EGU24-14798, updated on 07 Dec 2024
https://doi.org/10.5194/egusphere-egu24-14798
EGU General Assembly 2024

How climate and soil properties limit mineral-associated organic carbon (MAOC) accrual under afforestation. Findings from a climate gradient study in warm drylands.

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The efficiency of afforestation in climate mitigation has been a matter of debate in recent years. Specifically, there have been doubts about whether afforestation in drylands can be climate-positive. If afforestation can contribute to accumulation of soil organic carbon (SOC) and to the buildup of the mineral-associated organic C (MAOC) pools this may be a significant contribution to long-term C capturing in dry environments. However, there are still gaps in our understanding of how the interactions between vegetation type and climate affect MAOC storage. Furthermore, studies of MAOC dynamics have often disregarded the finite capacity of soils to store MAOC. In this work, we aimed at bridging these gaps by examining SOC and its partitioning between different soil size fractions in sites planted with Aleppo pine over 50 years ago (PF) as compared to neighboring fallow sites which were not actively forested (NF). This was performed at 16 sites along a climate gradient in Israel (ranging from 250-800 mm in annual precipitation) and differing in soil properties. MAOC in the 0-10 cm and 10-20 cm showed a general trend of increase with precipitation (more statistically significant in PF sites). Calcareous sites (>10% $CaCO_3$ equivalent) showed lower MAOC concentrations, which may arise from smaller fine-grain soil fraction but also from reduced input from vegetation due to poor nutrient availability. MAOC composed between 37-83% of total SOC with a weak decreasing trend with increasing SOC (regardless of afforestation). The decrease in MAOC/SOC points to possible MAOC saturation at~40 g C kg^{-1} soil, a value previously suggested for saturation in European soils. To investigate whether saturation could be limiting MAOC accrual, we examined the saturation limit using topsoil samples (collected at the 0-2 cm depth) selected for high total SOC. In the topsoil fine fraction SOC reached 95 g C kg^{-1} soil-fine-fraction, slightly above global reports for soils with high activity clays. Based on these topsoil measurements, MAOC even in the high SOC soils (at 0-10 cm depth), reached less than 70% of its capacity, suggesting that saturation was not a limiting factor. However, density fractionation

of the topsoil samples raised questions about whether they truly represent soil capacity to associate organic carbon. In the presentation we will discuss the concept of MAOC capacity in light of these findings and its implications for afforestation in dry climates.