

Toward quantifying sustainability, robustness, and fragility in socio-hydrological systems

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In this work, we mathematically operationalize a conceptual framework that couples resource, human, and infrastructure together in the form of a simple meaningful model, and apply it to a socio-hydrological system. The bi-directional dynamic feedbacks between the social and biophysical components of the system are captured in a few differential equations. Water availability and the state of infrastructure control how much humans can use water and their adoption of various behaviors. Humans then make use of water, via infrastructure, and decide on how much efforts they would invest in maintaining the infrastructure, controlling the water availability and the state of infrastructure. The model's simplicity affords clear analytical expressions for the system's sustainability and robustness/fragility against various types of disturbances. The modeling framework is grounded in a solid conceptual foundation upon which additional modifications and realism can be built to potentially reconcile socio-hydrology with other related fields.