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The role of ecohydrological patch types in carbon sequestration and nutrient uptake rate in a lake estuarine wetland experiencing rapid water-level rise

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Coastal wetlands are intrinsically heterogeneous and typically composed of a mosaic of ecosystem patches with different vegetation types. The patch type and vegetation density affect hydraulics, nutrient processing, and greenhouse-gases budgets. We studied carbon sequestration and nitrogen and phosphorus accumulation rates in a lake-estuarine wetland at different patch types across a microtopographic gradient and levels of influence from the main channel. Rapid lake level rise (~1 m/decade) at our field site, OWC, an estuarine marsh by Lake Erie shore in OH, USA, led to rapid increase in wetland water elevation. These were followed by changes in the patch types at each location within the wetland. We developed an approach to classify vegetation patch types from seasonal timeseries of NDVI from the HLS (harmonized Landsat-Sentinel) remote sensing dataset. We classify the location and extent of vegetation patches over the last decade and found rapid transition from cattail to floating-leaf vegetation. And while the bathymetry (the topography of the wetland bottom) was relatively constant, the rapid changes to water elevation and vegetation meant that the current patch-type identity did not provide a consistent indication of the local ecosystem characteristics over a timeframe of several years.

Using a microtopographic (hydrological) rather than vegetation-type (ecological) characterization of our soil core locations, we found that nitrogen accumulation mirrored carbon relative distribution, with larger rates at the shallow and deep locations than at the intermediate-depth ones. Both carbon sequestration and nitrogen accumulation rates were greater the farther they were from the main channel. Phosphorus accumulation rates were larger at the deeper microtopographic level than in the intermediate and shallow ones. Phosphorus accumulation did not vary in response to the influence of the main channel. Our results highlight the relevance of watershed-level management practices of phosphorus and nitrogen runoff to control carbon sequestration and nutrient accumulation in wetlands. Climate-change-induced water-elevation changes emphasize the relevance of microtopographic considerations in wetland-related projects, such as maximizing deep pools to enhance phosphorus accumulation.