Octa Journal of Environmental Research **Jan.- Mar.,2015**
International Peer-Reviewed Journal ISSN 2321 3655
Oct. Jour. Env. Res. Vol. 3(1): 007-014
Available online http://www.sciencebeingjournal.com

Research Article

Octa Journal of Environmental Research
(Oct. Jour. Env. Res.) ISSN: 2321-3655
Journal Homepage: http://www.sciencebeingjournal.com

ASSESSMENT OF CHLORIDE AND PHOSPHATE CONTENTS IN WATER OF CHILIKA LAGOON, ODISHA, INDIA

Sujata Mishra[a] and Lingaraj Patro[b]
a. Department of Botany, Godabarish Mahavidyalaya, Banapur, Odisha, India
b. Environmental Toxicology Laboratory, Department of Zoology & Biotechnology, K. B. D. A. V. College, Nirakarpur, 752019. Odisha, India
*Corresponding author's Email: **dr.lrpatro@rediffmail.com**
Received: 23rd Jan. 2015 **Revised**: 5th March 2015 **Accepted**: 16th March 2015

Abstract: Wetlands are receiving much international attention during past few decades with the better understanding of their values and functions. Wetland science is emerging as a unique discipline encompassing the terrestrial and aquatic ecology *i.e.* hydrology, limnology and engineering. The quality of surface water of Chilika lagoon with respect to physico-chemical parameters was investigated. The present investigation on evaluation of water quality such as chloride and phosphate contents of Chilika Lagoon will primarily address the changing characteristics and will be a step for formulating an action plan for integrating ecological, social and economical dimensions to promote sustainable development of the lagoon. The variables that are related to pollution sources showed differences. For the study of physico-chemical properties of water, the samples were collected monthly for a period of 2 years from July 2011 to June 2013 from six different sampling stations which spread over all the ecological sectors. Collection of samples was made from the predetermined stations of the water body by holding the polythene bottle (5 L.capacity). The samples were brought to the laboratory for analysis. At the spot of the sampling sites, the temperature of water was recorded. The water samples were analyzed in the laboratory by standard methods. The water samples were then filtered and were used for the measurement. Among the stations, Rambha shows the highest chloride content *i.e.* 10579.3±483.3 mg/L in summer season and Rambha shows the lowest chloride value *i.e.* 1008.00±266.8 mg/L in summer season. Among the stations, Kalupada ghat shows the highest value of phosphate content *i.e* 0.534±0.22 mg/L in the winter and Barakul shows the lowest value *i.e.* 0.013 ±0.002 mg/L in winter season.
Keywords: Chilika Lagoon; Brackish water; Physico-chemical properties; Chloride.
Postal Address: Department of Zoology & Biotechnology, K. B. D. A. V. College, Nirakarpur, 752019. Odisha, India. Mob: +91 9438055302

INTRODUCTION

Chilika lagoon, an unique tropical wetland with estuarine characters has been a subject of study for a number of workers over last hundred years and provided an excellent opportunity for study of different aspects like hydrology, limnology, ecology, geomorphology, flora, fauna, fisheries etc. Rama Rao *et al.,* (1988) compiled more than 200 scattered publications on flora, fauna, fisheries, limnology, hydrology, ecology, conservation and development and brought out a bibliography on Chilika lagoon.

Rajyalaxmi and coworkers (1989) studied the soil and water characteristics of confined Brackish water ponds of Chilika lake Fringe Area. Patnaik and Patnaik (1998) gave an account of hydrological and biological parameters to evolve a conservation strategy for a fragile wetland like Chilika lagoon. In the dry valley lakes, Southern Victoria Land, Antarctica, Lyons and coworkers (1998) reported that though lying within the same geologic domain and climatic regime the salinity is varying. Uncles *et al.* (2000) studied the seasonal variability of different parameters in Tweed estuary and reported that, longitudinal distribution of surface salinity depended strongly on freshwater runoff. During high runoff, the surface salinity was low and the fresh water-saltwater interface (FSI) was located close to the mouth. The reverse was true at times of low runoff. Carabetta and Warren (2000) reported that the expansion and retreat of phragmites in undistributed and restored tidal marshes is determined by the hydro-period and salinity.

Enhancing worldwide food production by synthetic organic pesticides brought their side effects such as toxicities to non-target species including human and the production of persistent residues in soil and water. Even if these compounds present in very low concentrations in water, they are hazardous because some species of aquatic life are known to concentrate them 1000 fold or more (Barlas, 2002). Atekwana and coworkers (2003) proposed a salinity delta super (13) C sub (DIC) model was able to describe sea water mixing in the estuary for the wet season but not for the dry season because river water salinity was higher than that of sea water and the salinity gradient between sea water and river water was small to the most seaward station. Factory manufacturing organo-chlorinated pesticides in recent years could discharge waste water containing DDTs into the river and water sheds in Yongdinghe River, Beijing. (Kang *et al,* 2003). Arjonilla and Blasco (2003) reported that, salinity does not affect the measure of nitrites and phosphates. In Conwy estuary in North Wales, Bowers *et al* (2004) found that, C DOM (coloured dissolved organic matter) is strongly correlated in a negative sense with salinity and more weekly correlated with DOC (Dissolved organic carbon). In upper Chesapeake Bay, the total concentration of the neutral chloro acetamide degradates was 20-30 times that of the parents. These micro pollutants therefore need more detailed attention as contaminants of potential environmental concern. (Hladik *et al,* 2005). Although soluble phosphorous accounted for 37% of the phosphorous in pond water, only 7% of the total Phosphorous in pond water was soluble reactive phosphorous (Masuda and Boyd, 1994). Low values of phosphates have been reported from various Himalayan lakes and reservoirs (Raina and Peter, 1999). Rejmaniova *et al.,* (2000) studied the oligotrophic wetlands of north Brazil and established how the increased input of phosphate accelerates plant density and eliminate cyano bacteria. The “p” concentration of Turag river is 0.34 mg/L. (Egashira *et al,* 2001). In Seine River estuary, the phosphorous imputes from domestic and industrial sources increased 3 fold from 1950 to 1980 but have decreased gradually in recent years in which high level “p” contamination have favoured strong alga development (Billen *et al,* 2001). In estuarine water of Rushikulya (Bay of Bengal), P was oligotrophic in all the stations where as nutrient index showed a decreasing trend upto station-3 as a result of land runoff near station-1. (Mahapatra *et al,* 2001). Baehr and Mcmanus, (2003) reported that, in the western arm of Lake Superior, the historical ‘P’ data reported are potentially systematically high because of this silicic acid interference. Mercante *et al* (2004) studied on the fee-fishing ponds located in the metropolitan region of Sao Paulo city (Brazil) and reported that, the phosphorous load derived from ration distribution increased the phytoplankton biomass, indicating an intense eutrophication process in these sites. Transformation of Ca bound "p" from the incoming river sediments into Iron Bound ''p" within the lake sediment is a major process contributing to the high SRP retention within the lakes (Maine *et al,* 2004). Perianez (2005) reported two-super (226) Ra sources direct discharged from the industrial complex and run-off from a phosphogypsum pile in a Spanish estuary.

EXPERIMENTAL

Sampling strategies: For the study of physico-chemical properties of water, the samples were collected monthly for a period of 2 years from July 2011 to June 2013 from six different sampling stations which spread over all the ecological sectors. With the global positioning system (GPS) the exact longitude and latitude of each station was determined (Table 1). Collection of samples was made from the predetermined stations of the water body by holding the polythene bottle (5 L. capacities) and usually from one foot below the water surface, plunging it there to avoid atmospheric contamination and bubbling. The bubbles were then turned until the neck pointed slightly upwards and completely filled. During filling up the bottles they were kept horizontally forward in the direction away from the hand. When filled, the bottles were raised and the stoppers were replaced while the bottles were inside the water. Above all, scrupulous care was taken to obtain a sample that was representative of the respective water body and to avoid accidental contamination of the sample during collection. To reach all the stations a flat bottom wooden boat was used. From each station, samples and field notes were collected in respect of various parameters like water chloride and Phosphorus. The samples were brought to the laboratory by keeping inside the dark wooden boxes for analysis of the parameters.

Analytical methods: The water samples were analyzed in the laboratory standard methods (APHA, 2004). Immediately after returning to the laboratory, the water samples were then filtered through Whatman No.2 filter paper into clean glass bottles. The chloride content is estimated by Argentometric method. The principle behind this method in a neutral or slightly alkaline solution potassium chromate can indicate the endpoint of the silver nitrate titration of chloride. Silver chloride is precipitated quantitatively before Red Silver chromate is formed. Interference-Bromide, Iodine and Cyanide and Sulphide can interfere in the chloride determination and can be removed by treatment with Hydrogen Peroxide. Orthophosphate in excess of 25 mg/L interferes by precipitating as Silver phosphate. Iron in excess in 10 mg/L interferes by masking the end point.

Procedure: We took 100 ml of sample and 5 ml of potassium chromate was added followed by titration with silver nitrate solution till a red precipitate colour of silver chromate is formed.

***Calculation**:*

$$\text{Chloride (mg/L)} = \frac{(A\text{-}B).\ N\ .\ 35450}{\text{Sample taken}}$$

Where,

A= ml of silver nitrate consumed for sample,
B= ml. of silver nitrate consumed for blank,
N= Normality of silver nitrate.

Phosphorus is estimated by Stannous chloride method in which Molybdo phosphoric acid is formed and reduced by stannous chloride to intensely coloured molybdenum blue. This method is more sensitive and makes feasible measurements down to 7 μg P/L by use of increased light path length. The reagent required in this process is phenolph thalein indicator aqueous solution, Ammonium molybdate reagents, Stannous chloride reagents, standard phosphate solution, reagent for extraction. The procedure involves preliminary sample treatment, colour development, colour measurement and extraction.

Calculation:

$$\text{mg P/L} = \frac{\text{mg P (in approximately 104.5 mL final value)} \cdot 1000 \text{ mg}}{\text{mL sample}}$$

Table 1. Longitude and Latitude of Stations selected in Chilika Lagoon

S.No.	Name of Stations	Longitude	Latitude
1	Bhusandpur	85°.47'	19°.83'
2	Kalupada Ghat	85°.42'	19°.86'
3	Balugaon	85°.22'	19°.67'
4	Barkul	85°.18'	19°.66'
5	Rambha	85°.13'	19°.53'
6	Palur Canel	85°.17'	19°.49'

RESULTS AND DISCUSSION

Due to large volume of data collected over the two years from July, 2011 to June, 2013, instead of giving the raw data obtained, only the monthly means with their standard errors were given in Table 4). The results presented in this section are stationed, seasonal and annual means of various physicochemical and biological parameters along with their standard errors. The results of the variables of physico-chemical parameters of water *i.e.* water pH, acidity, alkalinity etc. were examined and presented here. The maximum monthly concentration of dissolved chloride was 7958.9±790.8 mg/L in the month of February in 2011-12 and that of 2012-13 was 8593.3±930.8 mg/L in the month of February. In 2011-12, the minimum monthly dissolved chloride concentration was 4517.3±774.5 mg/L in the month of November and 5371.3±789.9 mg/L in the month of December in 2012-13 respectively. The seasonal means of both the years recorded were 6057.3±415.2 mg/L in rainy, 6237.7±434.0 mg/L in winter and 6951.2±338.7 mg/L in summer in the 1st year and 6406.7±393.1 mg/L in rainy, 6981.9±463.6 mg/L in winter and 7816.1±318.4 mg/L in summer in the 2nd year. The annual means of chloride content were 6415.4±230.3 mg/L in 2011-12 and 7068.2±231.0 mg/L in 2012-13 respectively. Among the stations, Rambha shows the highest chloride content *i.e.* 10579.3±483.3 mg/L in summer season and Rambha shows the lowest chloride value *i.e.* 1008.00±266.8 mg/L in summer season (Table-2). In 2011-12, the highest amount of phosphate of the lagoon was 0.280± 0.092 mg/L observed in the month of April while that of the 2012-13 was 0.263± 0.090 mg/L in the month of February. The lowest values of phosphate are 0.037± 0.002 mg/L in the month of September in 2011-12 and 0.032± 0.002 mg/L in the month of March in 2012-13. The seasonal means of both the years recorded are 0.0425±0.0034 mg/L in rainy, 0.1571±0.0350 mg/L in winter and 0.0439±0.0049 mg/L in summer in the 1st year and 0.0457±0.0056 mg/L in rainy, 0.1525±0.0337 mg/L in winter and 0.0390±0.0021 mg/L in summer in the 2nd year. The annual means of phosphate content were 0.0812±0.0123 mg/L in 2011-12 and 0.0793±0.0119 mg/L in 2012-13 respectively. Among the stations, Kalupada ghat shows the highest value *i.e.* 0.534±0.22 mg/L in the winter and Barakul shows the lowest value *i.e.* 0.013 ±0.002 mg/L in winter season (Table 3).

During the recent years, wetlands have attracted the attention of scientists and the experts to understand and study its values and functions. The unique ecosystem of Chilika lagoon has been a centre of attraction for a number of workers who have done pioneering and commendable work on various aspects of the lagoon. However, there have been conspicuous alternations in regard of physico-chemical parameters of water and sediments and biological parameters after opening of the new mouth in Chilika.

Table 2. Station, season and yearly mean with standard error of chloride (mg/L) of Chilika water during 2011-13

Stations/ Seasons	2011-12			2012-13		
	Rainy	Winter	Summer	Rainy	Winter	Summer
ST1	2929.16 ±807.1	8101.00 ±568.8	4531.00 ±595.0	3830.16 ±1017.2	8367.00 ±458.6	4666.00 ±689.9
ST2	1575.33 ±280.5	5275.16 ±2051.0	3380.33 ±471.6	1799.50 ±357.6	5724.33 ±2158.0	4122.66 ±305.3
ST3	6884.83 ±1068.4	8139.66 ±674.0	7146.00 ±1116.6	8348.16 ±601.5	9092.16 ±954.1	9746.50 ±241.4
ST4	7503.66 ±391.6	2333.66 ±578.2	8089.50 ±144.1	7762.16 ±409.5	2518.16 ±614.8	8319.16 ±138.9
ST5	8311.33 ±1767.2	5247.33 ±2131.7	10579.33 ±483.33	7969.00 ±1576.2	6869.16 ±2229.5	1008.00 ±266.8
ST6	9141.16 ±306.2	8324.33 ±682.2	8516.66 ±474.5	9242.00 ±358.0	9323.50 ±709.9	9023.16 ±298.8
Seasonal Mean	6057.3 ±415.2	6237.7 ±434.0	6951.2 ±338.7	6406.7 ±393.1	6981.9 ±463.6	7816.1 ±318.4
Year mean	6415.4 ±230.3			7068.2 ±231.0		

Table-3. Station, season and yearly mean with standard error of phosphate (mg/L) of Chilika water during 2011-13

Stations/ Seasons	2011-12			2012-13		
	Rainy	Winter	Summer	Rainy	Winter	Summer
ST1	0.051 ±0.010	0.126 ±0.022	0.027 ±0.002	0.051 ±0.001	0.138 ±0.022	0.037 ±0.005
ST2	0.032 ±0.002	0.528 ±0.224	0.044 ±0.006	0.030 ±0.003	0.534 ±0.222	0.054 ±0.014
ST3	0.039 ±0.001	0.045 ±0.009	0.061 ±0.031	0.041 ±0.002	0.048 ±0.011	0.034 ±0.003
ST4	0.038 ±0.004	0.031 ±0.021	0.028 ±0.002	0.030 ±0.003	0.013 ±0.002	0.033 ±0.003
ST5	0.037 ±0.004	0.056 ±0.127	0.038 ±0.001	0.049 ±0.005	0.128 ±0.091	0.040 ±0.005
ST6	0.037 ±0.004	0.042 ±0.004	0.029 ±0.002	0.035 ±0.003	0.048 ±0.006	0.031 ±0.002
Seasonal Mean	0.0425 ±0.0034	0.1571 ±0.0350	0.0439 ±0.0049	0.0457 ±0.0056	0.1532 ±0.0337	0.0390 ±0.0021
Year mean	0.0812 ±0.0123			0.0793 ±0.0119		

In a seasonal cycle water quality parameters change in any kind of lentic water body since the water contains a variety of substances which vary both qualitatively and quantitatively. However, the number of factors; physical, chemical and biological parameters greatly influencing the water body changes the water quality to a greater extent and ultimately affects the biological phenomena. During the present study, extensive survey was carried out for presenting the effect of new mouth on the physico-chemical and biological parameters leading to see the correlation among the biotic and abiotic factors of Chilika lagoon. In each water body, there should be a regular seasonal variation every year. This would indicate that there is no external stress on the water body. But on the other hand, if any variable related to pollution significantly differs periodically with the level of pollution, the water body will be considered to function unusually and the variation can be a direct indicator of the degree of external stress. The present study depicts a comparative account of the monthly and seasonal fluctuations of the physico-chemical parameters which are directly or indirectly influenced by external stress and man's action. The monthly means of data of water of Chilika were collected over a period of two years and the seasonal means along with yearly means are presented in the table. The chloride content of water seems to be a direct result of pollution of animal origin (Zafar, 1964). The Chilika water shows an increase of chloride in summer followed by winter and rainy season in both the years (Table-2). Similar seasonal variations have been observed in different water bodies (Uncles *et. al.,* 2000, Atekwana *et al.,* 2003). Between the years, second year shows higher chloride content than the first year. Among the stations, station 3, 4, 5 and 6 showed higher chloride content and stations 1 and 2 showed lower than those above. The water spread area of Chilika Lake from monsoon to summer. This large shrinkage of water might be the major cause of increase of salinity during summer. Similar findings have also been observed by Gonzalves and Joshi, 1946. The trends of phosphate fluctuations are found irregular among the stations in the water body. The phosphate concentration was lowest in rainy towards winter in the 1st year and lowest in summer towards winter season (Table 3). The low content of phosphate may be due to locking up of the nutrients in the dense macrophytic vegetation (Kundangar and Zutshi, 1985). Phosphate is one among the important nutrients in the lake. Though soluble phosphorous accounted more in the lake but only less was found in the form of soluble reactive phosphorous (Masuda, et.al, 1994). Between the years 2011-12 shows higher P value in comparison to 2012-13. Generally high levels of P contamination have favored strong algal development (Billene *et al.,* 2001, Panda and Pattnaik, 1998 and Mercante, *et.al.,* 2004).

Table 4. The monthly means of physcio-chemical parameters of water of Chilika lagoon during 2011-13 (mg/L)

Month (s)	2011-12		2012-13	
	Chloride	**PO_4**	**Chloride**	**PO_4**
July	5212.9 ±850.5	0.040 ±0.004	5467.9 ±878.0	0.059 ±0.016
August	5212.3 ±850.3	0.052 ±0.012	5379.1 ±874.2	0.053 ±0.014
September	6902.2 ±795.5	0.037 ±0.002	7514.3 ±623.8	0.035 ±0.002
October	6901.5 ±795.8	0.039 ±0.002	7265.6 ±653.5	0.034 ±0.002
November	4517.3 ±774.5	0.038 ±0.007	5371.9 ±789.6	0.047 ±0.007
December	4518.2 ±774.4	0.038 ±0.006	5371.3 ±789.9	0.044 ±0.007
January	7956.5 ±790.9	0.270 ±0.092	8591.2 ±930.8	0.257 ±0.089
February	7958.9 ±790.8	0.280 ±0.092	8593.3 ±930.8	0.263 ±0.090
March	6228.1 ±590.9	0.041 ±0.010	7442.5 ±753.8	0.032 ±0.002
April	5952.4 ±590.4	0.056 ±0.016	7444.5 ±753.7	0.034 ±0.002
May	7797.3 ±724.0	0.038 ±0.003	8188.8 ±634.9	0.043 ±0.005
June	7826.8 ±719.3	0.040 ±0.003	8188.6 ±634.8	0.045 ±0.005

Waste among the pollutant chloride is a major ingredient and probably dissolve solids are very much associated with the chloride content. In the sediment of the water body, organic carbon has been found significantly correlated with K, N and P (Arjonilla and Blasco, 2003). Chloride is significantly correlated with PO_4 and NO_3. Since important pollutants of the water body, it is quite easy to explain among the parameters (Arjonilla and Blasco, 2003). Phosphate has been significantly found correlated with acidity and CO_2 positively and with water temperature negatively. The positive correlations indicate that, the type of pollutants which contain phosphate create acidic environment in water coupled with carbonic acid formation in the water body. The negative correlation is clearly due to phosphate waste dilution during rainy season (Baehr and Mc Manus, 2003). For a possible ranking with regard to water quality of the stations of the water body, a numerical scale is proposed (Mohanty, 1981).

CONCLUSION

Stations are arranged in the scale not withstanding the less polluted or more polluted considering one variable at a time. This way each has its own number for each of the important variables which are related to pollution, these are pH, conductivity, DO, TDS, chloride, phosphate, nitrate, nitrite and CO_2. Eventually upon summation, a water body which considered the most polluted whereas the water body with the lowest score is considered as the least polluted and others remain in between them according to their numbers. Using this trial, which is based on various criteria, the six stations would be ranked from least polluted to most pollute: (i). Bhusandpur nali, (ii). Kalupada ghat, (iii). Balugaon, (iv). Barakul, (v). Rambha, (vi). Palur canal.

Bhusandpur nali <Kalupada ghat< Balugaon< Barakul<Rambha<Palur canal

It is interesting to note that, this ranking corresponds to the ranking of other biological parameters, which have been considered in combinations for example algal growth.

REFERENCES

APHA (American Public Health Association). Standard methods for the examination of water and waste water (19th edn.) American Public Health Association, AWWA, WPCF, Washington, DC.2004.

Arjonilla, M and Blasco, J.(2003). Nutrient analysis in Estuarine water effect of salinity. IN: Cienc.Mar. Vol.29, No-4, pp.389-395.

Atekwana, E.A., Tedesco, L.P. and Jackson, L.R. (2003). Dissolved Inorganic Carbon (DIC) and hydrologic Mixing in a subtropical Riverine Estaury, southwest Florida, USA, IN: Estuaries 26(6):1391-1400.

Baehr, M.M. and Me Manus, J. (2003). The measurement of Phosphorous and it's spatial and temporal variability in the western arm of lake Superior IN: J.Great lakes Res. 29(3):479-487.

Barlas, N.E.(2002). Determination of organo-chlorine pesticide residues in water and sediment samples in Inner Anatilia in Turkey. IN: Bull. Environ.Contam. Toxicol. 69(2):236-242.

Billen, G, Garnier, J, Ficht, A and Cun, C. (2001). Modeling the Seine River Estuary to Human activity in it's watershed over the last 50 years. IN: Estuaries. 24(63):977-993.

Bowers, D.G., Evans, D, Thomas, D.N., Ellis, K and Williams, P.L.B.(2004). Interpreting the colour of an estuary.IN: Estuarine, coastal and shelf science.[Estuar.Coast.Shelf Sci.] 59(1):13-20.

Carabetta, M., Warren, R.S. (2000). Hydroperiod and salinity influences on phragmites expansion and retreat in undisturbed and restoring tidal marshes, IN: Abst. Millenium Wetland Event. 6th Conf. INIECOL, Quebee, pp.157.

Egashira, K.,Lalif, M.A., Karim, A.J.M.S., Solaiman, A.R.M and Mochizuki, T. (2001). Preliminary assessment of quality of water in Gazipur District, Bangladesh.IN: J.Fac.Agri.Kyushu Univ. 46(1):75-82.

Gonzalves, E.A. and Joshi, D.B. (1946). Fresh water algae near Bombay. J Bomabay Nat. Hist. Soc., 46(1): 154-176.

Hladik, M.L., Hsiao, J.J. and Roberts, L.A. (2005). Areneutral chloro acetamide Herbicide degradates of potential environmental concern. Analysis and occurrence in the upper Chesapeake Bay.IN: Environ.Sci. Technol. 39(17):.6561-6574.

Kang, Y., Liu, P., Wang, Z., Lue, Y. and Li, Q. (2003). Persistent organo chlorinated pesticides in water from Guanting Reservoir and Yongdinghe River, Beijing.IN: J.Lake.Sci. 15(2):125-132.

Kundanagar, M.R. and Zutshi, D.P. (1985). Environmental features and plankton communities of two Himalayan rural lakes, Proc. Nat. Symp. Pure and Applied Limnol.32: 40-47.

Lyons, W.B., Welch, K.A. and Sharma, P. (1998). Chlorine-36 in the waters of the Memurdo Dry Valley lakes, Southern Victoria Land, Antarctica. IN: Geochim. Cosmochim. Acta 62(2):185-191.

Maine, M.A., Sune, N.L. and Bonetto, C. (2004). Nutrient concentrations in the middle parana River: Effect of the flood plain lakes.IN: Arch.Hydrobiol. vol.160,no.1. pp.85-103.

Masuda, K. and Boyd, C.E. (1994). Phosphorus fractions in soil and water of aquaculture ponds build on clayey ultisols at Auburn, Alabama. IN: J.work Aquacult. Soc. 25(3):379-395.

Mercante, C.T.J., Cabianca, M.A., Silva coasta, S.V and Esteves, K.E. (2004). Water quality in fee-fishing ponds located in the metropolitan region of Sao paulo city, Brazil, an analysis of the eutrophication process. IN: Acta. Limnol. Brazil.vol.16., no.1.pp.95-102.

Mohanty, R.C. (1981). Water quality studies of some water bodies of

Bhubaneswar. Ph.D. Thesis, Utkal University, Bhubaneswar.

Mahapatra, T.R., Padhy, S.N. and Sahu, B.K. (2001). Assessment of nutrients in the (Bay of Bengal), India, Rushikulya. IN: J.Environ. Pollut. Vol.8, no.3,pp.221-224.

Panda, P.C. and Patnaik, S.N. (1998). An enumeration of the flowering plants of Chilika lagoon and it's immediate neighbourhood. IN: Proceedings of the International workshop on sustainable development of Chilika lagoon.pp.122-148.

Patnaik, A.K. and Patnaik, S.S (1998). Hydro biological monitoring programme of Chilika lake launched through world bank funding. IN: Proceedings of the International workshop on sustainable development of Chilika lagoon.pp.88-92.

Perianez, R. (2005). Measuring and modeling temporal trends of super (226) Ra in water of a Spanish estuary affected by the phosphate industry. IN: Mar. Environ.Res. vol.60.no.1.pp.35-49.

Raina, H.S. and Peter, T. (1999). Cold water fish and fisheries in the Indian Himalayas: Lakes and Reservoirs. Fish and Fisheries of higher altitudes, Asia (ed. T.Petr), *In*: FAO Fish.Tech. Pap.No.385. FAO, Rome,pp.64-88.

Rajyalaxmi, T., Mohanty, A.N., Ravichandran, P. and Pillai, S.M. (1989). The soil and water characteristics of confined Brakish water ponds of Chilika lake Fringe Area. IN: M.Mohan Joseph (ed.) The Indian Fisheries Forum, Proceedings. Asian Fisheries Society, Mangalore,pp.125-128.

Rama Rao, S., Singh, U.P. and Mall, L.P. (1978). Pollution of river Kuan (Indore), India. Biological assessment of pollution. Water Res. 12: 555-559.

Rejmaniova, E., Komarkova and M.Lege (2000). The role of macrophytes and microphytes in biogeochemical process oligotrophic wetlands of northern Belize. IN: Abst. Millenium wetland Event, pp. 298.

Uncles, R.J., Bloomer, N.J., Frickers, P.E., Griffths, M.L., C.Harris, C., Howland, R.J.M., Morris, A.W., Plummer, D.H. and Tappin, A.D. (2000). Seasonal variability of salinity, temperature, turbidity and suspended chlorophyll in the Tweed Estuary. IN: Sci. Total Environ. 251-252(1-3):115-124.

Zafar, A.R. (1964). On the ecology of algae in certain fishponds of Hyderabad. India I. Physico-chemical complexes, *Hydrobiologia*, 23: 179-195

Source of Support: None.
Conflict of interest: None. Declared.