



Self Organization as a Tool for Complex System Understanding in a Changing World

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Recent developments in the field of complex systems provide new frontiers for the study of ecological organization and reorganization in a changing world. One of the hallmarks of complexity is that global phenomena emerge out of local interactions that affect global properties and behavior of systems. Non-linear interactions provide important sources for multi-level order that emerges from self-organization.

Organization is defined as the process of forming non-random patterns that characterize individuals, species, ecosystems and landscapes. Reorganization refers to pattern modulation driven by internal and/or external processes.

In ecological systems four global phenomena of self-organization result from local interactions among individual (population level), species (community level), organisms - environment (ecosystem level) and ecosystems (landscape level).

These types of ecological interaction, which operate in all ecological systems, will form networks of interactions resulting in a self-organized complex adaptive system. The challenge is to discover the principles that govern intra- and inter-level organization and reorganization as adaptive mechanisms.

On the population and community levels, local interactions determine the organization of individuals and species assemblages, i.e. the distribution of individuals and species and their abundance in time and space. On the ecosystem and landscape levels, the global phenomena are the organization of energy, materials and information fluxes. On these levels order appears in the form of functional properties such as nutrient cycling or biotically-induced mosaics of patches such as vegetation patterns in arid and semi-arid lands. All forms of organization are linked and important for understanding the functioning of ecological systems.

In my presentation I will demonstrate the principles that govern intra- and inter-level organization and reorganization of ecological systems in water limited systems.

Water limited ecosystems have many properties of complex adaptive systems. In addition to exhibiting feedbacks, thresholds, and hysteresis, the functioning of this ecosystem type is strongly affected by self-organization across multiple levels. As a complex adaptive system, water limited systems' dynamics are related to their potential for reorganization driven by land use and climate changes. Self- reorganization implies resistance to variability, the potential for adaptation to temporal or spatial variance and changes between states.

In addition to a discussion of the theoretical background of self-organization on multiple levels my aim is to present long term experimental studies on the relationships between:

1. Patterns of animal spatial distribution in a heterogeneous environment and population level organization
2. Species abundance and frequency of spatial occurrence patterns and community organization, using annual plant communities as a model
3. Patterns of parallel hydrological, pedological and ecological processes networks and ecosystem and landscape level organization and reorganization.