

Category II: Aquatic Ecosystems

Understanding the Spatial and Temporal Patterns of Wetland Evapotranspiration, Primary Production, and Nutrient Cycling

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Executive Summary:

The mechanistic processes that control the biogeochemical budgets and evapotranspiration in California wetlands are poorly understood. We propose research at UCI's San Joaquin Freshwater Marsh to better understand the ecological controls on wetland carbon, energy and water vapor exchange. We have been using the eddy covariance technique since 1998 to measure the CO₂ exchange (F_{CO_2}) and evapotranspiration (E) between the atmosphere and the San Joaquin Marsh. Eddy covariance is a non-invasive micrometeorological technique that measures the exchanges of gases and energy between the atmosphere and a few hectare patch of marsh. The marsh's CO₂ exchange and evapotranspiration fluctuated dramatically from year to year during this period, with particularly high rates of F_{CO_2} and E during the 2000 and 2003 growing seasons. The interannual shifts in F_{CO_2} and E occurred despite similar climatic and flooding regimes. The large year-to-year variability at the San Joaquin Marsh apparently reflects an unexpected and previously unreported phenomenon that helps to control marsh biogeochemistry and evapotranspiration. Our research goal is to understand the causes and consequences of this pattern.

We will focus on three questions. (1) What causes interannual variation in CO₂, energy and evaporative exchange? (2) How do the spatial patterns of plant growth change from year to year? (3) What are the consequences of interannual variation in CO₂ exchange for the nutrient budgets?

We will approach these questions with four sets of observations. (1) Continued measurements of the CO₂ exchange and evapotranspiration by the marsh, combined with new measurements of the inputs and outputs of Nitrogen and Phosphorus in surface water. (2) Replicated and controlled Mesocosm experiments to directly test hypotheses about the controls on marsh production and nutrient inputs and outputs. (3) Analyses of aerial photographs and remote sensing images (ETM+ and ASTER) to determine whether marsh production is spatially uniform, or whether it is a mosaic of high and low-growth patches that shift from year to year. (4) A large manipulation, either by a controlled burn or mowing, to further test our understanding of the causes of year-to-year variation in F_{CO_2} and E. This research will contribute a more mechanistic understanding of the controls on wetland biogeochemistry and evapotranspiration. Given the lack of previous research in this area, especially as it applies to Mediterranean-climate marshlands, we have a good chance making an original contribution. This research may contribute to the improvement of management techniques for wetlands, and, in particular, high productivity marshlands that fill in over time. This research may also contribute to understanding the effect of wetlands on the chemistry of surface water, and the effectiveness of constructed treatment wetlands. Finally, this project will contribute to the graduate and undergraduate education at UC-Irvine. 30359