EVALUATION OF NITRATE AND NITRITE CONTENTS IN WATER OF CHILIKA LAGOON, ODISHA, INDIA.

Sujata Mishra [1] and Lingaraj Patro [2*]

1. Department of Botany, Godabarish Mahavidyalaya, Banapur, Odisha, India
2. Environmental Toxicology Laboratory, Department of Zoology & Biotechnology, K. B. D. A. V. College, Nirakarpur, 752019. Odisha, India,

ABSTRACT

Wetland science is emerging as an unique discipline encompassing the terrestrial and aquatic ecology i.e. hydrology, limnology and engineering. Wetlands are receiving much international attention during past few decades with the better understanding of their values and functions. 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 Nitrate and Nitrite content 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. capacities). 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 (APHA, 2004). The water samples were then filtered and were used for the measurement. Among the stations, Palur Canal shows the highest value of nitrate content i.e. 4.565 ±1.941 mgl^{-1} in winter season and Kalupada Ghat shows the lowest value of nitrate content i.e. 0.247 ±0.098 mgl^{-1} in winter season. Among the stations, Barakul shows the highest value of nitrite content i.e. 0.638 ± 0.402 mgl^{-1} in rainy season and Barakul shows the lowest value of nitrite content i.e. 0.003± 0.001 mgl^{-1} in winter season.

Key Words:- *Chilika Lagoon, Brackish water, physico-chemical properties, Nitrate and Nitrite contents.*

Introduction

The first and foremost damaging source for water bodies is the surface contaminants. The results of regression analysis also suggest that, sewage sources and rainfall runoff from urbanized areas may contribute to faecal pollution in the estuary (Kelsey *et al*, 2003). The run off, in general, is a greater source than every sanitary waste water at least during the monsoon months. (Startor *et al*, 1974). The increase of biological waste products due to increasing population rate is directly or indirectly responsible for the first and second order pollution (Dugan, 1975). 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. Patro, 2007. 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 an estuary in Seto inland sea, Japan the fresh water runoff was a major source of new nitrogen. (Nitrate+Nitrite=2.1 x Salinity +74.3 and P<0.001). Nutrients are more directly transported into the surface layer of the sub-tidal zone by lower salinity water mass intrusion from the intertidal zone, most importantly during the warm period. (Magni and Mantani,2000). In Seine River Estuary Nitrogen input to surface water from urban sources has remained essentially constant while diffused inputs from agricultural soils have increased 5 fold as a result of more intensive agricultural practices and as well as the loss of retention capacity. (Billen *et al*, 2001). In estuarine water of Rushikulya (Bay of Bengal) the water quality with respect to "N" was oligotrophic towards riverine zone. The nutrient index showed an increasing trend from estuarine to riverine zone. (Mahapatro *et al*, 2001). Dissolved organic nitrogen production by phytoplankton exceeds the combined effects of dilution plus dissolved organic Nitrogen processing by the food-web. Nitrate concentration is influenced by dilution with low-nitrate water entering the estuary from the passes and by biological processes. (Morta Zavi *et al*, 2001) (Mishra & Patro, 2015). Due to intense use of artificial fertilizer and improper storage of animal fertilizers, NH-N, No-N and total po-p pollution are detected in water of the unconfined aquifer. (Cetinda and Okan, 2004).Riverine-contributed nitrate and soluble reactive phosphorous sustained the high macrophytic productivity in the lakes. (Maine *et al*,2004).

In Tapi river, Surat, Kapila and Patel (1999) are of opinion that, the nitrite concentrations were found out to be quite low. The range varies from 0.002 mg/l in September to 0.032 mg/l in May. Higher mean value of nitrite points to higher effluents and also due to oxidation of ammonia. Lower values of the nutrient during the rainy season could be attributed to the dilution effect. In Breton sound estuary, which encompasses 1100 km, Super (2) of fresh and brackish rapidly subsiding wetlands, Lane and coworkers (1999) reported that, statistical analysis indicated decreased total nitrogen (rapid reduction of No_3 and No_2) decreased salinity concentrations in the estuary due to diversion of the estuary. In Apala Chicola Bay, Florida, Morta zavi and coworkers (2001) reported that, dissolved organic nitrogen concentration in water at some stations within the estuary exceed end member concentrations. Discharge of municipal waste water from houses along the river, in addition to inflow of N-fertilizer applied to agricultural fields, was proposed to the contamination of Turag river. The No+N=3.6 mg/L (Egashira *et al*, 2001).

Materials & Methods

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 Nitrate and Nitrite content in water. 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 nitrate is estimated by the colorimetric method. Nitrate (NO_2^-) is determined through formation of a reddish purple azo dye produced at pH 2.0 to 2.5 by coupling diazotized sulfanilamide with N-(l-naphthyl) ethyl enediamine dihydrochloride (NED dihydrochloride). The applicable range of the method for spectrophotometric measurements is 10 to 100 µg NO_2^- N/L. Photometric measurements can be made in the range 5 to 50 µg N/L if a 5 cm light path and a green colour filter are used. The colour system obeys Beer's law up to 180 µg N/L with a 1 cm light path at 543 nm. Higher NO_2^- concentrations can be determined by diluting a sample. The apparatus required are colorimetric equipments. The reagents used are Nitrite-free water, colour reagent, sodium oxalate, ferrous ammonium sulfate, stock nitrite solution etc. The calculation was made by preparing a standard curve by plotting absorbance of standards against NO_2^- N concentration and computed the sample concentration directly from the curve.

The nitrite estimated by the cadmium reduction method in which the principle followed is NO_3^- is reduced almost quantitatively to Nitrate (NO_2^-) in the presence of cadmium (Cd). This method is recommended especially for NO_3^- levels below 0.1 mg N/L where other methods lack adequate sensitivity. The apparatus required are reduction column, colorimetric equipments. The reagents are nitrate-free-water, copper cadmium granules, colour reagents, ammonium chloride-Edta reagents, dilute ammonium chloride-Edta solution, hydrochloric acid, copper sulphate solution, stock nitrate solution, intermediate nitrate solution, stock nitrite solution, intermediate nitrite solution and working nitrite solution etc. The procedure involves the preparation of reduction column, treatment of sample, standards preparation etc.

Calculation:

The estimation of nitrite was made from standard curve which can be plotted by taking observance of standards against NO_3^- N concentration.

Table-- 1. Longitude and Latitude of the stations selected in Chilika Lagoon

Sl.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

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 & 5). 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. Nitrate and Nitrite content were examined and presented here.

The nitrate content ranged from 0.620 0.076 mgl^{-1} (January) to 1.341± 0.711 mgl^{-1} (December) during the 1st year and 0.706± 0.072 mgl^{-1} to 1.524± 0.818 mgl^{-1} (December) during the 2nd year. The seasonal means of both the years recorded are 0.7717± 0.0582 mgl^{-1} in rainy, 0.9977± 0.2494 mgl^{-1} in winter and 0.7421± 0.0342 mgl^{-1} in summer in the 1st year and 0.8115 ±0.0624 mgl^{-1} in rainy, 1.1414 ±0.2857 mgl^{-1} in winter and 0.8726± 0.0363 mgl^{-1} in summer in 2012-13 respectively. The annual means of nitrate content were 0.8371± 0.0861 mgl^{-1} in 2011-12 and 0.9414± 0.0982 mgl^{-1} in 2012-13 respectively. Among the stations, Palur Canal shows the highest value of nitrate content i.e. 4.565 ±1.941 mgl^{-1} in winter season and Kalupada Ghat shows the lowest value of nitrate content i.e. 0.247 ±0.098 mgl^{-1} in winter season (Table -2).

In 2011-12, the highest amount of nitrite content was 0.201±0.13 mgl^{-1} recorded in the month of July, while 0.242 ± 0.160 mgl^{-1} in the month of August during the second year. The minimum values were

0.006 ± 0.001 mgl^{-1} in the month of November during 2011-12 and 0.006 ± 0.0006 mgl^{-1} in the month of September during 2012-13). The seasonal means of both the years recorded are 0.103± 0.047 mgl^{-1} in rainy, 0.029± 0.011 mgl^{-1} in winter and 0.009 ±0.008 mgl^{-1} in summer during the 1st year and 0.118 ±0.054 mgl^{-1} in rainy, 0.015 ±0.0001 mgl^{-1} in winter and 0.014 ±0.001 mgl^{-1} in summer during the 2nd year respectively. The annual means of nitrite content were 0.0473 ±0.0164 mgl^{-1} in 2011-12 and 0.0496 ±0.0184 mgl^{-1} in 2012-13 respectively. Among the stations, Barakul shows the highest value of nitrite content i.e. 0.638 ± 0.402 mgl^{-1} in rainy season and Barakul shows the lowest value of nitrite content i.e. 0.003± 0.001 mgl^{-1} in winter season. (Table -3).

Discussions

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 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. 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.

Nitrates have immense significance as major nutrients for the succession and productivity of phytoplanktons and aquatic macrophytes. Nitrate content of the water body was highest in winter in both the years followed by rainy and summer season in the 1st year and followed by summer and rainy in the second year respectively. (Table-2). Between the years 2012-13 shows higher nitrate value than 2011-12. According Mortazavi *et al*., (2001) nitrate concentration decline within the estuary as salinity increases if the N/P ratio is less than about 7, N is the potential limiting factor and if the ratio is greater than 7, P is the potential limiting nutrient. If the ratio is approximately 7, then both nutrients or some other factors may be limiting (Panda and Pattnaik, 1998).

The trend of nitrite fluctuations is found irregular in the water body. The nitrite concentration was lowest in summer and highest in rainy season. Between the years, 2004-05 shows higher acidity value than 2011-12 (Table-3). According to Lane and Coworkers (1999) the rapid reduction of NO_3 and NO_2 decreased salinity concentrations in the estuary. According to Egashira *et al*, (2001), the N_2-contamination of Turag River is due to the discharge of municipal waste water from houses along the river in addition to inflow of N fertilizer applied to agricultural fields.

Nitrate is significantly correlated with acidity which is due to the nature of the type of waste which comes into the water body. Similarly nitrate is significantly correlated with water depth which may be due to the type of N_2^- metabolism resulting in more nitrate production in high volume of water (Kalacheva and coworkers, 2002).

For a possible ranking with regard to water quality of the stations of the water body, a numerical scale is proposed (Mohanty, 1981). 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 polluted:

(1). Bhusandpur nali, (2). Kalupada ghat, (3). Balugaon, (4). Barakul, (5). Rambha, (6). 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.

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

Stations↓	2011-12			2012-13		
Seasons→	Rainy	Winter	Summer	Rainy	Winter	Summer
ST1	0.448 ±0.071	0.325 ±0.134	0.662 ±0.043	0.537 ±0.098	0.342 ±0.138	0.747 ±0.017
ST2	0.503 ±0.065	0.247 ±0.098	0.617 ±0.092	0.550 ±0.077	0.267 ±0.105	0.798 ±0.080
ST3	1.190 ±0.193	0.477 ±0.154	1.027 ±0.023	1.262 ±0.188	0.515 ±0.163	1.167 ±0.068
ST4	0.663 ±0.204	0.282 ±0.119	0.540 ±0.133	0.837 ±0.140	0.292 ±0.125	0.758 ±0.056
ST5	1.422 ±0.154	0.645 ±0.263	1.007 ±0.098	1.660 ±0.155	0.633 ±0.281	1.257 ±0.067
ST6	0.538 ±0.049	4.057 ±1.681	0.495 ±0.096	0.427 ±0.028	4.565 ±1.941	0.453 ±0.058
Seasonal Mean	0.7717 ±0.0582	0.9977 ±0.2494	0.7421 ±0.0342	0.8115 ±0.0624	1.1414 ±0.2857	0.8726 ±0.0363
Year mean	0.8371 ±0.0861			0.9419 ±0.0982		

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

Stations↓	2011-12			2012-13		
Seasons→	Rainy	Winter	Summer	Rainy	Winter	Summer
ST1	0.009 ±0.0016	0.123 ±0.097	0.007 ±0.001	0.009 ±0.0009	0.031 ±0.010	0.015 ±0.006
ST2	0.010 ±0.0025	0.021 ±0.006	0.013 ±0.005	0.010 ±0.003	0.024 ±0.005	0.030 ±0.013
ST3	0.005 ±0.0004	0.011 ±0.002	0.004 ±0.001	0.006 ±0.0004	0.011 ±0.003	0.006 ±0.0008
ST4	0.587 ±0.3697	0.003 ±0.001	0.008 ±0.001	0.638 ±0.402	0.004 ±0.001	0.007 ±0.0009
ST5	0.005 ±0.0017	0.007 ±0.002	0.010 ±0.0009	0.003 ±0.0005	0.008 ±0.002	0.013 ±0.0007
ST6	0.009 ±0.0008	0.010 ±0.003	0.011 ±0.002	0.009 ±0.001	0.014 ±0.003	0.013 ±0.0014
Seasonal Mean	0.103 ±0.047	0.029 ±0.011	0.009 ±0.008	0.118 ±0.054	0.015 ±0.001	0.014 ±0.001
Year mean	0.0473 ±0.0164			0.0496 ±0.0184		

Table- 4. The monthly means of physcio-chemical parameters of water of Chilika lagoon during 2011-12

Parameters	July	August	September	October	Nove.	Dece.	January	February	March	April	May	June
Nitrate (mg/L)	0.775 ±0.155	0.767 ±0.154	0.813 ±0.057	0.730 ±0.069	1.327 ±0.703	1.341 ±0.711	0.620 ±0.076	0.701 ±0.070	0.701 ±0.075	0.719 ±0.075	0.763 ±0.061	0.783 ±0.063
Nitrite (mg/L)	0.201 ±0.13	0.194 ±0.13	0.007 ±0.0007	0.009 ±0.0007	0.006 ±0.001	0.007 ±0.001	0.051 ±0.033	0.053 ±0.033	0.009 ±0.002	0.011 ±0.002	0.007 ±0.0006	0.007 ±0.0007

Table- 5. The monthly means of physcio-chemical parameters of water of Chilika lagoon during 2012-13

Parameters	July	August	September	October	Nove.	Dece.	January	February	March	April	May	June
Nitrate (mg/L)	0.836 ±0.171	0.785 ±0.157	0.820 ±0.072	0.803 ±0.736	1.500 ±0.802	1.524 ±0.818	0.706 ±0.072	0.834 ±0.105	0.792 ±0.065	0.810 ±0.065	0.932 ±0.078	0.954 ±0.078
Nitrite (mg/L)	0.218 ±0.145	0.242 ±0.160	0.006 ±0.0006	0.006 ±0.0006	0.007 ±0.001	0.007 ±0.0008	0.023 ±0.004	0.025 ±0.004	0.012 ±0.002	0.013 ±0.002	0.015 ±0.004	0.015 ±0.004