Geomorphic and pedogenic forcing on the distribution of organic matter from vegetation to soil- a concern for paleoenvironment studies

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The $\delta^{13}C$ values of soil organic matter (SOM) have been used to reconstruct the abundance of C_3 and C_4 plants. However, the intimate connection of distribution of vegetation with geomorphic processes and landforms may impart different $\delta^{13}C$ value in the contemporaneous vegetation. Such variation would also get registered in the organic matter composition of the soil, with an erroneous assumption of a significant change in C_3 and C_4 abundance. Therefore, it is important to understand the effect of lateral variation in riverine geomorphic architecture and its impact on the $\delta^{13}C$ value of vegetation and soil. In this study, a lateral transect (6 km) of an undulatory geomorphic surface of north-south trending lateritic alluvium of South Bengal (India) was considered to unveil the effect of topography, and active channel distance on the contemporaneous vegetation and soil. A variation of ca. 50‰ is observed in the n-alkane H-isotopic composition (δD_{C31}) of the dominating tropical deciduous species (Sal- *Shorearo busta*). The $\delta^{18}O$ value of the groundwater and the river water was analysed to understand the source of water for the tropical trees. The D/H ratio suggests that the vegetation near the active channel was mostly influenced by the river water (enriched) and in distal areas by the groundwater (depleted). Preliminary study on the $\delta^{13}C$ values of the Sal species suggests an enrichment of ca. 7‰ away from the active river channel. The difference is attributed to the change in water-availability, canopy, topography, and vegetation density that varied along the transect. Disparity in the efficiency of water use was observed in the long chain n-alkane average chain length (ACL) and carbon preference index (CPI) distribution. The higher ACL (>29) and CPI (>2) values are mostly associated with the badlands or upland soil environment with very low moisture availability. Preservation of the contemporaneous vegetation signals in the litter layer was regulated by the geomorphology, vegetation density, and the soil texture. The upland, and the distal areas with sparse vegetation tend to preserve more positive $^{13}C/^{12}C$ ratio (−24‰) compared to the lowland with well-developed soils (−28‰). The upland and distal soils, with a coarser texture, suggests faster decomposition of OM (TOC% <0.2) due to higher percolation and soil aeration; whereas in fine-textured lowland soils depleted (−4‰) and high TOC% (>0.5) is observed. Further, due to continuous abrasion by the riverine process, the TOC is also low in the soils adjacent to the active river. The nitrogen isotopic composition ($\delta^{15}N_{SOM}$) increases as alteration/decay or leaching of SOM proceeds. The faster decomposition and microbial processing of SOM in upland and distal area soils registered higher $\delta^{15}N$ (+4‰) values whereas lower values are registered in low-lying areas. This geomorphic and pedogenic effect on the plant-soil system may result in ambiguous interpretation about the past vegetation and thus warrants detail vegetation, geomorphic and physical or chemical characterisation of the soil before employing it as a paleo-record archive.

Keywords: Vegetation, Soil organic matter, Geomorphology, Pedogenesis

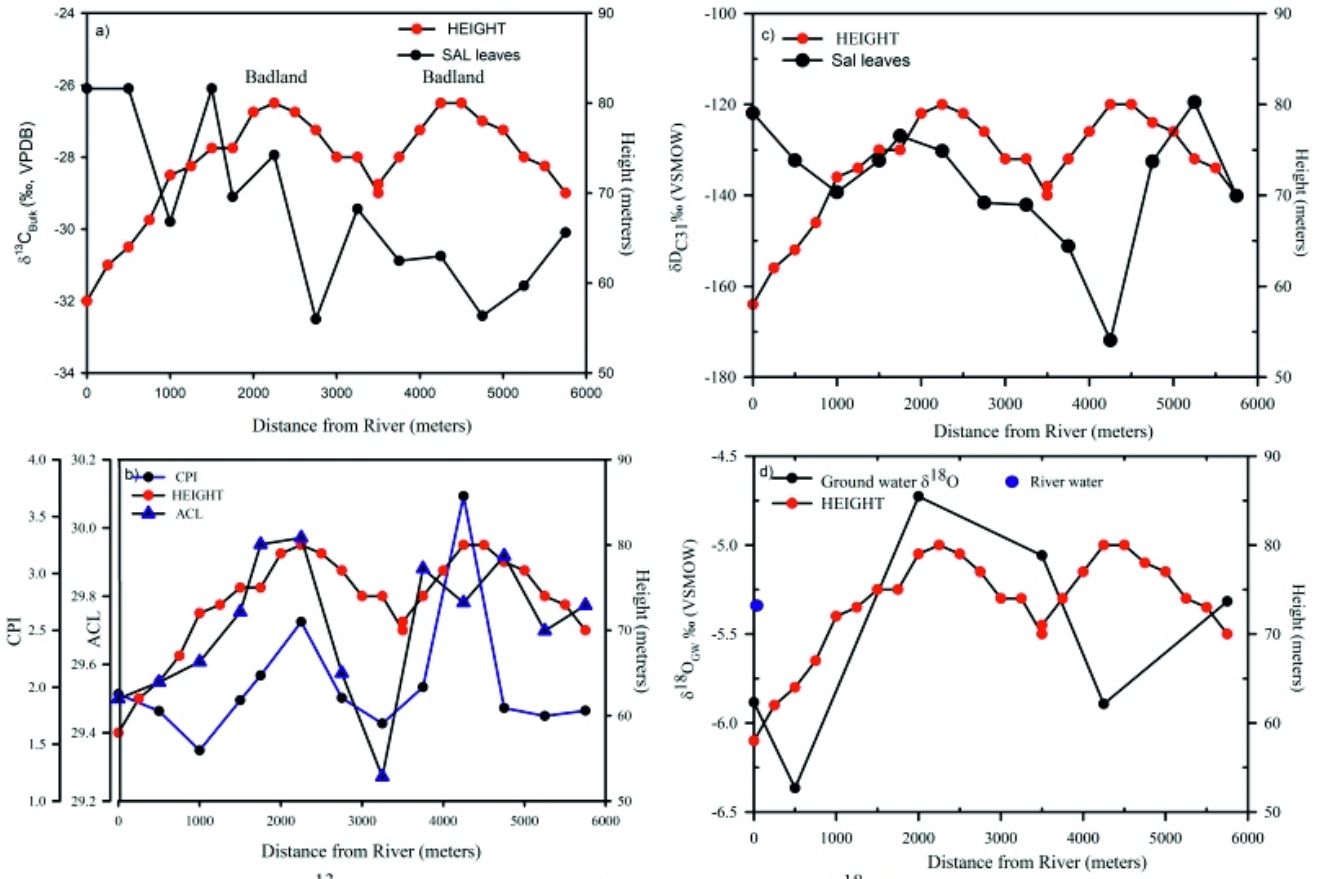

Fig. 1. Variation in the: SAL a) $\delta^{13}C_{Bulk}$, b) δD_{C31}, c)CPI and ACL value; and Groundwater $\delta^{18}O_{GW}$ value along the lateral transect of the river.

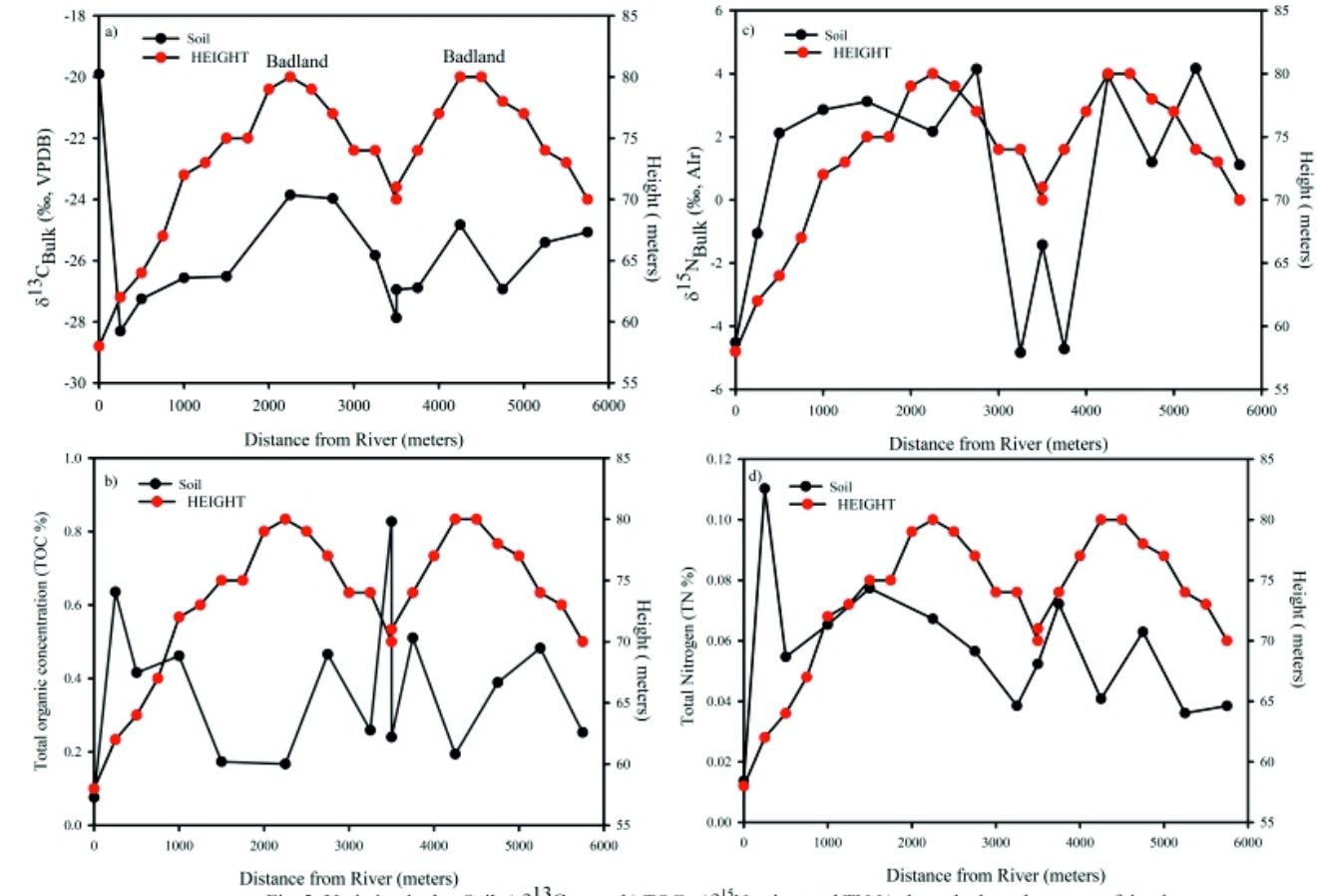

Fig. 2. Variation in the: Soil a) $\delta^{13}C_{Bulk}$, b) TOC, c)$\delta^{15}N$ value; and TN % along the lateral transect of the river.

