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Phytoplankton composition in relation to hydrochemical properties of certain floodplain Riparian wetlands of river Subansiri of North Eastern India

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ABSTRACT

A limnological investigation was carried out in Certain Floodplain Riparian Wetlands of River Subansiri of North Eastern India from June 2013 to May 2014. Water quality parameters like temperature, pH, dissolved oxygen, transparency, free carbon dioxide, chloride, nitrate and phytoplankton composition were investigated during the study period. Correlation coefficients were calculated among the various physicochemical variables and phytoplankton groups. Pearson Product Analysis for phytoplankton at the two sites was performed and it showed a high significance of Bacillariophyceae members between both the sites than other groups. A total of 46 species were identified belonging to Cyanophyceae, Chlorophyceae and Bacillariophyceae. Moreover, species of Chlorophyceae were recorded to be the most occurred group compared to others throughout the study which shows relatively unpolluted nature of wetland.

Keywords*:* Phytoplankton, Hydrochemical, Wetland, Subansiri River.

INTRODUCTION

A wetland is a natural entity of waterlogged condition similar mostly to the direction of the river. Wetland ecosystems are among the most productive ecosystems in the biosphere. Wetlands receive surface water inputs from streams (surface run off), precipitation, and overland flow and subsurface water inputs from surface infiltration, stream hyporheic zones, and ground water. These different inputs are important to wetland productivity because they contain markedly different quantities of transported nutrients (Stanley and Ward, 1997) and organic matter (Mann and Wetzel, 1995). Wetlands are recognized as ecosystems that harbour high biological diversity, provide sustenance for millions of people and face ongoing threats as results of human activities throughout the world (Gopal and Chauhan, 2001). As ecosystems, wetlands are highly volatile being particularly vulnerable to environmental fluctuations. Although wetland biodiversity constitutes a significant portion (e.g., 15-20%), of the total biodiversity of the Indian Subcontinent (Gopal and Chauhan, 2001) studies of wetland ecosystems are limited (Tsai and Ali, 1997; Gopal and Zutshi, 1998; Gopal and Chauhan, 2001; de Graaf and Marttin, 2003). In recent years, increasing anthropogenic interventions influence in and around aquatic systems and their catchment areas have contributed to a larger extent towards deterioration of water quality leading to accelerated eutrophication. The hydrogeochemical characteristics and phytoplankton biomass of water bodies are not constant and fluctuate with seasonal variation as well degree of pollution (Prasad, 2006). Phytoplanktons are integral components of freshwater wetlands, which significantly contribute towards succession and dynamics of zooplankton and fish (Payne, 1997). Community structure, dominance and seasonality of phytoplankton in tropical wetlands are highly variable and are functions of nutrient status, water level, morphometry of the underlying substrate and other regional factors (Gopal and Zutshi, 1998; Zohary et al. 1998; Agostinho et al. 2001). Phytoplanktons form the main producers of an aquatic ecosystem which control the biological productivity. They not only provide an estimation of standing crop but also represent more comprehensive biological index of the environmental conditions (Misra et al., 2001). Phytoplankton, which include bluegreen algae, green algae, diatoms, desmids and euglenoids etc are important among aquatic micro-flora. They form the basic link in the food chain of all aquatic animals (Misra et al., 2001). Many herbivores, mostly zooplankton, graze upon the phytoplankton thus, passing the stored energy to its subsequent trophic levels. The phytoplanktons float passively and spread uniformly and extend down to various depths, where hydrochemical properties influence the plankton population and its occurrence. Therefore, an attempt has been made to study "Phytoplankton Composition in Relation to Hydrochemical Properties of Tropical Community Wetland, Kanewal, Gujarat, India".

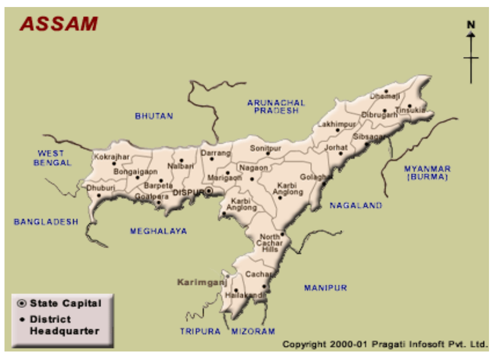
In recent past, studies on phytoplankton in relation to environmental conditions have been made by Demir and Kirkagac (2005)**.** Muzaffar and Ahmed (2007) studied the effect of the flood cycle on the diversity and composition of phytoplankton community of a seasonally flooded Ramsar wetland in Bangladesh. Moreno-Ostos et al (2008) investigated spatial distribution of phytoplankton in a Mediterranean reservoir. Cardoso and Marques (2009) determined the short-term patterns derived from the interactions of wind-driven hydrodynamics and the plankton community in a large, shallow lake. In India, studies on phytoplankton of lentic systems in relation to their environmental conditions have been made by Ganapathi (1941), Pandey et al. (2000). Mohan (1980) compared the values of organic carbon and planktonic biomass with that of dominant algal associations in two lakes of Hyderabad. Padhi (1995) in his studies on water chemistry and algal communities on the three freshwater ponds in and around Berhampur suggested revival methods using the algal communities as biological indicators. He recorded wide variations in pH, dissolved oxygen, BOD, COD, phosphate and nitrates. Pandey et al. (2000) investigated the nutrient status and cyanobacterial diversity of tropical freshwater wetlands of Udaisagar and clearly indicated elimination of sensitive cyanobacterial species from the substations receiving urban industrial effluents. Pulle and Khan (2003) analyzed the qualitative and quantitative concepts of phytoplankton and recorded 43 species, of which 18 were Chlorophyceae, 10 Bacillariophyceae, 10 Cyanophyceae and 5 Euglenophyceae. Angadi et al. (2005) studied physico-chemical and biological status of aquatic bodies and recorded 39 species of algae from four classes. In Gujarat state, Nandan (1983) studied the algal flora of polluted waters. Shaji (1989) and Jose (1990) evaluated the algae as pollution indicators in running waters. Rana and Nirmal Kumarphysico-chemical characteristics of water and sediments, diversity of macrophytes and planktons of certain wetlands of Central Gujarat. Nirmal Kumar (1992) also prepared indices based on chemical properties in relation to planktons. Kumar et al. (2005, 2008) also studied physico-chemical characteristics of water and sediments, diversity of macrophytes and planktons of certain wetlands of Central Gujarat. Nirmal Kumar (1992) also prepared indices based on chemical properties in relation to planktons.

MATERIALS AND METHODS

Study area: Certain floodplain riparian wetlands namely *Morikhaboloo beel and Dolamora beel* of the River Subansiri of Lakhimpur, Assam have been selected for the study.

Morikhaboloo Wetland: This floodplain riparian wetland of Lakhimpur District is located at Na ali and kaboloo area of Lakhimpur District. Morikhabaloo wetland is located between N27°06$^{/}$.917$^{//}$ latitude, E094°08$^{/}$.210$^{//}$ longitude and 216 ft altitude. It is situated nearly 14 km from North Lakhimpur town of Assam,India

Dolamora Wetland: This floodplain riparian wetland of Lakhimpur district is located at Bachagaon village of Lakhimpur District. Dolamora wetland is located between N27°06$^{/}$.314$^{//}$latitude, E094°07$^{/}$.662$^{//}$longitude and 200ft altitude. It is situated nearly 15 km from North Lakhimpur town of Assam,India.



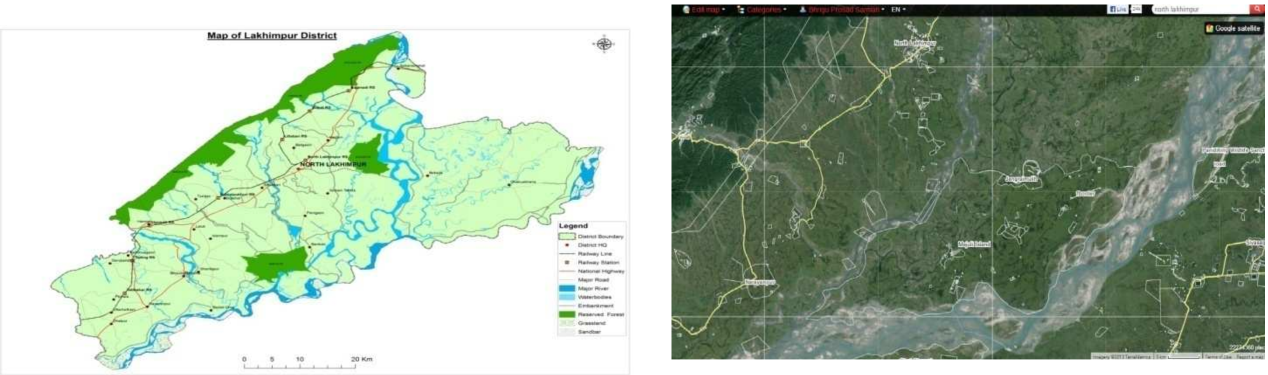


Figure 1. Map and satelliteview of Study area

Sampling: Composite water samples (sub-surface and middle depth) will be collected randomly from each sampling sites once a month with a 2 L plastic hydrobios water sampler and will be transferred to clean 2 L polyethylene containers and 250 ml capacity borosilicate glass bottles for nitrate, chloride in the laboratory. On the other hand temperature, transparency, pH, conductivity, DO and FCO_2 will be measured in the sampling sites.

Initial survey will be made by boat covering the selected wetlands to survey the species and to record their distribution. Phytoplankton and algae will be collected in bottles filled with 70% formalin aceto alcohol (FAA) (Sass, 1958) and will be taken to the laboratory for further identification.

RESULTS

Phytoplankton community: A total no. of 46 species were identified belonging to Myxophyceae, Chlorophyceae, Bacillariophyceae and Euglanophyceae. Moreover, species of Chlorophyceae were recorded to be the most occurred group compared to others throughout the study which shows relatively unpolluted nature of wetland.

Table 1: List of Phytoplankton species and their frequency

Group	Name of Species	Morikhaboloo			Dolamora		
		Monsoon	Summer	Winter	Monsoon	Summer	Winter
Myxophyceae	*Oscillatoria* spp.	++	++	+	++	++	-
	Anabaena spp	++	++	++	++	++	+
	Nostoc spp.	+	++	++	+	++	+
	Microcystis spp.	+	+	+	+	-	-
	Spirulina spp.	++	+	+	+	+	+
	Rivularia spp.	+	+	+	+	-	-
Bacillariophyceae	*Diatoma* spp.	++	++	+	++	++	+
	Denticula spp.	+	++	+	+	+	-
	Epithemia spp.	++	++	+	+	+	-
	Eunotia spp.	+	++	++	+	++	+
	Asterionella spp.	++	++	+	+	+	+
	Cyclotella spp.	+	++	+	+	+	-
	Frustulia spp.	++	+++	+	++	++	+
	Gynosigma spp.	+	++	+	+	+	+
	Navicula spp.	++	++	++	++	++	++
	Nitzchia spp.	++	+++	++	++	++	+
	Pinnularia spp.	++	++	++	+	++	+
	Raphidonema spp.	++	++	+	++	+	+
	Synedra spp.	+	++	+	+	+	+
	Melosira spp.	+	+	+	+	+	-
	Cocconeis spp.	+	+	-	+	-	-
	Gomphonema spp.	+	-	-	+	+	-
Chlorophyceae	*Bulbochaeta* spp.	++	++	++	+	++	-
	Chlorella spp.	++	+++	++	+	++	+
	Cladophora spp.	+	++	-	+	+	-
	Closterium spp.	++	++	++	+	++	++
	Microspora spp.	+	+	+	+	+	+
	Oedogonium spp.	++	++	-	-	++	+
	Pediastrum spp.	+	++	+	+	++	+
	Spirogyra spp.	+	++	+	+	+	+
	Ulothrix spp.	+	++	++	+	+	-
	Chlamydomonas spp.	++	++	+	++	++	+
	Chlorogonium spp.	+	+	+	+	+	+

	Carterea spp.	+	++	+	+	+	+
	Platymonas spp.	++	++	++	++	+	+
	Gonium spp.	+	+	+	+	+	+
	Eudonina spp.	++	++	+++	++	++	++
	Selenastrum spp.	+	+	+	+	+	+
	Sorustrum spp.	+	+	+	+	+	+
	Hydrodictyon spp.	++	++	+	+	++	+
	Pithopora spp.	+	+	++	+	+	+
	Chara spp.	++	++	++	++	+	+
	Nitella spp.	++	++	+	++	+	+
	Volvox spp.	+++	++	++	++	++	++
Eugleninceae	*Euglena* spp.	++	++	+	++	++	+
	Phacus spp.	+	+	+	+	+	-

- = Not detected; +++ = Abundant; ++ = Normal; + = Rare.

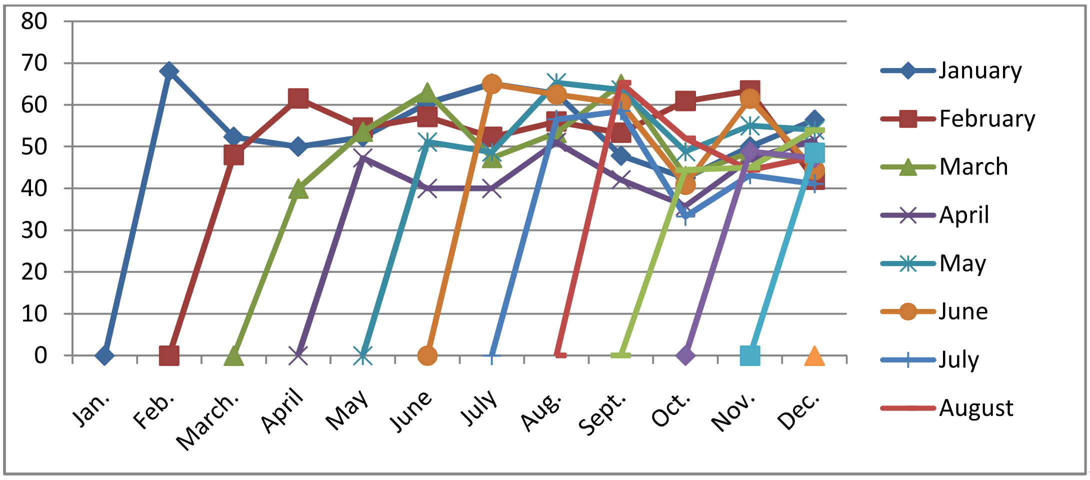
Table- 2: Monthly varations in phytoplankton density (no./l) of Wetlands

	Jan.	Feb.	March.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
CYANOPHYTA												
Microcystis sp.	-	-	-	-	-	-	-	-	1	1	-	-
Anabaena sp.	-	-	15	15	15	10	-	3	-	-	-	-
Nostoc sp.	-	-		-	-	-	-	-	-	1	-	-
Oscillatoria sp.	-	-	-	-	-	-	1	5	5	-	-	1
Phormidium sp.	-	3	-	-	-	-	-	3	2	-	5	-
Spirulina sp.	-	-	-	-	-	-	-	1	2	1	-	-
EUGLENOPHYTA												
Euglena sp.	-	-	3	-	-	-	-	-	-	2	-	-
Phacus sp.	-	1	-	-	-	-	-	-	-	-	-	-
CHLOROPHYTA												
Actinastrum sp.	3	2	-	-	1	-	1	-	-	-	5	7
Closterium sp.	-	-	-	-	-	1	-	2	3	-	-	-
Gonium sp.	3	-	1	-	2	3	-	3	2	1	-	1
Pediastrum sp.	1	-	-	-	-	-		3	1	-	-	-
Protococcus sp.	-	-	-	-	-	-	-	-	-	1	1	-
Microspora sp.	-	-	-	2	-	3	2	3	4	-	1	-
Spirogyra sp.	-	-	-	-	-	-	6	3	3	-	-	-
Ulothrix sp	-	-	-	-	1	1	1	4	1	-	-	-
Gonatozygon sp.	1	5	1	-	1	-	1	1	5	-	1	1
Dictyospherim sp.	-	-	-	1	2	3	-	-	-	1	1	2
Jygnema sp.	-	-	1	1	-	-	-	-	-	-	-	-
Rivularia sp.	-	-	5	-	3	5	-	5	-	-	-	-
Volvox sp.	-	-	-	-	-	10	3	3	4	-	-	-
Crucigenias p.	-	-	-	-	-	2	1	1	-	4	3	2
Coelospherium sp.	-	-	-	-	-	-	-	1	1	-	-	-
XANTHOPHYTA												
Voucheria sp.	1	1	-	1	-	2	-	-	-	-	-	1
Tribonema sp.	-	-	-	-	1	-	5	6	-	-	-	-
BACILLARIOPHYTA												
Amphora sp.	1	-	2	-	-	2	1	-	-	-	-	-
Bumillaria sp.	-	-	-	-	1	-	-	2	-	-	-	-
Cymbella sp.	1	-	-	-	-	1	1	-	-	-	-	-
Diatoma sp.	-	-	-	-	-	-	1	1	-	1	-	-
Flagillaria sp.	-	-	-	-	-	-	-	-	5	-	-	-
Frustulia sp.	-	-	2	1	-	-	-	-	-	-	-	-
Gomphoneis sp.	-	-	-	-	1	-	-	-	-	-	-	-
Gomphonema sp.	-	1	-	1	-	-	1	-	-	-	-	-
Gyrosigma sp.	-	-	3	-	-	1	-	-	2	1	-	-
Navicula sp.	-	5	-	-	-		-	-			-	-
Stauroneis sp.	3	-	-	-	-	-	-	-	-	1		1
Desmidium sp.	-	-	-	-	-	1	1	-	-	-	1	-
Pinnularia sp.	1	-	-	-	-	-	-	-	-	-	-	-
Synedra sp.	-	1	-	-	-	-	-	-	-	-	-	-
Tabellaria sp.	1	-	-	-	-	-	-	-	-	-	-	-
Micrasterias sp.	-	-	-	-	-	1	5	2	-	-	1	-
Melosira sp.	-	2	-	-	2	-	-	1	1	-	1	-
Cyclotella sp.	-	1	-	-	-	-	-	-	-	-	-	-
Ceratium sp.	2	3	1		-	-	-	-	-	-	-	-
Cyanophyta	0	3	15	15	15	10	1	12	10	3	5	1
Euglenophyta	0	1	3	0	0	0	0	0	0	2	0	0
Chlorophyta	9	8	8	4	10	28	15	29	24	7	12	13
Xanthophyta	1	1	0	1	1	2	5	6	0	0	0	1
Bacillariophy	9	13	8	2	4	6	10	6	8	3	3	1
TOTAL PHYTOPLANKTON (ind/l)	**19**	**26**	**34**	**22**	**30**	**46**	**31**	**53**	**42**	**15**	**20**	**16**

Table 3: Similarities index of phytoplankton

	Jan.	Feb.	March.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
January	-	68.0	52.3	50.0	52.3	60.4	65.1	62.7	47.8	42.5	50.0	56.4
February		-	48.0	61.5	54.5	57.1	52.3	56.0	53.3	60.9	63.4	42.1
March			-	40.0	53.6	63.0	47.3	53.3	65.0	43.0	48.6	47.0
April				-	47.3	40.0	40.0	51.1	42.1	35.8	47.0	51.6
May					-	51.1	48.7	65.3	63.6	48.8	55.0	54.0
June						-	65.0	62.5	60.4	40.9	61.5	44.4
July							-	56.5	58.5	33.3	43.2	41.1
August								-	65.3	52.0	44.4	47.6
September									-	44.4	45.0	54.0
October										-	48.8	47.3
November											-	48.5
December												-

Fig 1: Similarities index of phytoplankton



Physicochemical variables: **The physicochemical parameters of both wetlands are enumerated in following tables-**

Table 4: Monthly variations of water environment in Morikhaboloo Wetlnd

Motnhs Factors	June 2013	July 2013	Aug. 2013	Sept. 2013	Oct. 2013	Nov. 2013	Dec. 2013	Jan. 2014	Feb. 2014	Mar. 2014	Apr. 2014	May 2014	Mean (± Sd)
Air temperature (^{0}c)	31	32	31	30	28	22	19.0	18.5	19	22.6	25	30	24.04, ±3.40
Water temperature (^{0}c)	28.6	30.0	30.0	27.0	27.5	23.3	18.0	18.0	19.0	22.0	22.0	26.3	24.30, ±4.51
Transparency (cms)	137.0	100.0	72.0	91.0	118.0	136.0	177.0	152.0	138.0	128.0	130.0	149.0	127.33, ±28.68
pH	7.0	7.0	7.1	7.0	7.2	7.3	7.0	7.3	7.3	7.2	7.3	7.2	7.16, ±.13
Dissolved oxygen (mg/l)	11.2	4.8	6.4	5.6	7.2	8.6	8.6	8.0	10.4	7.8	8.5	8.1	7.93, ±1.8
Free carbon dioxide (mg/l)	6.0	8.0	4.0	4.0	4.0	6.0	6.0	6.0	4.0	4.0	6.0	8.0	5.5, ±1.5
Chloride (mg/l)	20.33	20.33	17.2	15.63	12.51	9.38	12.51	8.7	12.0	11.5	15.6	21.8	14.8, ±4.4
Nitrate (mg/l)	1.7	1.8	1.8	1.6	1.5	1.5	1.3	1.42	1.60	1.40	1.40	1.3	1.53, ±0.17

Table 5: Monthly variations water environment in Dolamora Wetlnd

Motnhs Factors	June 2013	July 2013	Aug. 2013	Sept. 2013	Oct. 2013	Nov. 2013	Dec. 2013	Jan. 2014	Feb. 2014	Mar. 2014	Apr. 2014	May 2014	Mean (± Sd)
Air temperature (^{0}c)	32	33	31	29	28	23	18	18.5	19	23	25	31	24.02, ±3.41
Water temperature (^{0}c)	27.4	31.0	31.3	26.0	25.5	24.3	17.0	16.6	19.0	22.0	21.8	25.3	24.28, ±4.53
Transparency (cms)	134.0	103.0	78.0	94.0	112.0	137.0	187.0	154.0	134.0	128.0	132.0	149.0	126.34, ±28.48
pH	7.0	7.0	7.1	7.0	7.1	7.4	7.1	7.3	7.2	7.2	7.4	7.2	7.18, ±.12
Dissolved oxygen (mg/l)	8.2	5.8	6.4	5.2	7.4	8.5	7.8	8.3	10.4	7.9	8.5	8.3	7.87, ±1.3
Free carbon dioxide (mg/l)	6.2	7.8	4.0	5	4.0	6.0	4	6.0	6	4.0	6.0	8.0	5.6, ±1.4
Chloride (mg/l)	18.33	20.33	16.2	15.63	13.51	9.37	12.58	9.2	12.0	9.2	15.6	23.0	15.8, ±4.7
Nitrate (mg/l)	1.7	1.9	1.8	1.5	1.3	1.3	1.3	1.42	1.60	1.40	1.23	1.3	1.43, ±0.16

Fig 2: Air temperature of Morikhaboloo and Dolamora Wetland

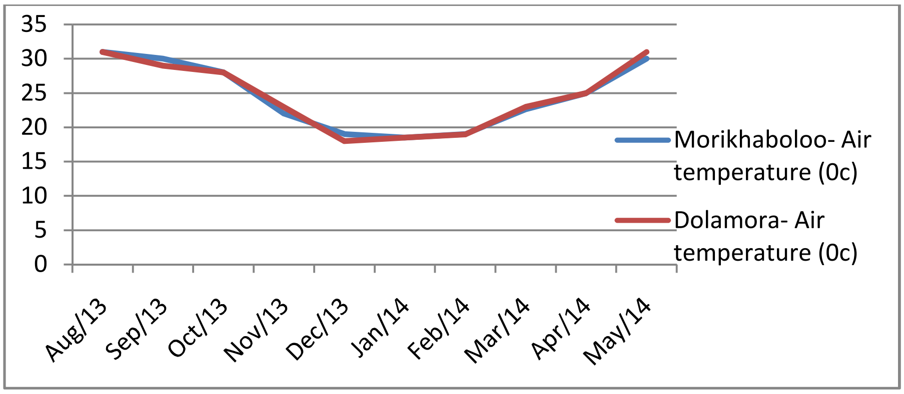


Fig 3: Water Temperature of Morikhaboloo and Dolamora Wetland

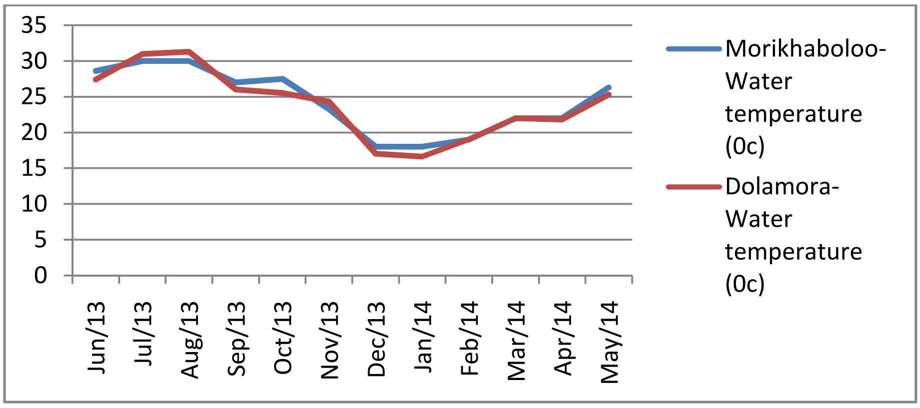


Fig 4: Trannsparency of Morikhaboloo and Dolamora Wetland

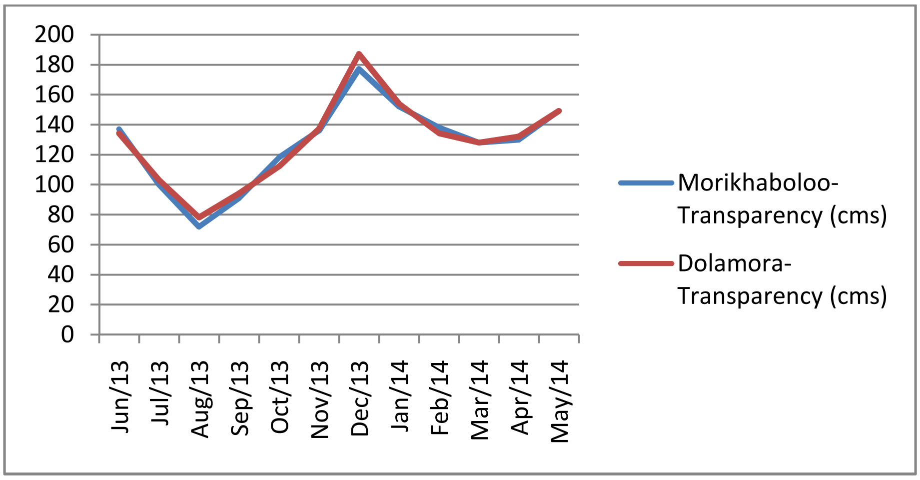


Fig 5: pH of Morikhaboloo and Dolamora Wetland

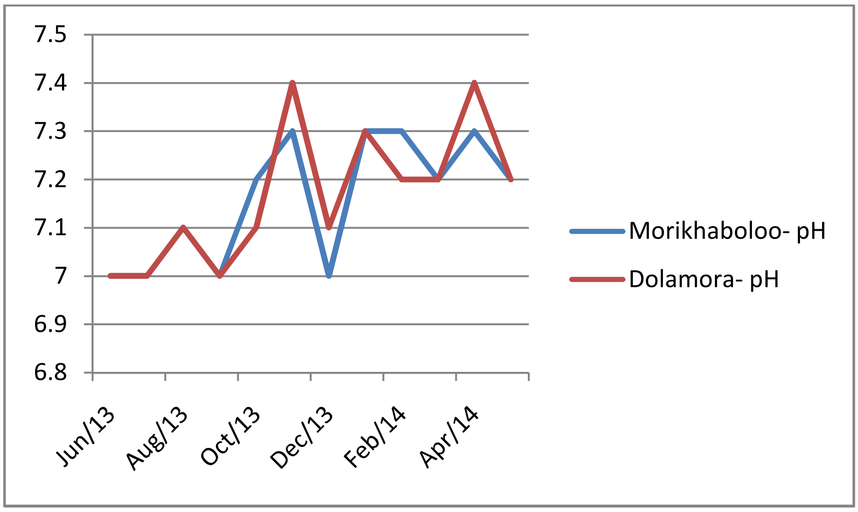


Fig 6: Dissolved Oxygen of Morikhaboloo and Dolamora Wetland

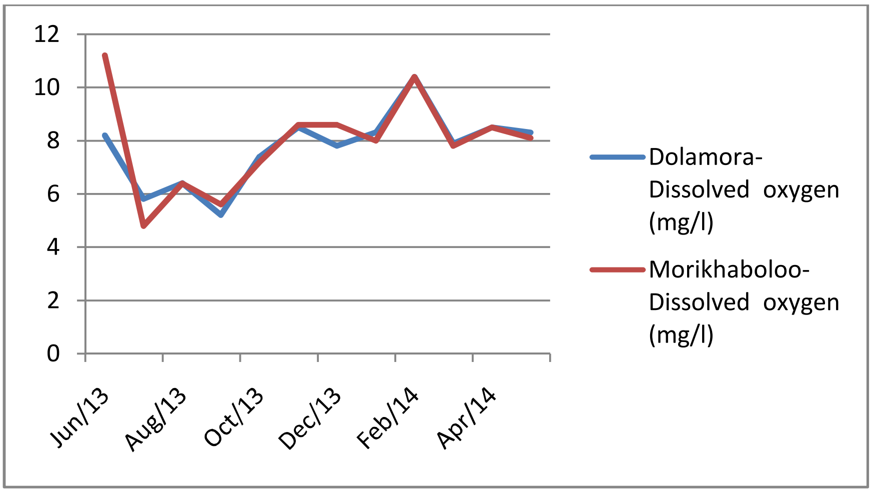


Fig 7: Free Carbon dioxide of Morikhaboloo and Dolamora Wetland

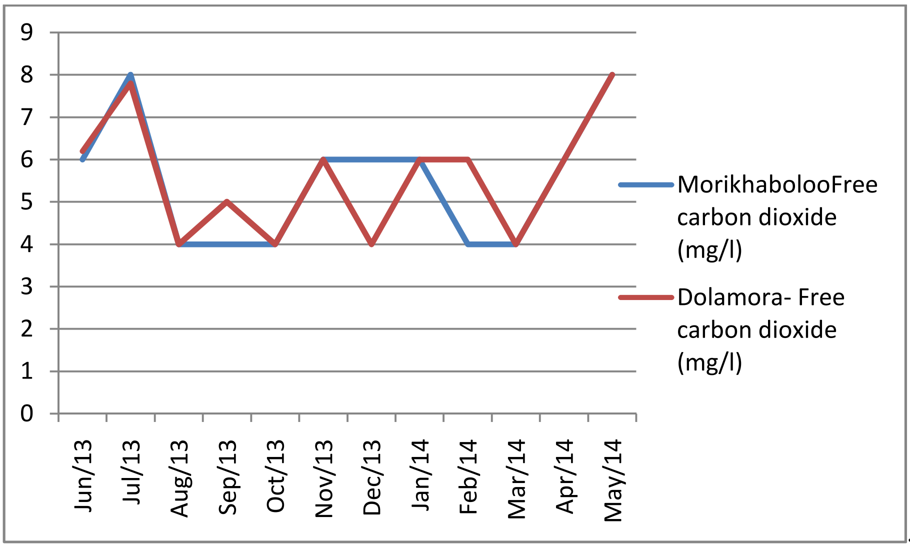
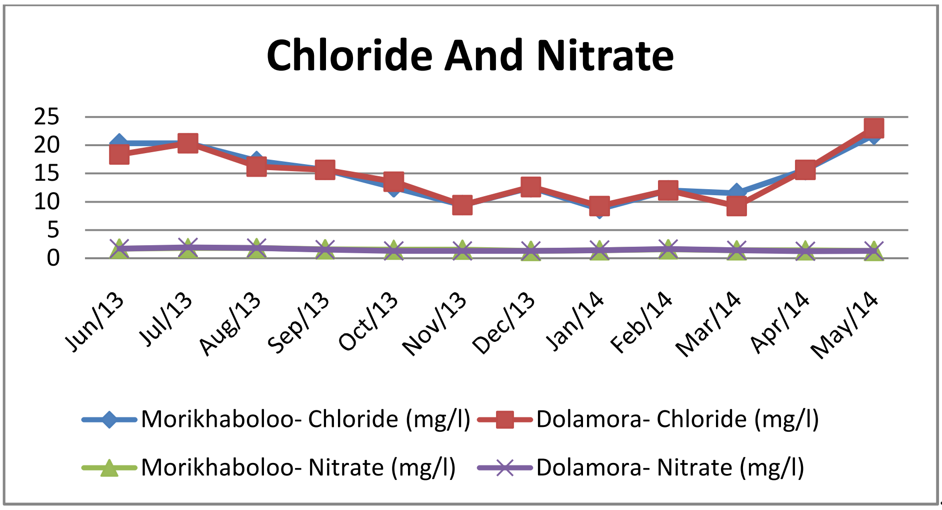


Fig 8: Chloride and Nitrate of Morikhaboloo and Dolamora Wetland



DISCUSSION

The present study deals with monthly variations of different abiotic factors in certain wetland of Subansiri River for three annual cycle as well as seasonal changes in major physico-chemical parameters. The species composition phytoplankton was analysed on seasonal basis

Among abiotic factors, water temperature ranged between 16.6 ^{0} and 31.0 ^{0}C in both wetlands. It therefore, depicted a tropical nature and followed a trend identical to that of air temperature throughout the study period. Transparency ranged between 72 and 177 cm; it showed almost a bimodal pattern and remained distinctly low (91-100cm) from July to September (rainy months).

Dissolved oxygen in wetlands ranged between 4.8 and 11.2 mg/l. The present observation did not reflect any definite pattern of seasonal fluctuation of dissolved oxygen in the studied wetlands. The concentration of free carbon dioxide varied between 4.0 and 8.0 mg/l and this parameter too did not depict any definite trend of seasonal variation.Nitrate concentration did not depict much seasonal variations in that *wetlands* (1.3-1.8 mg/l). It exhibited a marginal increase during the monsoon season.

Phytoplankton communities represented by 46 species. The major groups of phytoplankton viz., Cyanophyta, Euglenophyta, Chlorophyta, and Bacillariophyta were represented by 6, 2, 23, and 15 species respectively. The species richness of phytoplankton in both wetlands ranged from August to December and depicted an irregular pattern of annual variations. The population density of net plankton ranged between 36 and 90 no./l. It followed a multimodal pattern and indicated the peak in May and lowest in October. The population density of phytoplankton in wetlands ranged from 15 to 53 no. /l. The maximum was noticed in August and minimum in October. The species diversity of phytoplankton ranged from 0.513 to 1.262 with the following order of dominance- Chlorophyta > Cyanophyta > Bacillariophyta > Xanthophyta > Euglenophyta.

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