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Silicon cycle in Indian estuaries and its control by biogeochemical and anthropogenic processes

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Abstract

We study the silicon biogeochemical cycle and its associated parameters in 24 and 18 Indian estuaries during dry and wet periods respectively. We focus more specifically on dissolved Si (DSi), amorphous Si (ASi,) lithogenic Si (LSi), Particulate Organic Carbon (POC), Total Suspended Material (TSM), Dissolved Inorganic Nitrogen (DIN), salinity and fucoxanthin, a marker pigment for diatoms. Overall, we show that the estuaries have strong inter and intra variability of their biogeochemical parameters both seasonally and along salinity gradients. Based on Principal Component Analysis and clustering of categorised (upper and lower) estuaries, we discuss the four major processes controlling the Si variability of Indian estuaries: 1) lithogenic supply, 2) diatom uptake, 3) mixing of sea water and, 4) land use. The influence of lithogenic control is significantly higher during the wet period than during the dry period, due to a higher particle supply through monsoonal discharge. A significant diatom uptake is only identified in the estuaries during dry period. By taking into account the non-conservative nature of Si and by extrapolating our results, we estimate the fluxes from the Indian subcontinent of DSi, ASi, LSi to the Bay of Bengal (211 ± 32, 10 ± 4.7, 2028 ± 317 Gmol) and Arabian Sea (80 ± 15, 7 ± 1.1, 1717 ± 932 Gmol). We show the impact of land use in watersheds with higher levels of agricultural activity amplifies the supply of Si to the coastal Bay of Bengal during the wet season. In contrast, forest cover and steep slopes cause less Si supply to the Arabian Sea by restricting erosion when entering the estuary. Finally, Si:N ratios show that nitrogen is always in deficit relative to silicon for diatom growth , these high Si:N ratios likely contribute to the prevention of eutrophication in the Indian estuaries and coastal sea.

Keywords

Amorphous silica; Weathering; Diatoms; Land use; Monsoon; Land-to-ocean continuum