Operationalizing resilience: a rapid approach to social-ecological system assessment

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IGERT
INTEGRATIVE GRADUATE EDUCATION AND RESEARCH TRAINEESHIP

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Introduction

- Resilience is an essential property of social-ecological systems (SES) experiencing intense disturbance. Without resilience, these systems lose their defining attributes and enter an alternate, often undesirable, state.
- While there are existing frameworks for assessing the resilience of SES, most practitioners lack sufficient time and information to undertake extensive resilience assessments.
- We present a more simplified, replicable approach to resilience assessment that reviews the scientific, historical, and social literature to rate the resilience of a SES using nine resilience properties[1]:
  - Ecological variability
  - Diversity
  - Modularity
  - Acknowledgement of slow variables
  - Tight feedbacks
  - Social capital
  - Innovation
  - Overlap in governance
  - Ecosystem services
- We evaluated the effects of two large-scale projects, the construction of a major dam and the implementation of an ecosystem recovery program, on the resilience of the central Platte River SES, in Nebraska, USA.
- We used this case study to identify the strengths and weaknesses of applying a simplified approach to resilience assessment

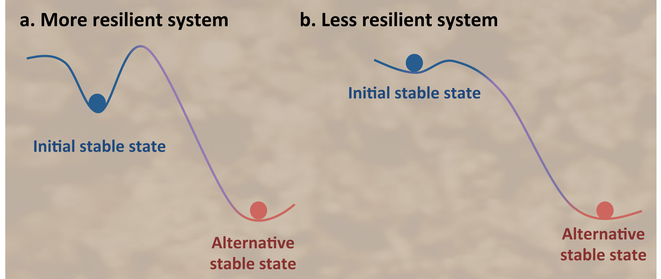

Figure 1. Conceptual interpretation of social-ecological resilience. The system on the left (a) has higher resilience, because a larger disturbance is required to displace the system from its initial stable state into an alternative stable state; it can absorb more disturbance without losing its defining ecological structure and function.

Constructed riverine wetland, March 2013. Photo credit Bethany Teeters (IGERT Trainee)

Early spring after burn Photo credit Bethany Teeters (IGERT Trainee)

Cranes landingat The Crane Trust, March 2013. Photo credit Bethany Teeters (IGERT Trainee)

Methods

We assessed the impact of two major events on the Platte River between Lake McConaughy to Chapman, NE (the closing of Kingsley Dam and the start of the Platte River Recovery Implementation Program (PRRIP)[2]) using nine key metrics of resilience adapted from Walker and Salt (2006)[3].

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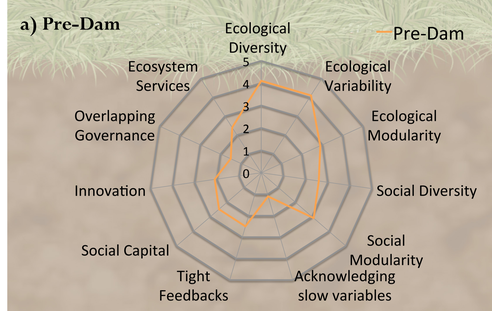
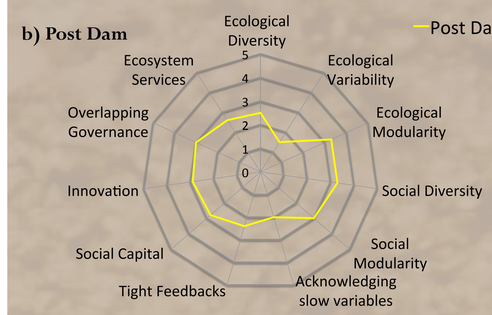
Assessing resilience: Scoring system used for assessing the resilience properties[1] of the central Platte River SES. The system may exhibit resilience in respect to a property (score 5), not be resilient in respect to a property (score 1), be in a neutral condition (3), or exhibit an intermediate level of resilience (scores 2 or 4)[3].

Resilience Property	Description	Score Categories
1. Diversity	"A resilient world would promote and sustain diversity in all forms."	**Ecological:** 5 = Large spatial/temporal heterogeneity in floodplain habitats (prairie, wet meadow, wetland, riparian forest, sandbars) 1 = Many floodplain habitats are replaced by crops and very few unvegetated sandbars exist **Social:** 5 = Planning and decision-making processes incorporate diversity of stakeholder interests and perspectives and the social system maintains a diversity of livelihoods 1 = Decisions are made from top-down with little or no effort to incorporate stakeholder interests
2. Variability	"A resilient world would embrace and work with ecological variability."	**Ecological:** 5 = Little or no regulation of river system, large variability in surface water hydrograph; periodic floods 1 = River system regulated such that there is very little variability in the surface water hydrograph **Social: n/a**
3. Modularity	"A resilient world would consist of modular components."	**Ecological:** 5 = River is very loosely hydrologically connected to the groundwater table and floodplain habitats through periodic high river flows and floods 1 = River is more hydrologically connected to the groundwater table and floodplain because of rare flood events and greatly reduced river flows **Social:** Extent to which deleterious effects of perturbation to the system can be compartmentalized 5 = Adequate avenues of communication/connectedness among stakeholders across vertical/horizontal scales 1 = Avenues of communication/connectedness non-existent across scales; decisions made independently
4. Acknowledging slow variables	"A resilient world would have a policy to focus on 'slow,' controlling variables associated with thresholds."	**Ecological: n/a** **Social:** 5 = Slow variables actively acknowledged and incorporated into long-term governance of the SES 1 = Slow variables not acknowledged or incorporated into the long-term governance
5. Tight feedbacks	"A resilient world would possess tight feedbacks (but not too tight)."	**Ecological: n/a** **Social** 5 = Experimentation, monitoring, and learning exist; increasing capacity to detect thresholds and to respond to change in a timely manner 1 = Experimentation, monitoring, and learning are not incorporated into the decision-making process
6. Social capital	"A resilient world would promote trust, well-developed social networks, and leadership (adaptability)."	**Ecological: n/a** **Social:** 5 = Social system supported by a high level of trust, well-developed social networks, and leadership, providing increased capacity to effectively and collectively respond to change 1 = Social system lacks trust, social networks, and leadership, prohibiting effective and collective respond to change
7. Innovation	"A resilient world would place an emphasis on learning, experimentation, locally developed rules, and embracing change."	**Ecological: n/a** **Social:** 5 = Learning and experimentation actively incorporated into decision-making process 1 = Learning, experimentation, and change discouraged; incentives in place that maintain status quo
8. Overlap in governance	"A resilient world would have institutions that include 'redundancy' in their governance structures and a mix of common and private property with overlapping access rights."	**Ecological**: n/a **Social:** 5 = Institutions flexible and include redundancy in governance structures; mix of common and private property with overlapping access rights 1 = Institutions are rigid and governed from the top-down with no redundancy in roles. Property and access rights are not mixed or clearly defined
9. Ecosystem services	"A resilient world would include all the unpriced ecosystem services in developmental proposals and assessments."	**Ecological**: n/a **Social:** 5 = Ecosystem services are recognized and given value in development proposals and assessments 1 = Ecosystem services are not recognized or given value in the development process

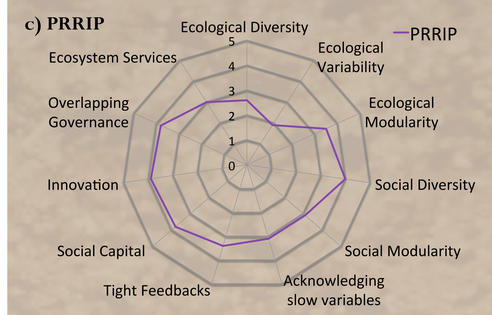
Results



The Platte River in summer 2011. Photo credit Trevor Hefley (IGERT Trainee)



River diversion for hydropower and irrigation in the Central Platte River. Photo credit Maggi Sliwinski (IGERT Trainee)



Irrigation ditch siphoning water from the Platte River. Photo credit Joana Chan (IGERT Trainee)

Figure 3. Resilience of the central Platte River SES during the
a) pre-Kingsley dam period, b) post-Kingsley Dam period, and
b) c) Platte River Recovery Implementation Program period.

Conclusions and Reflections

- Social resilience has increased since the pre-dam period for the central Platte River SES and ecological resilience was reduced in the post-dam as compared to the pre-dam or PRIPP periods
- Some variables were easier to assess than others either because there was sufficient data, particularly for ecological data; other properties were more difficult to assess because of a lack of information or because the variable was not clearly defined
- The social and ecological systems are likely to be very interrelated, but the fact that they do not necessarily change together lends credence to the argument that both kinds of resilience must be explicitly considered in order to understand the whole system resilience
- Resilience is an emergent property, so although our method is robust and relatively cheap and simple to replicate, quantifying resilience may be reductionist in its scope. Recognizing this limitation is critical to improving any approach to operationalize resilience

[1]Walker, B., and D. Salt. 2006. *Resilience thinking: sustaining ecosystems and people in a changing world.* Island Press, Washington, D.C., USA; [2]PRRIP (Platte River Recovery Implementation Program). 2009. *The land plan and land acquisition fact sheet.* [online] URL: http://www.platteriverprogram.org/News/Documents/Land%20Fact%20Sheet.pdf; [3]Kristine Nemec, Joana Chan, Joseph Hamm, Christina Hoffman, Trisha Spanbauer, Leo Acosta, Craig R. Allen, Trevor Hefley, Don Pan, and Prabhakar Shrestha. 2013. Resilience in Stressed Watersheds: Operationalizing Theory for the Platte River, USA. *(in review)*