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The concept of self-organizing systems. Why bother?

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Complexity theory and the concept of self-organizing systems provide a rather challenging conceptual framework for explaining earth systems change. Self-organization — understood as the aggregate processes internal to an environmental system that lead to a distinctive spatial or temporal organization — reduces the possibility of implicating a specific process as being causal, and it poses some restrictions on the idea that external drivers cause a system to change. The concept of self-organizing systems suggests that many phenomena result from an orchestration of different mechanisms, so that no causal role can be assigned to an individual factor or process. The idea that system change can be due to system-internal processes of self-organization thus proves a huge challenge to earth system research, especially in the context of global environmental change. In order to understand the concept's implications for the Earth Sciences, we need to know the characteristics of self-organizing systems and how to discern self-organizing systems. Within the talk, we aim firstly at characterizing self-organizing systems, and secondly at highlighting the advantages and difficulties of the concept within earth system sciences. The presentation concludes that:
- The concept of self-organizing systems proves especially fruitful for small-scale earth surface systems. Beach cusps and patterned ground are only two of several other prime examples of self-organizing earth surface systems. They display characteristics of self-organization like (i) system-wide order from local interactions, (ii) symmetry breaking, (iii) distributed control, (iv) robustness and resilience, (v) nonlinearity and feedbacks, (vi) organizational closure, (vii) adaptation, and (viii) variation and selection.
- It is comparatively easy to discern self-organization in small-scale systems, but to adapt the concept to larger scale systems relevant to global environmental change research is more difficult: Self-organizing systems seem to form nested hierarchies, and on different hierarchical levels self-organizing and externally driven subsystems might occur simultaneously.
- Traditional geomorphological concepts such as sensitivity to change, and intrinsic or extrinsic thresholds are compatible with the concept of self-organizing system, and these concepts are even enriched in their explanatory power when viewed in the larger framework of self-organization. The conceptual step to acknowledge self-organizing system change within earth system sciences thus can be regarded as relatively small.
The concept of self-organization suggests a change of focus for earth system change research: a shift from input–output relations toward the inner organization of systems, since external controls rather limit the degrees of freedom of a system instead of triggering changes. Many systems might in fact be rather autonomous, and the specific and observable external trigger might be less important than the intrinsic system state. Hence, neither gradual nor catastrophic system changes necessarily need an external driver. The concept of self-organization provides important caveats to generally attributing environmental change to external drivers, and it encourages a frank admission of ignorance in the face of complexity.