

LINKAGES BETWEEN VULNERABILITY, RESILIENCE, AND ADAPTIVE CAPACITY

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- **Generic systemic approach**

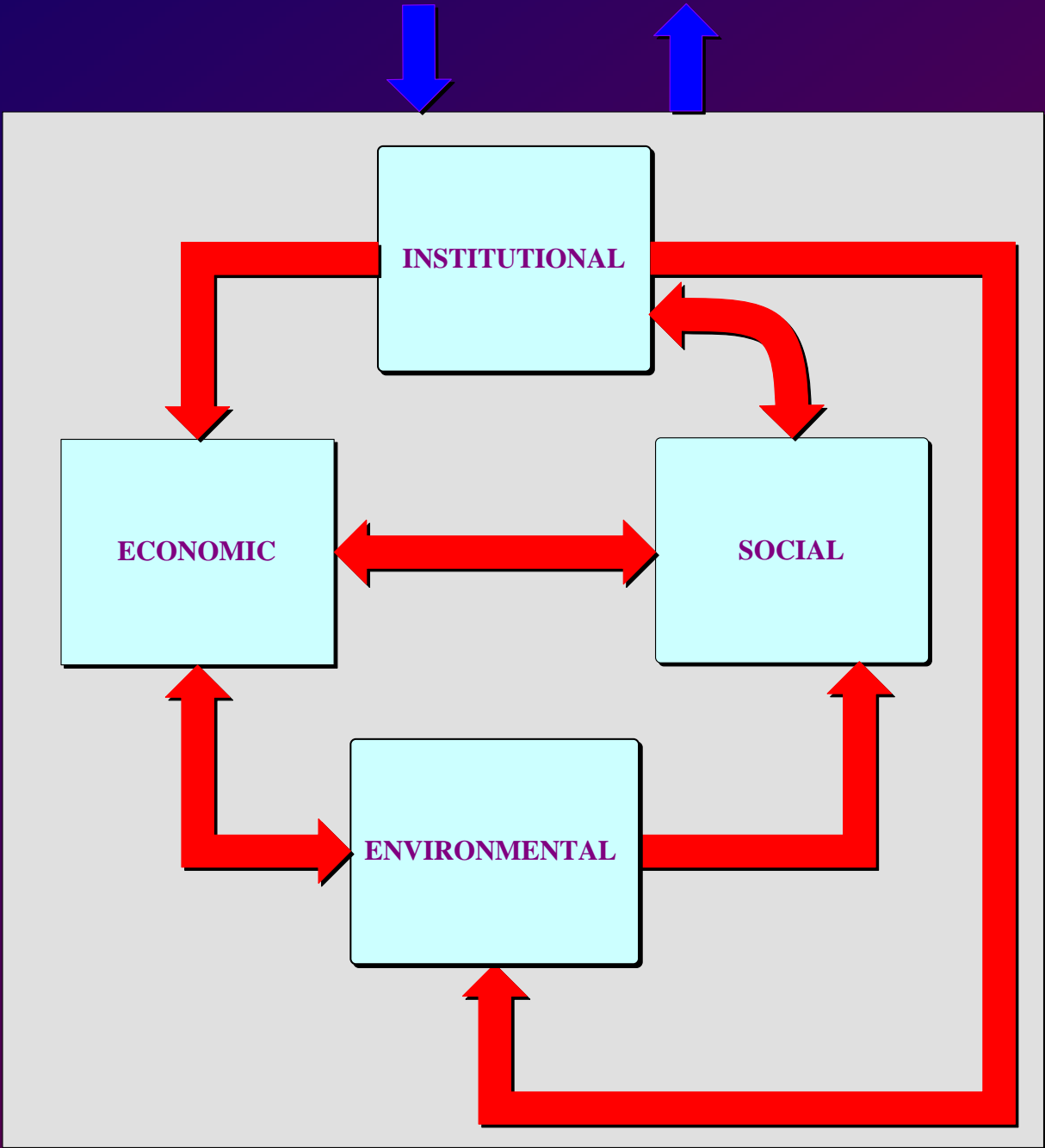
(Specifiable for different system types -social, ecological, socio-ecological)

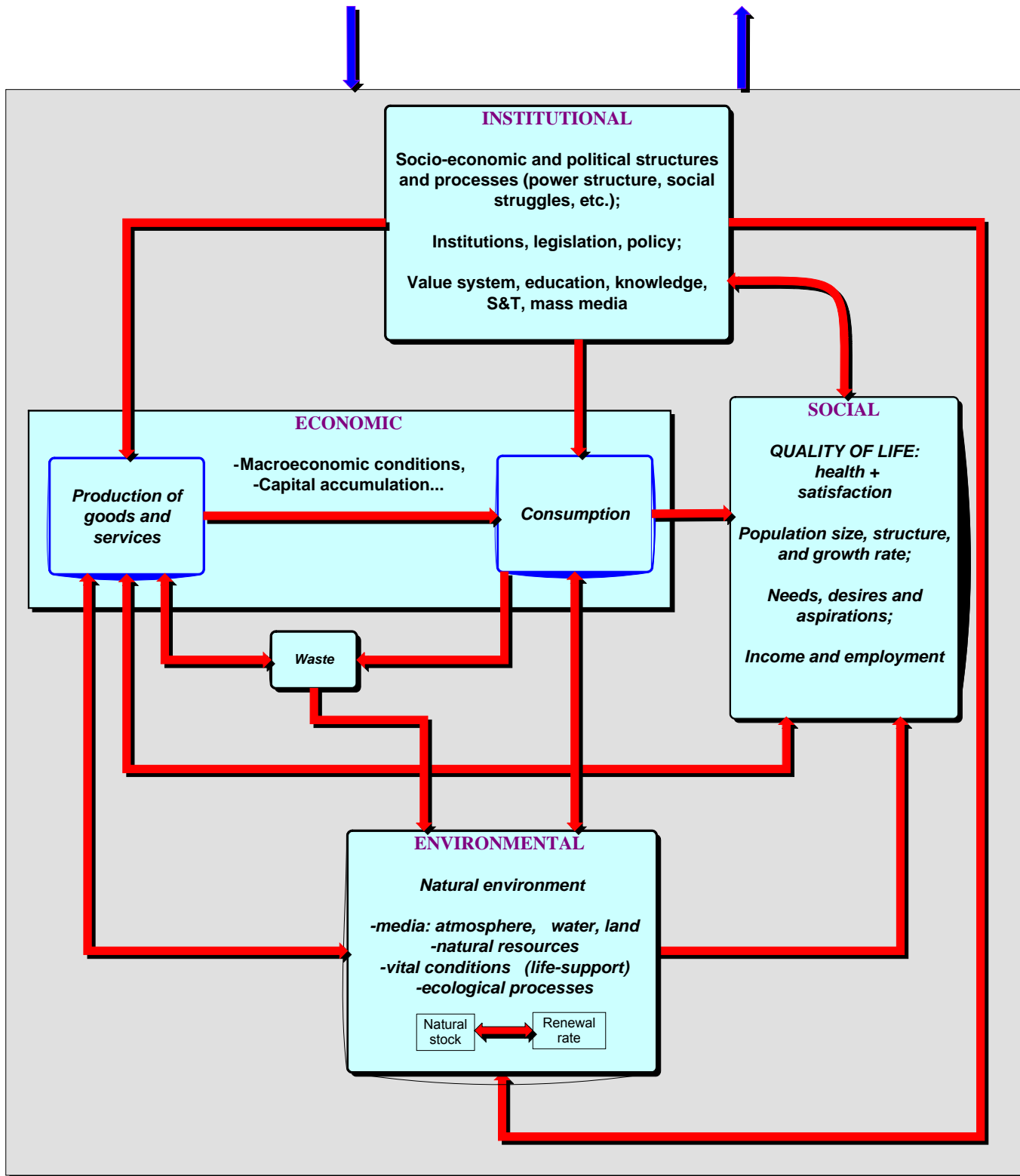
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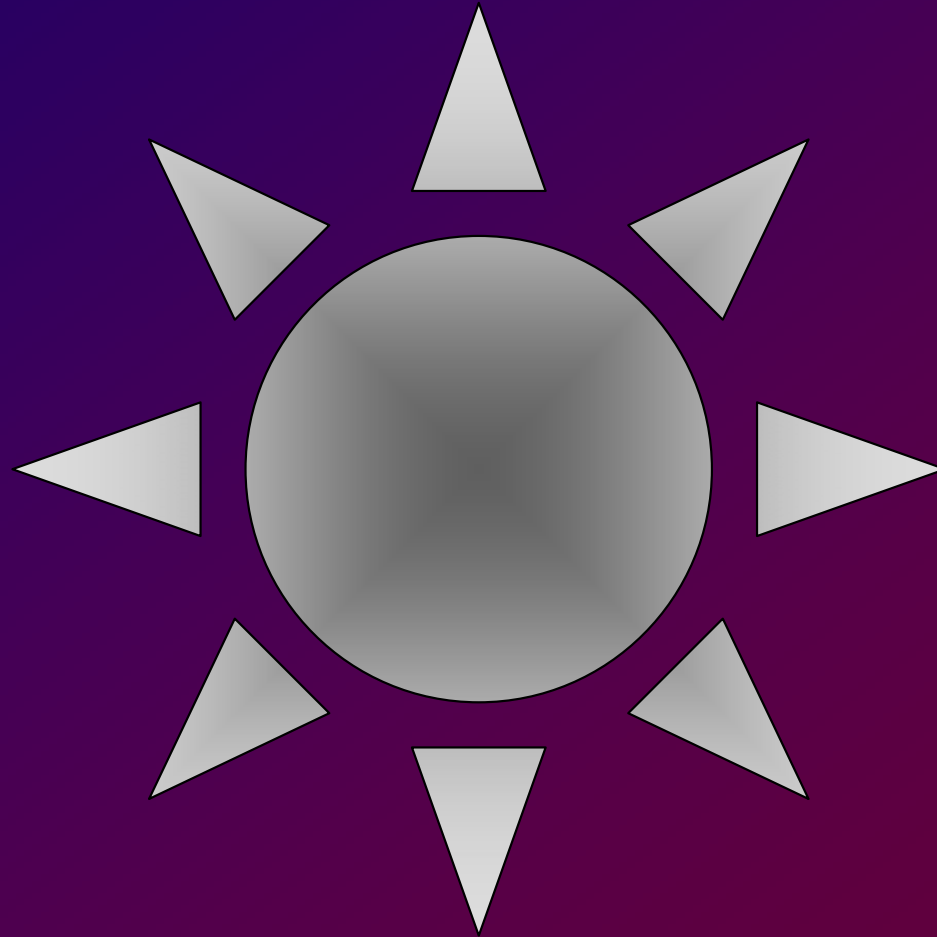
- **Diagnostic questions**

The Socio-ecological System

- A system that includes societal (human) and ecological (biophysical) subsystems in mutual interaction.\
- From local (household + surroundings)
to
- Global (the Earth System)







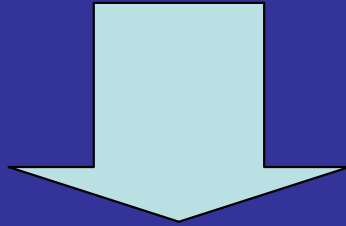
VULNERABILITY

- The propensity of a system to suffer significant transformations as a consequence of its interaction with external or internal processes or events (“perturbations”)
 - ◆ Significant transformation: a structural change of the system or, at least, relatively permanent and profound

**Vulnerable
system**

+

perturbation



transformation

issues at this entry level:

- Is V necessarily negative? (or, is the potential transformation always for the worse?) (“positive vulnerability”). V as a particular case of **Responsiveness to stimuli** ?
- Is the perturbation, stress, shock necessarily external?

Exogenous/endogenous:

- Characterization of events (perturbations, etc) as external or internal is scale-dependent
- A hurricane is external to the community, but internal to the Earth System; a civil war is external to the household, but internal to the country

CENTRAL COMPONENTS OF VULNERABILITY:

exposure, sensitivity, and
capacity of response

SENSITIVITY

Essentially,

∂ transformation
 ∂ perturbation

Inherent, in the absence of response

Attribute of the system, pre-existent the
perturbation

CAPACITY OF RESPONSE

- Ability of the system to:
 - ◆ Adjust to or resist the perturbation
 - ◆ Moderate potential damage
 - ◆ Take advantage of opportunities
 - ◆ Cope with the consequences of the transformations that do occur

Attribute of the system, pre-existing the perturbation

EXPOSURE

- Degree, duration and/or extension in which the system is in contact with, or subject to, the perturbation

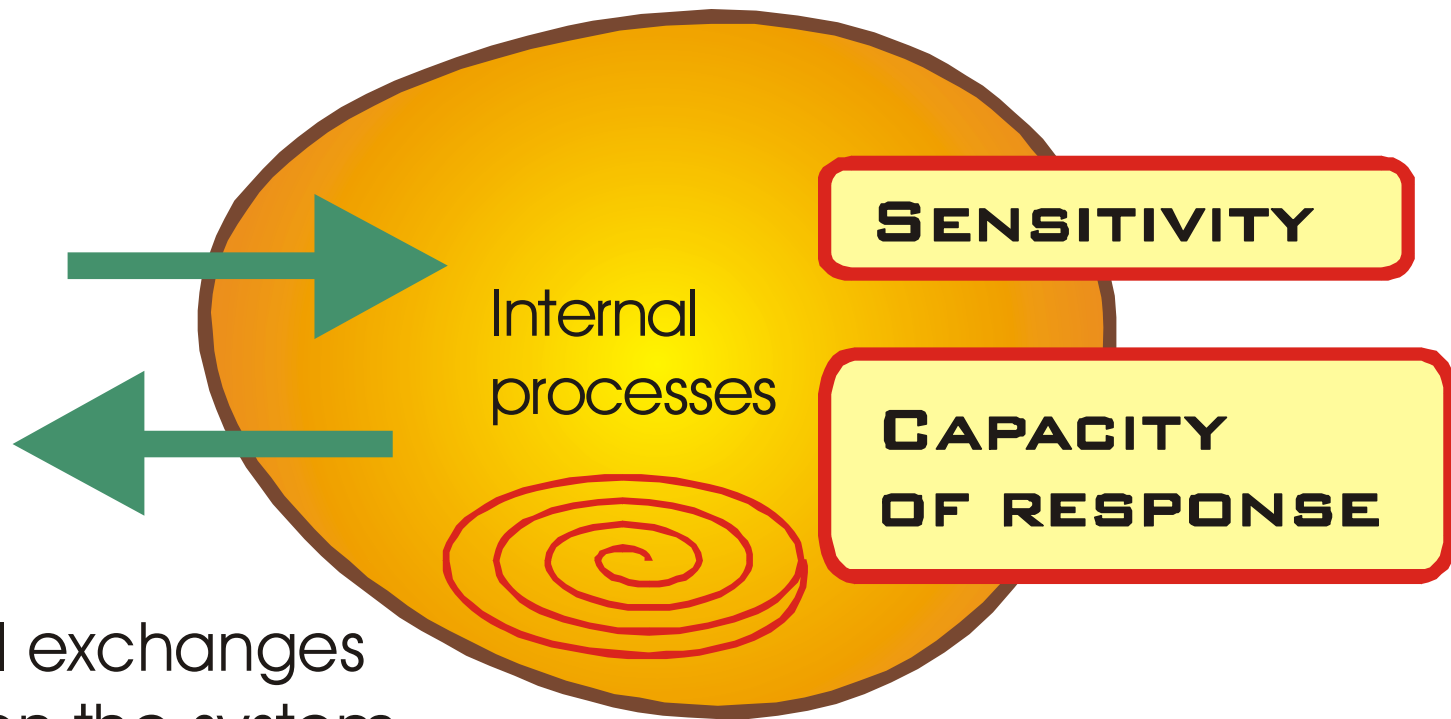
Attribute of the relation between the system and the perturbation

issue

- Should exposure be included within vulnerability?
- Wide agreement in that vulnerability is a property of the system
- A system may be very vulnerable, but it may persist as long as it is not exposed to the perturbation
- Vulnerability is an internal property of the system, becoming expressed/revealed when exposed to the disturbance (~ resilience)

vulnerability

SYSTEM



Normal exchanges
between the system
and its environment

perturbation, threat

External
processes

**PROBABILITY OF
OCCURRENCE**

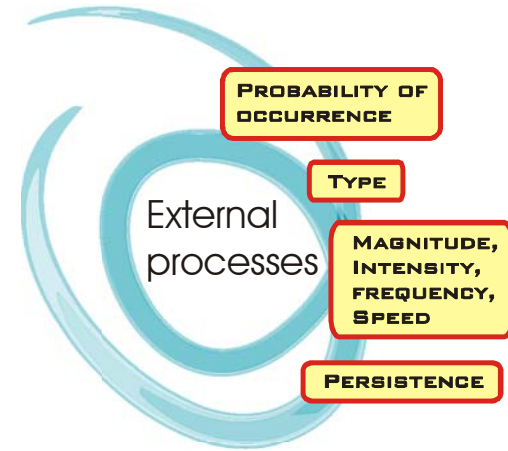
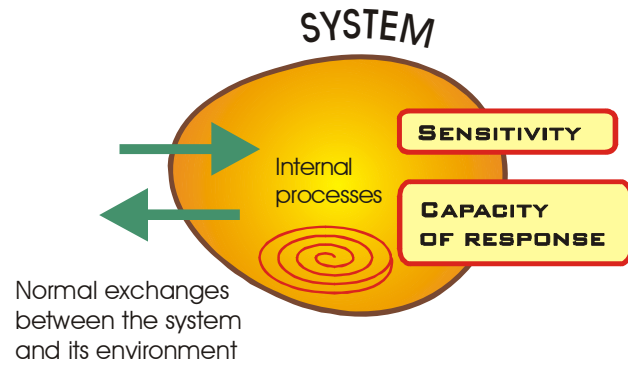
TYPE

**MAGNITUDE,
INTENSITY,
FREQUENCY,
SPEED**

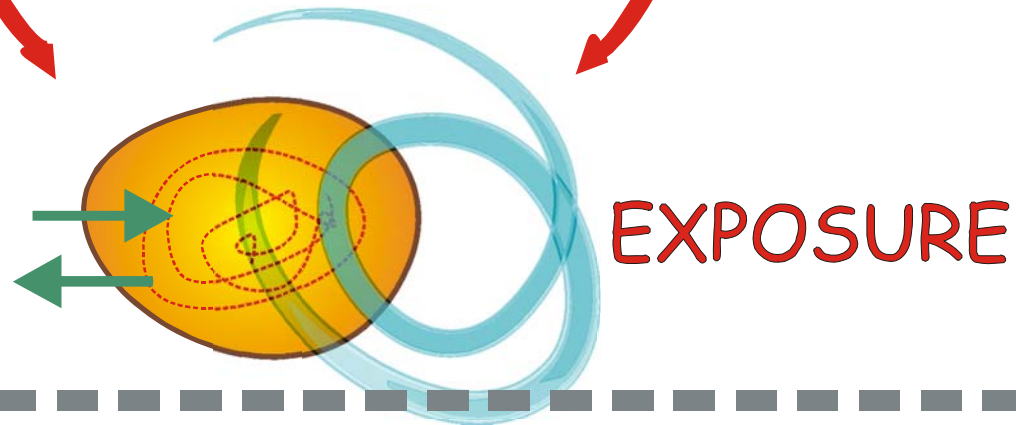
PERSISTENCE

VULNERABILITY

DISTURBANCE



BEFORE



AFTER

Transformation,
impact

TRANSFORMATION =

function of:

- perturbation/threat
- vulnerability,
- exposure

VULNERABILITY =
function of

- Sensitivity,
- Capacity of response

Or,
function of

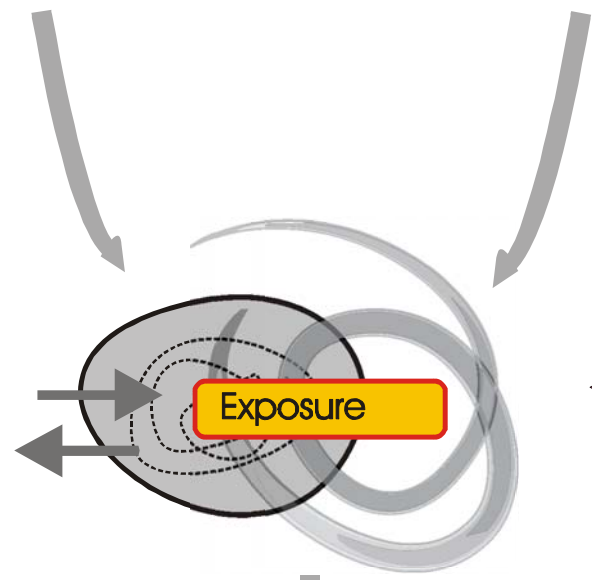
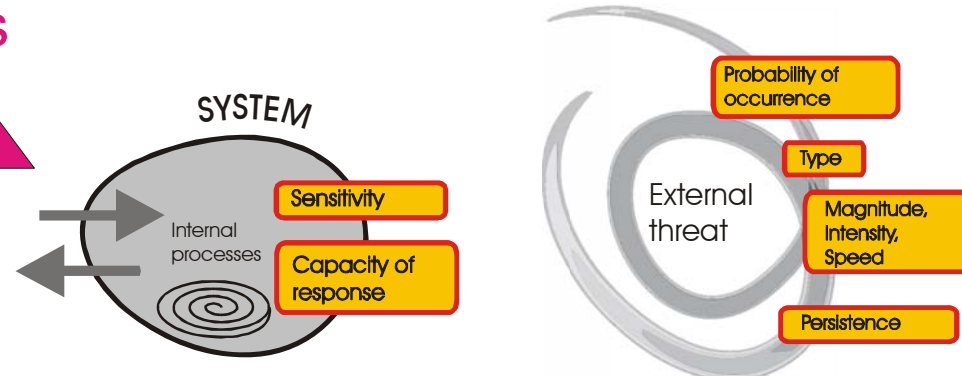
- Sensitivity,
- Capacity of response
- Exposure

Policy differentiation

- Different types of policies are appropriated for different aspects of the problematic situation

- Capacity building
- Assets, reserves
- Immunization
- Anticipation

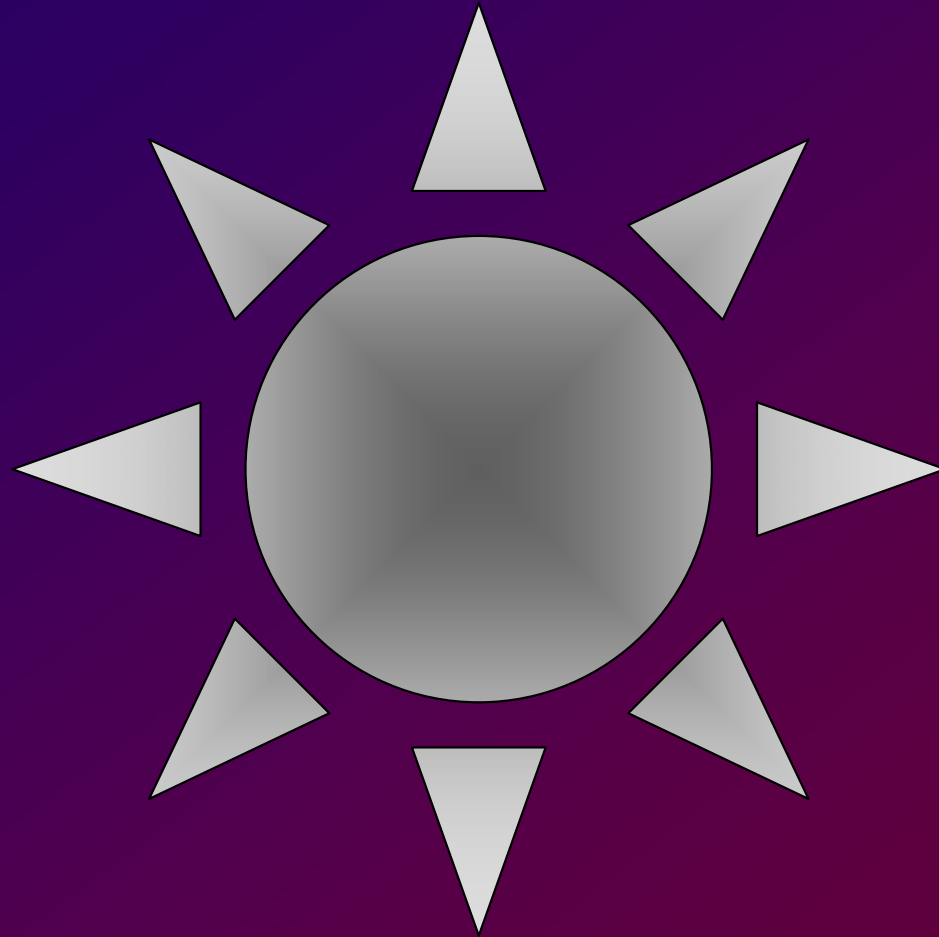
- Prevention
- Mitigation



- Shielding
- Relocation

- Adaptation
- Restoration
- Compensation

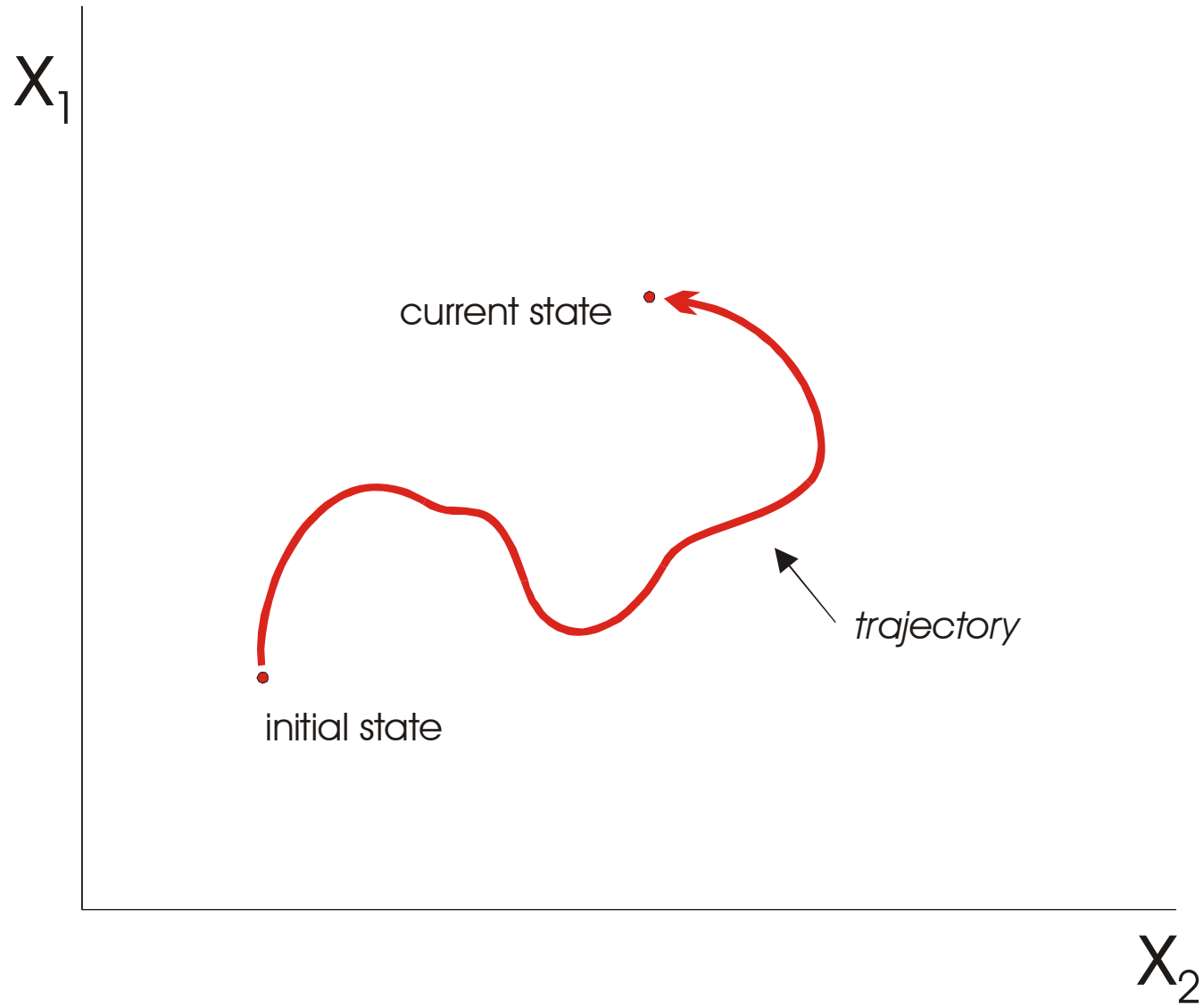
Transformation,
impact

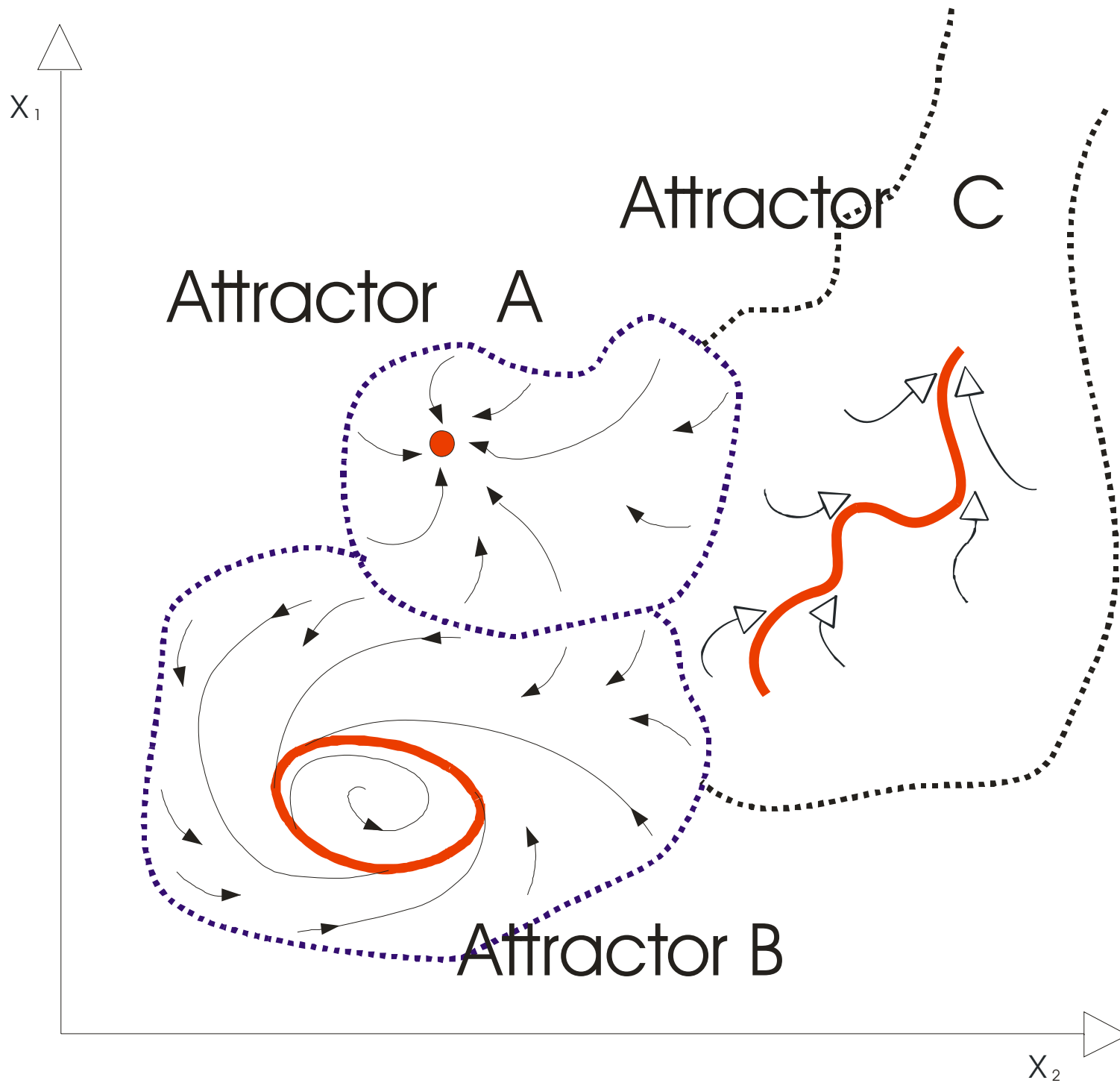


RESILIENCE

Originally referred to changes of the state of the system within its state space (resilience was related to the “size” and “depth” of the domain of attraction (dynamic attractor):

- “The amount of change a system can undergo and still remain within the **same domain of attraction**” (not in the same state; this would be stability=engineering resilience)





- Multistable systems
- Often it is assumed that the current domain is the good one and thus a flip to another domain is a collapse. But this is not necessarily so.

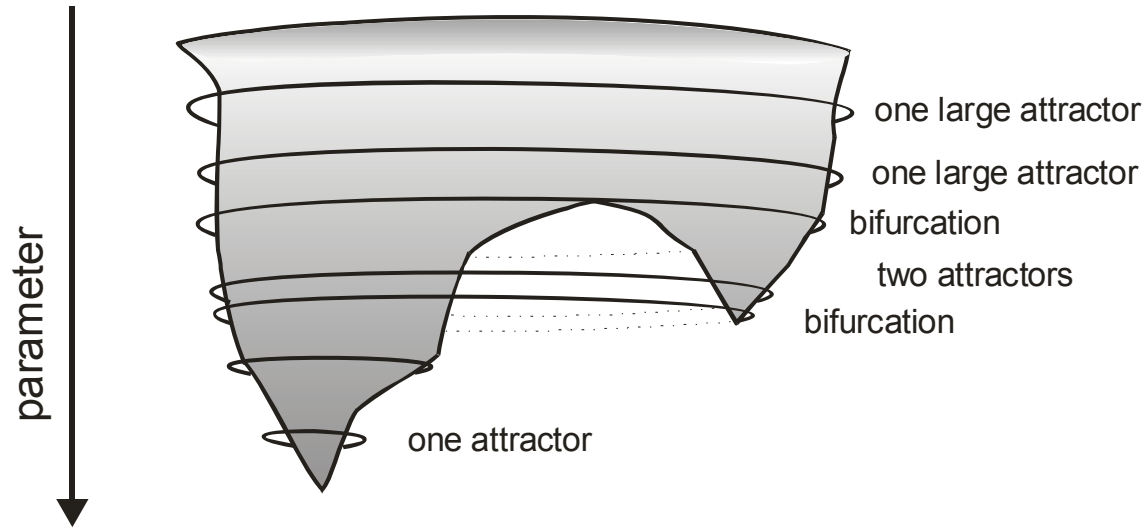
» Take-off theories of development?

Later on

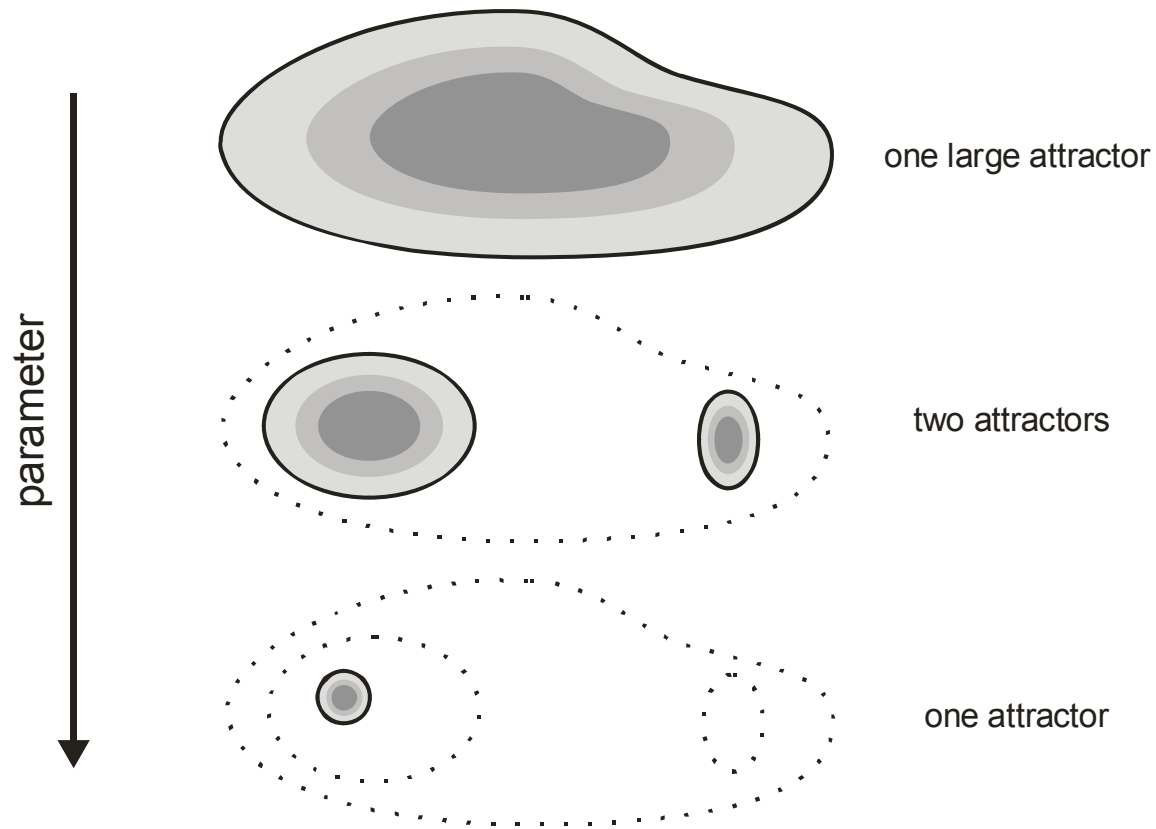
- Resilience was broadened to more structural changes: in the state space itself

Loss of resilience: Changes in the state space



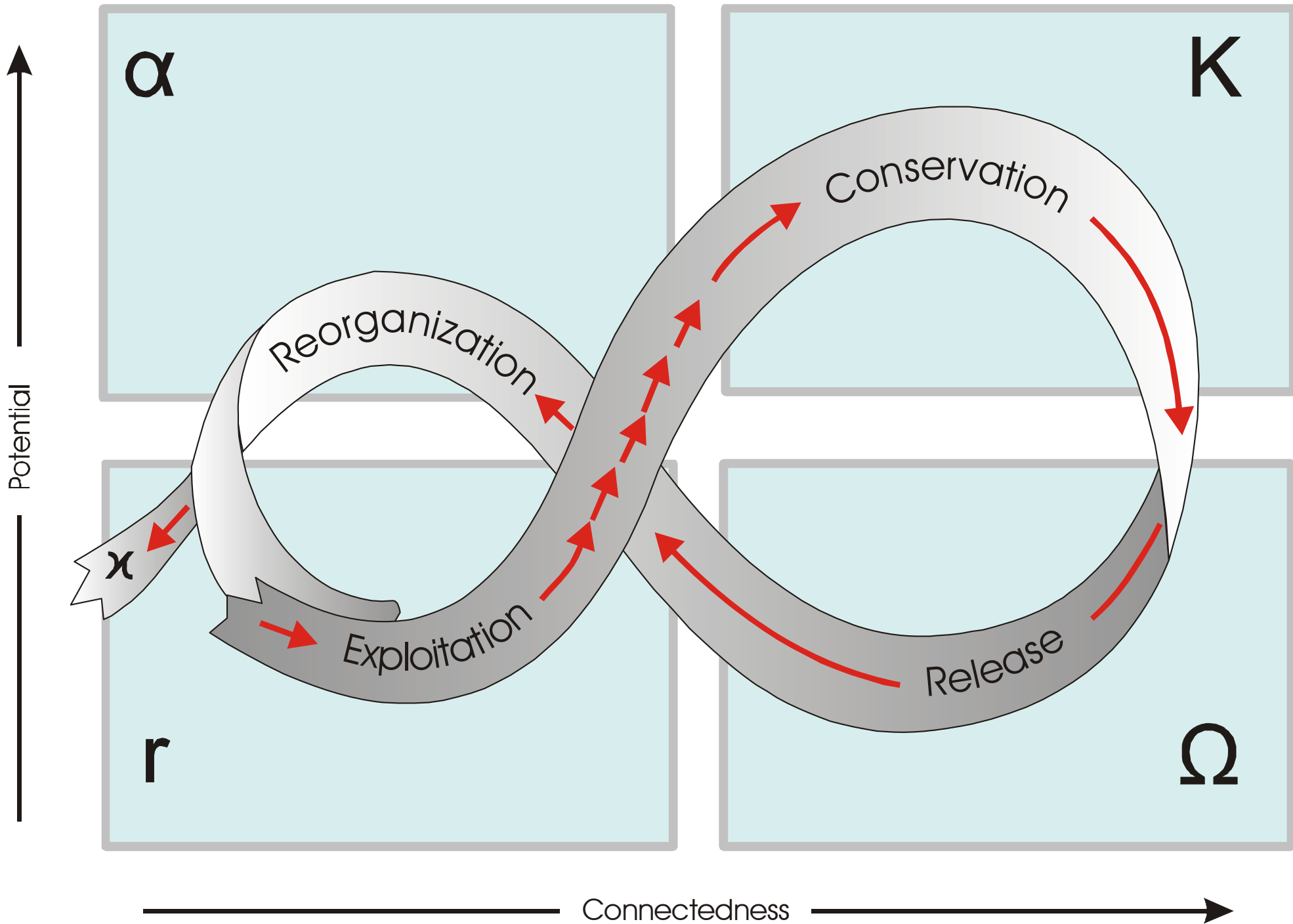


VIEW FROM ABOVE:



More recently

- extended to recovery and reorganization after deep transformations, the capacity to adapt to changes and generate novelty (the “adaptive cycle” metaphor).
- Adaptive cycle >> resilience



3 levels of stability

- Local stability (changes in state near equilibrium point) \equiv “engineering resilience”
- Changes in state between attractors within a given stability landscape \equiv “ecological resilience
- Structural stability (changes in the stability landscape) \equiv robustness/vulnerability

Is Vulnerability the flip side of Resilience?

A resilient system is less vulnerable than a non resilient system, but relation does not necessarily implies simmetry

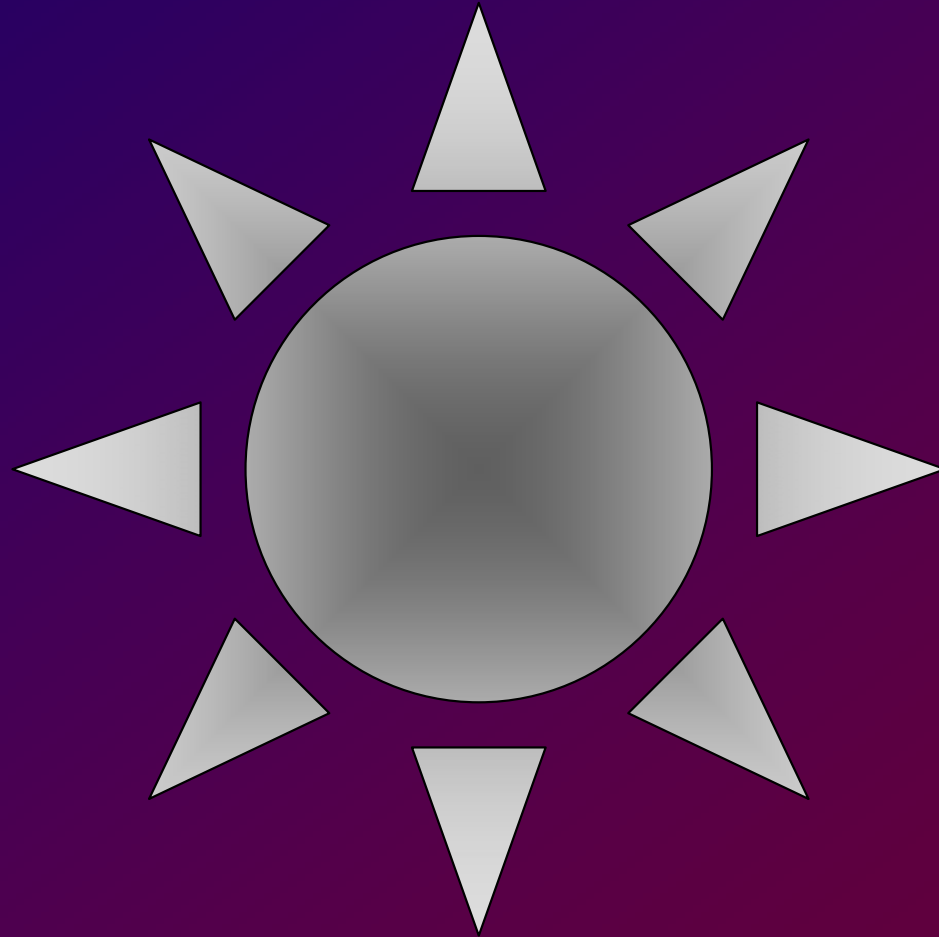
- Resilience is clearly related to the “Capacity of Response” component of vulnerability

But

- Resilience seems to be a subset of “Capacity of Response” at least for social systems

- Resilience is not clearly related to the “Sensitivity” component of Vulnerability
- A sensitive system may be resilient or not
- An insensitive system may exhibit low vulnerability and also low resilience (“armored system”)
- Sensitivity may open a system to threats, but an insensitive system may be unable to adapt and seize opportunity)

- Resilience does not encompass “Exposure”, but a history of exposure may be important to build resilience (at least in ecological systems)



ADAPTIVE CAPACITY

- In biological systems, adaptability means the capacity to adapt (i.e. to be able to live and reproduce) to a range of environmental contingencies, or to make the alteration or adjustment that will enable a species, population, or individual improve its condition in relationship to its environment (Dobzhansky)

IPCC

- **Adaptive Capacity:** the ability of a system to adjust to climate change, to moderate potential damages, to take advantage of opportunities, or to cope with the consequences
- In general, a system's ability to deal with exposure or risk

IPCC

- **Mitigation: actions upon origin and evolution of perturbation**

consists of activities that aim to reduce GHG emissions directly or indirectly (e.g., by changing behavioural patterns, or by developing and diffusing relevant technologies), by capturing GHGs before they are emitted to the atmosphere or sequestering GHGs already in the atmosphere by enhancing their sinks.

- **Adaptation: actions upon system**

adjustments in human and natural systems, in response to actual or expected climate stimuli or their effects, that moderate harm or exploit beneficial opportunities

- An adaptation is a concrete expression of adaptive capacity

What is left out

- AC in biological definition contains:
 - ◆ To cope with environmental contingencies
 - +
 - ◆ To improve its condition in relation to its environment (even if the environment does not change)

Issue:

- Common climate-oriented definitions of adaptive capacity seem to be reduced versions of a more general concept
- Is this important for Global Change research? Probably yes

A system with more adaptive capacity
will tend to be less vulnerable

But

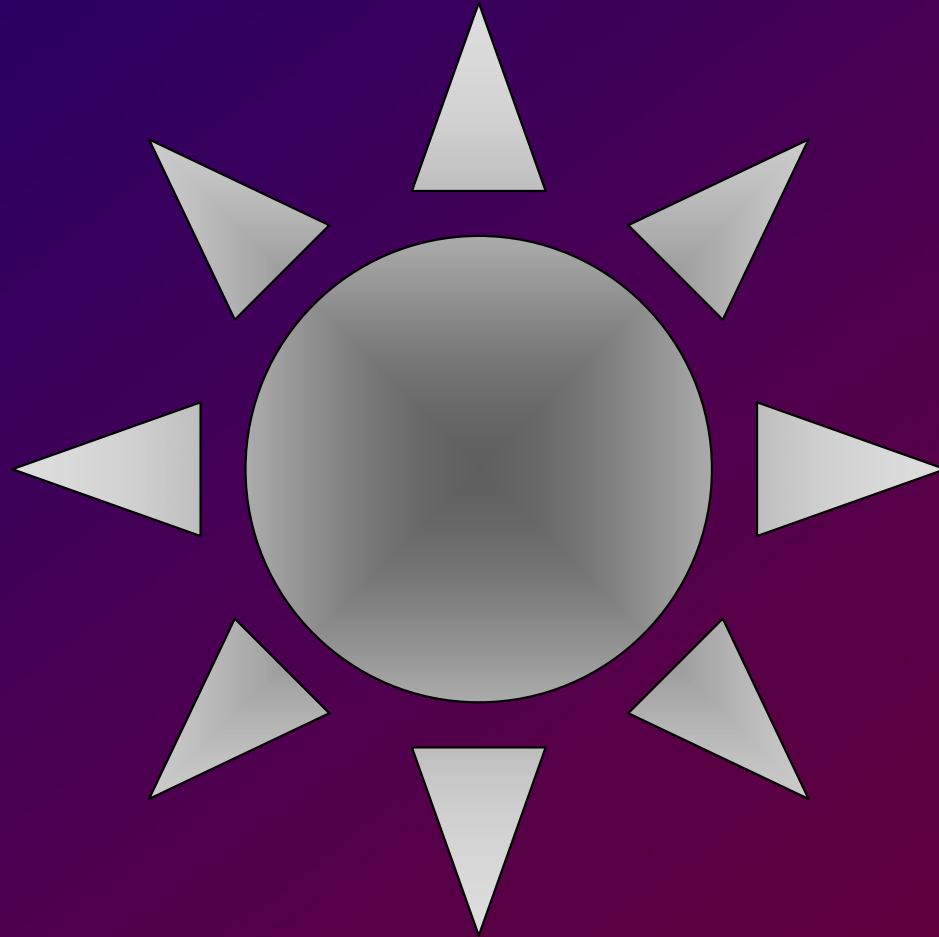
- Is Adaptive Capacity the flip side of vulnerability?
- Is Adaptive Capacity the same as the “Capacity of Response” component of vulnerability?

Adaptations may include:

- Changing the sensitivity of the system to perturbations
- Reducing the exposure of the system to perturbations
- Increasing the resilience of the system

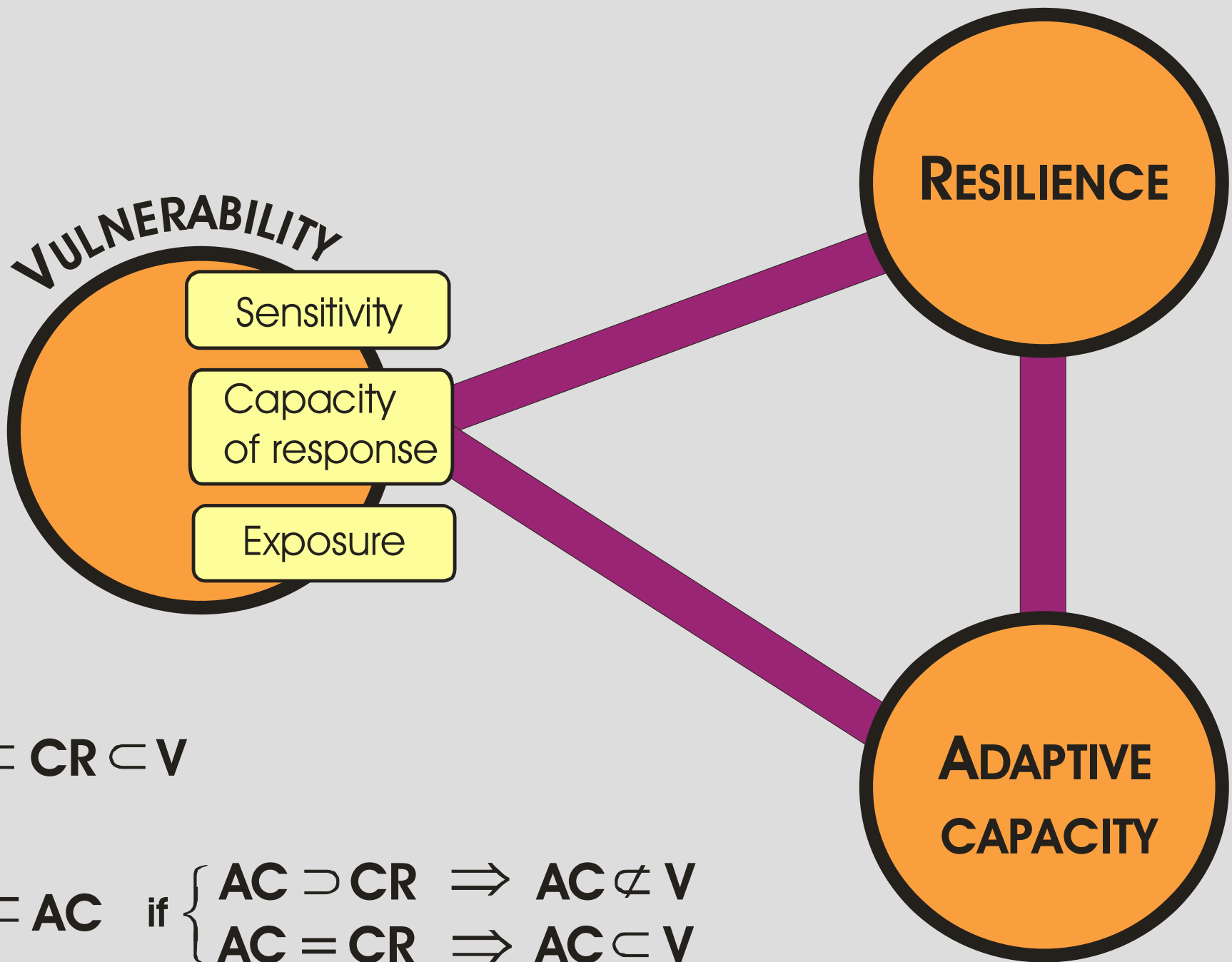
Thus, the concept of adaptive capacity seems to be broader than “capacity of response” (but it depends on definitions adopted)

- Is Resilience the same as adaptive capacity?
- Adaptive capacity seems to be a broader concept than resilience (unless resilience is stretched beyond its original meaning)



CONCLUSION:

- Vulnerability, Resilience, and Adaptive Capacity are related in non-trivial ways. If care is not used, the field of human dimensions research can become epistemologically very messy



$$R \subset CR \subset V$$

$$R \subset AC \quad \text{if} \quad \begin{cases} AC \supset CR \Rightarrow AC \not\subset V \\ AC = CR \Rightarrow AC \subset V \end{cases}$$

CONCLUSIONS

- There is considerable confusion, overlap and contradictions in the use of the concepts of V, R, AC
- Epistemologically, V, R, A are related in non-trivial ways

- Efforts should be made to develop clear (and hopefully, shared) specifications of the concepts in the abstract, ecological, and social senses, that are mutually compatible
- This can be critical for the interactions between social and natural sciences in the study of the coupled socio-ecological systems

Set of diagnostic questions may help

- What is meant by “harm” or “transformation” (structural change, shifting domains of attraction, moving away from equilibrium states or trajectories)?
- Is positive vulnerability a useful notion?
- Does vulnerability apply to internal perturbations?
- Is vulnerability a property of the system or of the relationship between the system and the perturbation?
- Is negative (perverse) resilience a suitable concept?
- Does adaptation include improvements of the system in a non-changing environment?
- Is adaptive capacity the same as capacity of response?
- Is resilience the same as adaptive capacity?

Line of research on Global Change

- Search for a general theory of change and transformation of SESs
- Requires ID (TD?) research with the participation of social and natural scientists

