BIOGEOCHEMICAL FLUXES OF CARBON AND NITROGEN FROM CHILIKA LAKE,EAST COAST OF INDIA

AJAY KUMAR RAY

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ABSTRACT

Studies on biogeochemical cycling and fluxes of carbon and nitrogen in Chilika lake, Asia's largest brackish water lake on the east coast of India revealed for the first time a strong seasonal and spatial variability associated with the salinity. The lake was studied during both monsoon (July, 2005 and July-August, 2006) and premonsoon (May, 2006 and March-April, 2007), in 35 selected locations, including the 11 major rivers and two tidal locations. The lake exchange water with the sea (Bay of Bengal) and the several rivers open into it.

The lake showed a contrasting level of nutrients in different seasons. During monsoon, the reduced species of nitrogen, NH_4^+ was dominated by 58% in the total DIN pool, while the oxygenated species, $N0_3^-$ dominated by 63% during premonsoon due to seasonal variation in their supply from the rivers and also in situ production and mineralization. The $P0_4^{3-}$ did not reveal any significant seasonal variation and remained at similar level with slightly higher concentration during monsoon (0.47 ± 0.12 umol l^{-1}) than in premonsoon (0.40 ± 0.14 umol 1^{-1}). Eutrophication indices revealed the oligotrophic status for nutrients in both monsoon and premonsoon, while mesotrophic status for NH_4^+ during monsoon and $N0_3^-$ during premonsoon. The distribution of nutrients behaved non-conservative during monsoon and exhibited a conservative distribution in the salinity range, 0-15 during premonsoon. PON was lower by 30% from premonsoon to monsoon due to its substantial mineralization. The N_20 concentration was higher by 68 % and $N0_3^-$ by 33% during premonsoon than in monsoon due to seasonal variation in their coupled

nitrification-denitrification. The N_20 fluxes varied significantly from lake gain during monsoon (-2.60 ±3.64 μmol m^{-2} d^{-1}) to significant source during premonsoon (46.7 ± 17.1 μmol m^{-2} d^{-1}). The significant diel variation of nutrients along with 0_2 exhibited an apparent coupled nitrification-denitrification process in the lake.

The lake showed a significant seasonal variation in the concentration of dissolved inorganic carbon (DIC), dissolved organic carbon (DOC) and particulate organic carbon (POC). POC was higher by 10% and DOC by 12 % during premonsoon than monsoon. DIC was higher by 21% during monsoon than premonsoon due to seasonal variation in their riverine supply and in situ production/mineralization. The higher DOC\POC ratio in parallel with high DIC/DOC ratio in the lake during monsoon was influenced by desorption of riverine POC in the total SPM pool. During premonsoon, low DOC/POC ratio and high DIC/DOC ratio towards high saline waters of the lake were influenced by the physical mixing of two end member water masses and affected significantly either by DOC respiration and/or its conversion to POC.

Surface water partial pressure of $C0_2$ ($pC0_2$), exhibited a significant gradient from higher level in the fresh water condition to low level in the high saline waters during both monsoon and premonsoon. The $pC0_2$ level varied from 668 to 11797 μatm during monsoon and 295 to 6493 μatm during premonsoon, showing an occasional sink in parts of the northern and central lake. The river concentration $pC0_2$ was several time high than all the lake sectors and also high during monsoon than premonsoon. The lake CH_4 concentration was nearly two times higher during premonsoon (73.2 ± 137 nmol l^{-1}) than monsoon (47.2 ± 43.4 mnol l^{-1}). The River strong compared to the premonsoon. ΔDIN and ΔDIP was positive during monsoon and negative during premonsoon. ΔDIC was positive during monsoon and negative during premonsoon, while ΔDOC was negative during both monsoon and premonsoon.

During monsoon, the DIC removal (2.06 Gg C d^{-1}) from the lake is equivalent to the riverine influx (2.05 Gg C d^{-1}) and in addition, almost 2.00 Gg C d^{-1} of $C0_2$ evaded to the atmosphere as DIC at the air-sea boundary. During premonsoon, the DIC gain (0.04 Gg C d^{-1}) in the lake was only nearly one-fourth of the total riverine influx (0.14 Gg C d^{-1}) and nearly three times (0.40 Gg C d^{-1}) effluxed to the atmosphere. The DOC gain in the lake during monsoon (1.48 x 10^6 mol d^{-1}) was nearly half of the premonsoon (2.98 x 10^6 mol d^{-1}). The carbon budget thus indicated that the lake was strongly heterotrophic by transforming riverine organic carbon to the atmospheric sink through negative net ecosystem metabolism (NEM) during monsoon. During premonsoon the NEM was positive indicating lake as autotrophic, where the photosynthesis activity exceeding the community respiration $(p\text{-}r>0)$. Overall, lake heterotrophy was predominant than the system autotrophy. The lake heterotrophy was also displayed through N-mineralization indicating the occurrence of denitrification during monsoon and nitrogen fixation $(nfix\text{-}denit>0)$ during premonsoon.

The present study indicates that the Chilka lake is an important region for biological transformation of organic carbon and nitrogen to inorganic form and its export to the atmosphere. Therefore, the biogeochemical study of lake ecosystem and the fluxes of $C0_2$, CH_4 and N_20 is highly essential to introvert its significant contribution in the global context.