Abstract: The importance of connectivity is well established in traditional disciplinary environmental fields, namely hydrology and ecology. Although conventions for defining connectivity in those fields differ, structural connectivity typically refers to the degree of spatial connectedness of landscape features, whereas functional connectivity refers to the degree of permeability of landscapes for certain processes, such as fluxes of water, solutes, or organisms. Process connectivity is emerging as a concept that integrates across disciplines by delineating how various drivers of environmental change interact dynamically in a process network. It is related to structural and functional connectivity in that the latter reflect process connectivity, but at the same time, a single process connectivity network can produce a wide variety of structural and functional connectivity characteristics. Conversely, a particular structural pattern may not uniquely arise from a single process network. Consequently, process-based classification of environments is a paradigm distinct from traditional structurally based classifications but arguably one that represents an improvement for predicting future responses to changing environmental conditions. Identification of dominant process interactions in complex and dynamic environmental systems is one of the outstanding challenges in earth and environmental science.

This seminar illustrates one approach for identifying the process connectivity of a particular environment and its relationship to structural and functional connectivity and then using that understanding to make broad inferences about the functioning of environmental systems elsewhere. The nontidal Everglades, often referred to as “unique,” is a rare example of a historically stable, low-gradient, parallel-drainage landscape. Based on similarity in structural features between the Everglades, Australian anabranching rivers, and boreal bogs, a hypothesized process network involving two distinct feedbacks was developed and validated using cellular automata modeling, a technique in which complex behavior can emerge from simple rules governing local interactions. Results suggested that although Everglades landscape morphology is relatively unique, the dominant process interactions controlling it are not. Additionally, under different environmental conditions, these interactions promote evolution of a wide variety of other, common landscape morphologies differing vastly in the connectivity characteristics of their channels, which also respond sensitively to perturbations in hydrology. Quantifying that structural connectivity through integrative, graph-theory-based connectivity metrics not only improves our ability to calculate functional connectivity and delineate process connectivity networks but also provides an indicator of imminent shifts in landscape structure and function as a result of environmental change. Application to the Everglades suggests that much of its landscape area will experience additional, rapid degradation if hydrologic restoration activities are not implemented within the decade.