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Soil organic carbon sequestration and dynamics along a chronosequence on fluvial terraces

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The aim of this work is to investigate the mechanisms of soil organic carbon (SOC) sequestration as a function of time and depth. A chronosequence, consisting of two orders (T2 and T1) of the Adige river terraces (Veneto region, North of Italy) and 3 sites (Q2, Q3, and Q4), has been investigated. The highest and oldest terrace (T1) is located in Montalto di Gaium, 125 m above the current Adige riverbed level. This terrace was probably formed during the last interglacial (*ca.* 125,000 years BP) and was characterized by Paleudalf soils. Conversely, T2 represents the youngest order of terraces (probably formed during the early Holocene) and is situated 15 m above the current riverbed level. The Q2 site was located in T1 whereas Q3 and Q4 in T2; all sites have a common vegetation. From each site, soil samples have been collected (1 profile and 2 cores per site) by soil horizon, and each horizon sub-sampled by depth (each 5 cm). Five-cm thick sub-samples have been characterized for pH, electrical conductivity, total organic C (C_{org}), total N (N_{TOT}), texture, and micro and macro nutrients. Particulate organic matter (POM) and mineral-associated organic matter (MAOM) have been isolated using a physical fractionation method and characterized by elemental (CHNS) and thermal analysis (TGA-DSC).

The average C_{org} content in the topsoil (20 cm) is quite constant in the three sites (27.4 mg/g), whereas the average N_{TOT} concentration ranges between 2.7 and 3.1 mg/g. In all sites, the C_{org} concentration along the profile is positively correlated with N_{TOT} ($p<0.001$); moreover, a positive and significative correlation between C_{org} and clay ($p<0.001$) was observed exclusively in Q2, while in all sites Ca, instead of Al or Fe, seems to play a major role in C_{org} sequestration. SOC stock in topsoil is 47% higher in Q2 (T1) (72±3 MgC/ha) than in Q4 (T2) (49±5 MgC/ha), but such a difference decreases at 35 cm (96±2 and 76±7 MgC/ha, respectively). Furthermore, in the site showing the deepest soil profile (Q3), the SOC accumulated between 35 and 80 cm (42 MgC/ha) represents the 33% of the total. The average content of the MAOM pool is constant along the T2 (Q3 and Q4) profiles (52%), while increases with depth in T1 (up to 62% in deeper layers).

Thermal indices (e.g., $WL_{400-550/200-300}$, TG-T_{50}, DSC-T_{50}) suggest that the stability of bulk SOM generally increases with depth in the three sites. Moreover, a general increase in the thermal stability of both MAOM and POM is observed with depth in all sites, with Q2 (i.e., the site in the oldest terrace) showing a larger increase of MAOM thermal stability in deeper soil compared to Q3

and Q4 (located on the youngest terrace).

While most of the studies on SOC sequestration and stabilization focuses on topsoils, our preliminary data show that a significant stock of more recalcitrant organic C accumulates in deeper soils. Future data will help to better understand the effect of time on SOC distribution among different pools and as a function of depth.