Dynamics of terrestrial materials in coastal areas: evaluation using multiple stable isotope signatures of H_2O, DIC and POM

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Evaluation of terrestrial loading of anthropogenic materials in coastal marine environments has become essential given the serious degradation of coastal habitats such as seagrass beds and coral reefs from human activities. Inputs of terrestrial materials change coastal water quality directly and indirectly, and local multiple organic sources such as mariculture fish feeds, resuspended sediment, and seagrass and mangrove detritus, and hydrodynamic characteristics complicate those influences. In order to assess the effect of allochthonous inputs in coastal areas, isotope signatures of water, dissolved inorganic carbon (DIC), and particulate organic matter (POM) were examined to identify sources and loading processes. Where freshwater simply mixes with seawater, $\delta^{18}O$-H_2O, a conservative tracer of freshwater input in coastal areas, linearly decreases with the decrease of salinity, hence can be used to calculate the mixing ratio as a basis. $\delta^{13}C$-DIC also linearly decreases with salinity since $\delta^{13}C$-DIC of river water is lower than that of seawater. But $\delta^{13}C$-DIC is also affected by photosynthesis and respiration in seawater through isotopic fractionation especially of CO_2 absorption. Where POM is dominated by phytoplankton, $\delta^{13}C$-POC is affected by $\delta^{13}C$-DIC which the phytoplankton used for photosynthesis, so river water inputs decrease the $\delta^{13}C$-POC. Terrestrial POM usually has lower $\delta^{13}C$ than phytoplankton. In the study sites, Bolinao (mariculture area) and Banate Bay (area affected by siltation) in the Philippines, $\delta^{18}O$-H_2O positively correlated with salinity in the wet season over the pycnocline layer, indicating freshwater inputs, and a similar pattern was also observed in $\delta^{13}C$-DIC, suggesting that large terrestrial DIC inputs overwhelmed local biological processes as the determinant of $\delta^{13}C$-DIC. On the other hand, $\delta^{13}C$-DIC correlated with the apparent oxygen utilization (AOU) in the bottom layer of the mariculture area in the wet season and all layers in the dry season in Bolinao, suggesting accumulation of CO_2 with low $\delta^{13}C$in the bottom layer in both seasons. Such CO_2 could have been generated by respiration and decomposition of sediment organic matter and excess fish feeds. In shallow seagrass beds, $\delta^{13}C$-DIC was mainly controlled by primary production. In Banate Bay, the variation of $\delta^{13}C$-DIC was small, and correlations with salinity and with AOU were not clear in the dry season, which is attributed to limited biological activity. $\delta^{13}C$-POC reflected lower $\delta^{13}C$-DIC in the wet season, but varied even when POC/Chl ratio was low. We tried to unravel underlying multiple processes by using mixing model of terrestrial water and seawater and focusing on the difference between model and measured values.

Keywords: terrestrial input, stable isotope ratio, dissolved inorganic carbon, particulate organic matter, tropical coastal area

