SOCIAL ECOLOGICAL SYSTEMS RESILIENCE ANALYSIS
USING SYSTEM DYNAMICS MODEL – CASE STUDY

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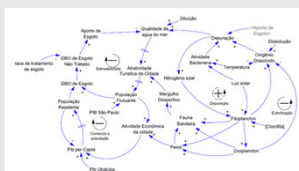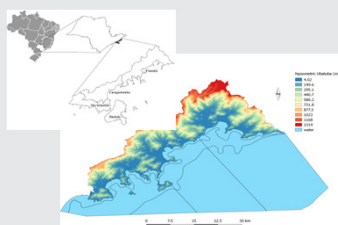
ABSTRACT

Governance of social ecological systems (SES) is a difficult task. Embrace its complexity, the coupled nature of social and ecological dimensions, feedbacks and non-linearity of its attributes and the necessity of dealing with society participation in the decision process make the challenge bigger. Resilience is a growing research field that can collaborate with this discussion. Resilience is a SES feature that enhance its capacity of maintain identity under different systems changes. This work uses system dynamics theory as foundation to build a Dynamic Resilience Index. This index uses Cobb-Douglas equation to encompass several resilience attributes as biodiversity, social networks, institutions, polycentric governance and others, and combine them with ecosystem services in a integrative and system based approach. The article concludes that system dynamics is a powerful tool to embrace resilience analysis and can collaborate with the social perspectives of social ecological systems analysis

Resilience?

"resilience, that is a measure of the persistence of systems and of their ability to absorb change and disturbance and still **maintain the same relationships between populations or state variables**" (HOLLING,1973)

"capacity of a social ecological system to continue providing **some desired set of ecosystem services in the face of unexpected shocks** as well as more gradual ongoing change" (BIGGS et al. 2015)
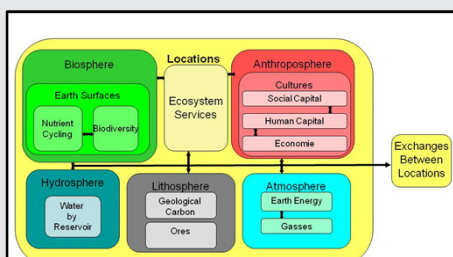
METHODS

MIMES
The Multi-Scale Integrated Model of Ecosystem Services

Ubatuba

Ecosystem Services Resilience

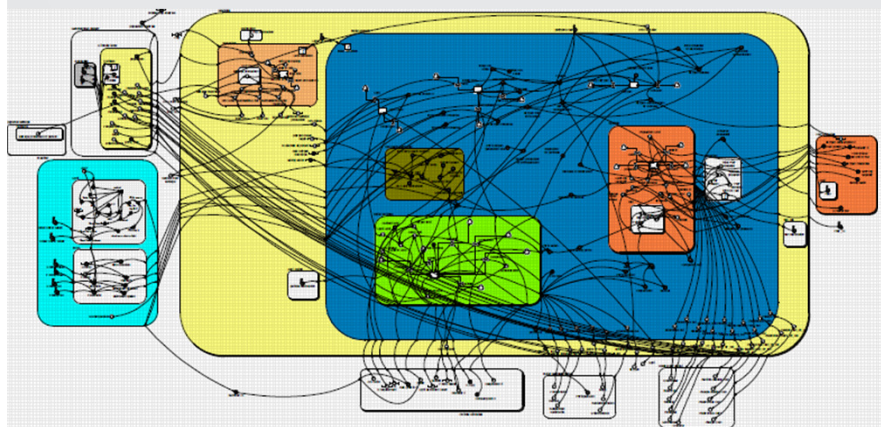**Diversity** - existence of multiple forms and behaviors;
Efficiency - performance with modest resource consumption;
Adaptability - flexibility to change in response to new pressures;
Cohesion - existence of unifying forces or linkages.
Maintain diversity and redundancy – systems with high levels of biodiversity and redundancies tend to be more resilient in providing ecosystem services;
Manage connectivity – ecosystem recover from disturbances using internal links of species and social actors.
Manage slow variables – identify slow variables and their feedbacks is a challenging effort, but understanding these general system features enhance resilient behavior;
Foster Complex Adaptive Systems (CAS) thinking – comprehension of the need of integrated approaches, non-linearity and uncertainty regarding ecosystem services production in social ecological system enhance the ability to deal with changes, and then increases resilience;
Encourage learning – studying how systems works reduces the uncertainties and enlighten non-linearity behavior, experimentation and monitoring thus can enhance knowledge and foster resilience;
Broaden participation – participation enhance relationships, can build trust, can possibly facilitate learning and make collective action possible.
Promote polycentric governance systems – provides a structure in governance that allows the other principles to develop and also enhances participation and social networks.

RESULTS
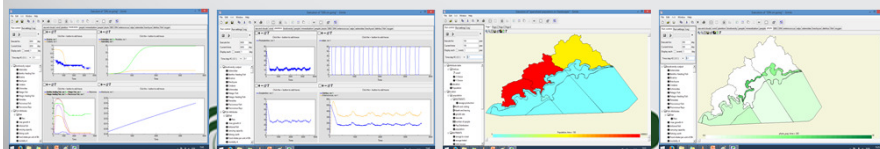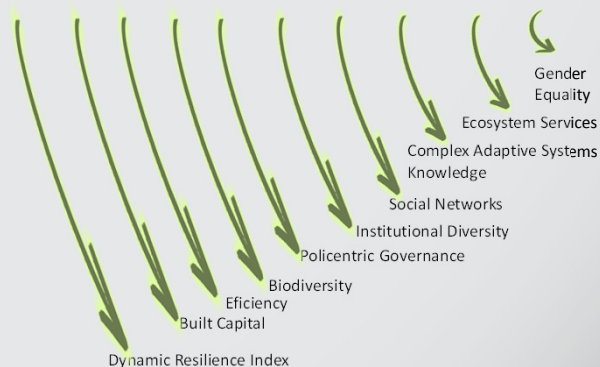

DYNAMIC RESILIENCE INDEX

$$DRI = (BK^{\gamma 1} . E) . B^{\gamma 2} . PG^{\gamma 3} . I^{\gamma 4} . SN^{\gamma 5} . CasK^{\gamma 6} . ES^{\gamma 6} . GE^{\gamma 7}$$

Gender Equality
Ecosystem Services
Complex Adaptive Systems
Knowledge
Social Networks
Institutional Diversity
Policentric Governance
Biodiversity
Eficiency
Built Capital
Dynamic Resilience Index

Do you want to see dynamics?