Distribution and sources of organic carbon in a mangrove-seagrass ecosystem (Gazi Bay, Kenya)

Introduction

- Given the importance of the tropics in the global riverine export of organic and inorganic carbon, the lack of data on the magnitude of carbon fluxes and transformations in river systems along the entire east African coastline represents one of the many gaps in our knowledge on carbon dynamics in the tropical coastal zone.

- The role of intertidal wetlands on carbon dynamics in estuaries is now widely recognized, since these highly productive ecosystems can induce major changes in the metabolic state of estuaries and the adjacent continental shelf (e.g. Cai et al. 1999 for salt marshes, Bouillon et al. 2003 for mangroves).

- Here, we report on the concentrations and stable isotope composition of different organic carbon pools in Gazi Bay (Kenya), a shallow tropical embayment with extensive mangrove forests along the entire east African coastline representing one of the many gaps in our knowledge on carbon dynamics in the tropical coastal zone.

Sampling area and Methods

- The carbon content and stable isotope composition of different organic carbon pools were studied in Gazi Bay (Kenya) in July 2003. Gazi Bay is a shallow tropical coastal ecosystem, with extensive mangrove forests intersected by 2 main tidal creeks (Kidogoweni and Kinondo, see Map) and a shallow bay largely covered by Thalassodendron ciliatum seagrass beds.

- Samples for suspended matter (POC, PN, and δ13C, δ18O), were filtered on pre-combusted 25 mm Whatman GF/F filters, dried, and measured with standard techniques (EA and EA-IRMS).

- δ13C-DIC and δ18O of dissolved oxygen were measured by headspace injection in an EA-IRMS setup.

Results & Discussion

- The distribution of particulate organic carbon along the salinity gradient of the tidal creeks indicated significant local inputs of organic carbon, with a δ13C signature (~-27 ‰) consistent with that of the dominant vegetation, i.e. mangroves (Figure 1 and 2).

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- Low water column Chi a values and high POC/Chi a ratios (Figure 3) are indicative of the predominance of macrophyte material or highly degraded organic material in the water column.

- At the boundary of the mangrove-seagrass interface, however, coinciding with a salinity of ~30, the carbon isotope composition of POC changes drastically, from about 27 ‰ as values as high as -14 ‰, indicative of a geographically sharp change in the relative contribution of mangrove and seagrass-derived organic carbon (Figure 2). This export of mangrove carbon has also been shown to contribute significantly to benthic mineralization (Figure 5, 6). On the other hand, seagrass material is similarly imported into the mangrove areas, but the contribution of seagrass material to mangrove sediments appears to be limited, overall.

- The sedimentary record, however, does indicate that mangrove carbon is exported from the system boundaries and trapped in the seagrass beds adjacent to the mangrove forest – δ13C values of sediment organic C are significantly more depleted than those of local seagrass material. This pattern is observed along a distinct spatial gradient in the relative contribution of seagrass- and mangrove-derived carbon was observed, and although a bidirectional exchange of material was clear, the data overall ... is limited to an area close to the forest boundary and are unlikely to exert a major influence on nearshore waters.

- The high spatial variability in the sources of the aquatic organic carbon pools is also mirrored in the distribution of pCO2 (data not shown), δ18O, and the δ13C signature of dissolved O2 (Figure 7), which indicate a distinct gradient from a high heterotrophic system (mangrove creeks: marked undersaturation of O2 concentration with elevated δ18DO2 due to microbial oxygen consumption which leaves the residual O2 pool enriched in 18O) to a net autotrophic region (seagrass beds: high O2 oversaturation, low δ18O2 due to the input of photosynthetically light O2). Similarly, the δ15N profile (Figure 8) shows internal production of isotopically light DIC in the mangrove creeks, consistent with inputs from mineralization. Overall, the data indicate that export of mangrove-derived organic carbon is limited to a geographically limited area close to the forest boundary, and unlikely to reach the coastal shelf area, i.e. unlike the South Atlantic Bight saltmarsh-dominated system (Cai et al. 2003).

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