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Towards the use of Structural Loop Analysis to Study System Behaviour of Socio-Ecological Systems.

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Maintaining socio-ecological systems in desirable states is key to developing a growing economy, alleviating poverty and achieving a sustainable future. While the driving forces of an environmental system are often well known, the dynamics impacting these drivers can be hidden within a tangled structure of causal chains and feedback loops. A lack of understanding of a system's dynamic structure and its influence on a system's behaviour can cause unforeseen side-effects during model scenario testing and policy implementation. Structural Loop analysis of socio-ecological system models identifies dominant feedback structures during times of behavioural shift, allowing the user to monitor key influential drivers during model simulation.

This work carries out Loop Eigenvalue Elasticity Analysis (LEEA) on three system dynamic models, exploring tipping points in lake systems undergoing eutrophication. The purpose is to explore the potential benefits and limitations of the technique in the field of socio-ecology. The LEEA technique shows promise for socio-ecological systems which undergo regime shifts or express oscillatory trends, but shows limited usefulness with large models. The results of this work highlight changes in feedback loop dominance, years prior to eutrophic tipping events in lake systems. LEEA could be used as an early warning signal to impending system changes, complementary to other known early warning signals. This approach could improve our understanding during critical times of a system's behaviour, changing how we approach model analysis and the way scenario testing and policy implementation are addressed in socio-ecological system models.