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Organic Carbon Degradation and Preservation in a Drained and Reflooded Peat Soil

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Peatlands cover about 3% of the earth's land surface and store ~650 Pg of carbon in organic matter (OM), about 20% of the total global soil carbon stock. Unfortunately, these carbon stocks are largely at risk as many have been exploited intensively by humans since the Industrial Revolution. The most common reason for peatland deterioration is land reclamation for agricultural purposes which led to a massive global peat draining. The drainage of the Hula Marsh in Israel, in 1957, caused soil fires, enhanced erosion, subsidence, and nutrient enrichment of the downflow water system. This led to the decision to reflood part of the area in 1994 and to keep the groundwater level in surrounding cropland at roughly ~ 0.8 to 1.4 m below the surface. As a result, the Hula Marsh has peat sections that were drained for ~37 years before reflooding, while other sections are still drained for more than ~ 66 years. Hence, the Hula Marsh allows us to study the aerobic degradation of organic matter following drainage, and its preservation following reflooding. Five sediment cores (4 m long) were excavated from cropland over the historic marsh area at different discrete locations. Using RockEval-7 (RE7) analyses and soil aerobic respiration experiments, we have evaluated the organic matter of the drained, re-flooded, and saturated sections of the soil profile.

Our findings show that in the upper, drained peat section, total organic carbon (TOC) is the lowest and the OM resistivity index (R-index) is the highest, inversely to the saturated section. The reflooded section values are a transition between these two sections. Both trends align with the expected oxidation and mineralization of the upper peat section and correlate to the water table history in all the soil profiles. The reflooded section experienced mineralization in the past, which presumably was lessened under the newly saturated conditions. Preliminary respiration experiment results indicate that the reflooded section has the highest decomposition rates and is more prone to decomposition. However, the drained and saturated sections have lower and similar respiration rates (per gram carbon) despite the differences in their OM characteristics.

Further study will focus on respiration rates in all cores and the OM characterization in the drained and reflooded sections.