Changes of Water Quality Parametres through ages in Chilika Lagoon & Its Remediation

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ABSTRACT

The Chilika, located along Orissa Coast, is the largest brackish water Lagoon in Asia. As part of its protection and conservation measures, a new mouth was dredge opened at Sipakuda to facilitate free water exchange between the Lagoon and the sea in September 2000. The physico-chemical parameters such as Temperature. pH, Transparency, Dissolved Oxygen (DO) and Nutrients - Nitrate, Phosphate and Silicate were studied from Chilika Lagoon during June 2007 to May 2008 from four stations. The present study was made to know the impact of opening of new mouth at Sipakuda. The maximum temperature was 38.3oC during May 2008. The temperature ranged from 19.3oC to 38.3oC.The average salinity ranged from 7.3 to 26.7 ppt recorded from Kalupadaghat station and Alupatana station which are present at the Northern and Outer Channel Sector respectively. The maximum Secchi disc value was observed to be 1.92 meter in Central Sector. The pH ranged from 6.3 to 8.9.The Dissolved Oxygen value ranged from 6.2 mg/l to 7.8 mg/l from Pathara (Southern Sector) and Kalupadaghat (Northern Sector).The nutrient value showed distinct seasonal and spatial variation. Phosphate value was lower as compared to Nitrate. The physico-chemical parameters showed noticeable changes after opening of new mouth at Sipakuda.

INTRODUCTION

The Chilika lagoon is a pear shaped water body located along Orissa coast, the East coast of India. It extends from south east corner of Puri district to Ganjam. The pear shaped, low latitude lagoon owes its shape to the presence of delta of the Mahanadi river in northern part, the rocky hills of Eastern Ghat and barrier spit separating the lagoon from Bay of Bengal. It is the largest brackish water lagoon of Asia with captivating beauty, abundant biological resources and rich economic attributes. It has earned the distinctive status of a highly productive, multi species fishery, occupying the top most position among the inland capture fisheries of India. It contributes significantly to the economy of the state by way of its natural living resources providing an excellent protein diet to the expanding population of the region.

The Chilika lagoon has originated since 5,000 years ago separated from the Bay of Bengal was having a water spread area of 2200 km2 during monsoon. The water depth of the lagoon was 1.5-2.5m during 1925 (Samaj 2008). This treasured gift of nature has

been the source of sustenance and survival for 0.2 million Indigenous fisher folk. It is considered as "Wetland of International Importance" under the Ramsar Convention since 1981. Orienting from north east to south west the major part of the lagoon lies in Puri district while only the narrow stagnant stretch extend into Ganjam district. The pear shaped lagoon is wider in the northern than southern region. It is situated on the southern part of Mahanadi delta complex. The lagoon is cut off from the Bay of Bengal by a continuous sandy spit measuring 60 km in length and 150 meter in width. The lagoon inlet opening into the Bay of Bengal is 300 m wide. There are 52 river and rivulets drains into the lagoon carrying a lot of silt in every year. The average rain fall in the area is 1,800 mm (Khandelwal et al, 2008). The salinity shows remarkable variation both temporally and spatially. During the monsoon a large volume of fresh water enters the northern and central zones and passes through outer channel into the Bay of Bengal. The southern sector remains relatively undisturbed because water renewal is much slower, hence brackish water condition prevails in this zone during monsoon.

Ecologically the lagoon is separated into four sectors namely Northern, Southern, Central and Outer channel sectors. The northern, central and the outer channel sectors are mostly influenced by fresh water inflow and tidal ingress pushing the sea water into the lagoon. Salinity is the most dominant factor determining the lagoon ecology and it depends upon the fresh water inflow to the lagoon from the Delta River and western catchments. The lagoon receives inflow from its western catchments (1,560 km2) and run off irrigation drainage from delta region (2,250 km2). Sea water exchange takes place predominantly through outer channel. The lagoon has huge catchment area of 4,146 km2 (Gupta et al, 2008).

First mouth was opened naturally at Magarmukh. The mouth was extremely shallow. Slowly the mouth was chocked due to a strong littoral drift of sands in the near shore region which arrests the tidal inflow of saline water into the lagoon. Due to this the salinity level decreases to 5-10 ppt which favours growth of macrophytic vegetation and the greatest effect was observed in the northern most part of the lagoon with intense growth of aquatic weeds like *Hydrilla, Eichhornia, Chara* (Satyanarayana, 1999). Hence the weeded area had increased from 20 km2 in 1972 to 685 km2 by 2000 (www. chilika.com.). So in order to enhance the salinity level in the lagoon, an artificial mouth has been opened at Sipakuda in 23rd September, 2000, approximately at the center of the long barrier spit separating the lagoon from the open sea. The opening was successful which brought vast change in the ecology of the lagoon with rise in the salinity, reduction in the weeded area.

Chilika Lagoon support a diverse and dynamic assemblage of fish, invertebrates, crustacean species belonging to marine, brackish and fresh water habitats, providing the basis of a productive fishery. It is an avian grandeur and the wintering refuge for more than one million migratory birds and has global importance as waterfowl habitat (Balchandran et al, 2003). Chilika is one of the lagoons in the world which supports

Irrawadi dolphin population (World Bank, 2005). Before opening of the new mouth 225 fish species, 24 prawn species and 28 crab species (total 277 species) were recorded from Chilika lagoon. After opening of the new mouth, 56 numbers of new records of fish and shell fish species were recorded comprising of 43 fish species, 4 prawn species, 7 crab species and 2 Indian lobsters (Mohapatra, 2007). The salinity was increased due to opening of new mouth at Sipakuda during 2000.

Recently a new mouth has been opened naturally at about 800 m towards north of the mouth of Sipakuda having 70 m width during 1st August, 2008. This natural mouth was widened and reached up to 450 m till 10th of August, 2008 (Samaj, 2008) and 500 m on 27th August, 2008 (Samaj, 2008).

MATERIALS AND METHODS

Chilika lagoon lying on the east coast of India is situated between the latitude 19° 28′ -19° 54′ N and longitude 85° 05′-85° 38′E (Fig 1). It fluctuates in area from maximum

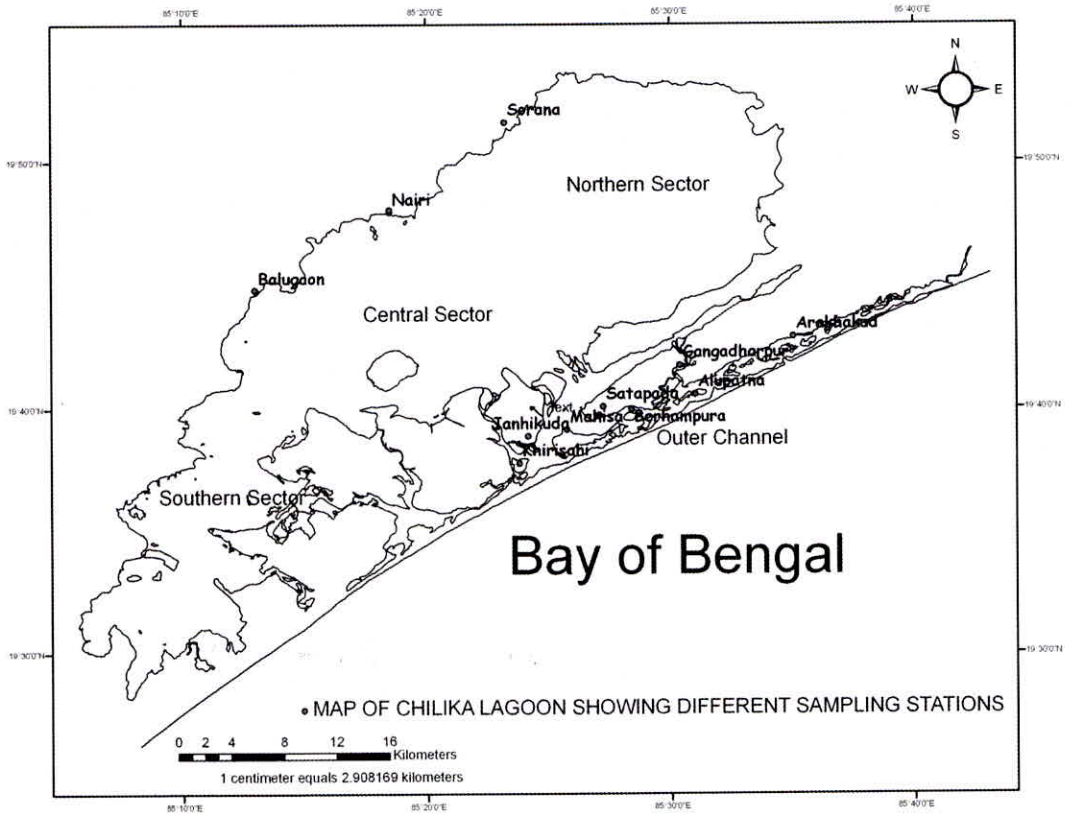

Fig. 1 : Map of Chilika Lagoon showing different sampling stations

of 1,165 km2 during monsoon to 906 km2 during the summer season (Average is 923 km2). The lagoon is separated by a sand bar of 100m and 1.5 m wide. A 30 m outer channel connects the lagoon with Bay of Bengal. The surface water samples were collected for analysis of various water parameters like transparency, pH, salinity, and dissolved oxygen, nutrients such as nitrate, phosphate and silicate. The water samples were collected from four stations situated in the four sectors covering the whole lagoon. The samples were collected during June 2007 to May 2008.

Transparency was measured by lowering the Secchi disc in the lagoonal water. Water temperature and pH were recorded immediately after collection using a standard centigrade thermometer of 0.01oC accuracy and field pH meter respectively. Salinity was determined adopting titrometric method, while Winkler's method was adopted for dissolved oxygen. Nutrients were estimated using filtered sample water adopting the spectrophotometric method.

RESULTS

Water samples were collected covering the whole Chilika lagoon and analysed for different water parameters for the study period. The year was divided into 3 season i.e. Pre- monsoon (Feb-May), Monsoon (June-Sept) and Post- monsoon (Oct-Jan).The results showed that the physico-chemical parameters in Chilika water exhibit spatial and seasonal fluctuations.

From table 1, during the monsoon season the highest transparency was observed to be 1.52 m from outer channel sector and the lowest was observed to be 0.95m from southern sector. The maximum pH was observed to be 8.7 from outer channel sector and the lowest was observed to be 7.6 from southern sector. The maximum temperature was observed to be 35.90 C from northern sector and the lowest was observed to be 33.40 C. The maximum salinity was observed to be 12.4 ppt from outer channel sector and the lowest was observed to be 7.3 ppt from northern sector. The dissolved oxygen

Table : 1 Variation of different water parameters and nutrients from Chilika lagoon during monsoon season (June 2007-September 2007).

Sectors	Trans-parency (m)	pH	Temp. (^{0}C)	Salinity (ppt)	DO (ml/l)	Nitrate (µmol/)	Silicate (µmol/)	Phosphate (µmol/l)
Northern	1.30	8.3	35.9	7.3	6.9	0.07	0.23	0.22
Sourthern	0.95	7.6	34.3	8.1	6.2	0.06	0.54	0.16
Central	1.46	7.9	36.1	7.6	7.1	0.02	0.32	0.30
Outer channel	1.52	8.7	33.4	12.4	6.5	0.09	0.27	0.35

was highest in the central sector being 7.1 ml/l and the lowest was 6.2 ml/l from southern sector. The nitrate, silicate and the phosphate value ranged from 0.02-0.09 µmol/l, 0.23-0.27 µmol/l and 0.16-0.35 µmol/l respectively.

From table 2, the highest transparency was observed to be 1.92 m from outer channel sector and the lowest was observed to be 0.80 m from northern sector. The

Table: 2 Variations of different water parameters and nutrients from Chilika lagoon during post- monsoon season (October 2007- January 2008).

Sectors	Trans-parency (m)	pH	Temp. (^{0}C)	Salinity (ppt)	DO (ml/l)	Nitrate (µmol/l)	Silicate (µmol/l)	Phosphate (µmol/l)
Northern	0.80	6.3	25.4	10.1	6.3	0.03	0.25	0.30
Southern	0.96	7.1	19.1	9.5	7.5	0.02	0.36	0.15
Central	1.28	8.2	27.9	11.7	7.1	0.05	0.31	0.22
Outer channel	1.92	7.9	29.1	16.8	7.8	0.08	0.36	0.26

highest pH was observed to be 8.2 from central sector and the lowest was observed to be 6.3 from northern sector. The temperature ranged from 19.1-29.10 C. The highest salinity was observed to be 16.8 ppt from outer channel sector and the lowest was observed to be 9.5 ppt from southern sector. Dissolved oxygen ranged from 6.3-7.8 ml/l. The nitrate, silicate and the phosphate value ranged from 0.02-0.08 µmol/l, 0.25-0.36 µmol/l and 0.15-0.30 µmol/l respectively

From table 3 the highest transparency was observed to be 1.85m from outer channel

Table: 3 Variations of different water parameters and nutrients from Chilika Lagoon during Pre- Monsoon season (February 2008- May 2008).

Sectors	Trans-parency (m)	pH	Temp. (^{0}C)	Salinity (ppt)	DO (ml/l)	Nitrate (µmol/l)	Silicate (µmol/l)	Phosphate (µmol/l)
Northern	0.96	7.5	34.3	15.4	6.5	0.03	0.32	0.18
Sourthern	1.23	7.2	38.3	16.1	6.9	0.05	0.35	0.16
Central	1.63	8.6	35.1	20.3	7.6	0.02	0.42	0.28
Outer channel	1.85	8.4	33.9	26.9	7.4	0.12	0.49	0.40

sector and the lowest was observed to be 0.96m from northern sector. The pH was observed to be 8.7 from central sector and the lowest was observed to be 7.2 from northern sector. The temperature ranged from 33.9-38.3 0 C. The salinity and the dissolved oxygen value varied from 15.4-26.9 ppt and 6.5-7.6 ml/l respectively. The nitrate, silicate and phosphate value ranged from 0.02-0.12 µmol/l, 0.32-0.49 µmol/l and 0.16-0.40 µmol/l respectively

Variation of physicochemical parameters of the Chilika lagoon has been studied by different authors in different years. This has been represented in the table 4. Baerjee and Roy Choudhuary (1996) have observed that temperature ranged from 17.5 to 32.0 oC in the Chilika lagoon. Nayak and Behera (2004) have observed the temperature variation from 20.3 to 33.5 oC. Nayak and Mohanty (2006) observed the variation of temperature from 23.9 to 35.6 oC. In the present study the temperature ranged from 19 to 38oC. So it may be concluded that the temperature is increasing significantly. The salinity variation observed by Banerjee and Roy Choudhuary (1996) was from trace to 36 ppt. Panda et al (1989) have observed the salinity variation from 0.34 -20.56 ppt. Nayak and Behera (2004) have observed the salinity variation from 0.1- 36.5 ppt. In the present study the salinity is observed to be 7.2- 27.3 ppt. The dissolved oxygen variation observed by Panda et al (1989) was 3.07 -3.75 ml/l. The dissolved oxygen variation observed by Nayak and Behera (2004) was 4.5- 12.5 ml/l. In the present study the dissolved oxygen ranged from 6.3-9.1 ml/l. It showed an increase in dissolved oxygen variation. Similarly the nutrient value showed significant increase after opening of the new mouth.

DISCUSSION

Mohapatra et al (2007) have worked on the Fisheries enhancement and biodiversity assessment of fish, prawn and mud crab from Chilika lagoon through hydrological intervention. They have summarized both the pre and post monsoon result. They have observed that salinity increases significantly during the post intervention period.. Salinity in the outer channel sector was high being 32.2 ppt and the lowest was observed in the southern sector being 13.1 ppt. Dissolved oxygen has no effect after opening of the new mouth. The result of Mohapatra coincides with the present result.

Nayak and Behera (2004) have studied the seasonal variation of the Chilika lagoon after opening of the new mouth near Sipakuda. The salinity was found highest being 32 ppt in Satapada which was in the outer channel sector. Lowest salinity was observed from Kalupadaghat which was 0.5 ppt. Salinity was high in the pre monsoon season as compared to the other season of the year. The result of Nayak and Behera coincides with the present result.

REMEDIATION

From the above result and discussion, it is clearly visible that the depth of the

Table 4 : Variations of physicochemical parameters of Chilika lagoon by different authors during different period of their study.

Temperature (^{0} C)	17.5-32.0	23.2-28.6	29.9-32.21	20.3-33.50	23.98-35.6	24.7-31.7	-
Salinity (ppt)	Trace-36.0	0.0-34.0	0.34-20.56	0.60-34.50	0.35-32.25	1.5-33.8	0.1-36.5
pH	7.6-10.0	7.0-10.66	-	6.8-9.6	6.35-9.25		7.1-9.9
Dissolved Oxygen(ml/l)	1.3-1.40	3.0-19.8	3.07-3.75	4.5-12.5	4.12-13.37	5.6-8.8	0.3-11.6
Trans-parency(M)	Trace-0.19	0.10-2.1	0.51-1.04	0.42-0.98	4.35-8.30	0.8-14.9	0.08-2.34
Nitrate (µmol/l)	Trace-0.18	-	0.23-0.85	0.08-0.38	0.03-3.03	-	0.13-42.80
Nitrite (µmol/l)	-	-	-		-	-	0.13-60.08
Phosphate (µmol/l)	Trace-0.18	-	0.45-0.70	0.12-0.58	0.16-0.40	-	0.04-7.56
Silicate (µmol/l)	0.10-0.60	-	16.021-126.63	0.35-5.32	0.20-0.45	-	-
Source	Banerjee &Roy Choudhary (1996) Mohapatra et al (1988)	Siddiqui &Rao (1995)	Panda et al (1989)	Nayak & Behera (2004)	Nayak and Mohanty (2006)	Mohapatra et al (2007)	Panda etal (2008)

Chilika lagoon is decreasing day by day. The temperature is also increasing slowly in due course of time. The salinity value fluctuates depending on the opening and closing of the lagoonal mouth. The variation of dissolved oxygen has been observed in different zones of Chilika lagoon depending on the various factors. Variation of pH is not so significant. The nutrient value is increasing significantly. There are several rivers and rivulets draining into the lagoon carrying a lot of silt and mud ultimately decreasing the depth of the lagoon. The lagoon has naturally originated and will vanish in the due course of time. But dredging operation in Chilika lagoon, control of the soil erosion by plantation in periphery of Chilika lagoon, gully control, increasing of the depth of the new mouth for free flow of water between the lagoon and the sea, creation of awareness among the local community, operation of less number of boats, banning of Khanda jal and Gheri culture will definitely increase the life of the lagoon.

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