Redox Biogeochemistry at High Temporal Resolution in a Freshwater Delta

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River deltas are hydrologically complex systems that experience changes in water level with river stage, tides, wind, and other forcings. Variable water levels generate heterogeneity in soil redox conditions over space and time, affecting microbial respiration, nutrient solubility, and greenhouse gas fluxes. This work explores how redox potential and water chemistry vary with hydrology in Wax Lake Delta (WLD), an actively growing freshwater delta in coastal Louisiana. Environmental sensors measuring water level, pH, conductivity, temperature, soil moisture, and soil redox potential at 15 min intervals were installed along two elevation transects spanning supratidal to subtidal zones on proximal and distal portions of Mike Island within WLD. Soil pore water was collected and analyzed for pH, conductivity, oxidation-reduction potential, base cations, nutrients, dissolved organic and inorganic carbon, major anions, and minor and trace elements. Water depth relative to the land surface varied with seasons and tides, and tidal variation (~30-40 cm) was more pronounced near the distal portion of the island. Soil redox potential was persistently reducing at all depths in subtidal soils and in deeper (>20 cm) supra- and intertidal soils. In shallow supra- and intertidal soils, redox potential fluctuated with the tides when the water table was near the surface or became persistently oxidizing during the summer as water tables fell. Dissolved Fe concentrations were high (up to 1.3 mmol L^{-1}) and strongly correlated with redox potential ($r = -0.75$, $p < 0.001$), indicating that Fe cycling may buffer redox conditions in this system. Water from shallow soils and/or soils in supra- and high intertidal zones were more oxidizing and had higher pH and higher concentrations of SO_4^{2-}, NO_3^-, and select trace elements. Water from deeper soils and/or soils from low intertidal and subtidal zones tended to be more reducing, acidic, and saline with higher concentrations of base cations, phosphate, Si, DIC, DOC, and reduced metals (Fe, Mn). Dissolved phosphate, As, and Si strongly correlate with dissolved Fe, indicating the potential for Fe oxidation and reduction reactions to regulate their solubility. These results indicate that redox conditions in WLD were more variable near the soil surface and at higher elevation sites that are periodically unsaturated, and that redox potential and water chemistry respond rapidly to changes in water level. Supratidal and high intertidal zones may represent areas of dynamic biogeochemical transformation driven by fluctuating redox conditions.