



## **Regional syndromes: towards a dynamical classification of social-ecological sustainability challenges**

James Dyke (a), John Dearing (a), Enlou Zhang (b), Wang Rong (b), and Ke Zhang (c)

(a) School of Geography and Environment, University of Southampton, Southampton SO17 1BJ, UK, (b) State Key Laboratory of Lake Science and Environment, Nanjing Institute of Geography & Limnology, Chinese Academy of Sciences, Nanjing 210008, China, (c) ARC CoE Coral Reef Studies, James Cook University, Townsville, QLD 4811, Australia

Schellnhuber et al (1997) first presented the concept of social-ecological syndromes as a means of mapping sustainability challenges facing modern regions to sets of sub-systems. They argued that the great diversity of global social-ecological systems could be represented as different combinations from a much smaller number of patterns of sub-systems. Here, we explore the possibility of extending this idea to an empirical and dynamical classification of system functioning, such as changes in the strength of connectivity, coupling between sub-systems and emergent phenomena. To demonstrate this approach we combine multi-decadal datasets for social, economic and biophysical changes from two contrasting regions in China. This allows us to reconstruct the evolution of system functioning in terms of regulating and provisioning ecosystem services. Climate records and political and policy time-lines provide insight about endogenous and exogenous drivers. Our findings show similar patterns in both regions of long-term trade-off between rising provisioning services and declining regulating services, but with important regional differences. In eastern China, the upward trajectory in provisioning services is strongly linked to the history of agricultural policy reforms but losses of regulating services are more an emergent phenomenon. In contrast, in southwest China, trajectories of provisioning and regulating services are both linked strongly to policy and development initiatives. In both regions, the last few years see the long term trade-off breaking down with provisioning services declining or remaining stationary while losses of regulating services continue to decline. Evidence exists in both regions that critical transitions have been crossed in some ecosystems. The strength of coupling between the socio-economic and biophysical sub-systems also remains strong and shows no sign of de-coupling in either region as required for sustainability. We discuss how our findings point the way towards the creation of a typology of syndromes that could, in principle, be applied worldwide. This approach would respect the inherent complexity and emergent properties of socio-ecological systems whilst avoiding the creation of complex models and representations that may prove to be as hard to understand as the real-world target system.