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Resilience of social-ecological systems

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'Resilience' is emerging as a key concept that researchers and organisations (including the United Nations and the World Bank) use to understand and deal with many of the problems facing contemporary environment and society. In this talk I provide an overview of research on the resilience of social-ecological systems and how physicists could contribute to its future development. I illustrate this theme with some recent results from my own work.

Local stability concepts of nonlinear dynamics are closely linked to the original, resistance to shock conception of resilience. Studies based on nonlinear dynamical approaches can still provide insights into the dynamics of social-ecological systems. This is particularly true with respect to regime shifts, a type of sudden change in a social-ecological system that is closely related to fold bifurcations. I summarise one recent work in which I used the recently developed nonlinear dynamical tool of generalised modelling to better understand regime shifts of a social-ecological system. Rather than analyse bifurcations for a specific model, generic modelling can identify bifurcations in a model class. The social-ecological system that we modelled consisted of a community of harvesters that could each choose whether to harvest a common pool resource at a community-efficient level or at a higher, self-interested level that led to overharvesting of the resource. The co-operators encourage the defectors to co-operate through a social ostracism mechanism. Among other results, we show that a nonlinear social-ecological coupling can lead to a regime shift even if there were none in the isolated social and ecological subsystems.

Resilience concepts are often used in a qualitative or heuristic manner to inspire particular research questions or management approaches. One recent line of research where resilience has become more quantitative is in the study of early warning signals for regime shifts. Here, generic early warning signals for regime shifts are calculated from time series observations. For example, an increasing variance can indicate a loss of stability and impending regime shift. Using the generalised modelling approach introduced above, I developed a generalised modelling-based early warning signal that can incorporate system-specific information into a generic early warning signal approach.

More recently, however, the understanding of resilience has expanded beyond local stability to include the ability of a system to adapt and transform in response to threats and challenges. So far modelling studies have generally not kept pace with these conceptual developments, but as I will outline network perspectives show potential to do so. Brainstorming on other modelling approaches that may meet modern challenges of resilience research will also be most welcome.

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