MACROPHYTE DIVERSITY IN RELATION TO WATER QUALITY OF BANGALORE LAKES

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ABSTRACT

Wetlands are the ecological barometers of a city as they regulate nutrients and also the micro-climate. Wetlands constitute a vital ecosystem performing the functions of nutrient uptake, shoreline stabilization, and groundwater recharge and provide fish, fodder and so on for the dependent local population.Wetland plants (Marophytes) are the base of the food chain. Through photosynthesis, they link the inorganic environment with biotic one. They provide habitat for other groups such as epiphytic bacteria, periphyton, macroinvertibrates and fish.Wetland Plants influence water chemistry, acting as both nutrient sinks through uptake and as nutrient pumps moving compounds from sediment to water column. The current study carried out comparative analysis of water quality and macrophyte diversity of nine different urban wetlands in Bangalore. Wetlands were monitored for a period of three months with the quantification of physico-chemical parameters using standard protocols. Total 14 species of macrophytes were recorded. *Eichhornia crassipes*, *Alternanthera philoxeroides* were the dominant macrophyte species found in these lakes. Physico chemical parameters like pH, EC, TDS, DO, nitrate, phosphate, total hardness,total alkalinity, BOD, COD, sodium and potassium were analysed. The dissolved oxygen ranged between 0 to 10.33 mg/l. The range of phosphate and nitrate was 0.03 to 2.79 mg/l and 0.2 to 0.74 mg/l respectively. The physico chemical parameters in lakes such as Rampura, Kalkere and Challghatta exceeded the permissible limits set by BIS and WHO standards for drinking quality and inland waters.

Keywords: Wetlands, Bangalore, Macrophytes

INTRODUCTION

Wetlands are the ecological barometers of a city as they regulate nutrients and also the micro-climate.Wetlands constitute a vital ecosystem performing the functions of nutrient uptake, shoreline stabilization, and groundwater recharge and provide fish, fodder and so on for the dependent local population. These fragile ecosystems functions as kidneys of the landscape and are rich repository of biodiversity. Unplanned rapid urbanization during the post globalization

period has led to the large-scale land cover changes threatening the very existence of wetlands. Wetland plants (Marophytes) are the base of the food chain. Through photosynthesis, they link the inorganic environment with biotic one. They provide habitat for other groups such as epiphytic bacteria, periphyton, macroinvertibrates and fish. Wetland Plants influence water chemistry, acting as both nutrient sinks through uptake and as nutrient pumps moving compounds from sediment to water column. They have the ability to uptake nutrients, metals and other contaminants (Gersberg et al., 1986; Reddy et al., 1989; Peverly et al,. 1995; Rai et al., 1995). They influence the hydrology and sediment regime of wetlands through for example, sediment and shoreline stabilization, or by modifying currents and helping to desynchronize flood peaks. They are routinely used to help identify or delineate jurisdictional boundaries of wetlands. Act as biological indicators of the health or ecological integrity of the wetland. Eutrophication has become a major environmental issue in many countries. The byproduct of agricultural activities, urbanization and industrialization result in nutrient enrichment (Koorosh et.al, 2009) and degradation of the available water resources. Physico-chemical characteristics are highly important with regard to the occurrence and abundance of species. Discharge of urban, industrial and agricultural wastes have increased the quantum of various chemicals that enter the receiving water, which alter their Physico-chemical characteristics. Nutrients like phosphorus, nitrogen from the domestic wastes and fertilizers accelerate the process of eutrophication.

Bangalore city is situated on a high altitude with a ridge that divides the region into three valleys, wherein rainwater cascades down to form major stream systems. The three valleys of Bangalore are Koramangala-Challagatta Valley, Hebbal Valley and Vrishabavathi Valley. There were 262 lakes (in 1960) within the Green belt area of the city, which has fallen to 81 in 1985 (Ramachandra et.al, 2003). The existing water bodies are contaminated by residential, agricultural, commercial and industrial wastes/effluents (Ramachandra et.al, 2003). Most of the lakes have vanished due to encroachment and construction activity for infrastructure expansion. The aim of this study was to survey macrophytes in selected wetlands of Bangalore and to determine the water quality of these wetlands in the presence of these macrophtes.

MATERIALS AND METHODS

Study area: Bangalore city, Karnataka, India is located between 12°39´ 13°18´N and 77°22´ - 77°52´ E. Bangalore (Fig. 2) city has a large number of lakes, ponds and marshy wetlands, which ensures a high level of ground water table and pleasant climate. Bangalore has no natural lakes but large numbers of manmade lakes that were built for various hydrological purposes and to meet the needs of drinking water and irrigation. Totally there were 262 lakes in the Bangalore city. The current studies on the temporal analysis of wetlands indicated a 58% decline in Greater Bangalore due to rapid and unplanned urbanization and expansion (Ramachandra and Kumar, 2008). Now, many of the existing lakes are reduced to cesspools due to direct discharge of industrial effluents, sewage and unregulated dumping of solid wastes (Ramachandra et al., 2006). The study was carried out for a period of three months.The selected lakes (Fig.1 and 2) chosen for the study period falls in

the Hebbal valley, Yallamallappa Chetty lake series.

Collection and Analysis of various physico-chemical parameters: The water samples were collected from various sites of selected lakes and carried to the laboratory in plastic polyethylene bottles and stored at 4°C for further analysis. The parameters like temperature, dissolved oxygen, total dissolved solids, electrical conductivity and pH were determined onsite, whereas chloride, alkalinity, total hardness, calcium hardness, magnesium hardness, sodium, potassium, nitrate and phosphate were determined offsite in laboratory as per the standardized methods of APHA, (2005) (Table 1).

Collection and Identification of Macrophytes: The macrophytes were collected from various lakes across Bangalore and identified by using the local Flora (Ramaswamy and Razi, 1973) and Cook CDK, Aquatic wetland plants of India.

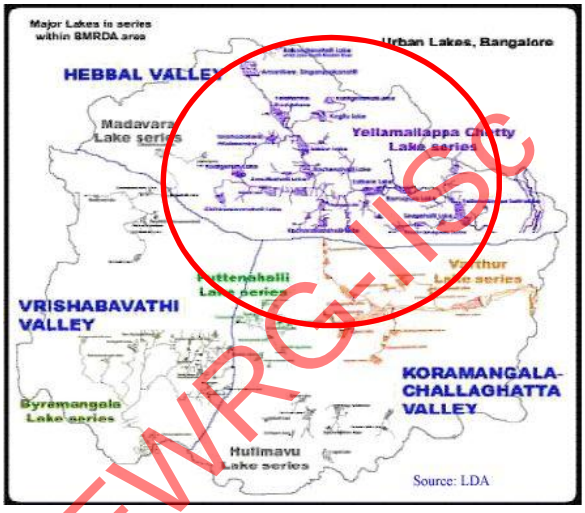


Figure 1: Three major valleys and lake series of Bangalore

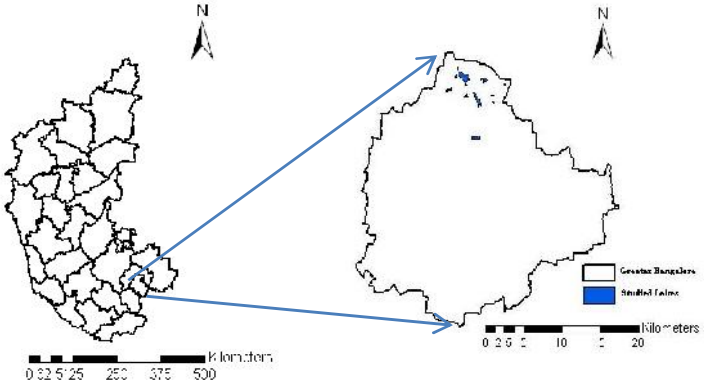


Figure 2: Study Area - Bangalore

RESULTS AND DISCUSSION

Diversity of Macrophytes in Lakes: Total 14 species were found in the studied lakes. 4 free floating, 4 rooted floating 2 submerged and 4 emergent (Figure 3). The macrophytes identified were classified as submerged, rooted with floating leaves, and floating and emergent macrophytes. Highest number of macrophyte species (10 species) was in Yelhanka lake (figure 4). Lowest number of macrophyte species were found in Kalkere and Rampura lakes.The lakes were found to be dominated by non-native and invasive macrophytes like *Eichornnia crassipes* (floating macrophyte) and *Alternanthera philoxeroides* (an emergent macrophyte).The diversity of macrophytes is shown in table 2. According to Macrophyte diversity and type (native or invasive) Yelhanka, Jakkur, Rachenhalli were ranked as Lakes with minimal pollution. Allalsandra, Kogilu, Nagavara and Challkere were ranked as moderate lakes and Kalkere and Rampura are polluted lakes.

Physico-Chemical Parameters of studied lakes: Table 3 shows the physico-chemical parameters of water of studied lakes between July to September 2014. The water temperature ranged between 23.3˚C and 28.5˚C. Highest temperature was recorded in Kalkere lake and lowest in Nagavara lake. The results of TDS varied between 298 and 788 mg/l. Kalkere lake recorded lowest TDS and highest was in Challakere lake. The results of EC ranged from 564 to 1159 µS. The pH values ranged from 7.12 to 8.4. Kogilu lake showed highest and Nagavara lake recorded lowest pH. The DO values of studied lakes varied between 0 and 10.33. Kalkere and Rampura recorded 0 DO values and highest DO was recorded in Challakere lake. The results of total Alkalinity of studied lakes varied from 126.67 mg/l in Kogilu to 548 mg/l in Challakere lake. Chloride values ranged between 126.67 mg/l and 265.54 mg/l.

Highest chloride values recorded in Yelhanka lake and lowest was in Kogilu. Total hardness values of studied lakes varied from 90-373.67 mg/l with highest in Challakere and lowest in Kogilu. Phosphate and nitrate concentrations of studied lakes ranged between 0.03 to 2.79 mg/l and 0.2 to 0.74 mg/l respectively. Sodium values were in the range of 159 to 910 mg/l, with highest value in Rachenhalli and lowest in Kogilu lakes. Potassium values ranged between 29.6 mg/l to 55.2 mg/l in studied lakes. Highest potassium values were observed in Jakkur lake and lowest was in Kogilu lake. The BOD and COD values ranged from 4 to 116.9 mg/l and 6 to 200 mg/l with highest in Kalkere lake and lowest in Rachenhalli lake. The variations of Physico-Chemical Parameters were shown graphically in figure 5 and 6. Physico-chemical parameters are closely supported to fast growth of these macrophytes in these lakes such as alkaline pH, high value of nitrate, calcium, magnesium, BOD, COD, high decomposition rate and low DO etc.

The results of Physico chemical parameters of water of these lakes showed that Kalkere, Rampura and Challghatta exceeded the permissible limits set by BIS standard for drinking and inland waters.Thus all conditions are suitable for fast and rapidly growth of macrophytes. Water of these lakes are highly polluted so it should be treated before the use for human purpose. It can't be used directly as a drinking water because all parameters and conditions indicates that water of these lakes is not portable.

Parameters	Methods	Reference
Onsite Measurements		
pH	Probe	(Eutech pH 110)
Electrical Conductivity (µS)	Probe	(Eutech pH 110)
Total Dissolved Solids (mg L^{-1})	Probe	(Eutech pH 110)
Dissolved Oxygen (mg L^{-1})	Probe	(APHA, 4500-O B)
Laboratory Measurements		
Chemical Oxygen Demand (mg L^{-1})	Closed Reflux, Titrimetric Method	(APHA, 5220 C)
Biological Oxygen Demand (mg L^{-1})	5-Day BOD Test	(APHA, 5210 B)
Alkalinity (mg L^{-1})	HCl Tritrimetric Method	(APHA, 2320 B)
Calcium Hardness (mg L^{-1})	EDTA Titrimetric Method	(APHA, 3500-Ca B)
Total Hardness (mg L^{-1})	EDTA Titrimetric Method	(APHA, 2340 C)
Chlorides (mg L^{-1})	Argentometric Method	(APHA, 4500-Cl- :)
Sodium (mg L^{-1})	Flame Emission Photometric Method	(APHA, 3500-Na B)
Potassium (mg L^{-1})	Flame Emission Photometric Method	(APHA, 3500-K B)
Phosphates (mg L^{-1})	Stannous Chloride Method	(APHA, 4500-P D)
Nitrates (mg L^{-1})	Phenol Disulphonic Method	APHA (1998)

Table 1: Standard methods followed for water quality analysis

CONCLUSION

Total 14 species of macrophytes were recorded during the study period from the lakes.The studied lakes were found to be dominated by non-native and invasive macrophytes like *Eichornnia crassipes* (floating macrophyte) and *Alternanthera philoxeroides* (an emergent macrophyte that had out-competed the other submerged species). The results of Physico chemical parameters of water of these lakes showed that Kalkere, Rampura and Challghatta exceeded the permissible limits set by BIS standard for drinking and inland waters. Macrophyte diversity and type also showed that Kalkere and Rampura were bad lakes compared to others.

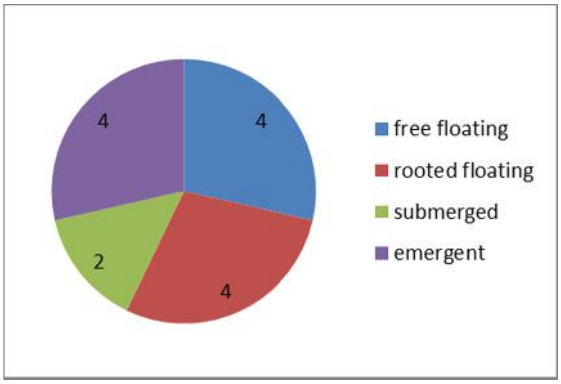


Figure 3: Number of Different types of Macrophytes in studied lakes

	Eichhornia crassipes	*Alternanthera philoxeroides*	*Lemna minor*	*Lemna gibba*	*Ludwigia perennis*	*Ipomea aquatica*	*Colocasia esculenta*
YELHANKA	+	+	+			+	+
KOGILU		+			+		
ALLALSANDRA	+	+					
JAKKUR	+	+	+	+	+		
RACHENHALLI	+	+			+		
KALKERRE	+	+					
RAMPURA	+	+					
NAGAVARA	+	+	+	+			
CHALLAKERE	+	+	+	+			+

	Pistia stratiotes	*Typha angustata*	*Polygonum glabrum*	*Cyperus rotundus*	*Hydrilla verticillata*	*Ceratophyllum*	*Potamogeton natans*
YELHANKA		+	+	+	+	+	+
KOGILU			+	+			
ALLALSANDRA		+		+			
JAKKUR		+	+	+			
RACHENHALLI		+	+	+			
KALKERRE		+					
RAMPURA		+					
NAGAVARA	+						
CHALLAKERE	+			+			

Table 2: Diversity of Macrophytes in studied lakes

	Wtemperature (^{0}C)	TDS (mg/l)	EC (µS)	pH	DO (mg/l)	COD (mg/l)	Alkalinity (mg/l)	Chloride (mg/l)
YELHANKA	27.10	562.00	912.00	8.26	8.13	18	214.67	265.54
KOGILU	24.80	298.00	564.00	8.40	5.85	20	126.67	123.07
ALLALSANDRA	25.95	430.00	738.00	8.33	6.99	19	170.67	194.31
JAKKUR	24.44	592.00	910.00	8.24	3.05	24	321.25	220.69
RACHENHALLI	27.40	572.00	894.00	7.25	4.88	6	232.00	254.65
KALKERRE	28.50	645.00	1049.00	7.23	0.00	200	470.67	178.45
RAMPURA	27.95	636.00	1006.00	7.57	0.00	152	470.00	188.39
NAGAVARA	23.30	408.00	730.50	7.12	1.95	68	264.00	132.54
CHALLAKERE	27.65	788.00	1159.00	8.14	10.33	60	548.00	247.79

	Total Hardness (mg/l)	Ca Hardness (mg/l)	Mg Hardness (mg/l)	Phosphate (mg/l)	Nitrate (mg/l)	Sodium (mg/l)	Potassium (mg/l)	BOD (mg/l)
YELHANKA	200.00	37.41	39.51	0.03	0.20	675.60	42.80	16.26
KOGILU	90.00	25.38	15.70	0.09	0.28	159.20	29.60	
ALLALSANDRA	145.00	31.40	27.61	0.06	0.24	417.40	36.20	16.26
JAKKUR	254.08	58.98	47.41	0.19	0.54	271.80	55.20	38.18
RACHENHALLI	174.67	33.67	34.26	0.04	0.30	910.40	51.60	4.07
KALKERRE	245.33	60.39	44.94	2.79	0.74	224.00	44.00	111.79
RAMPURA	249.67	64.93	44.89	2.28	0.66	226.40	42.20	116.87
NAGAVARA	189.33	43.69	35.39	0.79	0.47	171.40	35.60	50.82
CHALLAKERE	373.67	106.35	64.94	2.42	0.36	296.40	44.80	30.49

Table 3: Physico-chemical parameters of water of studied lakes

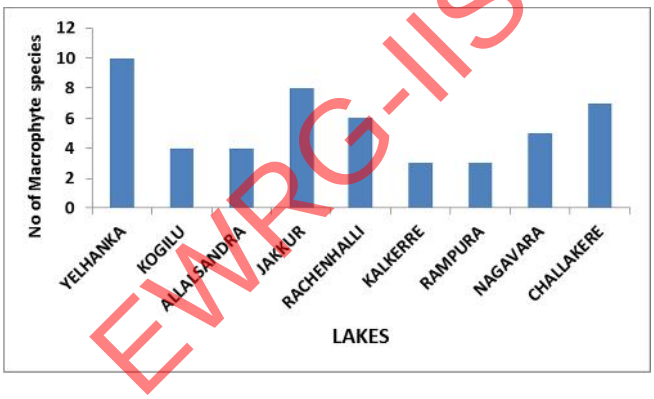
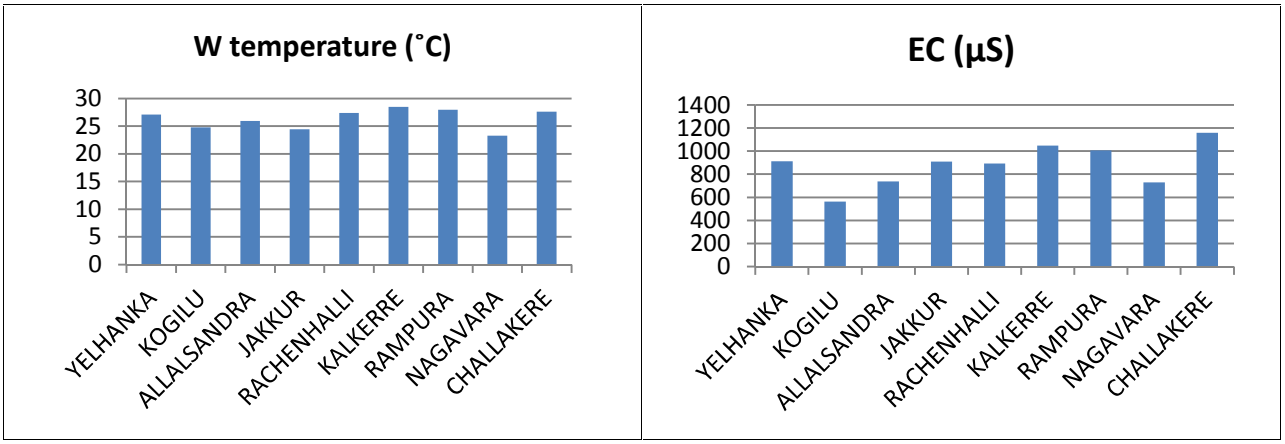


Figure 4: Total Number of Macrophytes in studied lakes



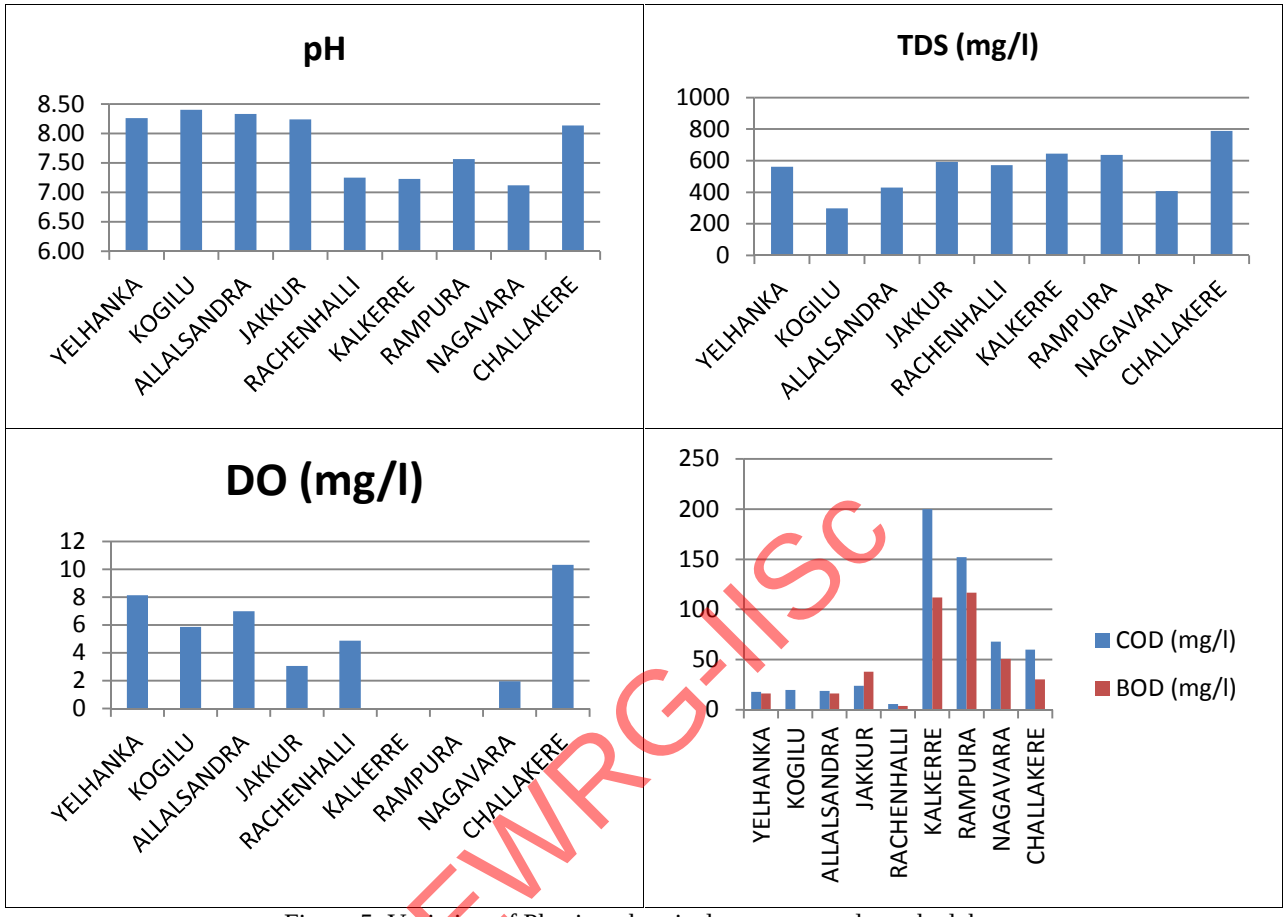
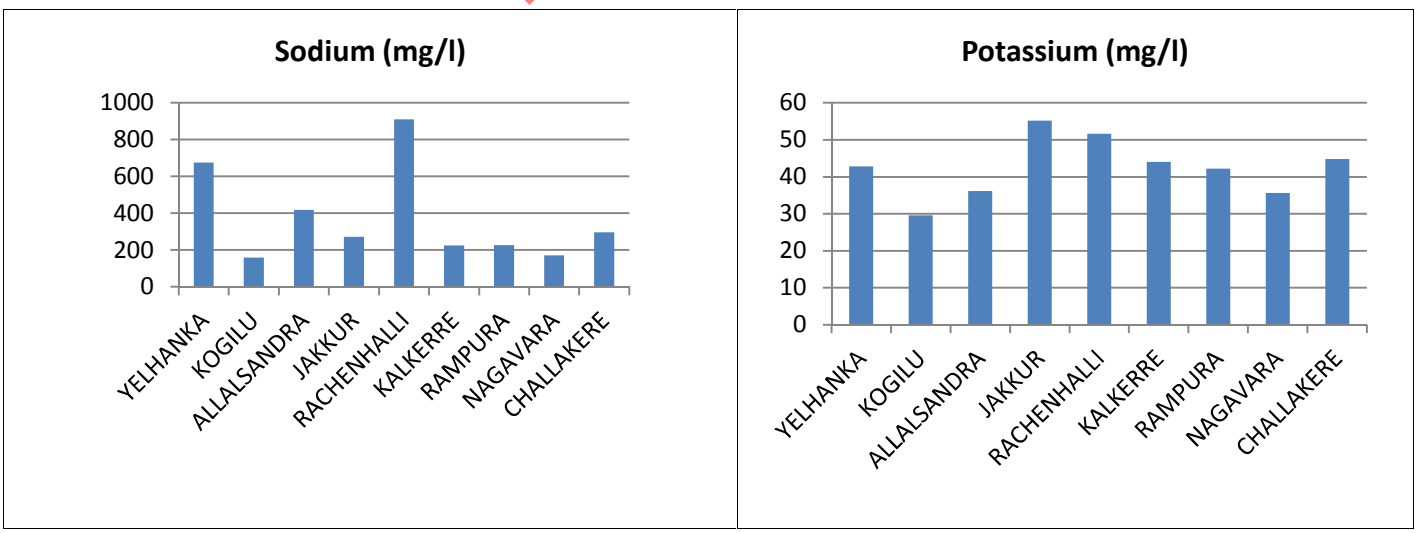


Figure 5: Variation of Physico-chemical parameters along the lakes



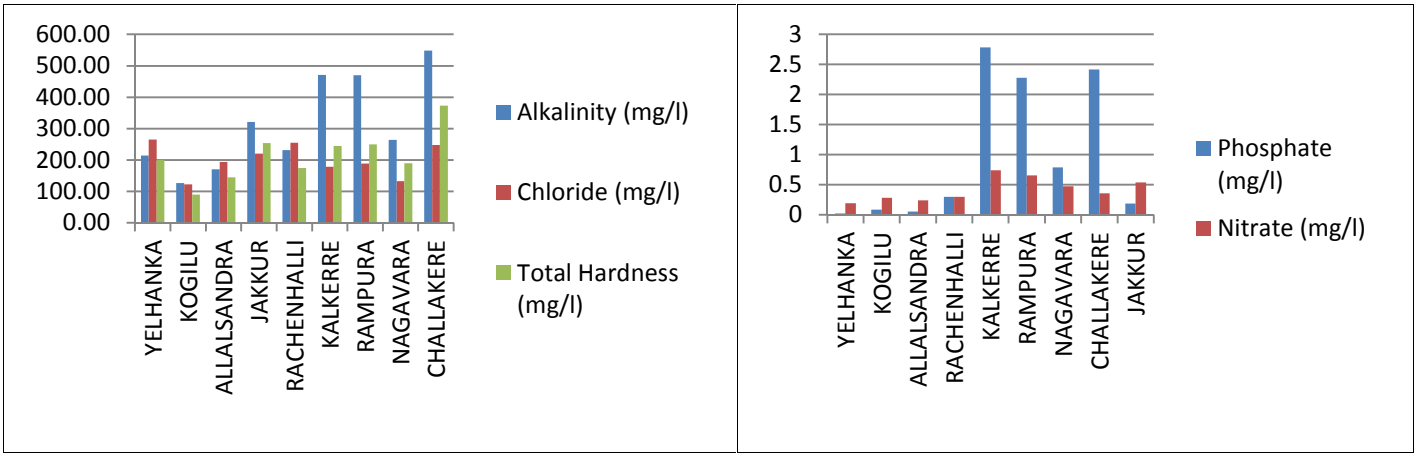
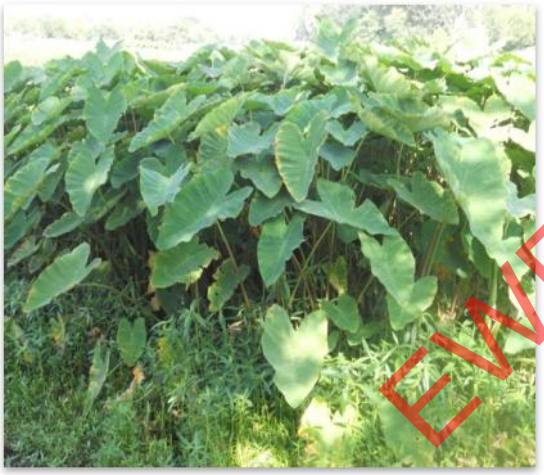


Figure 6: Variation of Physico-chemical parameters along the lakes



Colocasia esculanta

Ludwigia perennis

Potamogeton natans

Eichhornia crassipes

Typha angustata

Lemna gibba

Polygonum glabrum

Pistia stratiotes

Cyperus rotundus

Alternanthera philoxeroides

Figure 7: Macrophytes found in the lakes

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