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Original Research Paper

Investigation of Physicochemical and Biological Characteristics of Water and Sediments of Selected Lakes Around Dharwad, Karnataka

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ABSTRACT

The physicochemical and microbiological studies on water and sediments of Lakes Kelageri, Salakinakoppa, Navalur, Nuggikeri and Neersagar were carried out. Most of the physicochemical characteristics are within the permissible limits of BIS and WHO standards for drinking water except Salakinakoppa lake. Some samples were found to be highly contaminated with coliforms including *E. coli*. In all the lakes, some species of zooplankton were recorded. This investigation brought to the limelight that except Neersagar lake, the water of other lakes is unsuitable for drinking purposes but useful for agricultural and domestic purposes. The heavy metals such as iron, copper, lead, manganese, zinc, cadmium and magnesium were analysed in the water and sediment samples of the above lakes using atomic absorption spectrophotometer. The results revealed that by and large, all the metals except cadmium were present in the samples in various concentrations. The nutrients like N, P, K, etc. were also found in the samples.

INTRODUCTION

Water is one of the valuable natural resources whose quality has vital concern for the human welfare. Growing population, urbanization, erosion of soil, increasing living standards, unscientific management and other anthropogenic activities including unhygienic conditions have severe impact on the quality of limited water resources.

Lakes, which are important sources of drinking and irrigation water, and life supporting system for the biotic components can get degraded and deteriorated when influenced by severe anthropogenic activities and by the use of chemicals, fertilizers, etc. Pollutants from various sources like domestic sewage, pesticides, fertilizers, etc. disturb lake ecosystems and increase the level of nutrients, which give rise to algal blooms and extensive growth of aquatic weeds. Urban lakes and tanks all over the country are in varying degrees of environmental degradation. This is due to the encroachment, eutrophication, and loads from domestic and industrial effluents, and deposition of silt, town garbage and cleaning of vehicles.

Water quality can be ascertained either by monitoring physicochemical parameters or analysing inhabiting biota. In India, water quality studies are partially adequate. Bharati & Hosmani (1975), Taranath (1993), Hegade & Kale (1995), Sachhidanadamurthy & Yajurvedi (2004), Mahadev et al. (2004), Jayalakshmi Devi & Belagali (2005), Kanamadi & Kudari (2008), Belagali & Padmanabha (2005, 2006a, b) and many others have investigated the water quality of some areas. In Karnataka particularly the lake waters around Dharwad are not much subjected to investigation by continuous

Fig.1: Karnataka.

monitoring. Therefore, the present study has been undertaken to investigate the water and sediment quality characteristics of the lakes of selected areas of Dharwad.

MATERIALS AND METHODS

Dharwad district of Karnataka is spread over between 15°152' and 15°412' North latitude and 74°432' and 75°152' East longitude, and has 2 canals, 74 reservoirs (more than 40 ha) and 1160 tanks (less than 40 ha). Total area is 427,329 hectares. The average rainfall is 940-1080 mm and temperature ranges from 13°C to 35°C and the humidity 66-69 %. In a year totally 60-67 rainy days are recorded.

Five lakes were selected for the present study. Water and sediment samples were collected during December 08 to February 09 between 6 a.m. to 9 a.m. to study the physicochemical and microbiological characteristics. Analysis was carried out by using the standard procedures of APHA, AWWA, WPCF (1995).

RESULTS AND DISCUSSION

The general information of all the five lakes is given in Table 1. Average values of the physicochemical parameters of each water body are summarized in Table 2, and physicochemical parameters of sediment samples of the lakes are given in Table 3. The microbiological parameters are shown in Tables 4, 5 and 6.

The pH, EC, TDS, sulphates, nitrates, phosphates, fluorides, BOD and COD are high in all the lakes in comparison to Neersagar lake. This is due to the presence of minerals, algal blooms, and their photosynthesis, microorganisms, decay of organic matter, agricultural run off, inflow of waste materials, industrial effluents and vegetative residues, etc.

Oxygen is an index of the physical, chemical and biological processes going on in water. It is moderately soluble in water and its solubility decreases with increase in temperature. Higher concentration of dissolved oxygen was found in Neersagar lake followed by Kelageri, Nuggikeri, Navalur and Salakinkoppa lakes. The high DO of Neersagar is due to slightly lower temperature and less microbial activities. Lower concentration of DO in other lakes is due to decomposition of organic matter and the presence of more microorganisms.

The BOD is highest in Salakinkoppa lake and lowest in Neersagar lake. This is due to deposition of biochemically degradable high organic load, as these lakes receive domestic sewage, effluents and other anthropogenic activities. The increase in BOD of Navalur lake is due to the effluents let out by the dairy industry and deposition of carbon particles generated from exhaust of vehicles moving on the nearby highway road. The low COD of Neersagar Lake is an indication of low quantity of organic as well as oxidisable materials in the water bodies which may be attributed to the less sewage contamination and less anthropogenic activities. Free CO_2 is less in Neersagar lake. It shows

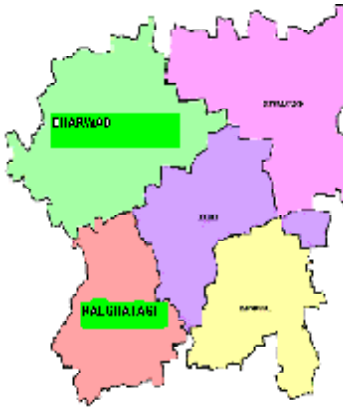

Fig. 2: Dharwad district.

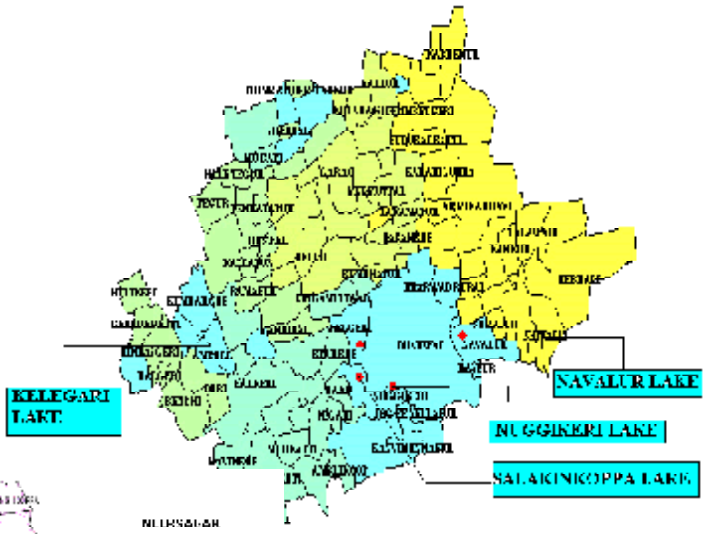

Fig. 3: Dharwad taluk.

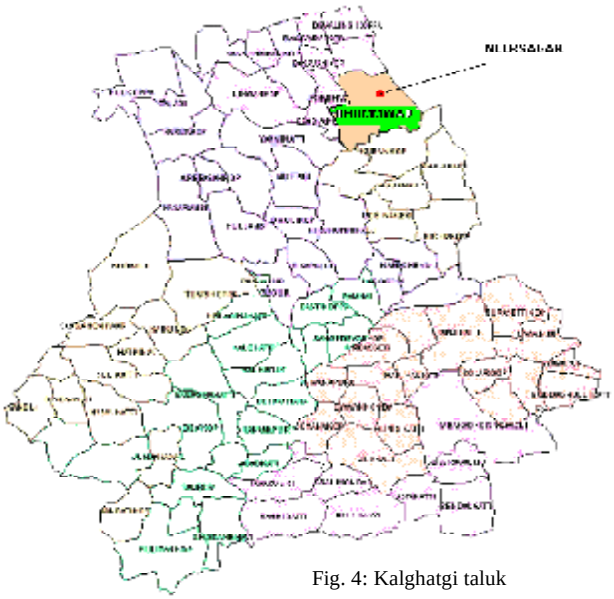

Fig. 4: Kalghatgi taluk

that the acidity is less in comparison with other lakes which may be due to less algal blooms and microbial activities.

Comparing the turbidity values of all the lake water samples, it was found that Salakinkoppa lake water has highest turbidity value, which may be attributed to inflow of water from the catchment area containing much silt. The high turbidity may be due to strong wind action, high plankton concentration, more suspended silt particles and organic matter.

The suitability of water for the irrigation and domestic purpose is based on the electrical conductivity of water. The variation in conductance is due to change in the quantity of salts present in water and sediment. As the conductivity is within the permissible limits, the water bodies under study are suitable for these purposes.

Fig. 5: Kelageri lake

Fig. 6: Navalur lake

Fig. 7: Nuggikeri lake

Fig. 8: Salakinkoppa lake

Fig. 9: Neersagar lake

The presence of nutrients like nitrogen, phosphorus and potassium in moderate quantity in the sediment samples indicates that the water of lakes is highly useful for agricultural purpose. Chlorides are high in four lakes except Neersagar. It may be due to increased anthropogenic activities, use of chemical fertilizers in agriculture and inflow of silty water containing salts.

The flocculation value is smaller for Neersagar lake showing that the water is less contaminated and has less suspended particles. Phosphate content is more in all the lakes except Neersagar. It may be due to use of detergents, chemical fertilizers and certain biological processes. The sediment sample of Neersagar lake has less alkalinity, which may be due to less deposition of carbonates and organic matter.

Sodium was present in all the lakes as its salts are highly soluble in water. The industrial discharges and sewage increase the presence of sodium. Nitrates and sulphates in all the lakes are moderate. This may be due to sewage and agricultural run off and attributed to increased anthropogenic activities. The ammoniacal-nitrogen occurred in small quantity in Neersagar lake than other lakes. This may be due to high bacterial decomposition of organic matter present in the sediment.

The metals like iron, copper, magnesium, lead, zinc, manganese and boron were in small quantities, and are within permissible limits. The cadmium was not detected in the water samples in any of the lakes under study. The hardness of Neersagar lake water is less because of the presence of carbonates, bicarbonates and calcium in small quantity. Comparatively, the TDS is more in Salakinkoppa lake, which may be due to more soil erosion, inflow of more waste materials and the presence of microbes, salts and faecal materials. *E. coli* test showed presence of pink and red colour colonies in all the water samples with dense in Salakinkoppa water sample and low in Neersagar lake water sample. The *E. coli* test shows presence of more faecal matter in water samples of all the lakes

Table 1: The general information of the five lakes.

Sl. No.	Lakes	Taluk	Area	Distance from Dharwad city	Nature of soil	Maximum depth
1	Neersagar	Kalghatagi	3.4 sq. km	18.5 km (south)	Blackish	10.5-13.0 m
2	Nuggikere	Dharwad	77.09 (ha)	5.6 km (south)	Brownish	3.0-4.0 m
3	Navalur	Dharwad	60.29 (ha)	8 km (east-south)	Blackish	2.5-3.0 m
4	Kelageri	Dharwad	189.25(ha)	2 km (north)	Brownish	5.0-7.5 m
5	Salakinakoppa	Dharwad	50 (ha)	8.5 km (west)	Brownish	2.0-3.0 m

Table 2: Physicochemical characteristics of water samples of the lakes around Dharwad.

Sl. No.	Parameters	WHO standards	Kelageri Lake	Nuggikeri Lake	Navalur Lake	Neersagar Lake	Salakinakoppa Lake
1	Air Temperature		22.6	22.7	22.8	22.3	22.5
2	Water Temperature		23.8.	24.2	23.6	23.2	23.4
3	pH	6.5-8.5	8.04	8.58	8.17	7.97	8.1
4	Conductivity	-	426	408	422	383	481
5	Turbidity	10	9.5	11.9	14.8	8.2	88.0
6	Dissolved Oxygen	5.0	. 4.6	4.2	3.7	6.2	3.2
7	B.O.D.	28-30	1.62	1.74	1.90	0.82	1.96
8	C.O.D.	10	13.5	13.4	14.7	11.6	14.1
9	Free CO_2		8.2	8.1	7.9	6.6	8.9
10	Carbonates		5.5	7.4	5.6	7.2	7.5
11	Bicarbonates		70.8	71.4	75.8	42.8	80.7
12	Total Hardness	200-600	148.2	142.6	132.7	118.3	159.2
13	Calcium	75-200	43.8	41.4	45.2	22.1	39.7
14	Magnesium	50-150	30.2	24.6	26.2	13.2	21.5
15	Sodium		0.0407	0.0674	0.0429	0.0335	0.0546
16	Nitrates	20-45	0.50	0.52	0.04	0.03	0.08
17	Sulphates	42-45	6.8	6.3	6.8	5.9	6.3
18	Phosphates	5.0	6.8	6.2	6.1	2.5	5.8
19	Chlorides	200-600	96.2	98.3	73.2	58.5	84.3
20	Fluoride	1.5	0.16	0.11	0.13	0.08	0.16
21	Amm-N		12.3	14.5	14.8	10.6	14.7
22	Floc. value		4.8	5.2	5.6	4.6	11.5
23	TDS	500	163.6	146.1	182.5	56.9	252.8
24	Iron	20	0.09	0.05	0.03	0.28	0.04
25	Copper	1.0	0.006	0.003	0.001	0.004	0.003
26	Manganese	0.5	0.00	0.00	0.006	0.005	0.002
27	Lead		0.0062	0.0065	0.0009	0.0010	0.0006
28	Zinc	5.0	0.0886	0.0894	0.0346	0.0330	0.0304
29	Cadmium		Nil	Nil	Nil	Nil	Nil

Note: All the units are expressed in mg/L, except pH, temperature (°C), conductivity (μmhos/cm) and turbidity (NTU).

except that of Neersagar lake. *Staphylococcus aureus* test shows the presence of *Staphylococcus aureus* type of colonies only in Salakinkoppa and Navalur lakes. MPN of coliform test also reveals presence of *E. coli*. Table 4 shows that the MPN index values of all the lakes are higher than 4.0, except Neersagar lake. Hence, the water of Neersagar lake is fit for drinking purpose.

CONCLUSION

From the study, it can be conclude that Neersagar lake water is suitable for drinking, agriculture and domestic purposes. Other lakes are useful for domestic, irrigation and industrial purposes. The analysis

Table 3: Physicochemical characteristics of sediment samples of the lakes around Dharwad during Dec. 08 to Feb. 09.

Sl. No.	Parameters	Kelageri Lake	Nuggikeri Lake	Navalur Lake	Neersagar Lake	Salakinakoppa Lake
1	pH	8.51	8.92	8.68	8.21	8.62
2	Conductance	0.431	0.544	0.293	0.258	0.207
3	Alkalinity	112.8	118.7	114.3	106.5	120.5
4	Organic matter	2.93	2.17	2.06	1.79	3.03
5	$CaCO_3$	2.5	3.0	2.5	2.5	3.0
6	Organic carbon	0.79	0.6	0.8	0.46	0.52
7	Nitrogen	217	210	220	213	215
8	Phosphorus	19.5	20.0	35.0	31.0	28.5
9	Potassium	220.0	225.0	230.0	246.0	245.5
10	Sodium	0.4973	0.5447	0.5301	0.3851	0.4113
11	Chlorides	43.07	31.95	15.14	8.75	18.69
12	Boron	41.6	8.33	89.0	4.5	44.0
13	Copper	0.0575	0.0406	0.037	0.0528	0.039
14	Iron	0.0521	0.0710	0.0282	0.0721	0.0969
15	Lead	0.0069	0.0070	0.0071	0.0066	0.0075
16	Zinc	0.1131	0.1194	0.1082	0.0955	0.1048
17	Magnesium	0.0380	0.7307	0.9045	0.4050	0.6142
18	Cadmium	Nil	Nil	Nil	Nil	Nil

Note: All the units are expressed in mg/L, except pH and conductivity (mmhos/cm).

Table 4: Microbiological analysis of water (Total microbial count).

Dilution	Sample	No. of colonies	Color	Shape	Elevation	Surface	Observed microorganisms & Gram reaction
10^{-1}	Kelageri	5	White	Punctiform	Convex	Smooth	*Bacilli* (-)
10^{-2}	Lake	2	Cream	Round	Raised	Rough	*Bacilli* (+)
		2	White	Irregular	Flat	Smooth	*Monococei* (+)
10^{-1}	Nuggikeri	3	Cream	Filamentous	Flat	Wrinkled	*Actinomycetes(+)*
10^{-2}	Lake	5	White	Punctiform	Convex	Smooth	*Monococei* (+)
		2	Cream	Filamentous	Flat	Wrinkled	*Actinomycetes* (+)
		1	Cream	Irregular	Flat	Rough	*Streptococei* (+)
		2	Creamish white	Round	Raised	Smooth	*Bacilli* (-)
10^{-1}	Navalur	4	Cream	Round	Raised	Smooth	*Bacilli* (+)
10^{-2}	Lake	1	White	Round	Flat	Rough	*Streptococei* (+)
		2	Cream	Round	Raised	Smooth	*Bacilli* (-)
		1	White	Irregular	Flat	Smooth	*Monococei* (+)
10^{-1}	Neersagar	5	Creamish	Punctiform	Flat	Smooth	*Bacilli* (-)
10^{-2}	Lake		No colonies				
10^{-1}	Salakinkoppa	2	Cream	Punctiform	Convex	Smooth	*Streptococei* (+)
10^{-2}	Lake	1	White	Irregular	Flat	Smooth	*Monococei* (+)
		2	Cream	Round	Raised	Rough	*Bacilli* (G-ve)

Table 5: Microbiological analysis of water (Total fungal count).

Dilution	Sample	No. of colonies	Color		Surface	Observed
			Front	Back		
10^{-1}	Kelageri Lake	3	Cream	Cream	Mucous	Yeast cells
10^{-2}			Cream	Cream	Mucous	Yeast cells
10^{-1}	Nuggikeri Lake	2	Light pink	White	Powdery	Fusarium
10^{-2}			No colony			
10^{-1}	Navalur Lake	3	Cream	Cream	Mucous	Yeast cells
10^{-2}		2	Black	Black	Cottony	Mucor
		1	Light pink	White	Powdery	Fusarium
10^{-1}	Neersagar Lake	2	Black	Grey	Cottony	Rhizopus
10^{-2}		1	Cream	Cream	Mucous	Yeast cells
		1	Green	Green	Powdery	Pencillium
		1	Light pink	White	Powdery	Fusarium
10^{-1}	Salakinkoppa	3	Cream	Cream	Mucous	Yeast cells
10^{-2}	Lake	1	Black	Black	Cottony	Mucor
		2	Black	Grey	Cottony	Rhizopus
		1	Light pink	White	Powdery	Fusarium
		1	Green	Green	Powdery	Pencillium

Table 6: MPN Test of water samples (Presumptive test).

Water sample	Permissible limit (MPN Index/100ml.) for potable water	3 of 10 mL	3 of 1mL	3 of 0.1mL	MPN index per 100mL
Kelageri	4	3	0	2	64
Nuggikeri	4	1	1	1	11
Navalur	4	2	2	0	21
Neersagar	4	1	1	1	4
Salakinkoppa	4	3	3	3	= 2400

of sediment samples of all the lakes reveals that they are suitable for irrigation purpose. Microbial analysis of water samples shows that they are contaminated with microbes like coliforms, except Neersagar Lake, which can be used as potable water.

To avoid the possible pollution of lakes, it is advisable to grow fibrous, woody shrubs in the water inflow streams, canals, and different types of grasses around banks of the lakes. They avoid erosion of soil and consequently the deposition of heavy metals and salts through silts. The continuous monitoring and use of water purifiers and desiltation of lakes every year may turn them into rich source of water for all the purposes.

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