Godavari Estuarine Processes

Nittala S. Sarma
School of Chemistry, Andhra University, Visakhapatnam
(*email: nssarma@rediffmail.com*)

Godavari is the largest of Indian peninsular rivers. Upon reaching the eastern coastal plain, downstream of the dam at Dowlaiswaram (near Rajahmundry), the river divides into two main distributaries Gautami and Vasishta that give rise to a sprawling estuarine deltaic system fringed with tidal creeks and dense mangrove forests before reaching the Bay of Bengal. Along the arcuate delta, the position and orientation of ancient beach ridges reveal sea level fluctuations and delta progradation.

The mean discharge of water is estimated as 2,830 m^3s^{-1} (~$90*10^9 m^3 yr^{-1}$), 95% of which occurs in the monsoon months (June-September). At the river mouth, circulation pattern changes rapidly with tide, local winds and sea breeze. Littoral current that is directed up coast (northerly longshore current) during premonsoon and monsoon causes erosion of the bottom that results in formation and accretion of the sand spit (Godavari point) and the northwest trending sandbar. The enclosed Kakinada Bay measuring 150 km^2 is a stratified water body in nonmonsoon season when the salinity can go up to 34 psu and pH to 8.3. The Godavari estuary is well mixed with the tidal effect dominating in the lean season. The (semi-diurnal) tidal amplitude is 0.5-2 meters. In January, a strong tidal current of 55 cm s^{-1} was measured at the river mouth that decreases upstream. A salt wedge begins to develop in the early monsoon (May) and by September the estuary is well stratified as the runoff becomes maximal. The flushing time is inversely proportional to the discharge; which is ~4 tidal cycles (48h) in September (wet season) and ~46 tidal cycles (552 hrs) in December (dry season).

Studies of primary productivity are virtually absent. More than 60 species of phytoplankton dominated by diatoms are reported. Dinoflagellates and bluegreen algae are represented by three species each. Among macroalgae, *Bostrychia tenella* and *Caloglossa leprieurii*, both red algal species occur, throughout the year. Meiobenthic nematodes constitute as much as ~90% of benthos. Together with that of Krishna, the Godavari estuary forms forte of prawn fishery with *Penaeus monodon* being the largest species, whose seedlings are harvested from wild on a large scale. A greater number of foraminiferal species, fourteen of them in higher abundance, were identified in this estuary than in any other (peninsular river) estuary. This is attributed to the availability of favourable substrate in plenty.

Since 1971, when the first hydrographic report appeared, the Godavari estuary has received a lot of attention especially in the wake of extensive aquaculture activity in recent times. Among nutrient elements, Si shows a distinct nonconservative behaviour and ammonia, nitrate and phosphate are less non-conservative. The C/N (atomic) ratio of suspended matter is ~18 in the upstream region but decreased to ~11 seaward. A detailed study of the influence of tidal circulation on the diurnal distribution of nutrients in the estuary, is an immediate requirement. And in turn, how do these nutrients influence the productivity and biodiversity is the logical end product that we need to know.

Osmium, and its isotopes, and uranium are found to behave conservatively, although there are differences between the Gautami and Vasishta arms in the case of the former (Os).

Water of the mangrove ecosystem is more enriched in nutrients. In the low saline Coringa mangrove water, dissolved oxygen was only half and BOD twice that of the respective concentrations of 183μmol kg^{-1} and 72 μmol kg^{-1} in estuarine water. The ΣN which is the sum of NO_3^--N, NH_4^+-N and NO_2^--N remained nearly constant at 19 μmol kg^{-1} in the estuary-mangrove system. However, NO_3^--N was 3 times lower in the estuary than in waters of mangrove region whereas both the NH_4^+-N and NO_2^-N exhibited behaviour in the opposite with 3-4 times higher values in estuarine waters. The role of suboxia in nitrogen turnover and release of sediment bound metal into the water column, a key mechanism operating in mangroves, has not been addressed so far. In the Godavari estuarine water, (dissolved) Fe is lower than world average while PO_4-P (5 μmol kg^{-1}) and particulate inorganic phosphorus (1.6 mg L^{-1}) are high compared to other peninsular rivers. Formation of $FePO_4$ in the colloidal/particulate phase and its subsequent mobilization in sediment under suboxic/anoxic condition may be an interesting problem to investigate.

Distinctly different behaviour between the estuary proper and the tidal creeks along with the fringing mangroves is shown for pH, alkalinity, total suspended matter, particulate and dissolved organic carbon, chlorophyll a, $\delta^{13}C$ and bacteria. Similarly, pCO_2 sharply increased to 2345±1328 ppm (433±77 ppm) in the Coringa mangrove, resulting in CO_2 oversaturation of ~650% compared to that of the estuary proper of ~120%. The mangrove creeks are thus an active site of mineralization and CO_2 flux to the atmosphere. Nevertheless, the export of organic carbon to the coastal ocean is dominated by *in situ* produced phytoplankton by a factor of 5 than that from mangrove region.

Compared to the world average the dissolved organic carbon in Godavari was low; 2.02 mg L^{-1} in the premonsoon and 0.3-1 mg L^{-1} in the postmonsoon season. The dissolved organic carbon did not undergo any change in the estuary but the particulate organic carbon nearly halved from 1.2 mg L^{-1} at the riverine end to the mouth. A high background humic organic matter was found to contribute to dissolved fluorescence in the adjacent coastal water. Higher levels of dissolved trace metals in the estuary might help humic acids retention in solution *via* chelation. Any systematic study of the Godavari estuarine system should be integrated with coastal ocean study.