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Smart social adaptation prevents catastrophic ecological regime shifts in networks of myopic harvesters

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In the anthropocene, the rise of global social and economic networks with ever increasing connectivity and speed of interactions, e.g., the internet or global financial markets, is a key challenge for sustainable development. The spread of opinions, values or technologies on these networks, in conjunction with the coevolution of the network structures themselves, underlies nexuses of current concern such as anthropogenic climate change, biodiversity loss or global land use change. To isolate and quantitatively study the effects and implications of network dynamics for sustainable development, we propose an agent-based model of information flow on adaptive networks between myopic harvesters that exploit private renewable resources. In this conceptual model of a network of socio-ecological systems, information on management practices flows between agents via boundedly rational imitation depending on the state of the resource stocks involved in an interaction. Agents can also adapt the structure of their social network locally by preferentially connecting to culturally similar agents with identical management practices and, at the same time, disconnecting from culturally dissimilar agents. Investigating in detail the statistical mechanics of this model, we find that an increasing rate of information flow through faster imitation dynamics or growing density of network connectivity leads to a marked increase in the likelihood of environmental resource collapse. However, we show that an optimal rate of social network adaptation can mitigate this negative effect without loss of social cohesion through network fragmentation. Our results highlight that seemingly immaterial network dynamics of spreading opinions or values can be of large relevance for the sustainable management of socio-ecological systems and suggest smartly conservative network adaptation as a strategy for mitigating environmental collapse. Hence, facing the great acceleration, these network dynamics should be more routinely incorporated in standard models of economic development or integrated assessment models used for evaluating anthropogenic climate change.