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Influence of Salinity on Organic Matter Stabilization and Greenhouse Gas Emissions in Mangrove Soils

TAINARA NOVAES BISPO, DR. FRANCISCO RUIZ, PHD AND TIAGO OSÓRIO FERREIRA

"Luiz de Queiroz" College of Agriculture / University of São Paulo

Mangrove forests are essential for soil organic carbon (SOC) sequestration and stabilization. However, with climate change, this stability may be altered due to rising sea levels and increased salinity, leading to the destabilization of soil organic matter (SOM). Thus, this study aimed to investigate how this destabilization influences the accumulation of gases: Carbon Dioxide (CO_2) and Methane (CH_4). The experiment was conducted using mangrove soil from the Iguape-Cananéia estuarine system, São Paulo (SP), Brazil, and included 24 experimental units: six randomly assigned field replicates for each of the four salinity treatments (based on seawater salts: 28 PSU, 35 PSU, 42 PSU, and 50 PSU). Gas samples were collected from the experimental units four times over 120 days using BD-type nylon syringes fixed on sealed lids at the top of each cylinder. Sampling was performed at established intervals of 0, 20, and 40 minutes. Gas concentrations were determined by gas chromatography, and fluxes were calculated using the ideal gas law (PV=nRT). CO_2 fluxes showed a general decreasing trend over time, with significant reductions in the highest salinity treatment (50 PSU) in the 8th week, as shown in a linear mixed model ($p = 0.0201$). Higher salinity thus reduced CO_2 emissions, likely due to microbial suppression. H_4 emissions show mixed trends, likely due to competition between sulfate-reducing and methanogenic bacteria. PCA analysis indicated that CO_2 positively correlated with Eh (oxidative conditions, 28 PSU) and high salinity led to lower Eh and higher pH, negatively affecting CO_2 fluxes. Therefore, future climate-driven salinity shifts may alter mangrove carbon storage and GHG emissions. These results highlight the need to consider salinity changes in conservation and climate mitigation efforts.