GROUND WATER FLUX AND COASTAL PRODUCTIVITY BLOOM

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The west coast of India is environmentally more sensitive than the east coast as it is bordering one of the most sensitive ecosystems, the Arabian Sea. If there is a possible threat to the well being of the living resources of EEZ of India, then the coastal waters of southwest coast of India, and in particular, Cochin region is the prime location prone to trigger it due to the discharge nearly 0.105 Mm^3d^{-1} of effluents. Conventional understanding of coastal waters of Arabian Sea is that the activation of mud banks by monsoon forcing triggers intense geo-chemical processes leading to high productivity. Mud banks, as they appear only during monsoon and disappear with its retrieval, are unique in their formation and functions, and have turned out to be economically important for its rich biological resources. As far as the chemical features are concerned, the general picture so far emerged out is that except during the monsoon periods, the southwest coastal waters remained oligotrophic and surface chlorophyll *a* typically ranges from 0.1 to 5.3 $mg.m^{-3}$, while primary productivity ranges from 100 to 360 $mgC.m^{-2}.d^{-1}$. Recent studies contradict these findings and had shown that even after the monsoon period, fresh injection of nutrients by hitherto unknown processes fertilizes the coastal waters that are either permanent or quasi-permanent in nature.

Increased human population along the coastal belt has also resulted in concomitant increases in widespread use of septic tanks and nutrient inputs to coastal waters, particularly from regions occupying limestone beds. It has been found that domestic wastewater from septic tanks provide more nitrogen than that due to precipitation or use of fertilizers. More than 70 % of households in these coastal belt and adjacent areas of Vembanad Lake do not have proper sanitation facilities and significant amounts of nitrogenous nutrients can accumulate in the groundwater and a coastal fertilization due to its discharge into coastal ocean through ground water seepage seems to be a possibility.

During the typical pre-monsoon months, the nitrogenous nutrients in the coastal region remained low except for the mud bank area, with nitrate-N up to (4- 10 μM). The input of these nutrients supported high primary production up to 14 mg/m^3 of chlorophyll *a* (peak column production of 1529 $mgCm^{-2}d^{-1}$), approximately 3 times greater than the peak values reported so far from these waters. It is difficult to point out a definite source to these high nutrients during this period, as the fresh water discharge was at the minimum.

During the post monsoon season , the regions in the vicinity of the narrow coastal strip had nutrient enrichment with nitrite (0.5 – 2.0 μM), phosphate (0.4 – 2.8 μM) , ammonia (1 – 7 μM) and nitrate (1 – 6 μM). The enriched particulate organic carbon (> 3.5 mg/l)

and Chlorophyll *a* (14.8 mg/m^3) were also the notable features. The regions with high nitrite had nitrate levels up to 6 μM and the low levels of ammonia had ruled out the nitrification as a significant process responsible for nitrite accumulation. The N/P ratio in the coastal waters was below 15 during post monsoon period, possibly due to the disproportionate release of P from mudbank sediment. However, a band of N/P > 15 funneling out from southern region was indicative of an 'external source' of nitrogenous compounds into the coastal waters.

With the injection of nutrients in non-monsoon months when mud banks were passive, a new influence of Vembanad Lake on the coastal waters is very clear. The causative factors discussed are indicative of existence of a subterranean flow connecting Vembanad Lake to the adjacent coastal waters through the submerged porous lime shell beds. Continuous nutrient entry through such process is bound to upset coastal water productivity pattern. If the existence of the subterraneous channels linking Vembanad Lake to the adjacent coastal ocean is proved, it might even re-construct the historical evidence that the subterraneous flow plays a decisive role in the formation of mud banks along this region.

Localized phytoplankton productivity boosting in southwest coastal Arabian Sea during the monsoon season was partially attributed to nutrient rich ground water discharges into coastal region from a narrow strip of porous lime shell bed separating the Vemabadu Lake (Cochin Backwaters) and the sea. Due to high environmental degradation, poor sanitary facilities and poverty, this strip was identified by IUCN as high priority area for detailed study for ICZM. Forcing of nutrient rich ground water occurs when the water level difference between sea and lake attains a critical value to overcome the frictional resistance. Such conditions prevail during heavy fresh water discharges and on the sea level remaining at its annual low. The nutrient rich ground water fluxes seem to induce seasonal variability in the coastal water quality, primary productivity (three times coastal productivity) and slow changes in species diversity. A shortage of silicon, relative to the supplies of nitrogen and phosphorus seems to accelerate the growth of flagellated phytoplankton and red tides. The phytoplankton growth stimulation of Zn and Fe is of high significance as the dissolved zinc had enrichment in the lake with 116 ug/l in 1986 and with 879 ug/l in 1991. The possibility of heavy rains and flash floods linked with cyclones are high with climate variability, the critical conditions for ground water flow can prevail in other seasons and also at similar coastal locations. Any noticeable change of the current oligothrophic nature of the coastal region can contribute to the removal of atmospheric carbon. Attempts for reversing the eutrophication and biodiversity changes require management strategies for watersheds reaching far inland from the coastal region, restoration of wetlands and floodplains that act as nutrient traps. The control of nutrient rich ground water flow into coastal region is feasible by an improvement in the living conditions and sanitary facilities of the thickly populated coastal areas. The idea that land-use mosaic among sub-watersheds influence coastal processes may apply globally to any coastal regions hugged by wetlands and underlain with limestone deposits and to be potential regions of ground water discharges to coastal seas.

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