Chemical and biochemical indicators of pedogenesis in saltmarshes sediments and soils

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Introduction: Saltmarshes provide an unique natural system where flooding is an essential component of the ecosystem equilibrium.
From a pedological point of view, intertidal coastal soils can be classified according to the entity of their aquic conditions. Recently, the introduction of the subaqueous soils into the soil classification systems (1; 2) led to the possibility to approach the study of saltmarshes ecosystem as a unique soil catena which cover both the provisionally and permanently submerged areas of intertidal environments. Although there is almost no doubt that the terrestrial substrates in saltmarshes (TESs) can be defined as "soil", many scientists are still sceptical in defining the intertidal (ITSs) and subaqueous substrates (SASs) as proper soils.
The evaluation of the quality of the soil organic matter (SOM), responsible of many physicochemical and biochemical soil processes, is one of the most important indicators of soil formation and development. The degradation of the SOM in saltmarshes sediments and soils is sensibly lowered or even stopped by the lack of oxygen; however, its study in intertidal areas is difficult due to the interaction of many abiotic and biotic factors (e.g. redox changes, water and bio-turbation processes, biochemical transformations, etc.) and stressors (e.g. salinity and anoxia). SOM cycle can be evaluated by the study/analysis of its total, soluble, humified, and available fractions. Soil enzymes are partially responsible of the degradation processes, and therefore their activities can be used as indicators of the soil degradation potential. Combining the analysis of diverse SOM fractions and of the activity of soil enzymes may help to define the presence and the entity of one of the most important soil pedogenetic process in SASs: the humification.
The aim of this work was to define changes in physicochemical or biochemical indicators and/or processes along a TES-ITS-SAS soil transect in three saltmarshes, to gain knowledge useful to evaluate if ITSs and SASs can be considered as proper soils.

Methods: Triplicate subaqueous (SASs), intertidal (ITSs) and terrestrial soils (TESs) were collected in the saltmarshes of the Baiona Lagoon (Northern Italy) and classified according to their pedogenetic horizons. Each horizon was analyzed for its nutrients composition, and the SOM quality on each soil horizon was investigated by quantifying SOM, total and water-soluble organic carbon (TOC, WSC), microbial biomass carbon (MBC) and humic fraction (HS). Moreover, soil degradation potential, microbic quotient (Qmic) and total enzymatic activities (TSA) were estimated on each soil horizon.

Results and Discussion: All soils profiles showed a gradual decrease of some chemical indicators related to the increase of soil submergence. The C:S index and the salinity profiles were thus identified as indicators of the soil hydromorphism. SOM, TOC and MBC were statistically higher in A than in AC and C horizons. Among the A horizons, ITSs were those showing the highest values for these parameters (11% TOC, 1.6 mg kg^{-1} MBC, 0.9 mg kg^{-1} WSC). These results reflect the influence of the type of annual biomass deposition on ITSs, but also the important role of the tide oscillation, that promotes the continuous alternation of red-ox exchanges and the subsequent acceleration of the organic matter turnover. The analysis of the Qmic suggested a progressively less conservative behaviour of SOM going from TESs to SASs and from Ato C horizons. The TSA, however, showed no significant difference, with exception of SASs, where this parameter increased along the soil profile (Fig 1).

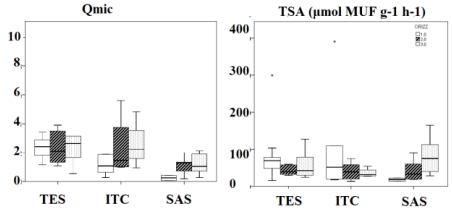

Fig. 1: Microbic quotient (Qmic) and total enzymatic activity in the different saltmarshes areas.

The FT-IR spectra of HS extracted from the soil profiles (Fig 2) showed the presence of the typical humic acids molecules not only in TESs, but also in ITSs and SASs, characterized by a decreasing intensity of the aromatic functional groups going from TES to SAS.
This work, finally, confirms the presence of a weak, but persistent humification process also in ITS and SAS soils.

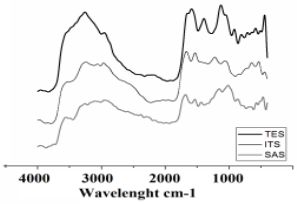

Fig. 2: FT-IR analysis of the HS extracted in the soil epipedons of the different saltmarshes areas

References: [1] IUSS Working Group WRB (2014) [2]Soil Survey Staff (2014) Keys to Soil Taxonomy, 12th edn. [3] Reddy and De Laume (2008), CRC Press.