Dynamics of Dissolved Inorganic Carbon in the Godavari Estuary, East Coast of India

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The major biogeochemical role of river system in the global carbon cycle is typically considered to be the fluvial export of organic and inorganic carbon from the terrestrial environment to the ocean. In the macrotidal estuaries, where the long residence times of both water and suspended matter allow a significant modification in the speciation of chemical compounds by biological activity and physico-chemical processes. It is now well established that estuaries are net heterotrophic ecosystems, where total respiration exceeds gross primary production. This organic matter accumulates preferentially in the upper estuary where it is respired aerobically, results in significant oxygen depletion. Intense bacterial respiration and a long residence time of the river water in the estuarine region lead to the build-up of high partial pressure of CO_2 (pCO₂) in the water column.

Time-series variations in dissolved inorganic carbon (DIC) components were measured at 13 stations in the Godavari estuary, covering about 35 km from upstream to the mouth, from June 2008 to May 2009. The salinity variations in the Godavari estuary were mainly depended on the freshwater discharge, which is controlled by the water levels in the dam reservoir. The freshwater in the dam reservoir were normally stored for 6 to 7 months before it is discharged into the estuary. Therefore, dam enhances the residence time of waters that lead to occurrence of intense bacterial decomposition of organic matter. As a result, pH of the dam waters decreases to as low as 6.5. Based on the ^{13}C of DIC, it was observed that significant amount of carbonate dissolution do also occur due to decrease in pH and the mass balance calculations suggest that >60% of the DIC contributed by carbonate dissolution. It was also observed that ground waters contain an order of magnitude higher concentration of DIC compared to that of estuarine waters and exchange between them highly possible. Nevertheless, when discharge is at peak, the entire estuary filled with low pH and high pCO_2 of as high as >30,000 atm during peak discharge period. This is the highest pCO_2 levels have been reported so far in the world estuaries. During the no discharge periods, the mean pCO_2 levels were < 600atm. The water-air flux of CO₂ peaks during high discharge period and annual flux of CO₂ to the atmosphere was 0.032 TgC, which is half of that of community respiration (0.068 TgC).