Feedbacks between Differential Peat Accretion and Anabranching River Mechanics in the Ridge and Slough Landscape

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Degradation of the regularly patterned ridge and slough landscape in the central Everglades has coincided with drainage alterations and flow reductions over the past century. Typically, landscape degradation takes the form of topographic flattening, with sawgrass (*Cladium jamaicense*) from ridges overtaking open-water sloughs, and/or a loss of landscape directionality (Science Coordination Team, 2003), yet causes of landscape degradation are poorly understood.

Based on a literature synthesis and a newly developed mechanistic model, *PeatAccrete 1.0*, it is proposed that two feedback mechanisms explain the main features of landscape morphology: a differential peat accretion feedback similar to that controlling hummock and hollow elevations in boreal bogs, and an anabranching river-type feedback between flow, morphology, sediment depostion, and sediment entrainment. *PeatAccrete 1.0* numerically simulates the relationship between species-specific net peat production rates, phosphorus concentration, and water table, formulated in accordance with field experiments reported in the literature. Simulation results provide evidence that this differential peat accretion feedback governs vertical differences in topography between ridge and slough and results in the attainment of an equilibrium ridge height. This feedback mechanism does not, however, result in the attainment of an equilibrium ridge width and produces rounded ridges, which contrast with the flat morphologies observed in the better preserved portions of the ridge and slough landscape. It is proposed that an anabranching river-type feedback redistributes sediment produced within sloughs to ridge edges and governs cross-sectional and longitudinal features of ridges, resulting in the attainment of an equilibrium ridge width, a flat morphology, and regular cross-stream patterning. Scaling arguments and an understanding of the role of vegetation in sediment transport and capture, combined with comparisons to classic anabranching rivers and numerical modeling provide support for the application of the anabranching river paradigm to the ridge and slough landscape.

PeatAccrete 1.0 provides insight into ecohydrological feedbacks and offers possible reasons for landscape degradation and potential restoration strategies. Results indicate that a lower average depth produces a lower equilibrium ridge height with respect to the hydrologic baseline but that P enrichment, increased hydroperiod, and more reduced redox potentials result in the attainment of a higher equilibrium ridge height. Therefore, in locations where hydroperiod has not been altered significantly, landscape degradation is more likely due to slough infilling (e.g. by a deficit in sediment transport or reduced decomposition rates) than to ridges decreasing in elevation. However, model results suggest that P enrichment and decreased redox potentials allow initiation of ridge growth on smaller topographic perturbations, which under some circumstances could allow sawgrass growth on former slough bottom locations.

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