8. SUMMARY
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Chilka, the largest brackish water coastal lagoon in India is very significant for sustaining a great biological diversity, socio-economic potentiality and above all for recognition as one of the Ramsar sites. Realising the very importance of this lagoon system, the present investigation on 'Ecological investigation on the plant resources of the lake Chilka, Orissa, India' was undertaken. In the present work seasonal and sectorial variations of physico-chemical conditions of water like depth, temperature, tides, waves and currents, pH, transparency, salinity, dissolved oxygen were studied. Quantification of nitrite, nitrate, ammonium, phosphate and carbonate of the lake water in some special habitats were assessed. The observations made are summarised below:

1. On the basis of correlation of different physico-chemical parameters, four sectors can be recognised in the lagoon.
2. Water depth is highest at central sector and lowest at outer channel sector.
3. During summer the water temperature is maximum and in winter it is minimum.
4. Tidal condition is only restricted to the outer channel sector. Water current and waves are dependent on the wind direction and seawater/fresh water influx.
5. During winter the water transparency is highest and lowest during monsoon in all the sectors.
6. Salinity is maximum at outer channel sector during summer and minimum at northern sector during monsoon. On the basis of salinity condition, the lake has three zones; fresh water zones at northern sector, brackish water zone at both central and southern sectors and marine water zone at outer channel sector.
7. In monsoon and post-monsoon the D.O. is more or less similar and shows the highest value whereas during summer and winter showing lower value.
8. pH is generally alkaline in nature and somewhat acidic in highly eutrophicated condition of water.

Parameters studied for sediment analysis of the different parts of the lake are the percentage of coarse sand, fine sand, silt, clay, Organic carbon, N, P, K and pH as well as conductance.

The major findings on the sediment are:

1. Percentage of coarse sand is higher in all the sectors in respect to other sediment particles. Outer channel has the maximum coarse sand. Fine sand is maximum at central sector and minimum at outer channel sector.
2. Silt is highest at northern sector and more or less similar in other sectors.

3. Clay shows highest values at central sector and lowest at outer channel sector.

4. Percentage of NPK is in the following order: Nitrogen: Southern sector (SS) > Central sector (CS) > Northern sector (NS) > outer channel sector (OCS); Phosphorus: NS > CS & SS > OCS; Potassium: SS > NS & CS > OCS.

5. Percentage of organic carbon is in the order of OCS > NS > CS > SS;

6. Sediment of outer channel sector has the alkaline condition where as in the other sectors it is acidic to alkaline in nature.

7. Nature of conductance of lake sediment is CS > SS > NS > OCS.

Major findings on the diversity, distribution (spatial and temporal), association, quantification and correlation with water quality of phytoplankton/periphyton are:

1. 71 genera of phytoplankton are distributed of which Myxophyceae, Chlorophyceae, Xanthophyceae, Bacillariophyceae and Dinophyceae are 12, 20, 1, 35 and 3 respectively.

2. Diversity on spatial distributions of different groups are as follows: Mixophyceae: CS > NS > SS > OCS; Bacillariophyceae: OCS > SS > CS > NS; Dinophyceae: OCS > CS & NS (nil); Xanthophyceae is only found in central sector.

3. Diversity on temporal distributions of different groups are: Summer and post-monsoon: Bacillariophyceae > Chlorophyceae > Myxophyceae > Dinophyceae > Xanthophyceae. In monsoon and winter only the diversity of Myxophyceae is greater than Chlorophyceae.

4. Aquatic macrophytes/seaweeds playing hosts to the periphyton can be arranged accordingly to the number of genera adhering as Potamogeton pectinatus > Ruppia maritima > Najas indica > Ceratophyllum demersum > Enteromorpha intestinalis > Hydrilla verticillata > Halophila Sp.

5. Chlorophyll content of phytoplankton reveals that phytoplankton biomass is higher and more or less same both in central and southern sectors than outer channel except in monsoon and lowest at northern sector. In all the sectors phytoplankton biomass is the highest during monsoon months and lowest during summer time in the central and southern sectors. In outer channel sector during post-monsoon phytoplankton biomass is lowest as in the northern sector except monsoon, more or less similar in all the seasons.
Phytoplankton chlorophyll content (biomass) has been well correlated with water temperature, transparency, pH, salinity and dissolved oxygen are as follows:

1. Generally phytoplankton biomass has the decreasing tendency to the increase of temperature.
2. Phytoplankton biomass is the best in the pH range 7-8.5.
3. Phytoplankton biomass has the increasing trend to the higher transparency.
4. Phytoplankton biomass shows two peaks one at salinity 4-13 ppt and other at the range of 25-31 ppt. The tolerance limit of phytoplankton biomass for salinity as around 33-35 ppt.
5. Higher Phytoplankton biomass contributes to the increase in dissolved oxygen apart from other factors.

The algal mats formed in this lake with different compositions in different sectors: Northern with *Microspora*; Central with *Rhabdonema* sp., *Lyngbya* sp., *Spirogyra* sp. and *Chaetomorpha* sp.; Southern with *Rhabdonema* sp. Maximum number of aquatic macrophytes growing in algal mat area at northern sector (7) and minimum at central sector (5).

In highly eutrophicated water with nitrite, nitrate, phosphate and ammonium contents algal bloom with vigorous growth of blue greens than that of diatoms and greens. *Phormidium corium*, *Phormidium tenue* and *Anabaena circinalis* are the dominant bloom components associated with three genera of greens and two genera of diatoms.

In the polluted area of the lake, the genera of *Myxophyceae*, *Chlorophyceae* and *Bacillariophyceae* growing are 6, 5 and 8 respectively.

Rocky submerged edges of the island and some macrophytes mainly inundated at brackish water harbours 12 seaweed species of which *Rhodophyceae* 7 sp., *Chlorophyceae* 3 sp., *Charophyceae* 1 sp., and *Phaeophyceae* 1 sp. Maximum seaweed population was found at southern sector and northern sector is completely lacking of it. Seagrasses are growing in all the sectors except at northern. 4 species and 1 subspecies of seagrasses are distributed in this lake. Maximum seagrass concentration is noted at southern sector. Maximum biomass of *Halophila* is noted during summer and minimum in winter except at outer channel where it is in monsoon. Maximum biomass of *Ruppia* is found at southern sector near Somolo island during summer. Increase of *Halophila* biomass is directly correlated to the increase of temperature and it is not true for
Ruppia. Both of them tolerate the salinity range of 10-28 ppt. Seagrass biomass has the decreasing trend to dissolved oxygen.

In this lagoon system 67 species of aquatic macrophytes are distributed of which Helophytes are dominants with 33 species and Tenagophytes are completely absent. Among the other growth forms number of species under Vittate, Pleustophyte, Epiphyte, Hyperhydate and Rosulate are 9, 12, 6, 6 and 1 respectively.

Maximum aquatic macrophytic diversity is noted at the northern sector. There are 32 species exclusive to fresh water (low salinity?) zone, 14 grow both in brackish and marine water and 11 in fresh water zone as well as brackish water zone.

In the polluted condition of the lagoon a few plants can grow vigorously like Potamogeton pectinatus, Najas indica, Najas graminea, Schoenoplectus maritimus, Nymphoides hydrophylla and the seaweeds like Enteromorpha intestinalis, Chaetomorpha media, Polysiphonia sp. and Ceramium sp.

Seasonal variation of the plant diversity on the Nalban island, the bird sanctuary of the lake reveals the following number of species in different seasons: summer - 15, monsoon - 6, post-monsoon - 8 and winter - 9.

The analysis of the floristic diversity shows the presence of 377 species of vascular plants of which 288 belongs to Dicotyledons, 80 to the Monocotyledons and 9 to the Pteridophytes. The number of genera of Dicotyledons and Monocotyledons are 217 and 56 respectively and of families 75 and 16. Of the aquatic macrophytes 38 (excluding seagrasses) species are Monocotyledons and 25 species Dicotyledons besides 4 Pteridophytic species. Among the economically important plants there are about 185 species for medicinal, 10 as vegetables, 15 as fodder, 6 with uses of paper pulp, fibre and thatching. A good number of plants supply food to the fishes and about 56 species provide food and shelter to the birds.

Among the existing flora 4 species are rare and 16 species are in threatened condition. A total number of 63 species reported from the study area that could not be found by the present author during the whole course of study period.

The landmass of Chilka and surrounding area are of island, shoreline or spit and adjoining areas or bank sites, islands are pure rocky, sand covered rocky, sand-clay covered rocky and sandy types. Most of the islands have the vegetation of coastal scrubs with some seaweeds, seagrass and aquatic macrophytic population at their edge. On the shore or spit and adjoining areas the vegetation mainly of dry coastal vegetation.
Records show that the water spread area of the lagoon shows a decreasing trend. Migration/alteration/closure of spit mouth and outer channel area are also affecting the saline water inflow in the lagoon. Freshwater discharges from the rivers and declining saline water inflow is greatly altering the brackishness/salinity condition of the lake where by its lagooner character is under great threat. Increasing population pressure in and around the lake add to the pollution of the water, alteration in the biodiversity and remarkably the waterfowls.

Much more baseline data in an integrated manner are required and priorities are to be decided by all concerns including the policy makers. The general awareness is a key to the conservation of this internationally renowned lagoon.