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Salinity pattern of the Chilka lagoon with special reference to the daily variations during the monsoon season

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Abstract

Daily variations of salinity at nine selected stations in the Chilka lagoon spread over the entire area during the monsoon season from June to first week of October 1996 and seasonal variations in four sectors including outer channel of the lagoon during 1996 and 1997 were studied. Daily observations on the surface and bottom salinity values showed sharp declining trend from July to October in northern sector and outer channel with wider range of variations, while in the southern sector, the values increased slowly during June-August and decreased during September-October with minimum range of variation. Maximum range of variations in the monsoon salinity values were observed at station-6 followed by station-7 and the minimum range was recorded at station-3 which is a deeper basin. Seasonal variations during 1996 and 1997 showed single oscillation in four sectors and for the whole lagoon. The pattern of seasonal changes in the salinity values showed gradual rise from November to March and sharp rise there after till June. Low salinity phase in the nothern and central sectors continues for about 8 to 9 months (July-February/March) and high saline phase in the outer channel continues for 7 months (December-June). Interestingly, the highest and the lowest salinity values were recorded at station-6 in the nortthern sector. Monsoonal intensity, weak ingress of semi-diurnal tide, slow discharge of flood water through shallow Muggermukh area and long outer channel (35 km), shallow northern sector, deeper southern basin and week circulation cause spatio-temporal variations in the salinity regime.

Chilka, the largest brackishwater lagoon, 19°28′ - 19°54′N and 85°05′/-85°38′ - in the sub continent is a unique wetland ecosystem characterised by marine, estuarine and freshwater environments supporting a wide range of flora and fauna. The lagoon is also important from the point of bio-diversity conservation and the well being of human communities. The lake is connected to the Bay of Bengal by a 35 km long channel, spread over 790km^2 in summer and receives drainage from few branches of the Mahanadi river system and some local rivulets. Its geomorphic, physiographic and hydrographic features show the characteristics of a 'typical lagoon'. In total, 53 rivers/rivulets draining into the Chilka result in deposition of 3,65,000 tonnes of silt per annum. The total surface freshwater in-flow into the lagoon has been estimated at 1760 MCM annually, while

the direct precipitation to the lagoon contributes 870 MCM of water and the total evaporation loss has been estimated at 1286 MCM (Anon, 2000), which significantly influences the salinity gradient of Chilka.

The study of ecological parameters of this unique brackishwater lagoon is of paramount importance with regard to its fisheries resources in particular and the socio-economic condition of a large impoverished population living in and around the lagoon in general. Among different physico-chemical parameters, the pattern of salinity variation plays the most important role in structural changes in benthic community (Patnaik, 1971). This influences the recruitment pattern, breeding, migration, appearance and disappearence of many fish species, fluctuation or decline of fisheries, explosive growth of weeds etc. (Mohanty, 1975, 2001). The fish production from the lagoon has decreased from the highest of 8600 m.t. during 1980s to 1642 m.t. in 1997-98, showing a clear declining trend (Anon, 1997). General accounts of physico-chemical conditions of the lagoon are available (Banerjee and Roychoudhury, 1966; Rajan, 1968 and Mohanty, 1975). The salinity pattern including daily variations of both surface and bottom waters during a complete monsoon season has hitherto not been studied, which is necessary for hydrographic model study of the lagoon to suggest effective measures for improvement of the salinity regime. The present communication assumes greater importance since the salinity pattern of the Chilka lagoon is fast changing due to continuous siltation, weak circulation, shrinkage of water spread area, explosive weed growth and weak ingress of semi-diurnal tide.

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Material and methods

Nine stations in the Chilka lagoon at Rambha, Keshpur, Kalijai, Balugaon, Kaluparaghat, Haridas Satpara, Arakhakuda and Lake mouth (Fig. 1), which are distanced about 75 km, 66km, 65km, 57km, 58km, 60km, 31km and 9km respectively from the lagoon mouth were selected. These stations represent the entire lagoon for the study of spatio-

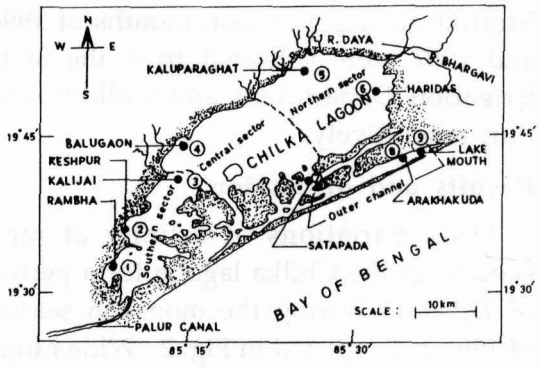

Fig. 1. *The station locations (Number and name of the locations) in the Chilka lagoon for the study of the salinity pattern.*

temporal pattern of salinity variations. Separate field laboratories at these nine stations were setup for *in-situ* analysis of water samples collected daily from the surface and bottom at 07.00h and 16.00h during the monsoon period of 122 days in 1996 (08.06.1996 to 07.10.1996) and there after fortnightly once at these same stations during 1996 and 1997 for the study of variations in salinity. Water samples from the surface and bottom were collected in the manner as described by Mohanty (1975). Each station in the lagoon was marked by a fixed wooden gauge/pole graduated in metre to enable reading of water depth. Flat bottom wooden boats were used to collect water samples from the stations. Water samples were analysed immediately in the station laboratories using standard method (APHA, 1989). The salinity was determined by the direct titration method as described by Harvey (1960) and was cross checked by ATAGO, S-10, Salino meter (Japan). Data on flood discharge into the lagoon and rainfall at Puri and Khurda during monsoon months of 1996 and 1997 were collected from the State Irrigation Department and Collectorate, Puri respectively.

Results and discussion

Daily variations of salinity at nine stations in the Chilka lagoon for a period of 122 days during the monsoon season of 1996 are depicted in Fig. 2. Wide range of variations in the salinity values showing higher-lower pattern at station 5, 6, 7, 8, and 9 and moderate variations showing lower-higher-lower pattern at station 1, 2, 3, and 4 were recorded. The pooled averge values of surface salinity for the entire lagoon ranged from 1.59 to 27.28 ppt and there was no marked difference in the salinity values of surface and bottom waters, as the lagoon is shallow.

Monthly mean values of salinity computed from the daily observations during the monsoon season (June to October) ranged from 0.74 to 23.42 ppt, 2.24 to 19.68 ppt., 7.94 to 18.15 ppt., 7.54 to 33.38 ppt and from 5.07 to 29.99 ppt in the nothern sector, central sector, southern sector, outer channel and for the entire lagoon respectively. Average salinity values among four sectors of the Chilka lagoon during monsoon period of four months (1996) ranged between 7.58 ppt (northern sector) to 19.28 ppt (outer channel). Lowest and highest average salinity for the entire monsoon period were recorded at station-5 and station-9 respectively. Monsoonal salinity pattern in the lagoon showed distinct declining trend from June to October, except for southern sector where the salinity increased from June to August and declined thereafter, registering highest value in August and lowest in October. Maximum and minimum variations in daily and monthly mean salinity values during the monsoon period were recorded in outer channel and southern sector respectively.

Daily fluctuation of salinity during 14-20 September, 1996 at all stations in the northern, central and southern sector (Fig. 2) was due to heavy low pressure rain during the period. The computed

mean salinity values from the daily observations at nine stations during the monsoon months of 1996 present more accurate salinity pattern. Both the northern sector and the outer channel exhibit almost fresh water condition during monsoon. A strong unidirectional flow of the flood water from rivers falling into the northern sector of the lagoon takes place towards the mouth through heavily silted Muggermukh area and 35 km long outer channel and the semi-diurnal tidal influx in the outer channel becomes weak, lowering the salinity values to the minimum during July-October. This is in agreement with the observations made by others (Ramanandham *et al.* 1964 and Banerjee and Roychoudhury, 1966). The central sector is moderately influenced by flood water from three small rivulets causing moderate fluctuations of salinity in the monsoon months. The southern sector, a comparatively deeper basin, is least influenced by freshwater discharge during monsoon with minimum fluctuations of salinity.

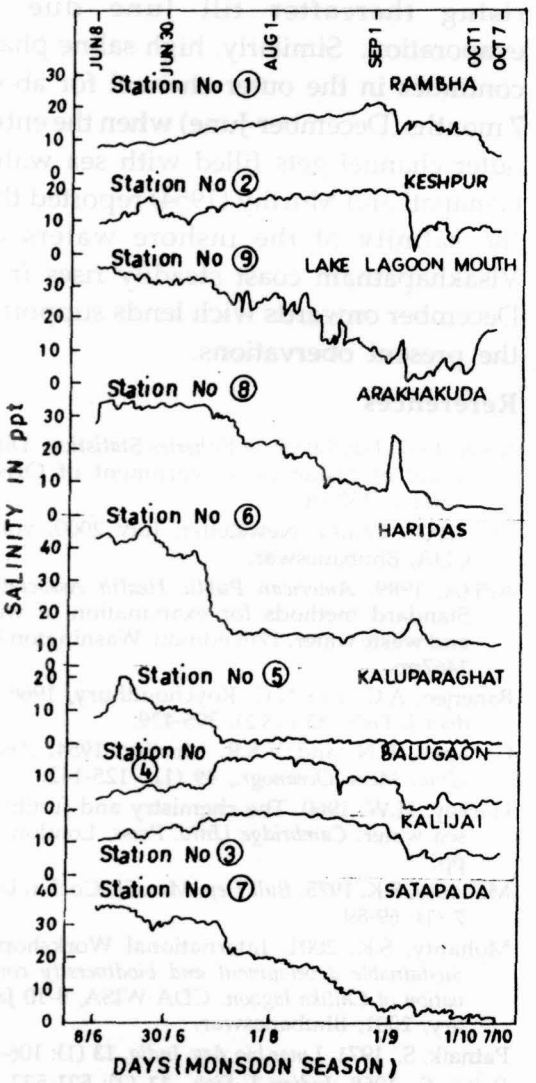

Fig. 2. *Salinity pattern of the Chilka lagoon at selected stations during monsoon period of 1996 (8/6 - 7/10)*

Seasonal variations

The monthly mean salinity of the Chilka lagoon showing the annual pattern of variations in four sectors including the outer channel and for the lagoon as a whole are presented in Fig. 3. Among three sectors (except outer channel) both the lowest (0.74 ppt) and the highest (27.74 ppt) monthly mean values of salinity were recorded in the nothern sector during October, 1996 and June, 1997 respectively. Average monsoon salinity value in 1996 was slightly higher than that of 1997 which is attributed to the influx of more sea water into outer channel. The annual cyclic changes of salinity (mean values) in all the four sectors and for the whole lagoon showed single oscillation (Fig. 3). The northern sector which is more shallow being heavily silted up by the discharges of monsoon floods becomes dilute in

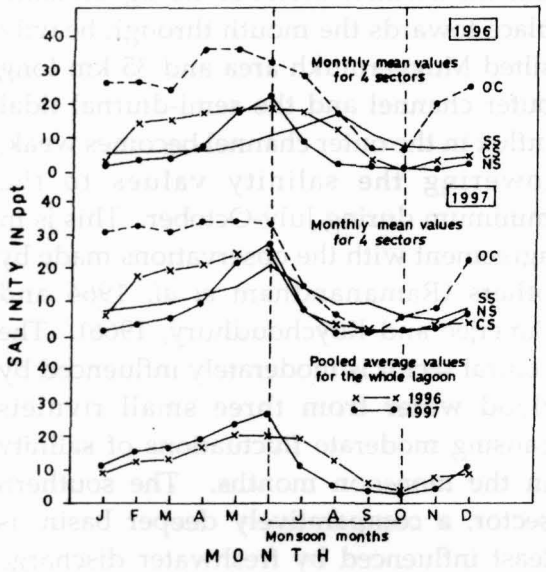

Fig. 3. *Salinity pattern of the Chilka lagoon during 1996 and 1997*

monsoon months and more saline due to evaporation in summer and thus, shows maximum variation. The study indicated that the salinity rises gradually from November to March and then sharply upto June (Fig. 3). This is generally governed by monsoonal intensity in association with other factors like weak tidal impact, poor circulation and silt-choked condition of Palur canal from November onwards when monsoon flood ceases to flow towards the mouth. Most interestingly, both the highest salinity (38.18 ppt) in June, 1997 and the lowest (0.02 ppt) in November, 1996 were recorded at station No-6 (Haridas) in the northern sector.

The vital Muggermukh area which is the confluence point between the main lagoon and the outer channel is very much shallow due to heavy siltation. It prevents quicker discharge of monsoon flood water from the northern sector into the sea and the impact of semi-diurnal tide of about 1.5 m amplitude becomes weak in the 35 km long outer channel. Therefore, the low salinity phase in the northern and central sectors continues for about 8-9 months (July-February/March) and starts rising thereafter till June due to evaporation. Similarly, high saline phase continues in the outer channel for about 7 months (December-June) when the entire outer channel gets filled with sea water. Ganapati and Murthy (1954) reported that the salinity of the inshore waters off Visakhapatnam coast steadily rises from December onwards wich lends support to the present obervations.

References

Anon. 1997. *Hand Book on Fisheries Statistics*. Directorate of Fisheries, Government of Orissa, Cuttack, 137 pp.

-----, 2000. *Chilika*. Newsletter, July 2000, vol. 1, CDA, Bhubaneswar.

APHA, 1989. *American Public Health Association*. Standard methods for examination of water and waste water. 17th edition, Washington DC, 1467pp.

Banerjee, A.C. and N.C. Roychoudhury, 1966. *Indian J. Fish.*, **13** (1&2): 395-429.

Ganapati, P.N. and V.S.R. Murthy, 1954. *Andhra Univ. Mem. Oceanogr.*, **49** (1) : 125-142.

Harvey, H.W. 1960. The chemistry and fertility of sea water. *Cambridge Univ. Press*, London: 234 pp.

Mohanty, S.K. 1975. *Bull Dep. Mar. Sc.* Cochin Univ. **7** (1): 69-89.

Mohanty, S.K. 2001. International Workshop on *Sustainable development and biodiversity conservation of Chilika lagoon*. CDA-WISA, 8-10 January, 2001, Bhubaneswar.

Patnaik, S., 1971. *J.mar.bio.Ass. India*, **13** (1): 106-125.

Rajan, S., 1968. *Indian J. Fish.*, **11** (2): 521-532.

Ramanandham, R., M.P.M. Reddy and A.V.S. Murthy, 1964 *J.mar.biol.Ass. India* **6** (2): 183-201.