Influence of Tides on Total Organic Carbon in the Macrotidal Estuary, 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 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 and most of the community respiration is supported by terrestrial organic carbon. It was observed in the Godavari estuary (our study region) where ~20-90% of the community respiration is supported by the terrestrial organic carbon. The river discharge is the major source of organic carbon during monsoon (June-September) whereas upstream rivers almost dry up during non-monsoon period. It is interesting to know the source of organic carbon during non-monsoon period (October to May) to support intense community respiration when phytoplankton production to respiration (P:R) ratio is 0.32. During non-monsoon period, the major source of organic carbon to the estuary is exchange of through tides, pore water and ground waters.

TOC concentrations decreased from upstream to the mouth (by 130 mol L^{-1}) and similar pattern was observed in the total bacterial counts as well as benthic macroalgae assemblages suggesting that intense biological activity in the upstream river. Bacterial respirations rates were significantly higher (5-20 mol L^{-1} d^{-1}) in the upstream than mouth (<8 mol L^{-1} d^{-1}). As a result, pH of the upstream waters was normally as low as 6.5 to 7.0 that increases to >8.0 towards mouth. In order to examine the influence of tides on spatial distribution of total organic (TOC) during non-monsoon period, time-series observations were conducted at 6 stations, spanning from upstream to mouth of the estuary, and sampling was carried out at 3 hours interval for 10 days from spring to neap tide. The tidal amplitude during spring tide was 1.5 m whereas it was 0.5 m during neap tide. TOC concentrations showed significant tidal variations and were higher by 30-100 mol during high than low tide period. Interestingly, the average TOC was also higher by 20-300 mol during neap than spring tide period suggesting significant amount of pore water intrusion into the water column during former period. The pore water TOC concentrations were higher by an order of magnitude than that of water column and benthic exchange experiment suggests that ~8-60 mol m^{-2} d^{-1} of TOC diffuses to the water column at sediment-water interface. The spring to neap tide difference in TOC was

decreased from upstream (200-350 mol) to the mouth (20-35 mol) by an order of magnitude that could be due to relatively higher silt fraction in the upstream compared to the mouth resulting in higher exchange in the former than latter. The TOC concentrations in the ground water, along the bank of the river, were an order of magnitude higher than that in the water column. However, the exchange rates between ground and estuarine waters are unknown. However, significant contribution is expected. This study suggests that dominant heterotrophic activity than phytoplankton production in the estuarine waters during non-monsoon period is supported by the organic carbon inputs from the pore waters driven by the tidal variations and ground water exchange.