Everglades project - Modeling Soil Dynamics

Project Overview and Background:

Ecosystems are considered “stable” if the state variables and processes of interest (e.g., vegetation, productivity, nutrient cycling) return to more or less the same state after a disturbance (DeAngelis and Waterhouse, 1987). In wetlands systems, stability is critically linked to a wetland’s ability to accrete soil (or erode) and maintain hydrologic conditions suitable for plant productivity (Mitsch and Gosselink, 2003). In coastal marshes, for instance, accretion rates and thus surface elevation must keep pace with rising sea-levels. When sea-level rise outpaces accretion, a resilience threshold may be exceeded, leading to loss of wetland habitat (Kearney et al., 1988; Reyes et al., 2000; Lane et al., 2006). Other disturbances, such as widespread plant mortality or soil overdrainage, can lead to peat loss and more open, eroded systems, with novel community structure and ecosystem function (Cahoon et al., 2003).

Specific Management and Restoration Objectives:

The integrative empirical and modeling approach described here will provide a tool for understanding how Everglades plant communities and soils will respond to hydrologic restoration measures over time periods that are relevant to ecosystem restoration. The goal of this work is to generate a quantitative framework for understanding Everglades ecosystem responses to altered hydrology, including (1) the effects of past climate variability and water management on system stability and (2) effects of future hydrologic changes (e.g., restoration effects and natural climate variability) on system stability. Specific objectives of this work are:

- To quantify the extent to which peat accretion in tree islands (and long-term stability) is affected by changes in water depths, water flow and sediment transport.
- To quantify the extent to which peat accretion in ridges and sloughs, and the consequential effects on their microtopographic differences, is affected by changes in water depths, water flow and sediment transport.
- To identify the ecosystem processes (for example: plant productivity-hydrology relationships, litter quality effects on decomposition, soil oxidation/compaction rates) that are most sensitive to hydrologic drivers and can be used to provide an understanding of the long-term accretion and stability of Everglades wetlands.

Methods and Procedures:

This one-dimensional (1-D) accretion model structure and assumptions draw on previous examples from other wetland systems (e.g., Morris and Bowden, 1986; Callaway, 1994;

Rybczyk et al., 1998; Day et al., 1999; Nungesser et al., 2003; Saunders, 2003). Main components of this model includes above and belowground production of competing plant species, litter quality and abiotic (including hydrologic) controls of soil organic matter (SOM) decomposition, sediment deposition/erosion, soil compaction, fluctuating hydrology (mainly water depths) and the interrelationships among these processes. This model will be designed to simulate accretion rates, elevation changes and soil profile changes in organic matter and mineral matter, along with paleoecological proxies specific to Everglades systems (Saunders et al., 2006; Chmura et al., 2006) over decades to centuries.