteria which produced hydrogen sulphide gas highly toxic to fish life. Higher concentration of sulphates were observed and could be attributed due to run off from the agriculture land during flood in the monsoon period and sulphate enters into the lake water body from the catchment area through surfsce runoff and domestic waste water.

Nitrate is the most highly oxidized form of nitrogen compounds commonly present in natural waters. Nitrate is an important factor for controlling the occurrence and abundance of phytoplankton. The nitrate values varied in different lakes a follows: Byramangala lake recorded 2.0-6.8 mg/; Yelahanka lake recorded 5.3-9.5 mg/l; Hebbal lake recorded 3.2-5.2 mg/l and Koramangala lake recorded 4.3-7.2 mg/l. The highest recorded in Yelahanka Lake and lowest recorded in Hebbal lake. Maximum values during monsoon months revealed that the lake water derived nitrate from allochthonous input through influx of rain water fron catchment areas. Alll the values with in the desirable level of (45 mg/l) presvribed by ISI and 20 mg/l. (ICMR). The higher concentration of nitrate is an indicator of organic pollution and eutrophication. [67] Stated that nitrate was generated by heterotrophic microbes as a primary end product of decomposition of oxygenic matter either directly from protein or organic compound. [68] stated that presence of excessive nitrate in water is due to manmade domestic activities and fertilizers from fields.

Potassium is main cation in natural water, in fresh water such as lake water. It occurs in natural water salty through found in small amount. It plays a vital role in metabolism of fish it also an important macro nutrients. The potassium values varied in different lakes as follows: Byramangala lake recorded 16.0-24.0 mg/l; Yelahanka lake recorded 28.0-82.0 mg/l; Hebbal lake recorded 2.3-9.2 mg/l and Koramangala lake recorded 6.3-12.4 mg/l. The highest values were recorded in Yelahanka lake and lowest recorded in Hebbal lake. Highest value of potassium was observed in monsoon months. The rainfall and sedimentary rock strata form almost the entire source of potassium in water body.

On the basis of the values of physic-chemical characteristics of lakes, (Byramangala lake, Yelahanka lake, Hebbal lake and Thalli lake). Byramangala lake is found to be highly polluted because of pouring of sewage and other domestic which provided high levels of nutrients and low levels of dissolved oxygen (due to the decomposition of organic matters from sewage entering the lake). Yelahanka lake the runoff from surrounding agricultural fields and concentration of chemical constituents in partially dried aquatic environment, were cause for the deterioration of water quality of lake. In Hebbal lake is moderately polluted because less pouring of sewage and sedimentation indicates less dissolved oxygen and high nutrients resulting eutrophication of lake. Koramangala lake is influenced by The above data on physico-chemical parameters clearly show that Byramangala lake, Yelahanka lake and Hebbal lake water were polluted and not safe for drinking purpose while Koramangalas lake water samples were not polluted were safe for drinking purpose. The values for different parameters evaluated fall for below the acceptable limits in three of the lakes studied necessary to drink water after proper treatment, boiling and filtrations.

5. Conclusion

Water resources are of critical importance to both natural ecosystems and human development. It is essential and required for maintaining a healthy state of all the animals. The study of water bodies has gained immense importance in recent years because of their multiple uses for human consumption, agriculture and industry. Thus the demand for water has increased with the increase in human activities and therefore, several of the important concepts in ecology have been developed from studies of the aquatic ecosystems and organisms. The present work focuses on some selected aspects of physico-chemical parameters of fresh water and polluted water of a ten lakes in and around Bangalore in general and Magadi hill rang lakes and reservoirs in particular

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