Complex Coastal and Marine Socio-Ecological Systems

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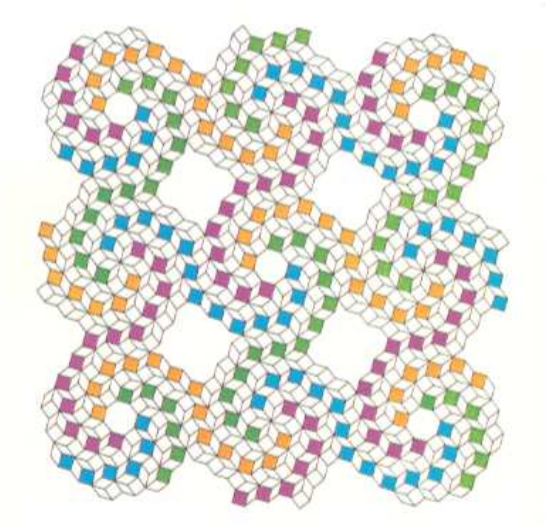
Learning objective and outline

1. Understand key concepts of complex coastal and marine social-ecological systems
   - Complex adaptive systems
   - Social-ecological systems
   - Ecosystem services
   - Scale
   - Resilience

- Social-ecological systems frameworks
- Defining your SES
- Examples of SES

Social-Ecological systems *are* Complex System

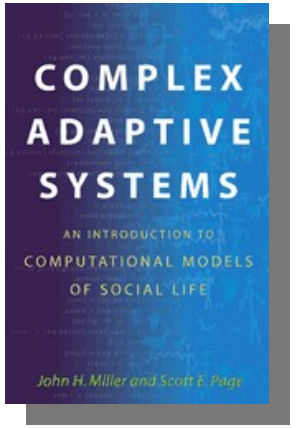
- Complex systems exhibit characteristics that stem from the interactions and patterns within the system
  - Non deterministic, unpredictable
  - Process dependent
  - Multiple-scale feedbacks
  - Self-organizaton

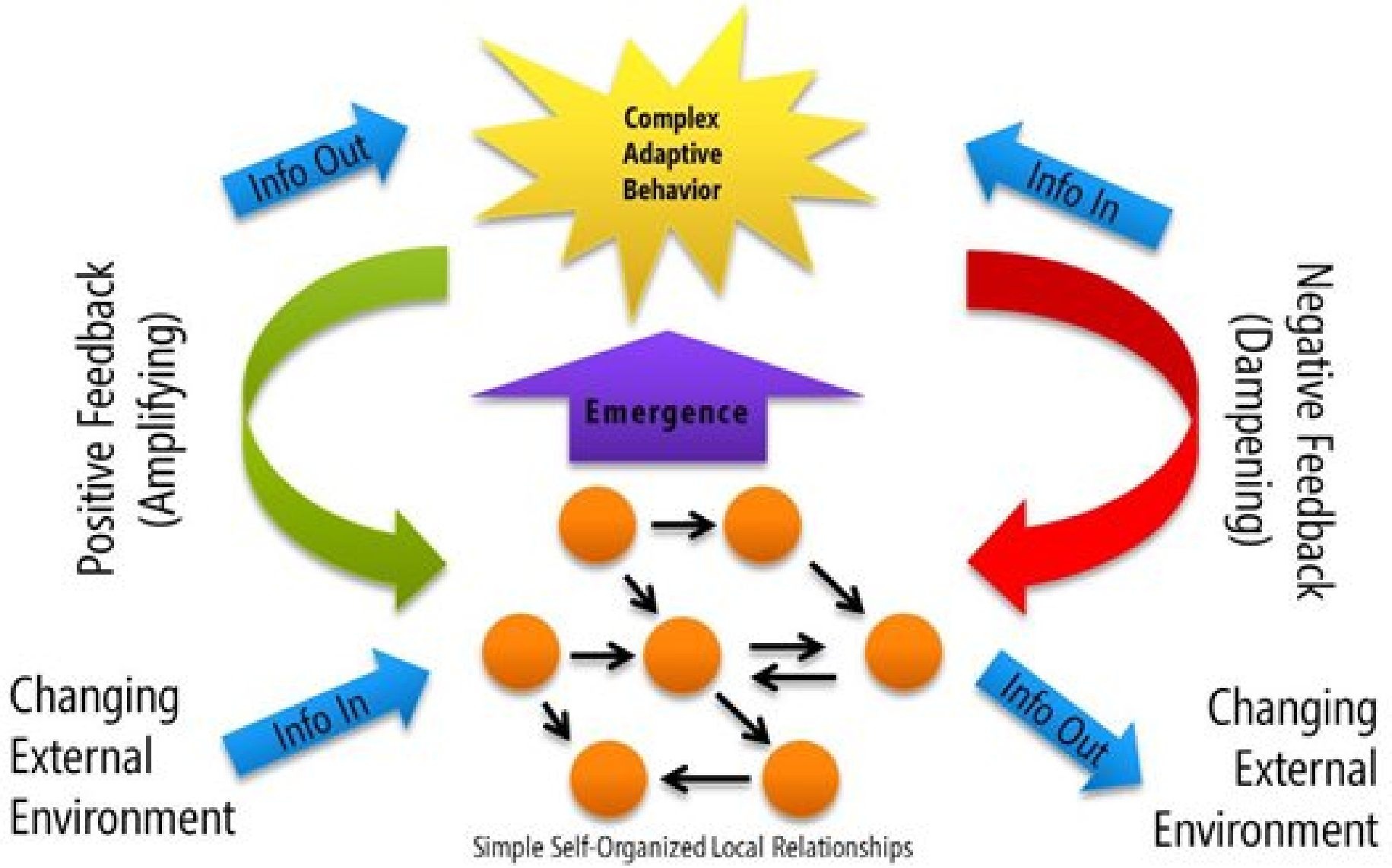


Complex adaptive system (CAS)

- When they have the capacity to self-organize, learn and adapt they are complex adaptive systems (CAS)

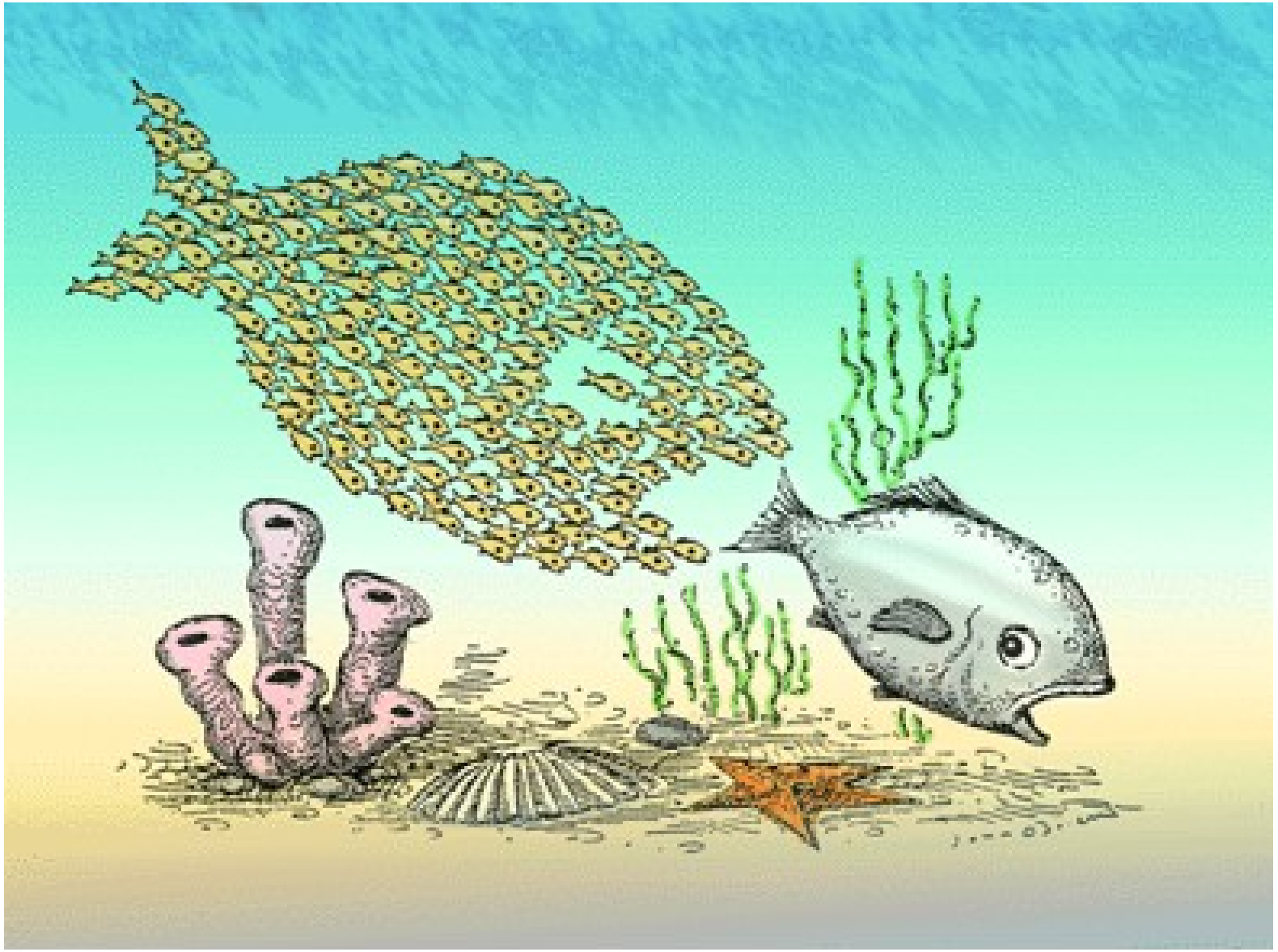
- Properties: agregation, non-linearity, diversity, uncertainty, self-organization, resilience




Complex
Adaptive
Behavior
Info Out
Info In
Positive Feedback
(Amplifying)
Negative Feedback
(Dampening)
Emergence
Changing
External
Environment
Info In
Info Out
Changing
External
Environment
Simple Self-Organized Local Relationships

Complex adaptive behaviour

- Informal pedestrian path formation
- Slow traffic jams
- Stadium waves
- Standing ovations
- Stock markets
- Human societies
- Immune systems
- Human and other animal brains
- Ants and termites
- Birds flocking
- Fish schooling
- Ecosystems



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Why Social-Ecological Systems approach for Oceans research governance?

Social ecological system (SES)

- Human society shapes nature
- Nature shapes human society
- Humans and nature coevolving
- Social and ecological systems are inevitably linked and integrated … the delineation between the two systems is artificial and arbitrary (Berkes and Folke 1998)

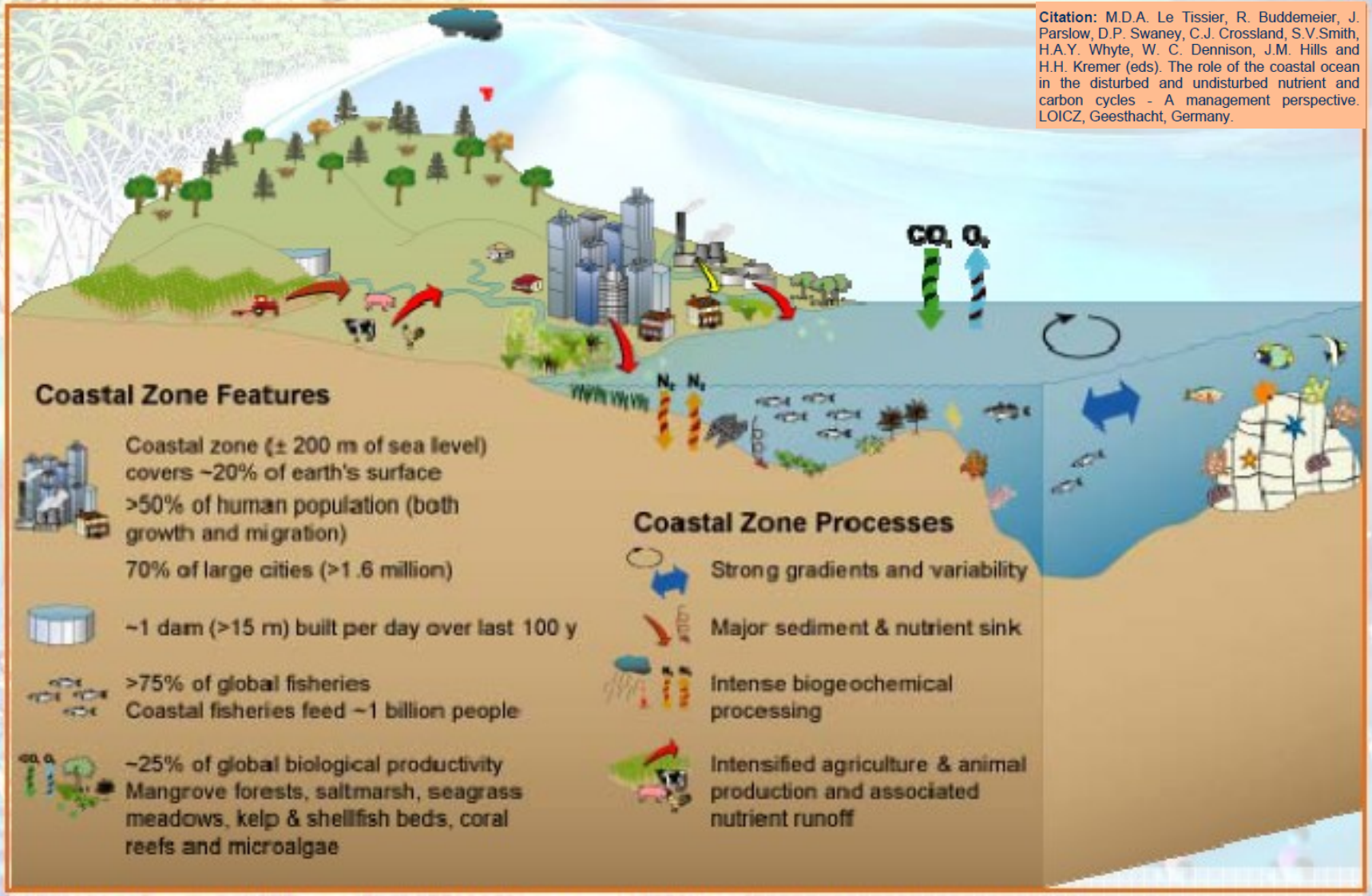
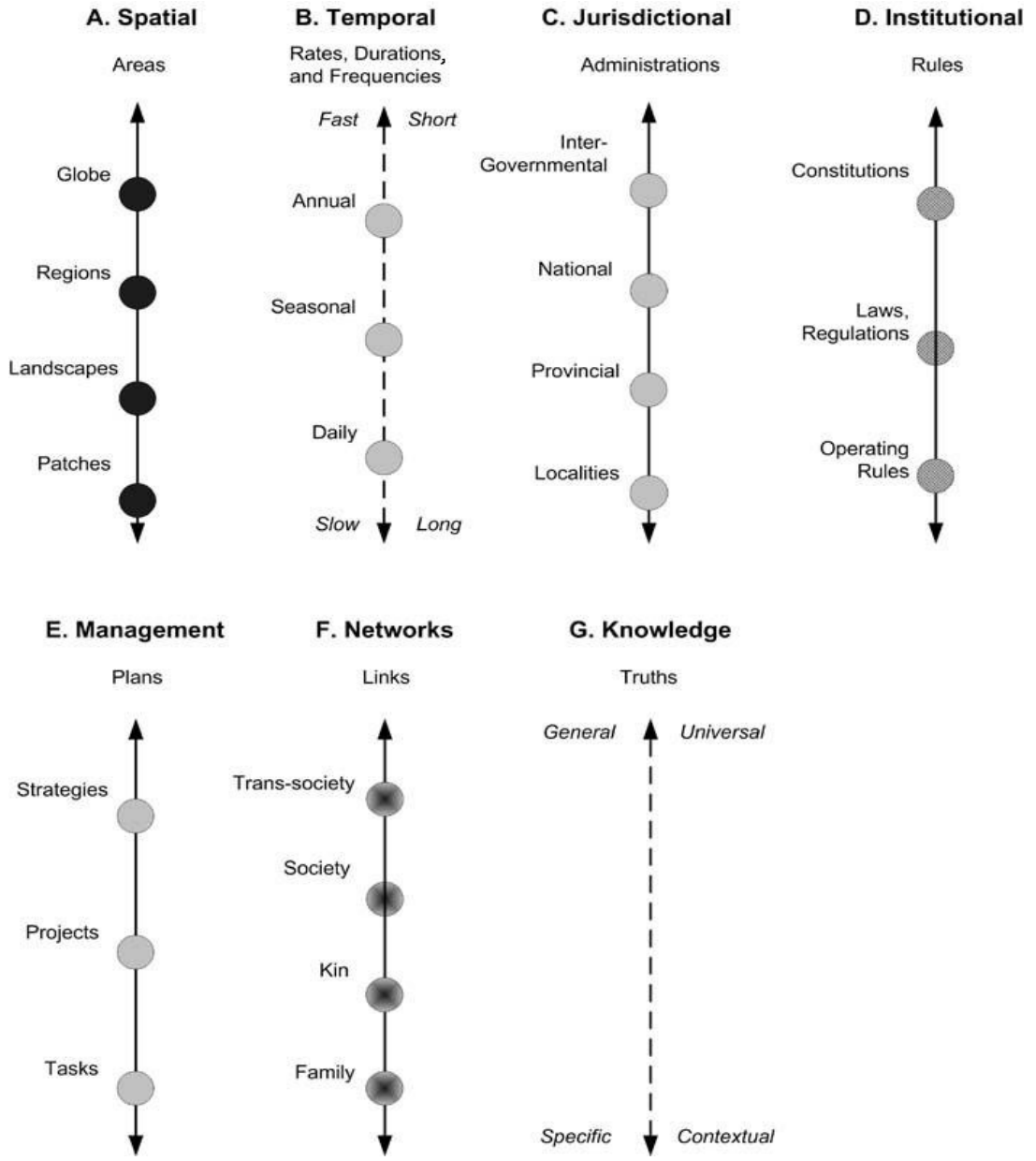


***Figure 3**. Conceptual diagram showing the key features and processes of the coastal zone.*

Coastal Ecosystem Services

Scales and Levels
(Cash et al. 2006)

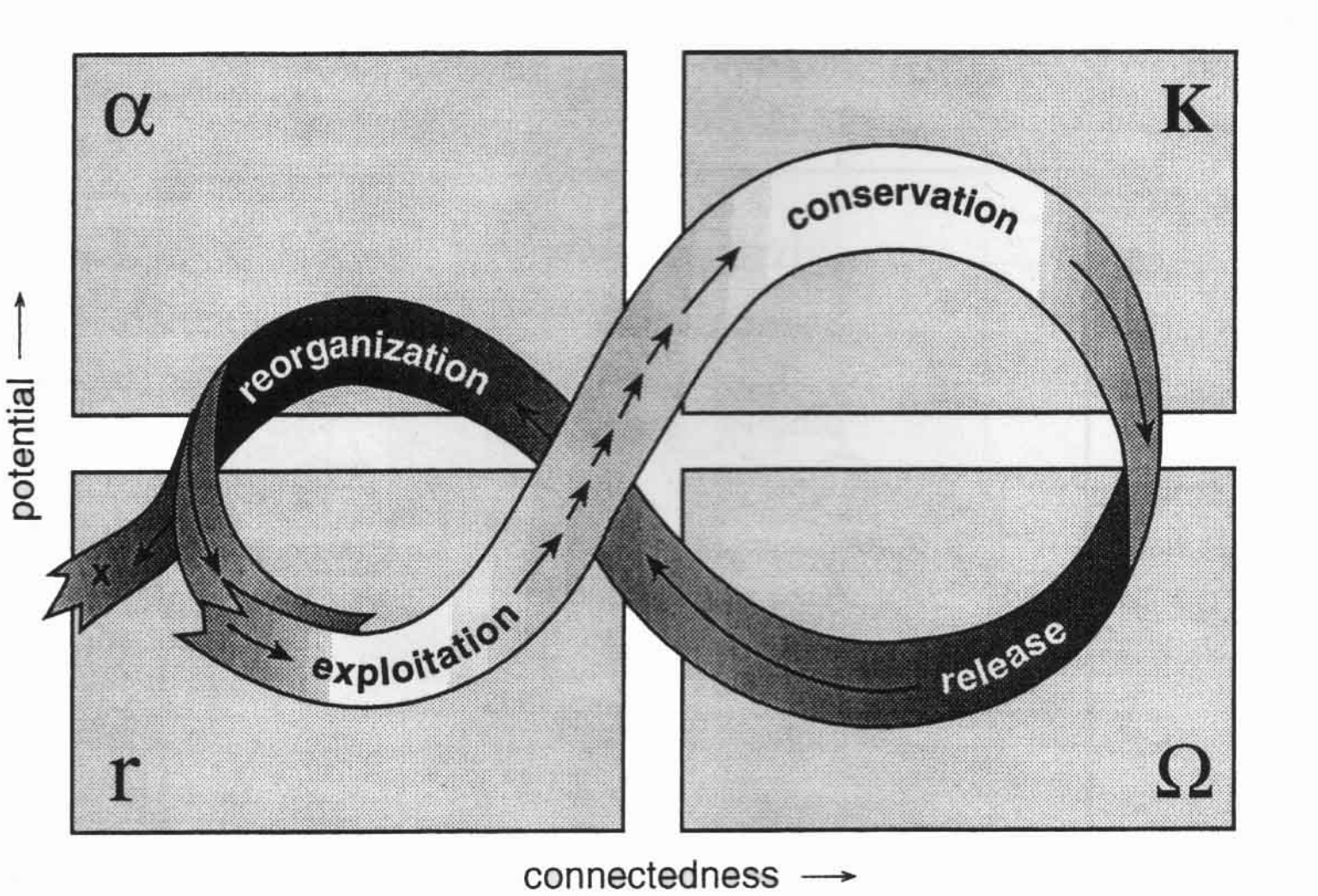


Ecosystem dynamics

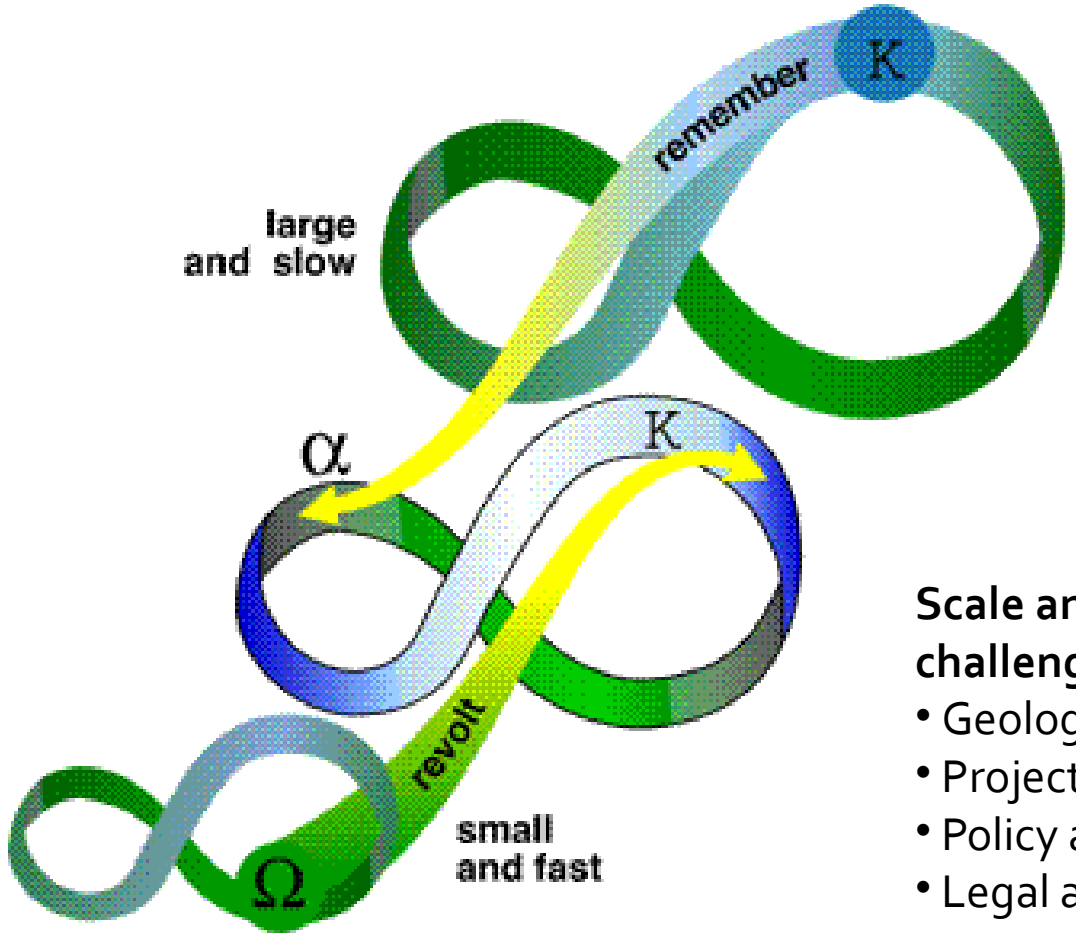
Holling et al. (1995) observed that:

- Ecological change are not gradual and continuous, they are epsotic
- Spatial attributes are not uniform or unvariable at different scales
- Ecosystem has no singular equilibrium state, but may have alternating stable states and multiple equilibria
- Ecosystem are hierarchically structured (panarchy)

Holling's Adaptive Renewal Cycle (1986)



Scale: processes and variables on different size and temporal cycles



Scale and cycle mis-matches can challenge governance

- Geological, climate etc. cycles
- Project versus political cycles
- Policy and management cycles
- Legal and institutional cycles

Gunderson, Lance and C. S. Holding.

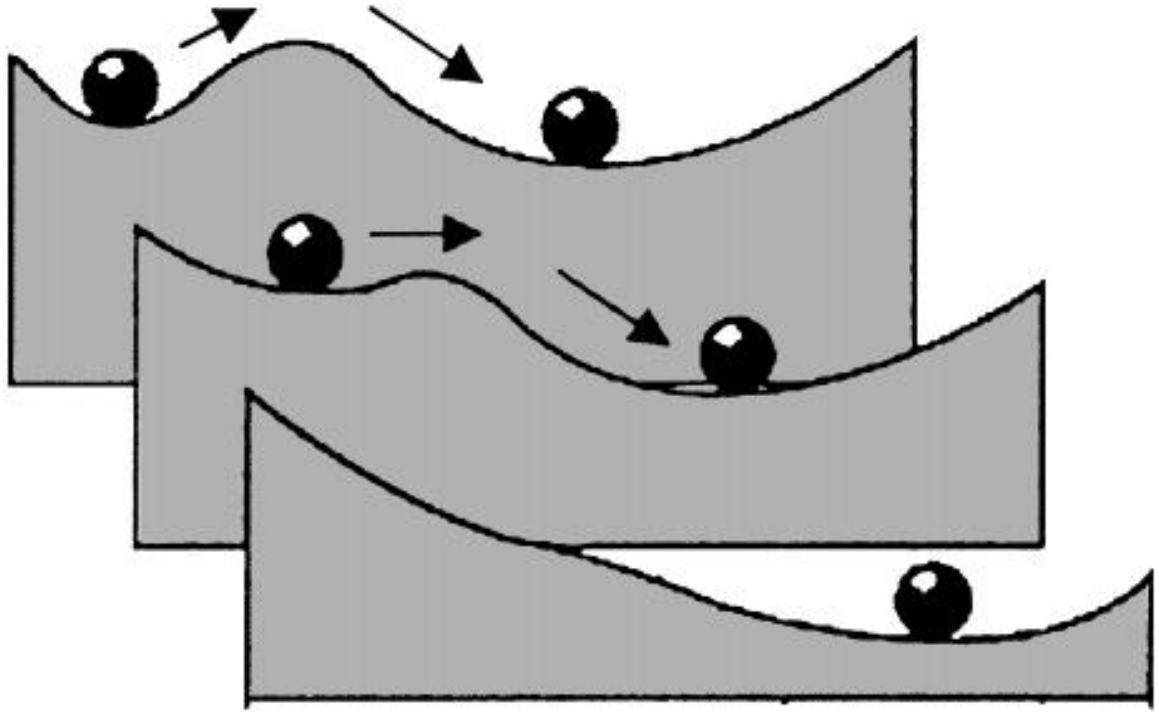
Resilience

(Holling 2001)

- the extent to which ecosystems can absorb recurrent natural and human perturbations and continue to regenerate without slowly degrading or unexpectedly flipping into alternate states

- the capacity of a system to absorb disturbance, undergo change and still retain essentially the same function, structure, identity, and feedbacks

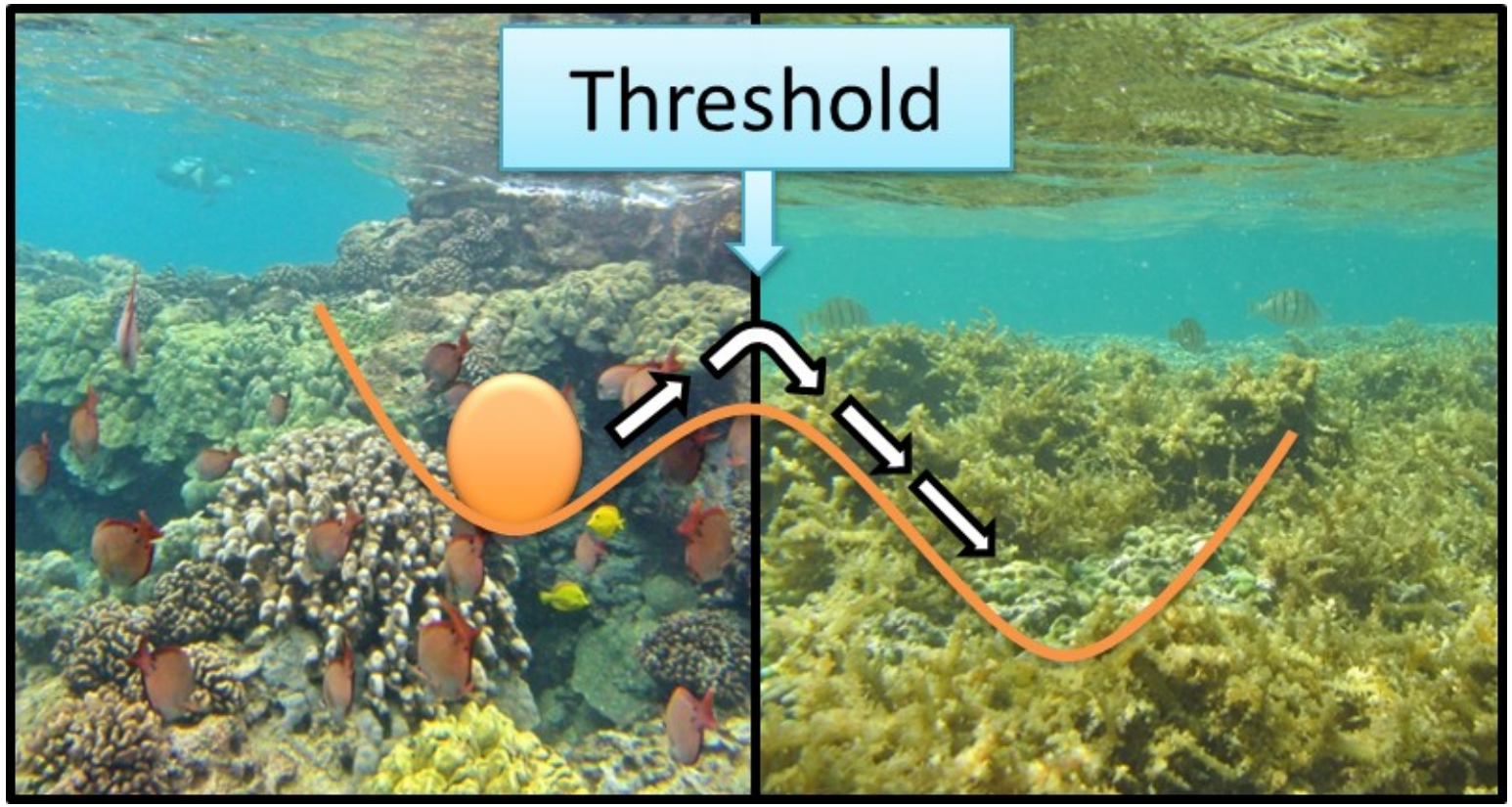
Resilience
(Gunderson 2000)



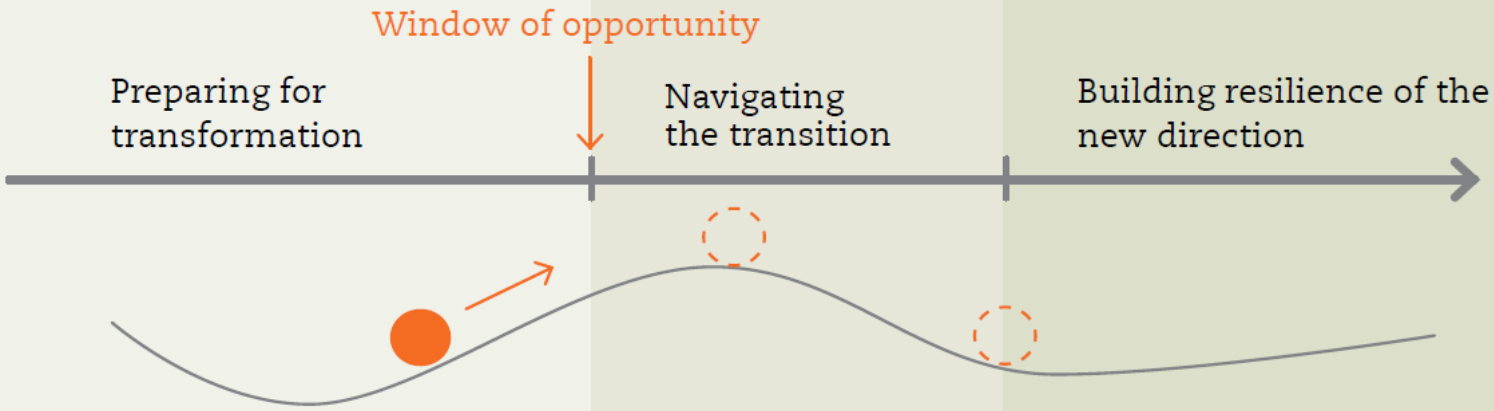
Valleys represent stability domains, balls represent the system, and arrows represent disturbances. Engineering resilience is determined by the slopes. Ecological resilience is described as the width. Adaptive capacity refers to the ability of the system to remain in a stability domain, as its shape changes

(*http://mysite.verizon.net/vzesz4a6/current/id610.html)*

Losing resilience - Shifting domains



Transform-ability



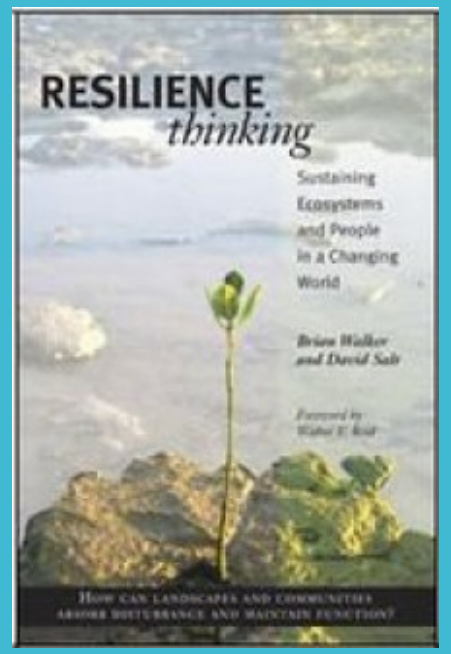
In the preparation phase, institutional entrepreneurs and their networks may work simultaneously at different scales of the social-ecological system. By intervening at broader institutional levels, they can open up new trajectories of development.

In the navigation phase, cross-scale brokers can provide bridging functions that connect different actors operating at different scales and launch new initiatives and scale up innovations.

In the building resilience phase bridging organizations can create incentives and foster values for stewardship in the new context.

Source; Olsson et al. 2004, Folke et al. 2009

Resilience



"Resilience" as applied to ecosystems, or to integrated systems of people and the natural environment, has three defining characteristics:

1. The amount of change the system can undergo and still retain the same controls on function and structure
2. The degree to which the system is capable of self-organization
3. The ability to build and increase the capacity for learning and adaptation

- http://www.resalliance.org

Examples of Frameworks Linking Social and Ecological System

Analysis oriented

Action oriented

The Resource system approach for fisheries mng't (Charles 2001)

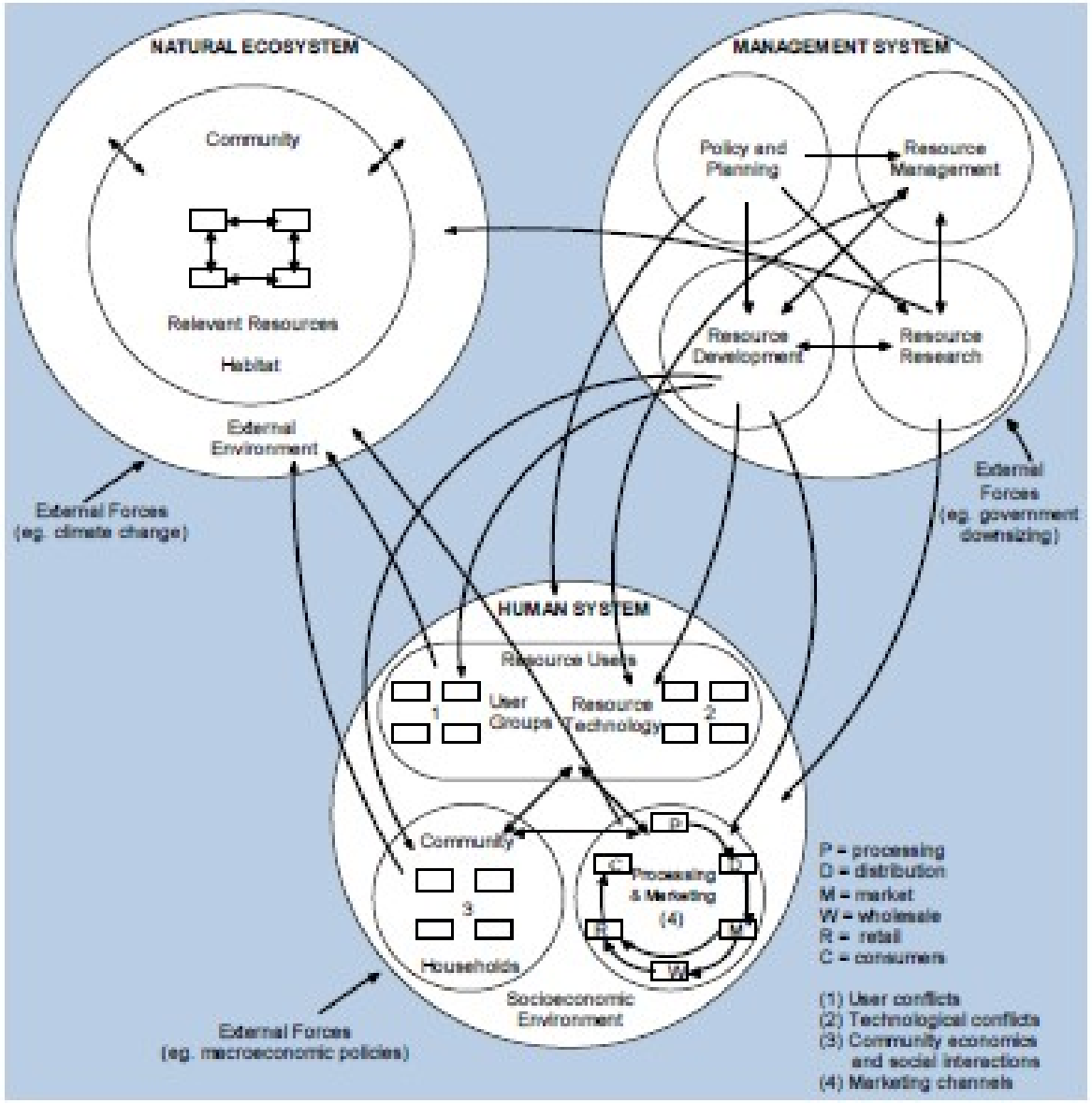
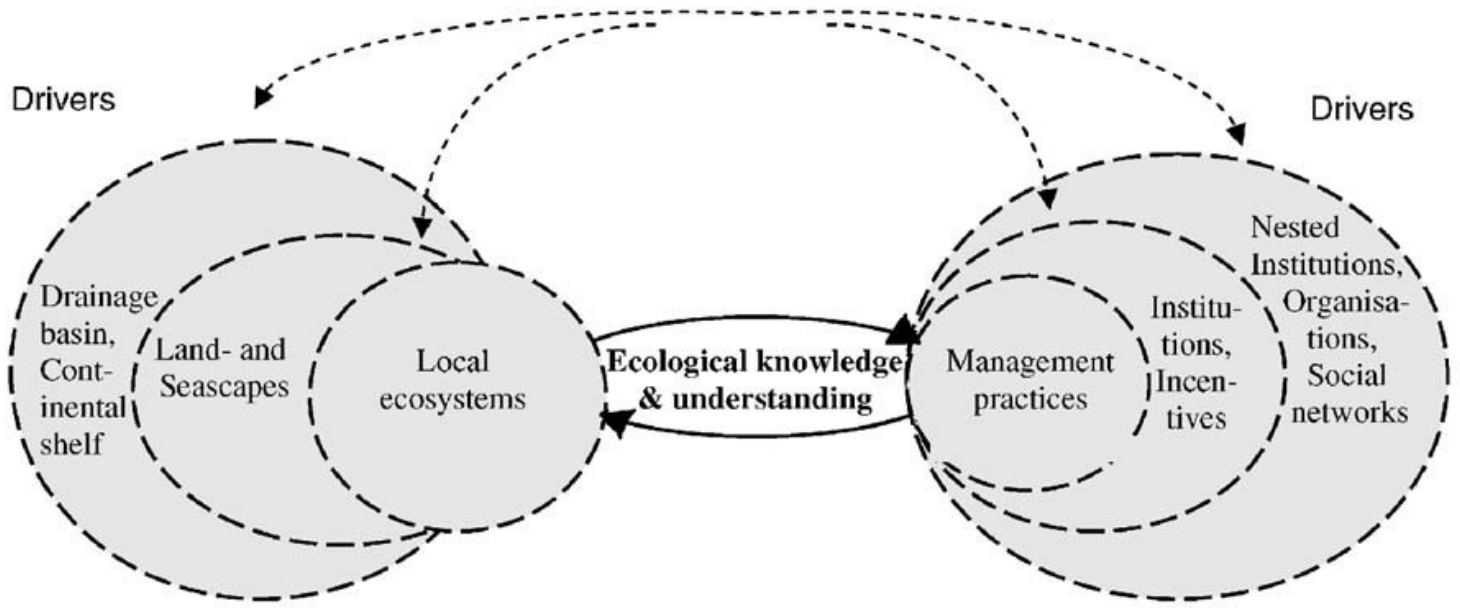


Figure 2. The resource systems approach (Charles 2001).

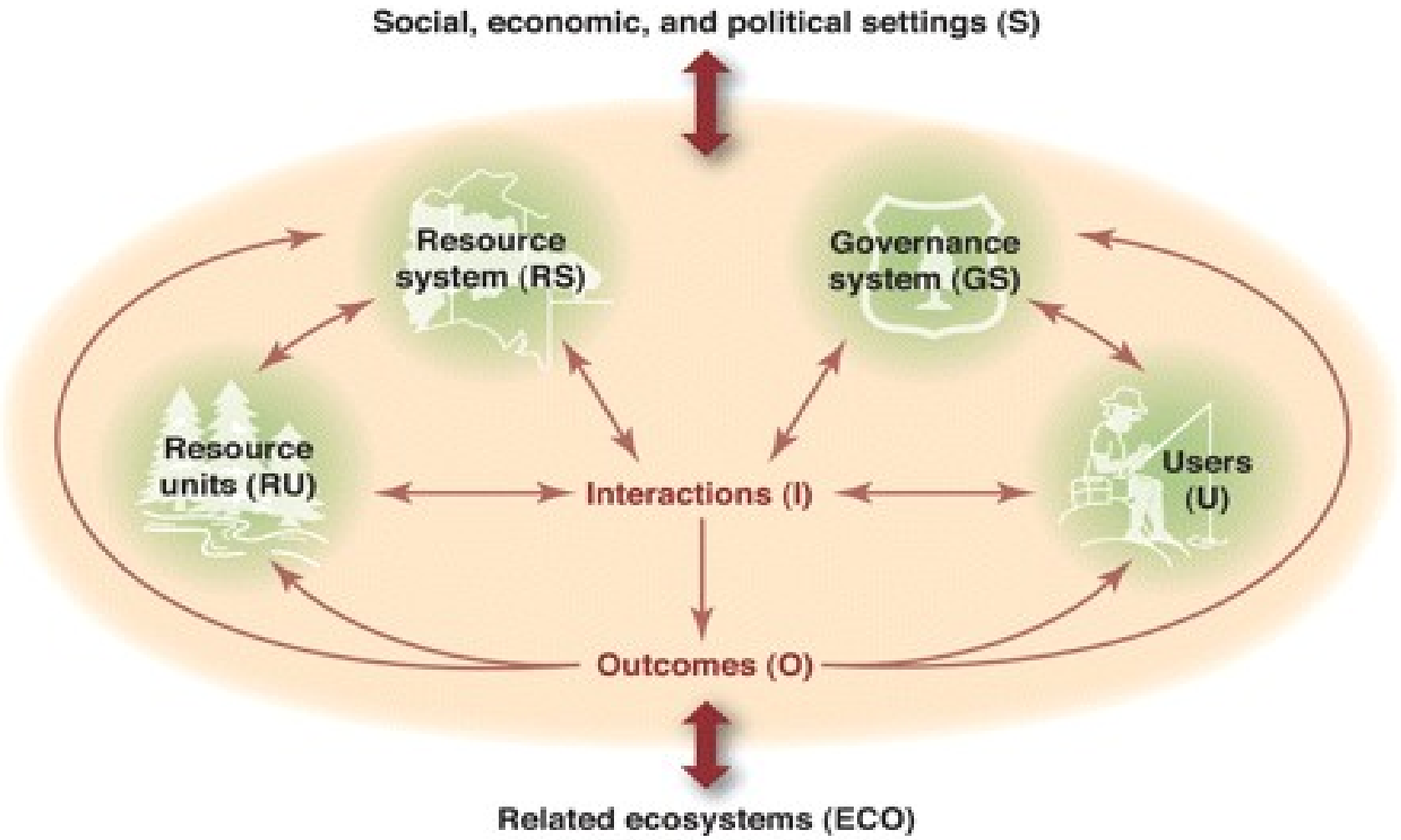
Social-Ecological Systems in traditional management systems (Berkes et al. 2003)



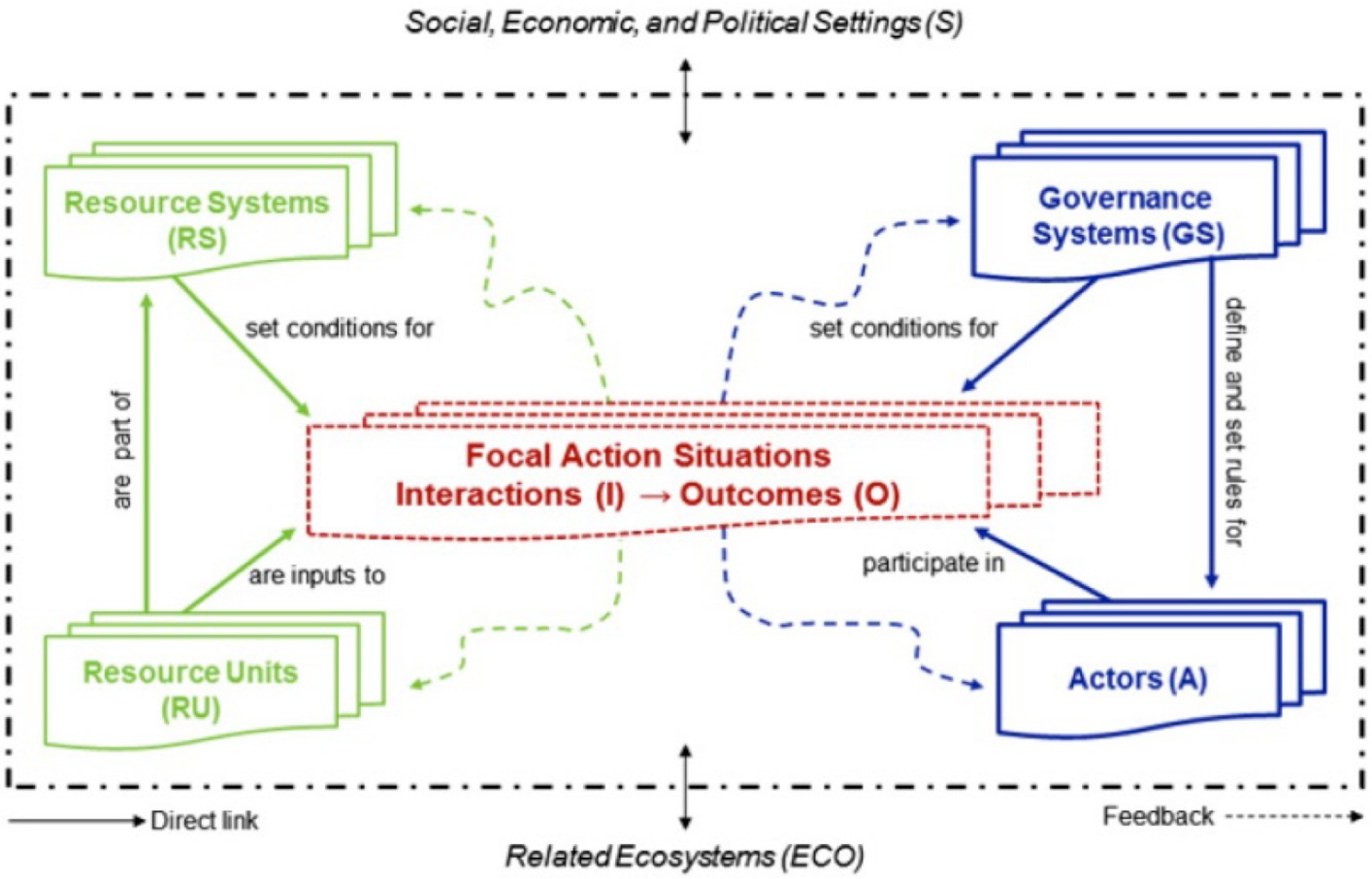
(A)

Analyzing Sustainability of Social-Ecological Systems – (Commons)

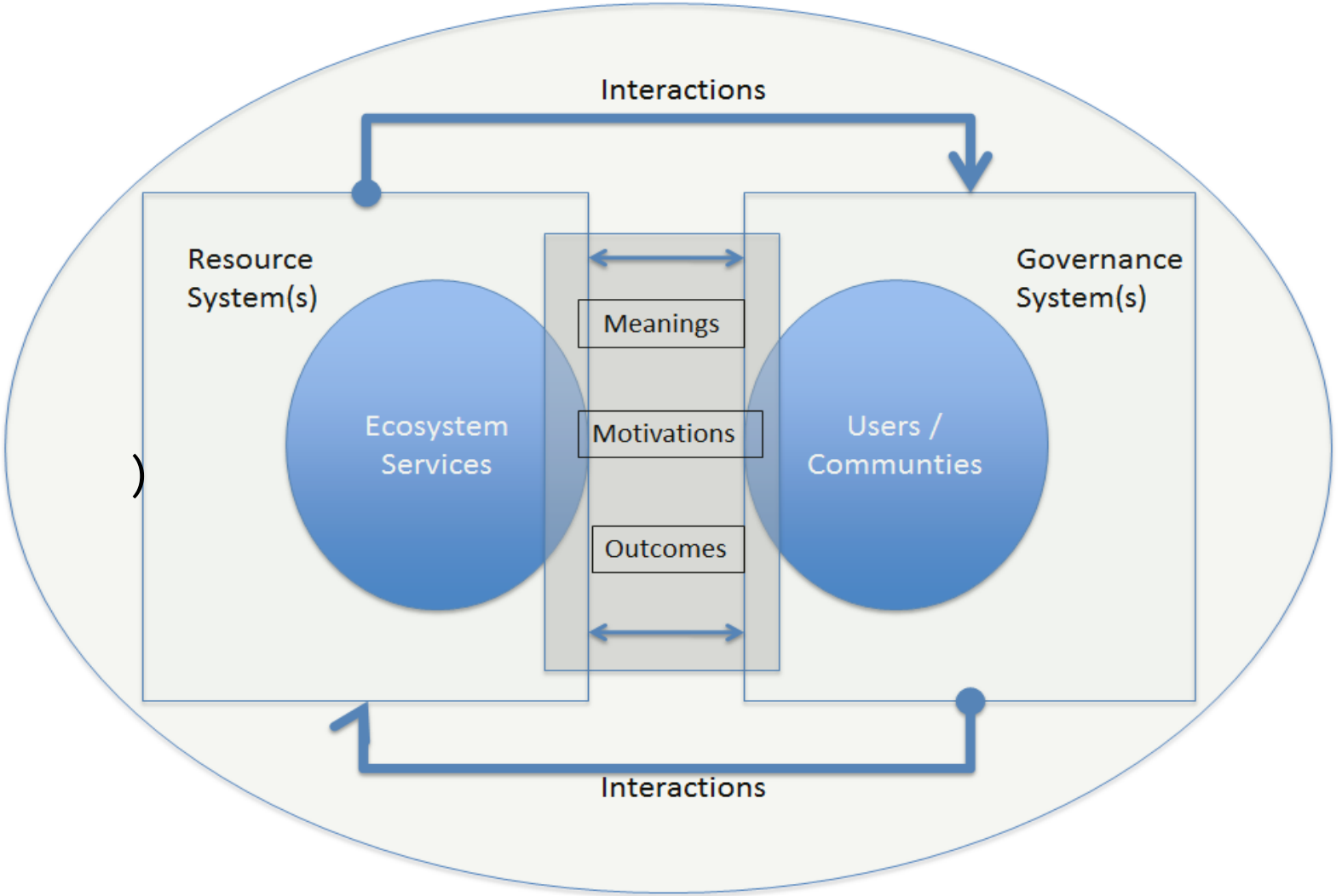
Ostrom's Framework (2009)



Another version of Ostrom's framework

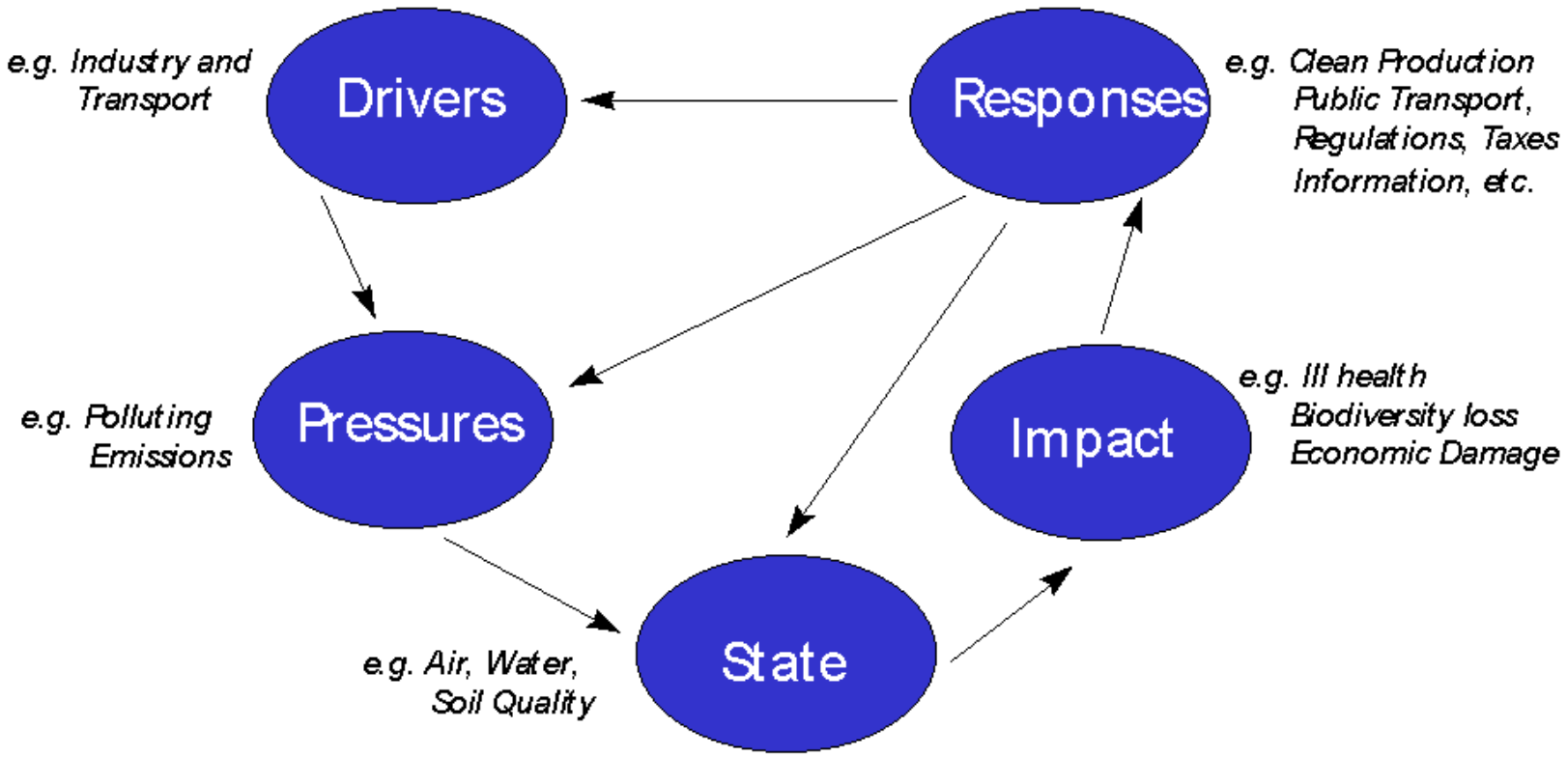


Social-Ecological Systems for Community Conservation
(Berkes et al 2015)

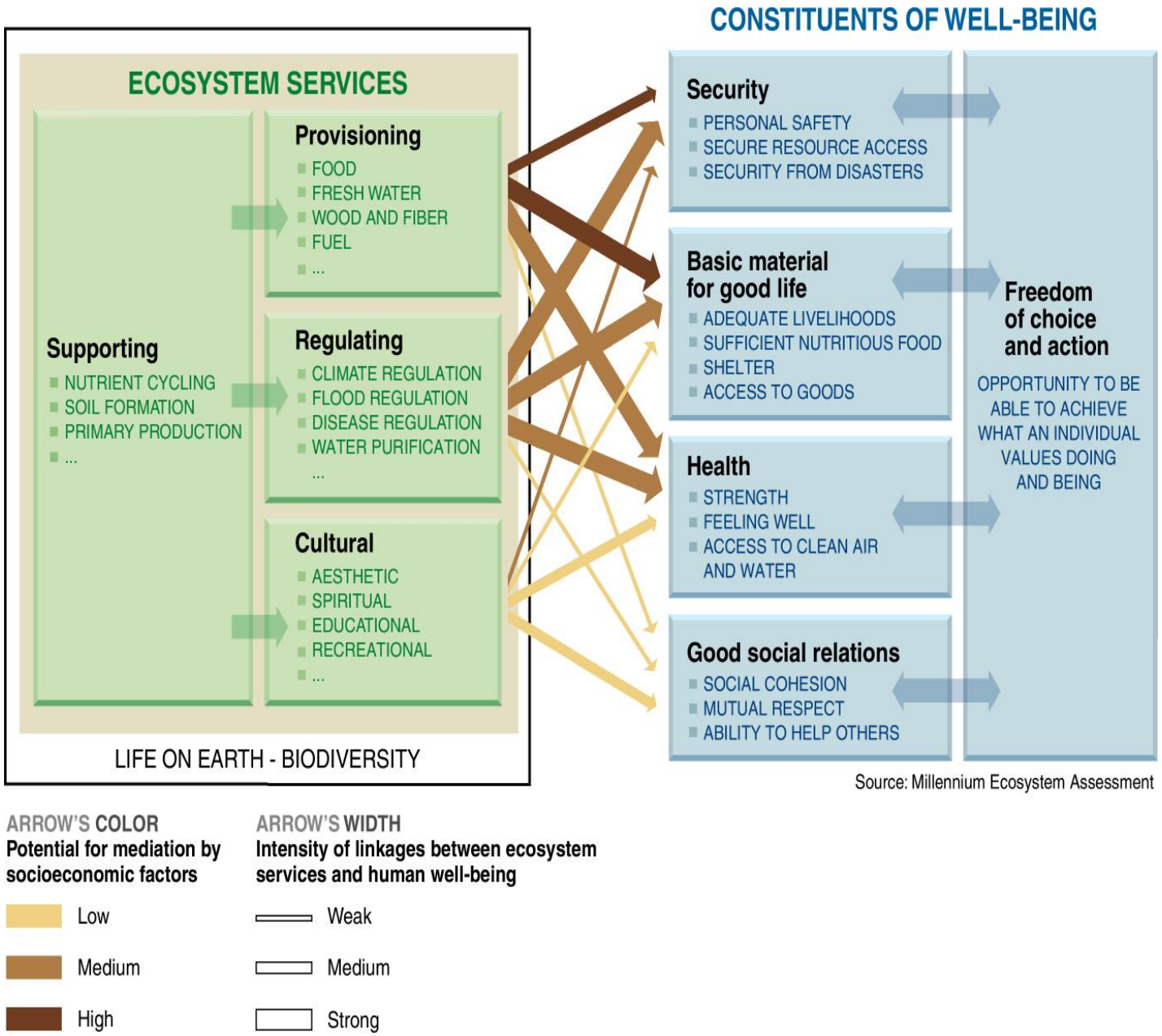


Community Conservation Research Network

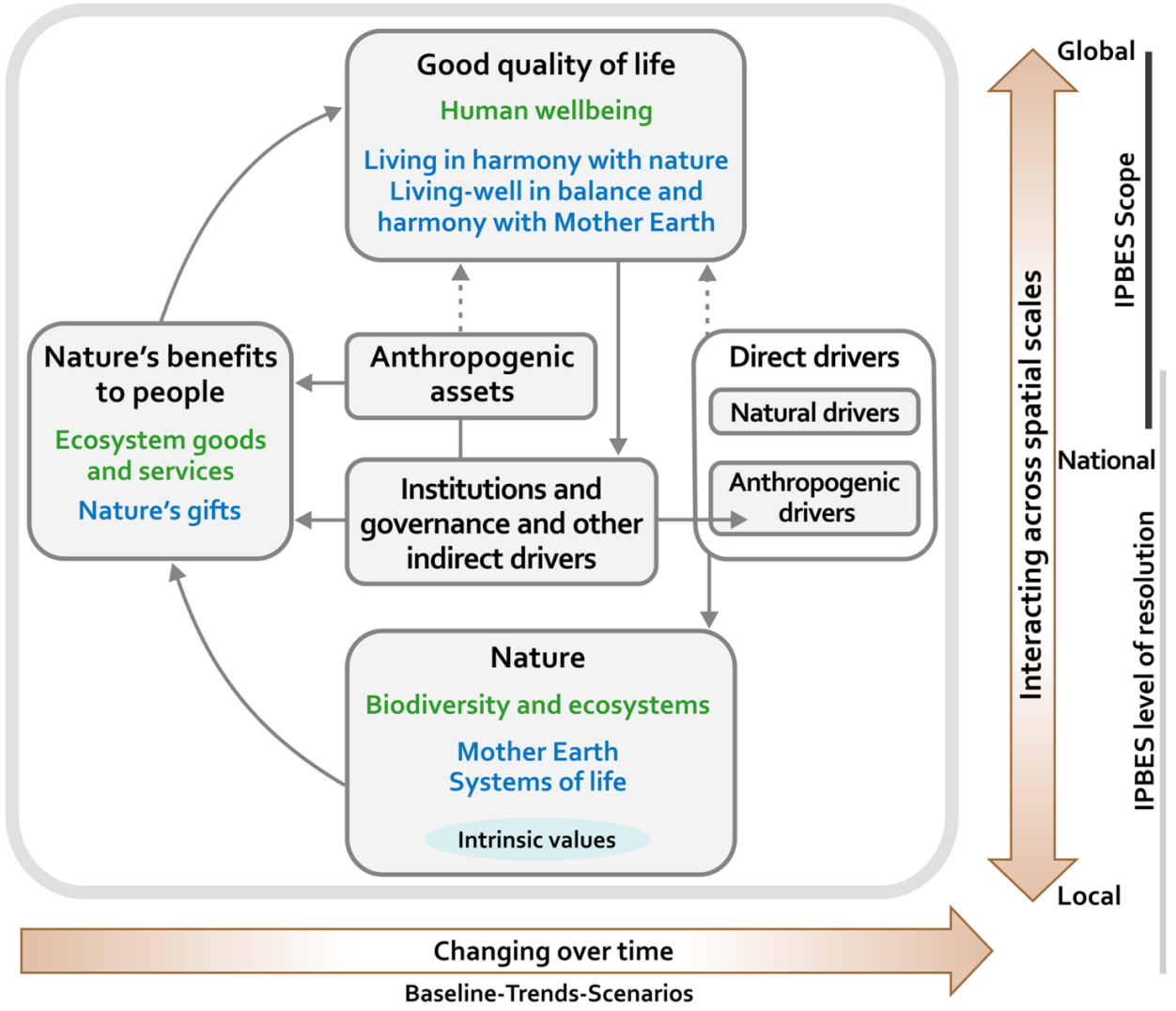
DPSIR
(European Environmental Agency)



Millennium Ecosystem Assessment Framework (MA 2005)



IPBES Conceptual Framework (Diaz et al. 2015)



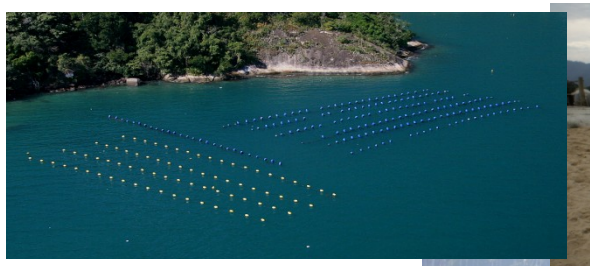
Defining your SES

- What is your question?
- What is the problem you wish to address?
- Who are the stakeholders? Their interests? Their values? Their knowledge?
- In what biophisical (ecosystem) scale the problem can be addressed?
- In what social (institutional scale) scale the problem can be addressed?
- What time scale is needed to answer your question?

Multiple stake-holders

Oil & Gas

Urban Sewage disposal



Mariculture

Different fisher groups

Nuclear power plant

Harbor

Researchers

Protected areas

Fish traders

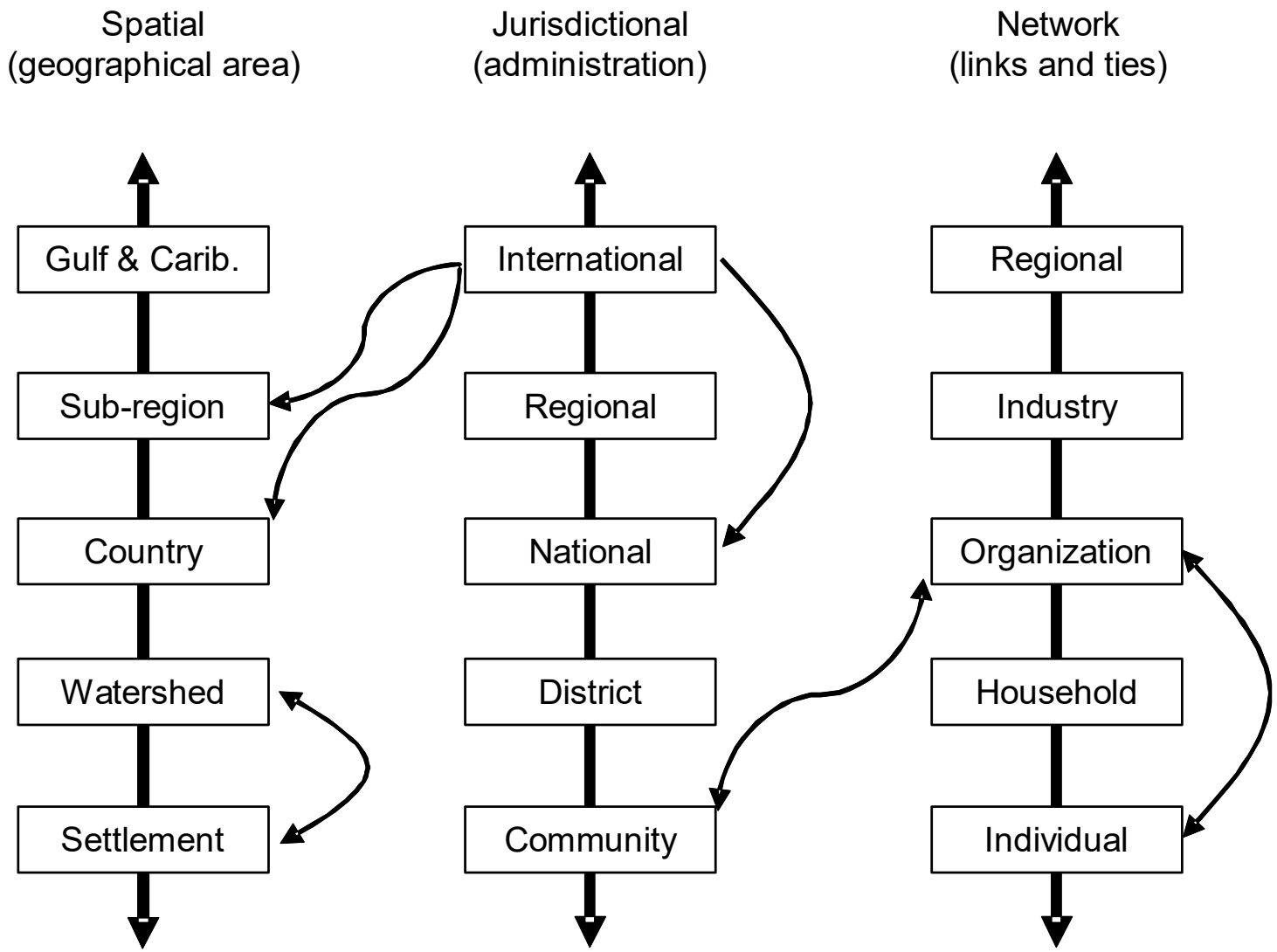
Navy

Beach tourism

Sight seeing tourism

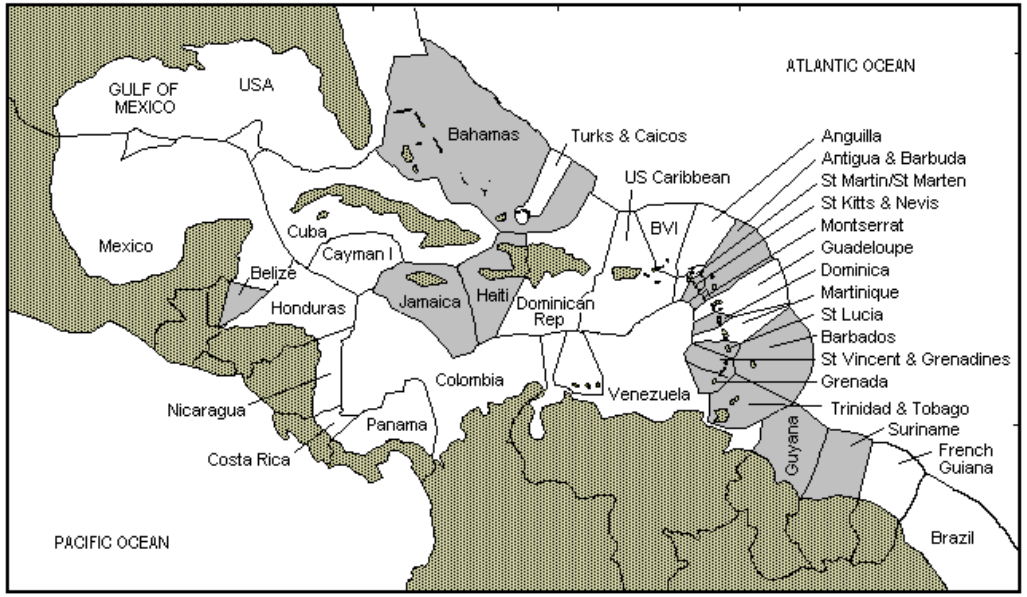
diving

Example from The Caribbean

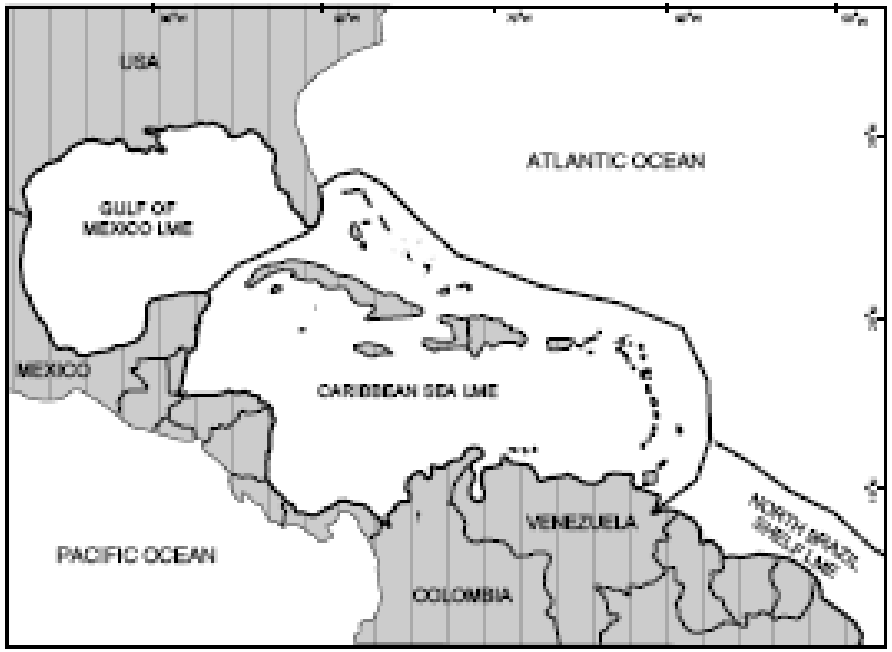


The Caribbean

"social"



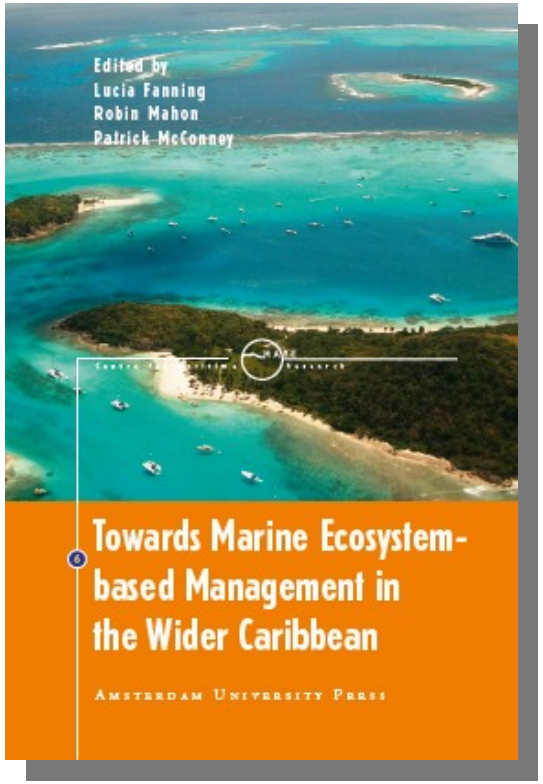
social-ecological system



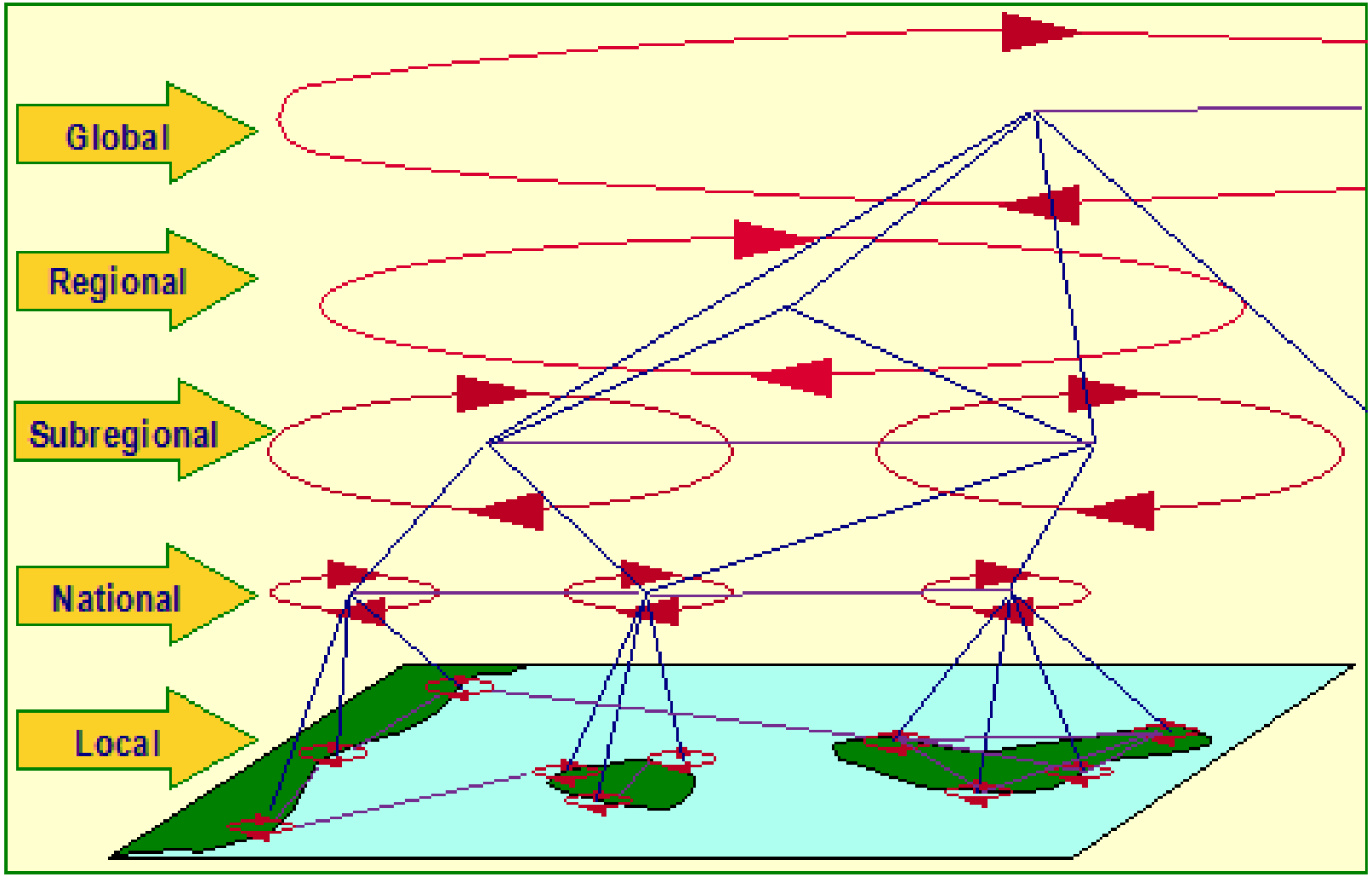
"ecological"

Nested institutions of governance

Community managed area local level plan



Multi-scale policy-cycles are based on regional governance framework

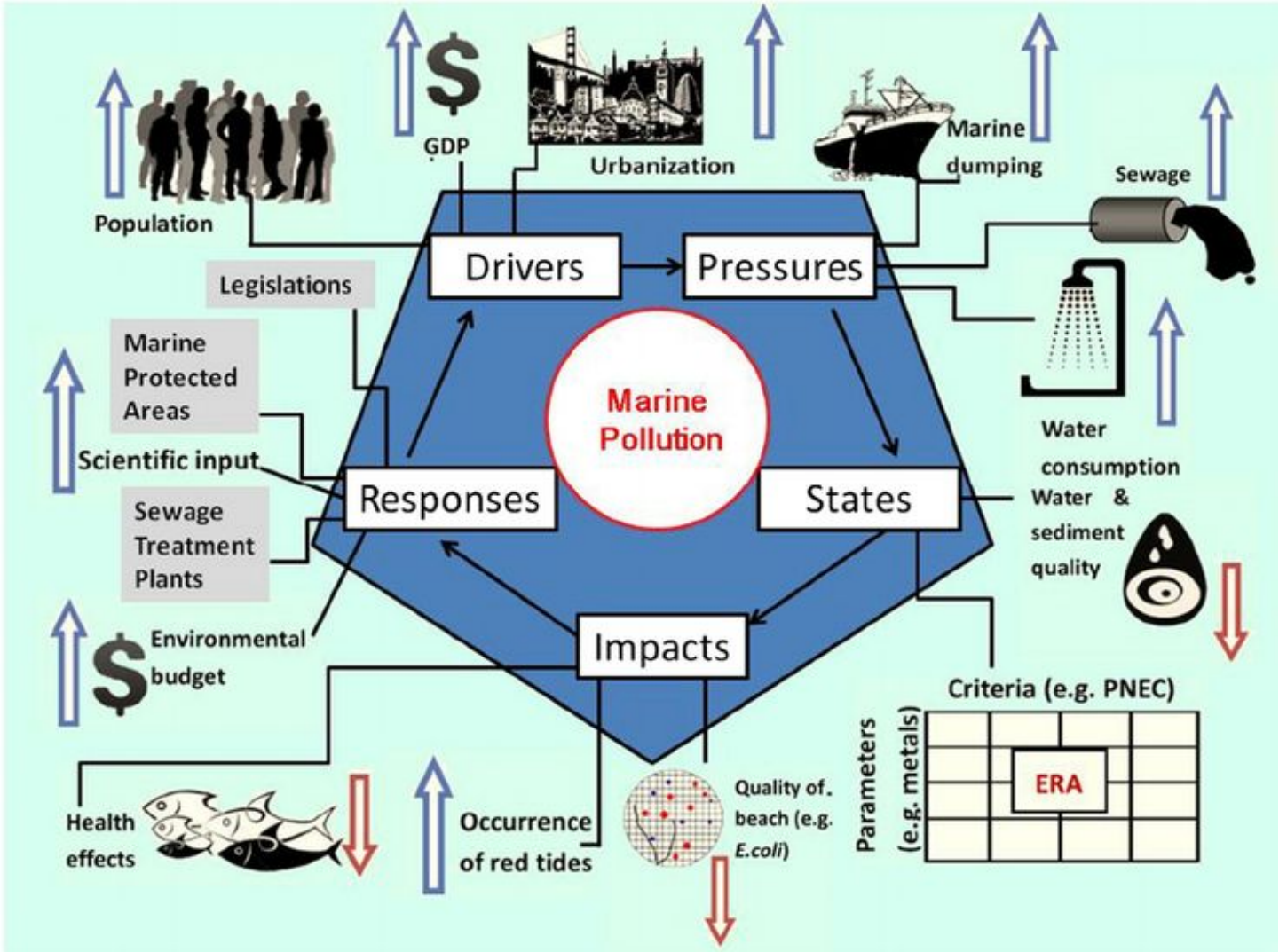


Key indirect drivers leadings to direct drivers of ecosystem change in the Brazilian coast zone

(Marone et al. 2011)

Increase of the population and urbanization in the coastal area
Growth of the tourism and leisure industry
Increase in industrialization and in public and private services
Increase on the demand for no-renewable energy
Intensification of sea and terrestrial transportation
Intensification of aquaculture
Intensification of conservationist view and policies (governmental agencies and NGOs)
Expansion of new Pentecostal evangelical movements
Increase in number of environmental and developmental NGOs
Cultural homogenization (consumerism, lack of criticism, individualism and immediacy in the context of the globalization)

DPSIR analysis of marine pollution



Ibiraquera Lagoon, South Brazil

Parnarchy and Adaptive cycles - Focus on fisheries mgn't (Seixas & Berkes 2003)

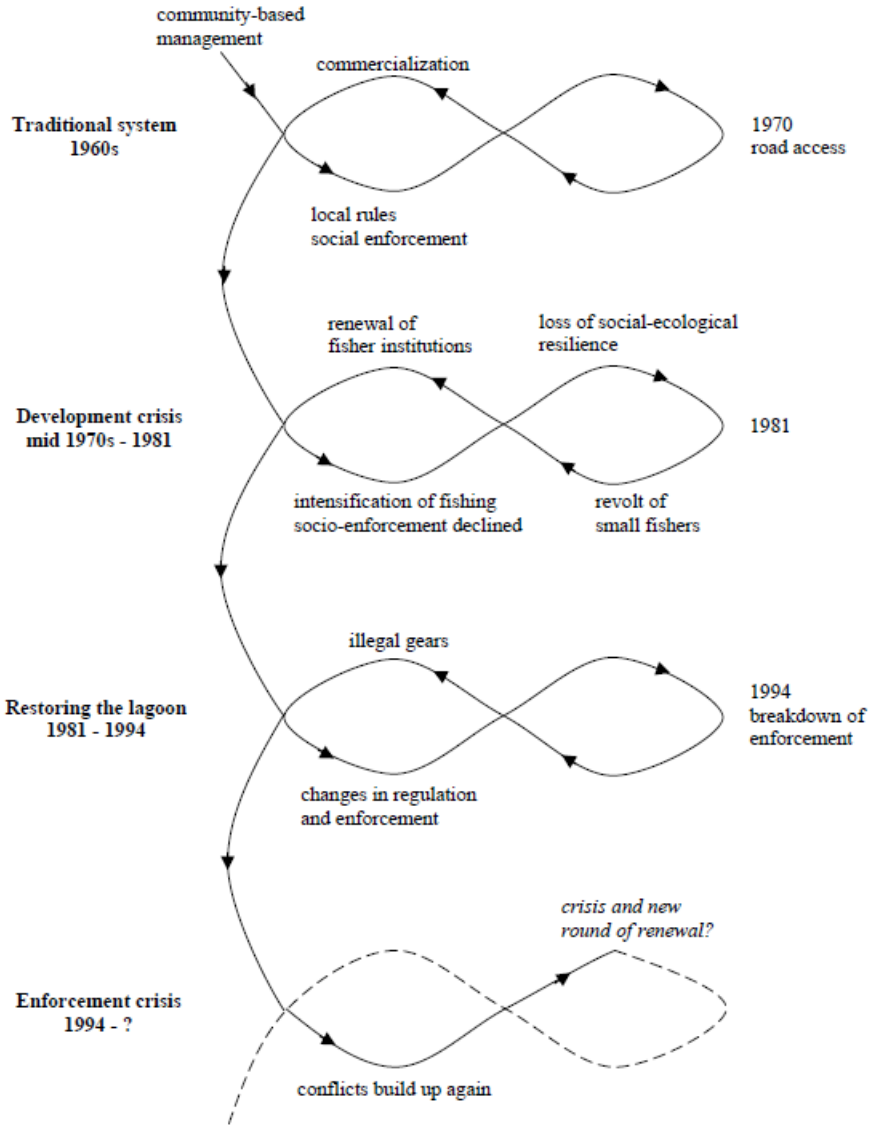
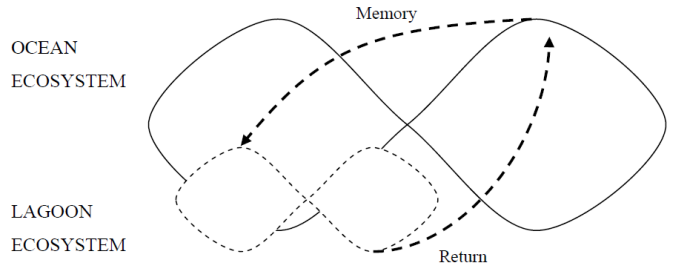


Figure 3.3: Different periods of Lagoon and fishery management in Ibiraquera, as represented by successive iterations of the adaptive renewal cycle (Holling 1986, Gunderson et al. 1995).

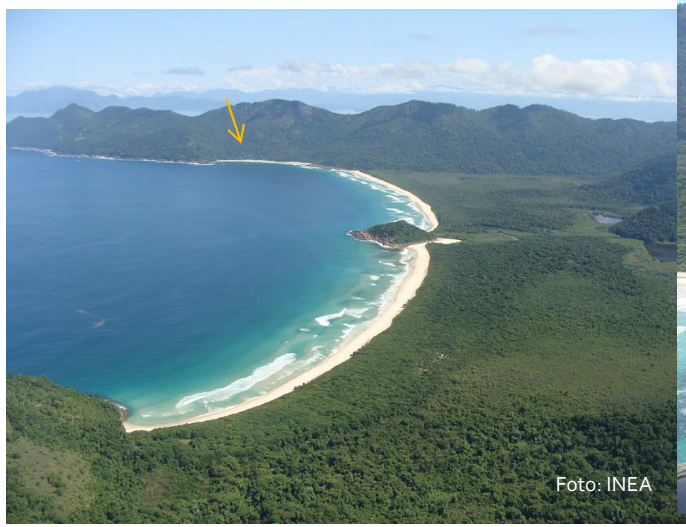


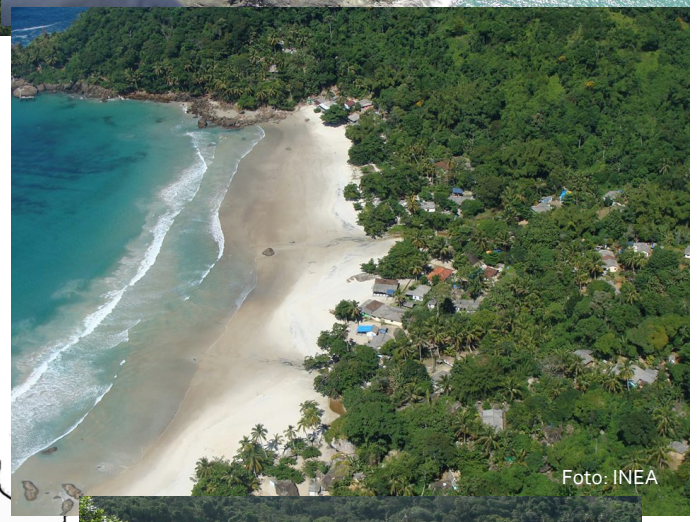
Memory (remember): renewal of shrimp larvae and fish from ocean to lagoon

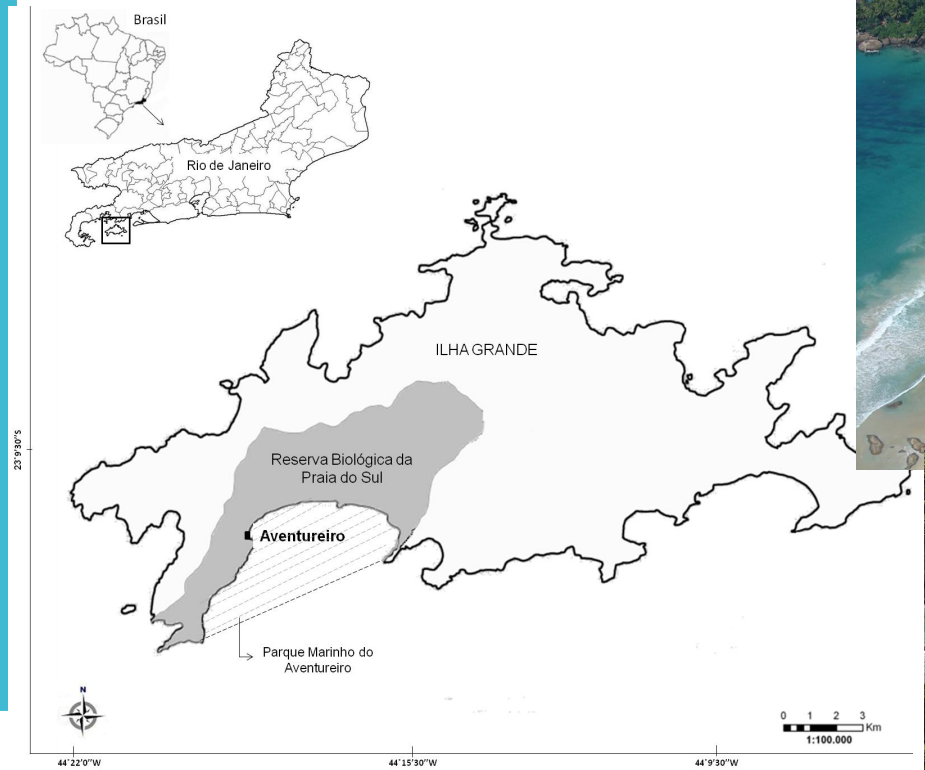
Return (revolt): return of adult shrimp and fish from lagoon to ocean

Figure 3.2. Panarchy: the nested relationship between the small ecosystem (lagoon) and the larger ecosystem (ocean). Panarchy idea after Holling (2001) and Gunderson and Holling (2002).

Aventureiro, Ilha Grande Rio de Janeiro Brazil

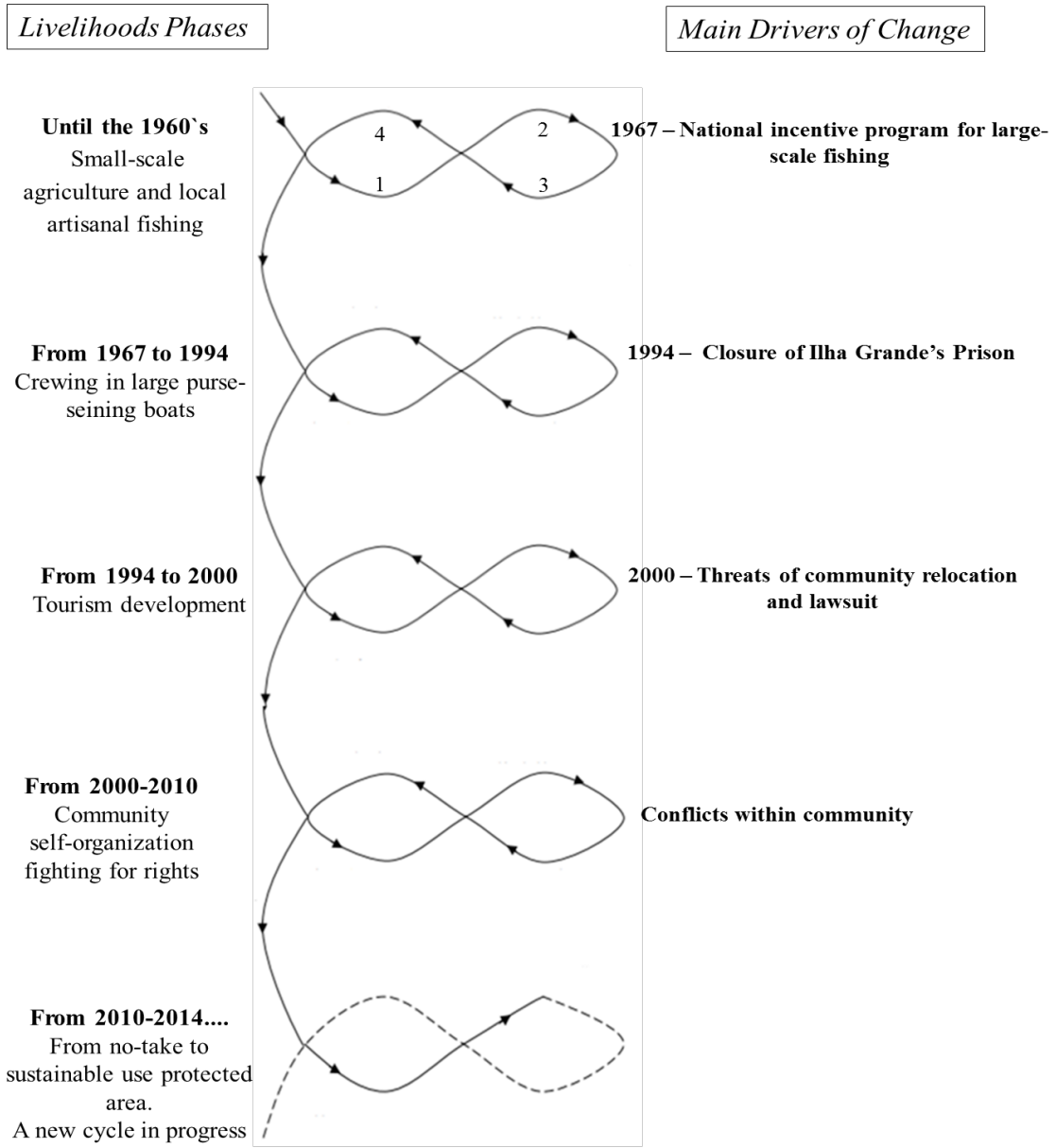




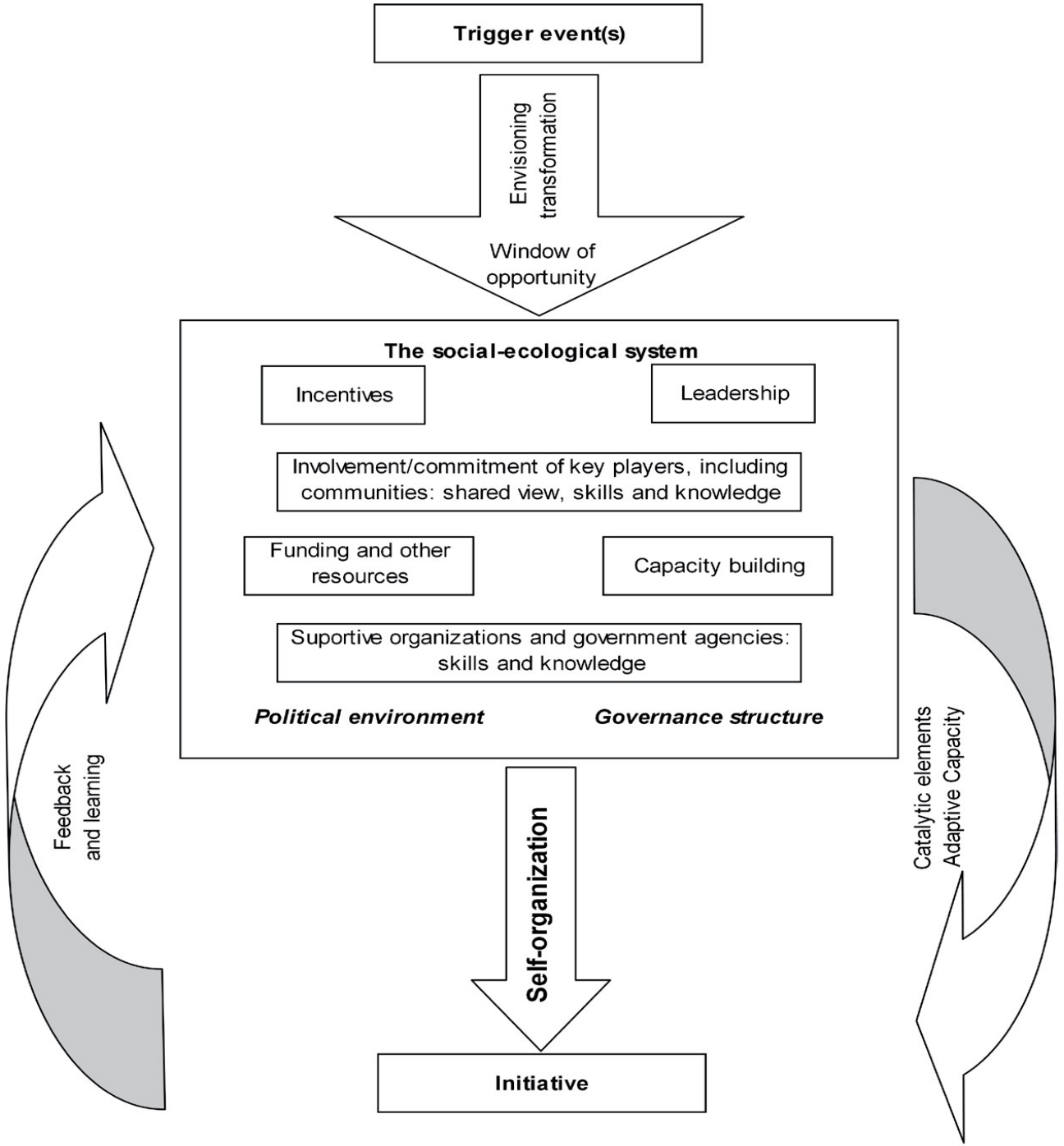


Por
D. Prado
C. S. Seixas

Pathway of social-ecological change - focus on livelihoods (Prado et al. 2015)



Self-organization of SES in integrated conservation and development initiatives (Seixas & Davy 2008)



Pred Nai community, Thailand Mangrove forest restoration and management (Senyk 2005)

Q: Shall one foster resilience in SES?

Building resilience in local social-ecological lagoon systems
(Berkes & Seixas 2005)

Learning to live with change and uncertainty	**Promote diversity for re-organisation and renewal**
Learning from crises Building capacity to respond to change Developing coping strategies	Maintain diversity of institutions Maintain diversity of functional groups – ecological memory. Use social memory Support experimentation
Combine different kinds of knowledge	**Promote self-organisation**
Building capacity to monitor the environment Combining local and scientific knowledge Building capacity for participatory management Creating cross-scale mechanisms to share knowledge	Building capacity for resource-users to self-organise Self-organising for equal access to fisheries and distribution of benefits Build conflict management mechanisms Matching the scale of ecosystem and governance Creating multi-level governance

7 Principles for Building Resilience in Social-Ecolgical Systems
(Simonsen et al. 2015)

- Maintain diversity and redundancy
- Manage connectivity
- Manage slow variables and feedbacks
- Foster complex adaptive systems thinking
- Encourage learning
- Broaden participation
- Promote polycentric governance systems

Thank you!