Socio-ecological systems (SES)
Systems Resilience
Thresholds

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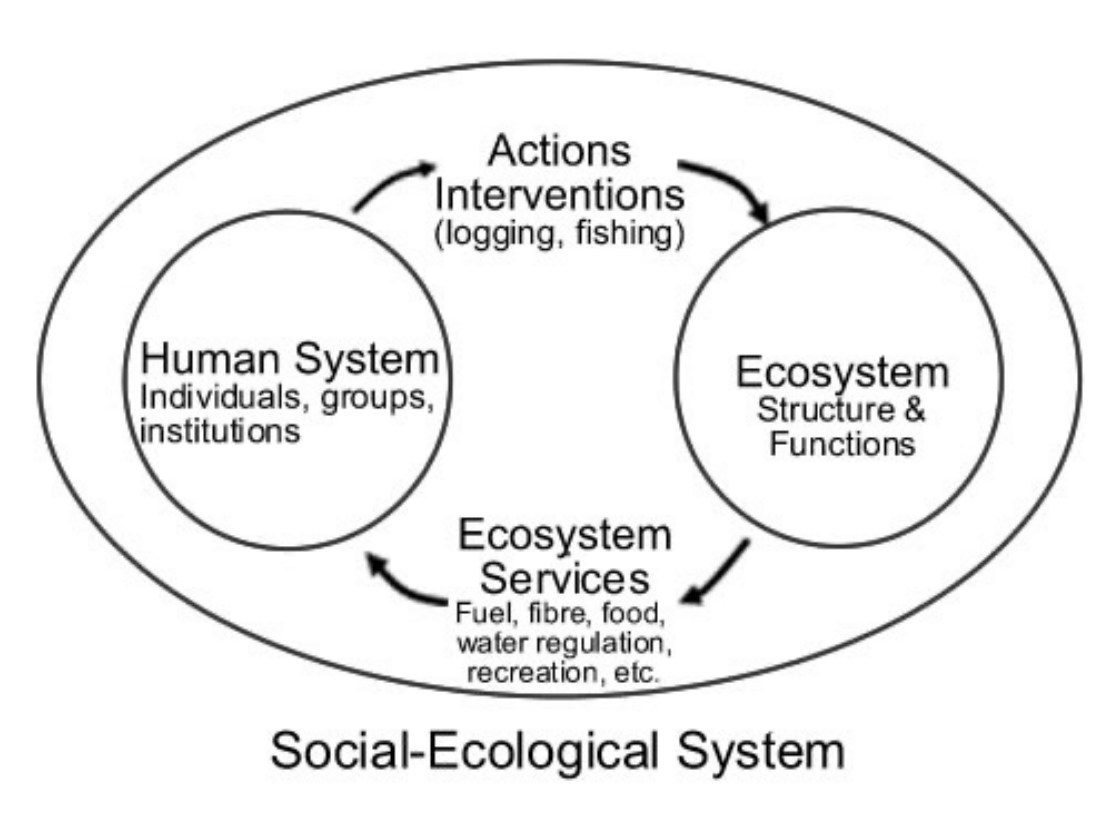
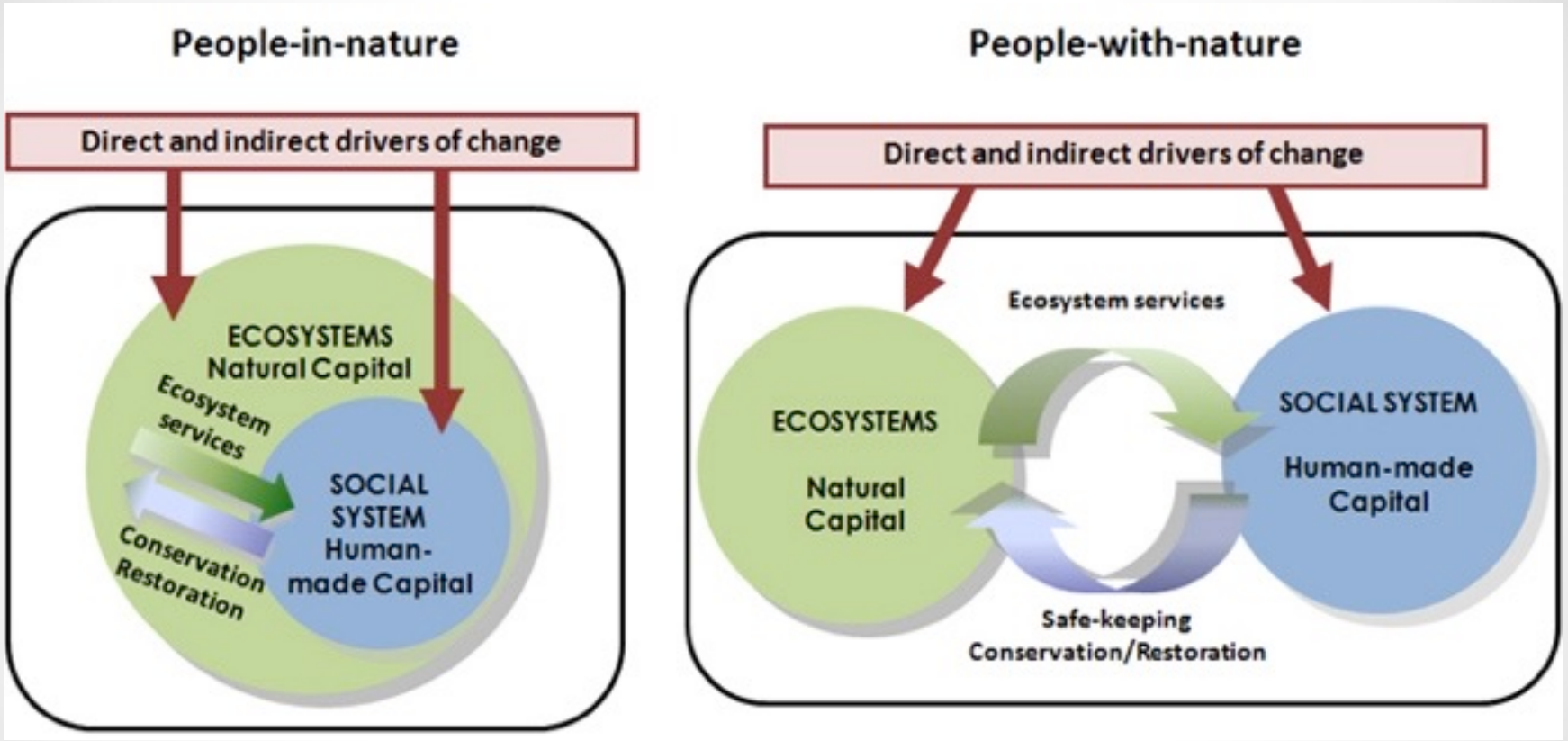
Socio-Ecological Systems (SES)

Resilience Alliance




People-in-nature
Direct and indirect drivers of change
ECOSYSTEMS
Natural Capital
Ecosystem services
SOCIAL SYSTEM
Human-made Capital
Conservation
Restoration
People-with-nature
Direct and indirect drivers of change
Ecosystem services
ECOSYSTEMS
Natural Capital
SOCIAL SYSTEM
Human-made Capital
Safe-keeping
Conservation/Restoration

Four essential dimensions:
Actors, Governance, Resource Units and Resource Systems

Actors within and outside a Governance System
Governance System characterized by formal and informal rules at one or more identifiable geographical scales
Resource Units inhabit and interact with a Broader Resource System
Resource System is characterized by particular ecosystem types and biophysical processes, also at one or more geographical scales

Interaction among these four dimensions are mediated by broader social, economic and political settings and related ecosystems

Together these dynamics lead to diverse outcomes at particular temporal and spatial scales

Socio-Ecological Systems (SES) Framework

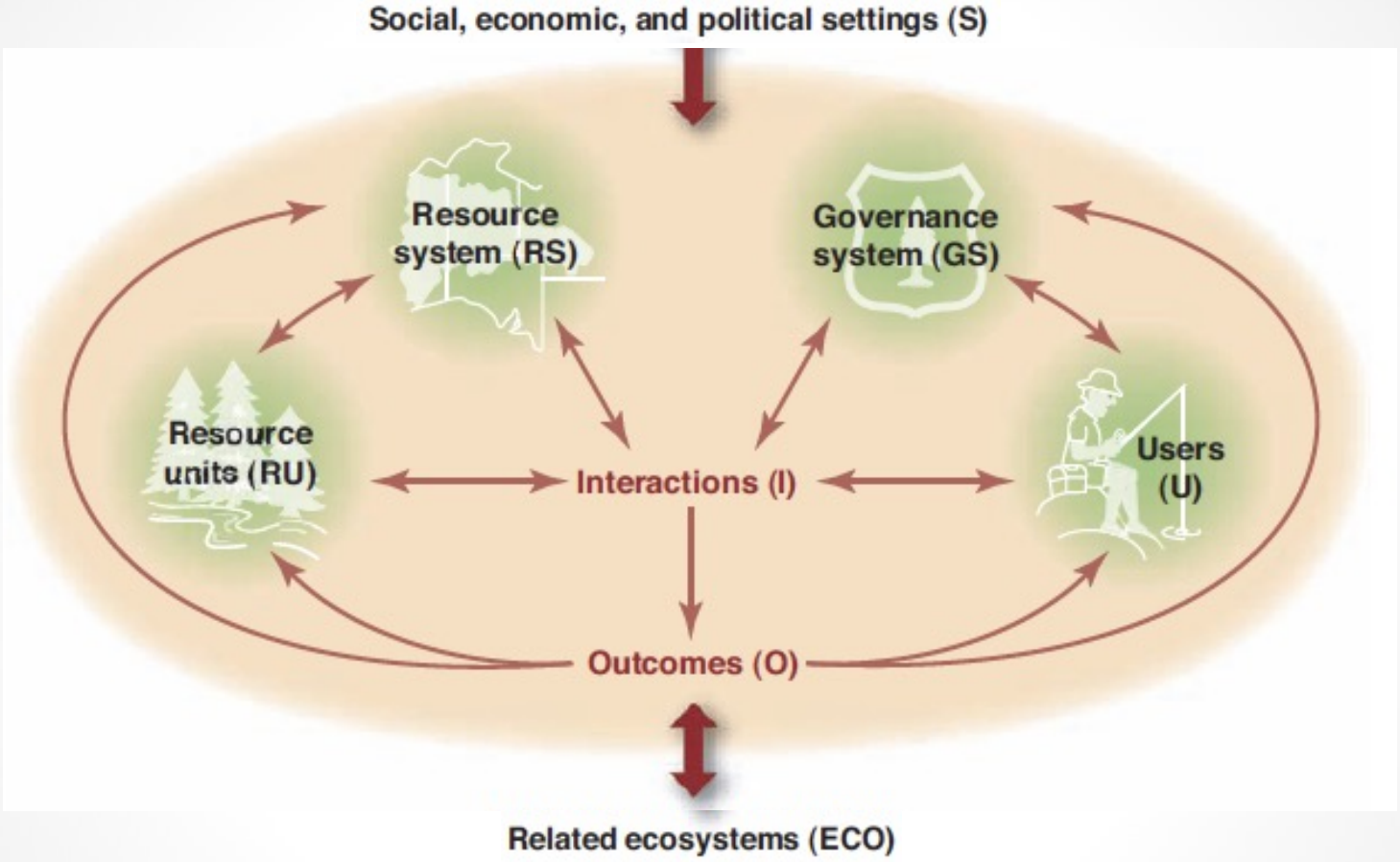


Fig. 1. The core subsystems in a framework for analyzing social-ecological systems.

OSTROM, 2009

Social, economic, and political settings (S)

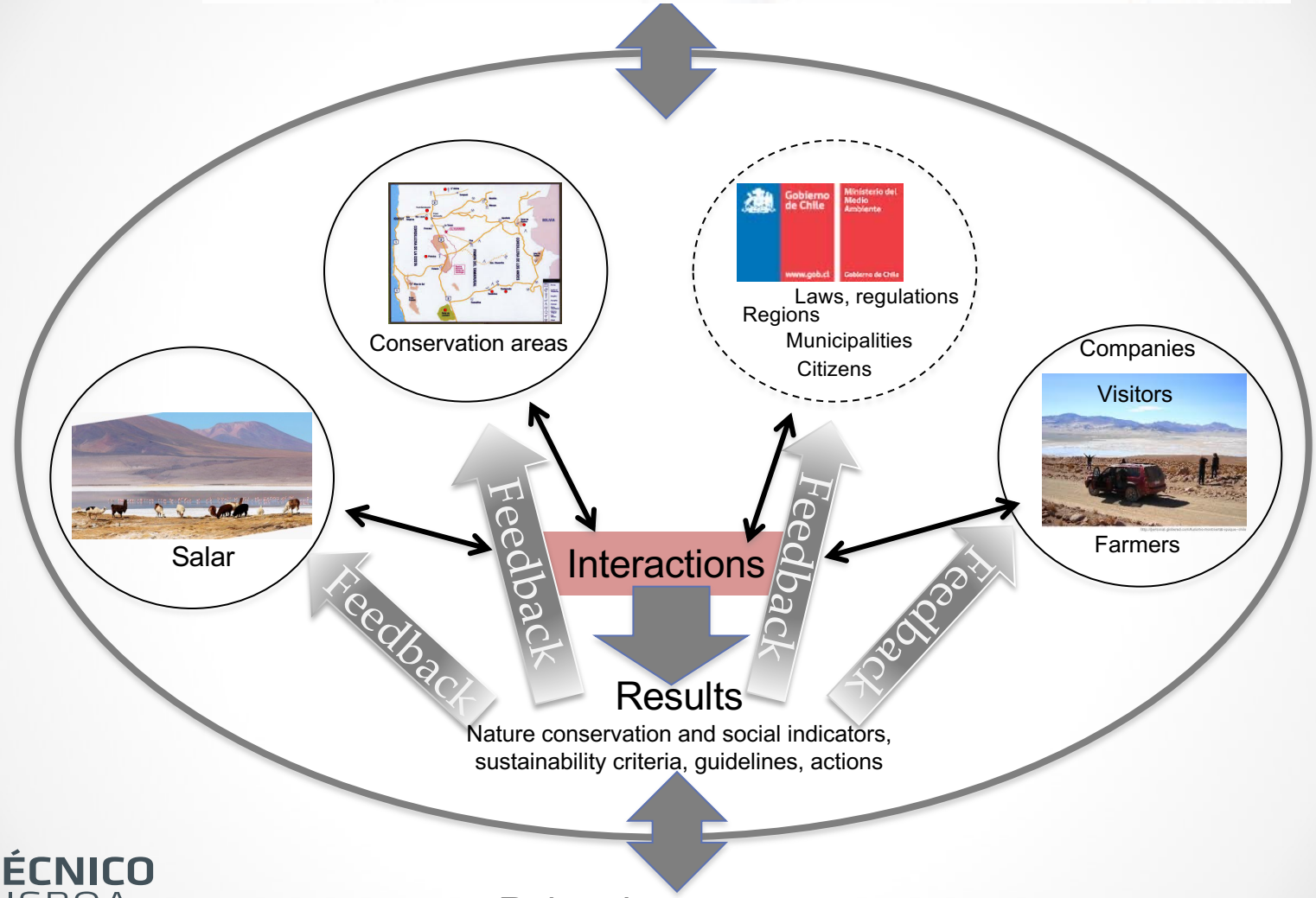


Table 1. Examples of second-level variables under first-level core subsystems (S, RS, GS, RU, U, I, O and ECO) in a framework for analyzing social-ecological systems. The framework does not list variables in an order of importance, because their importance varies in different studies. [Adapted from (*12*)]

Social, economic, and political settings (S)

S1 Economic development. S2 Demographic trends. S3 Political stability. S4 Government resource policies. S5 Market incentives. S6 Media organization.

Resource systems (RS)	*Governance systems (GS)*
RS1 Sector (e.g., water, forests, pasture, fish)	GS1 Government organizations
RS2 Clarity of system boundaries	GS2 Nongovernment organizations
RS3 Size of resource system*	GS3 Network structure
RS4 Human-constructed facilities	GS4 Property-rights systems
RS5 Productivity of system*	GS5 Operational rules
RS6 Equilibrium properties	GS6 Collective-choice rules*
RS7 Predictability of system dynamics*	GS7 Constitutional rules
RS8 Storage characteristics	GS8 Monitoring and sanctioning processes
RS9 Location	
Resource units (RU)	*Users (U)*
RU1 Resource unit mobility*	U1 Number of users*
RU2 Growth or replacement rate	U2 Socioeconomic attributes of users
RU3 Interaction among resource units	U3 History of use
RU4 Economic value	U4 Location
RU5 Number of units	U5 Leadership/entrepreneurship*
RU6 Distinctive markings	U6 Norms/social capital*
RU7 Spatial and temporal distribution	U7 Knowledge of SES/mental models*
	U8 Importance of resource*
	U9 Technology used

Interactions (I) → outcomes (O)

I1 Harvesting levels of diverse users	O1 Social performance measures (e.g., efficiency, equity, accountability, sustainability)
I2 Information sharing among users	
I3 Deliberation processes	
I4 Conflicts among users	O2 Ecological performance measures (e.g., overharvested, resilience, bio-diversity, sustainability)
I5 Investment activities	
I6 Lobbying activities	
I7 Self-organizing activities	O3 Externalities to other SESs
I8 Networking activities	

Related ecosystems (ECO)

ECO1 Climate patterns. ECO2 Pollution patterns. ECO3 Flows into and out of focal SES.

*Subset of variables found to be associated with self-organization.

RESOURCE

“Resources are means to support human beings; can not be assessed beyond the meaning and values allocated by people” (Rees, 1985)

RESOURCES MULTIFUNCIONALITY

WETLAND FUNCTIONS (ECOSYSTEM SERVICES)

- Recharge / download of groundwater;
- Change in flooding regimes;
- Sediments stabilization/ coastline stability;
- Sediments retention/ toxic substances;
- Deposition of CO_2 , CH_4, NO_x, etc.
- Nutrients processing/ water quality;
- Production and basis of the food chain;
- Wildlife habitat / nursery;
- Fisheries
- Cultural Heritage
- Recreation and leisure
- Scientifc

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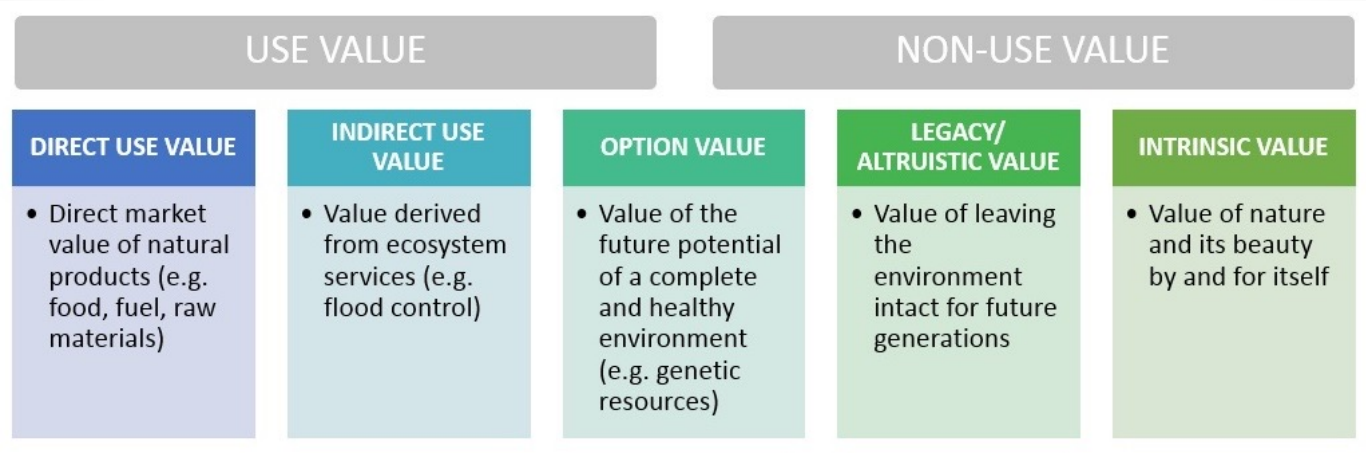
VALUE

the importance, worth, or usefulness of something

- Ecological/Cultural value: rarity, distinction, particularities, functionality
- Personal value: principles or standards of behaviour; one's judgement of what is important in life
- Market value: meaning in the market, monetary worth

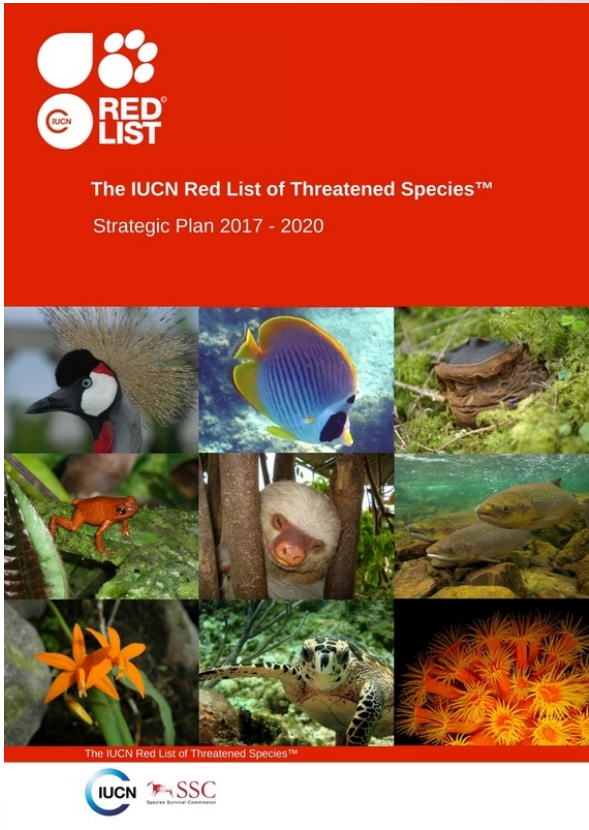


SENSITIVITY and VULNERABILITY

SENSITIVITY - The degree to which a system is affected (adversely or beneficially)Narrow range of survival

Eg IUCN red list of threatened species

VULNERTABILITY – the degree to which a system is susceptible, or unable to cope with, adverse changes



E.g. Coastal fisheries

- Small-scale fisheries important for local human communities for both income and food security
- Effects of fisheries on marine populations and ecosystem health

Meeting human needs while sustainaing ecosystems and the benefits they provide is a global challenge

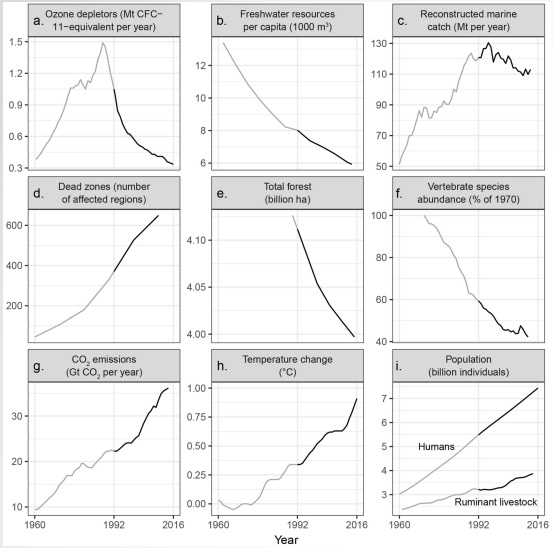
E.g. Rural tourism

- Rural tourism is important for local rural communities for both income and to maintain cultural identity
- Effects of tourism on tranquility and on pressures on infrastructures

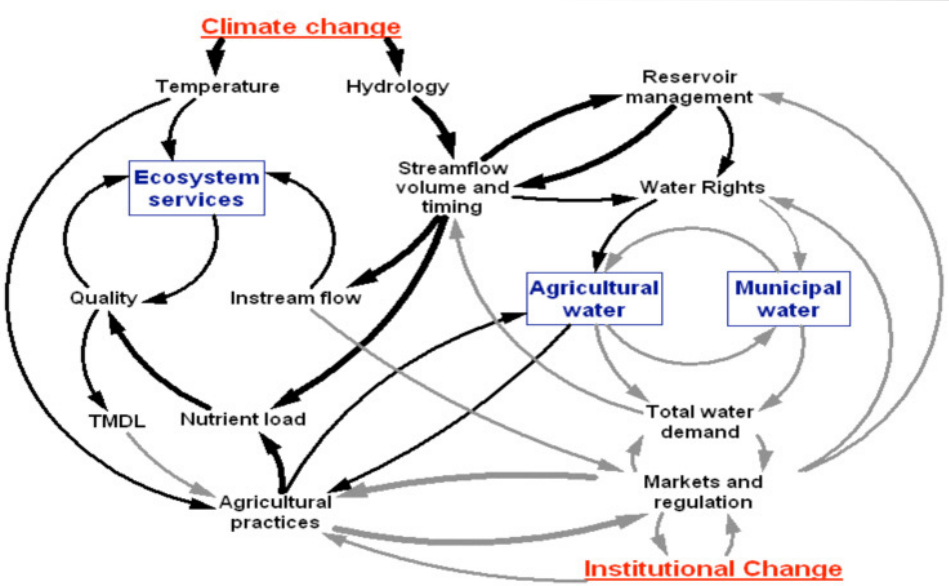
Thinking in systems

Best and Holmes, 2010

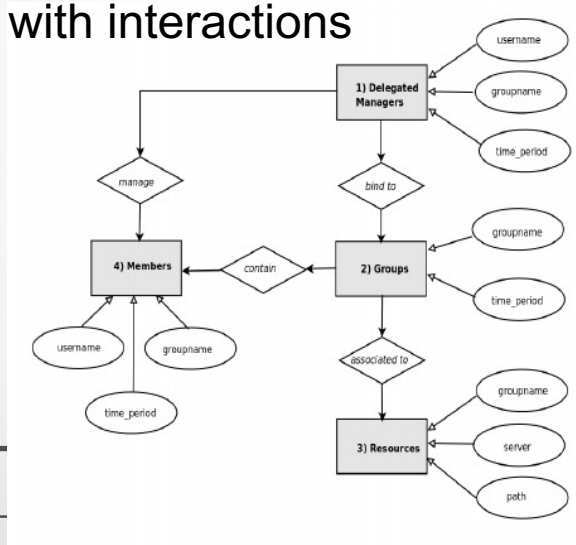
linear models:
one-way process



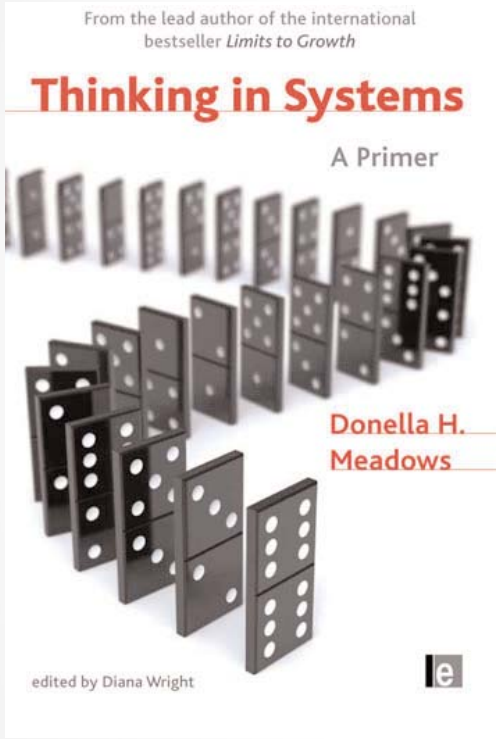
systems models: activation of parts to be linked together



relationship models: linear with interactions

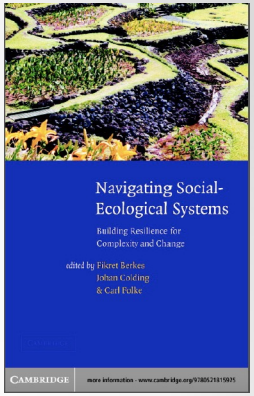


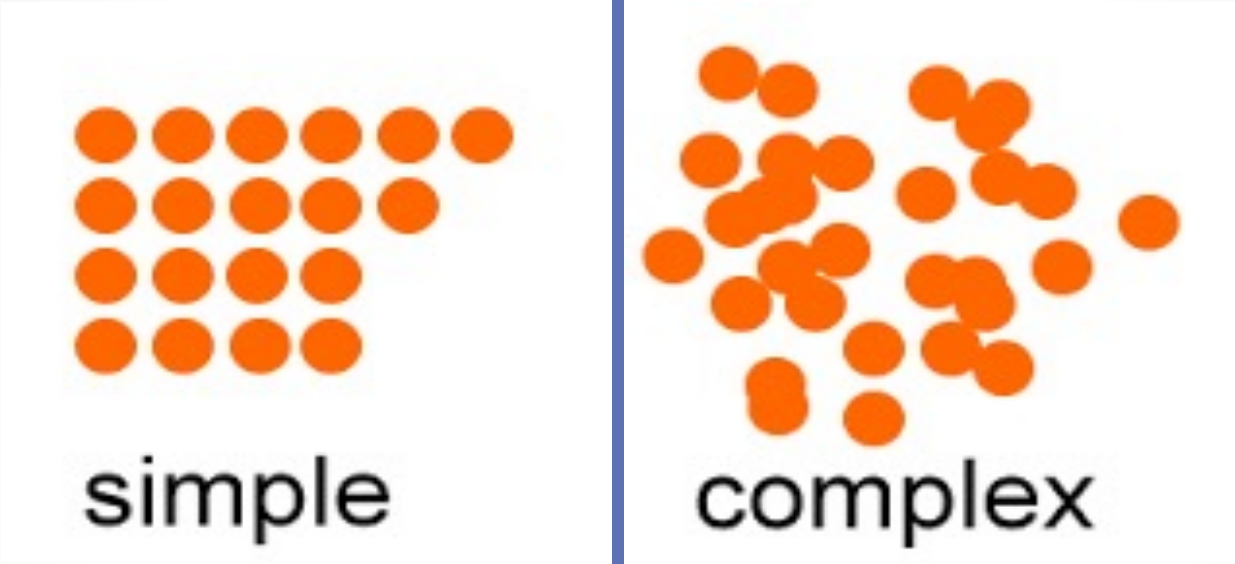
Thinking in systems



Russel Ackhoff, 1989

Simple and complex systems





one that can be adequately captured using a single perspective and a standard analytical model

has a number of attributes not observed in simple systems, including nonlinearity, uncertainty, emergence, scale, and self-organization

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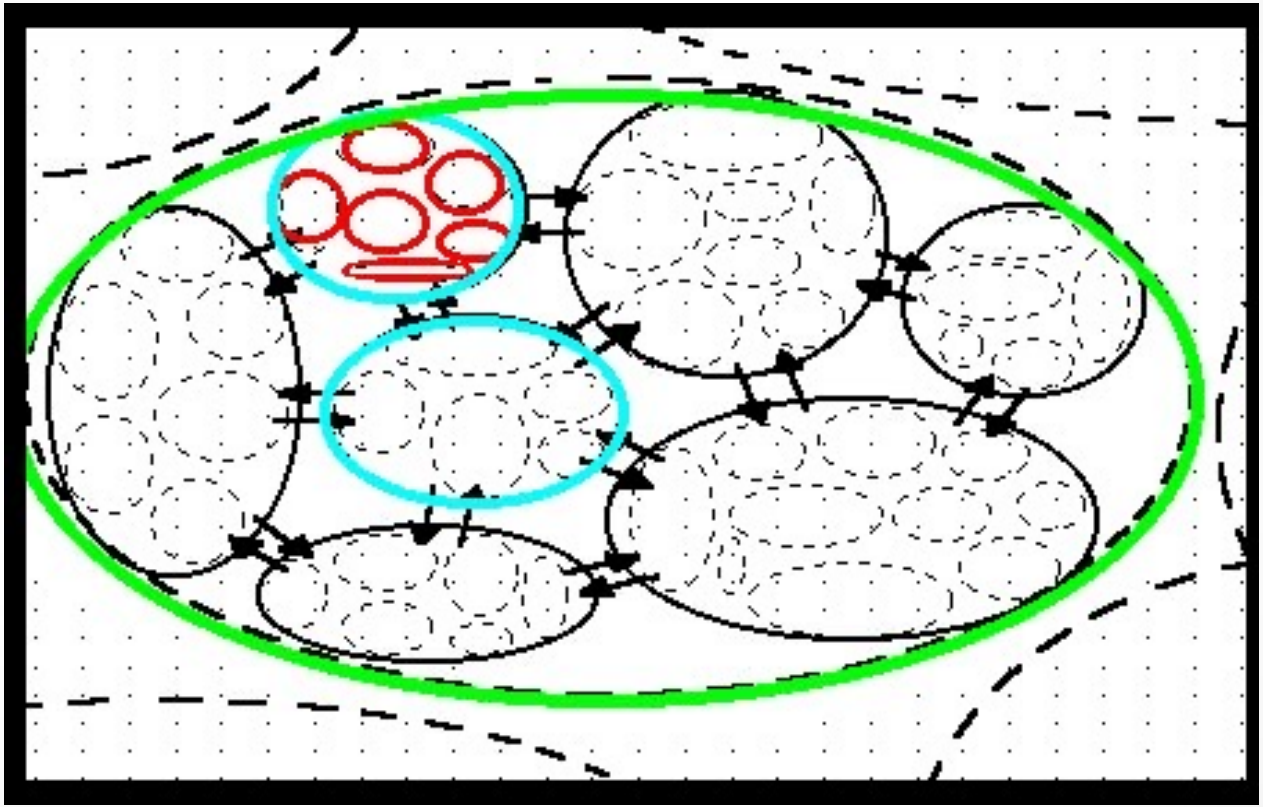
Complex systems – systems nested in systems and feed-back relationships



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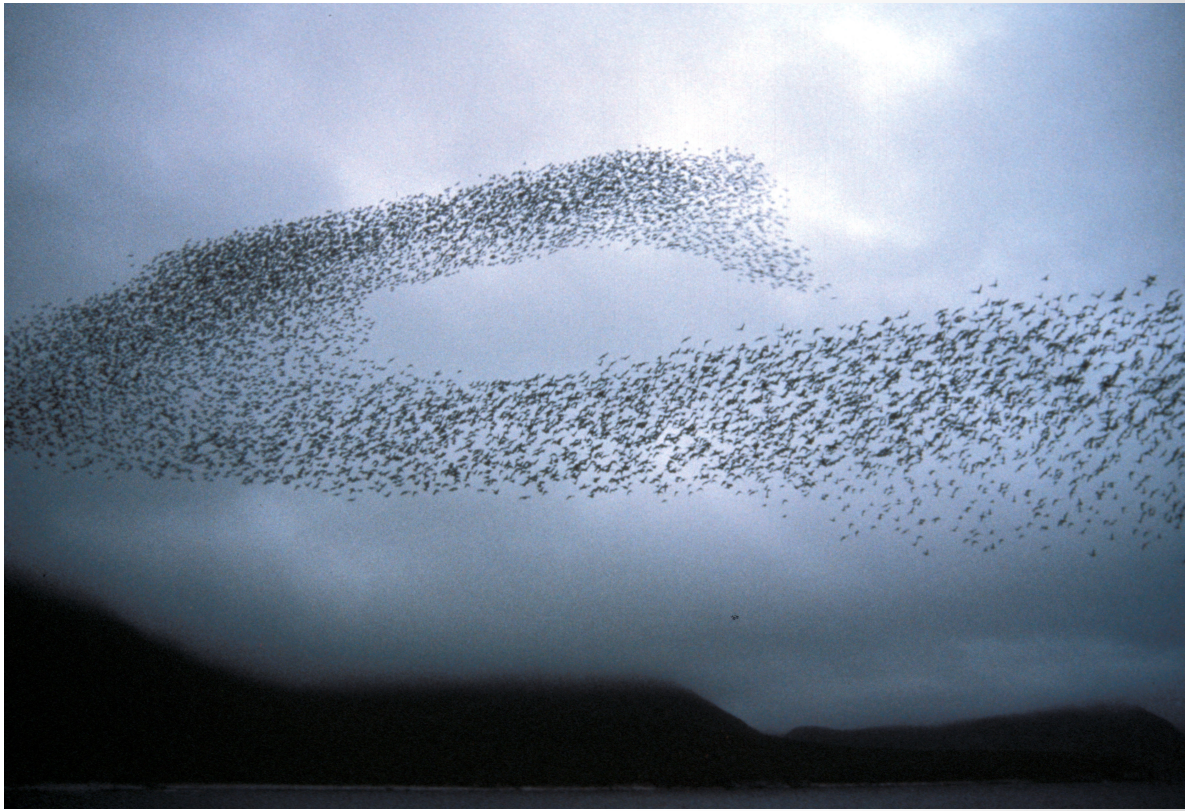
Complex systems – systems self-organization
Cycles of growth and renewal: non-linear and unpredictable

Craig Reynold's Flocking rules

1. Separation - avoid crowding neighbours (short range repulsion)
2. Alignment - steer towards average heading of neighbours
3. Cohesion - steer towards average position of neighbours (long range attraction)



https://www.youtube.com/watch?v=QbUPfMXXQIY

https://www.youtube.com/watch?v=V4f_1_r80RY

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Resilience is a property of systems

The ability to absorb disturbances, to be changed and then to re-organise and still have the same identity (retain the same basic structure and ways of functioning).

It includes the ability to learn from the disturbance.

Key to resilience is diversity

Diversity provides functional redundancy

http://www.resalliance.org/564.php

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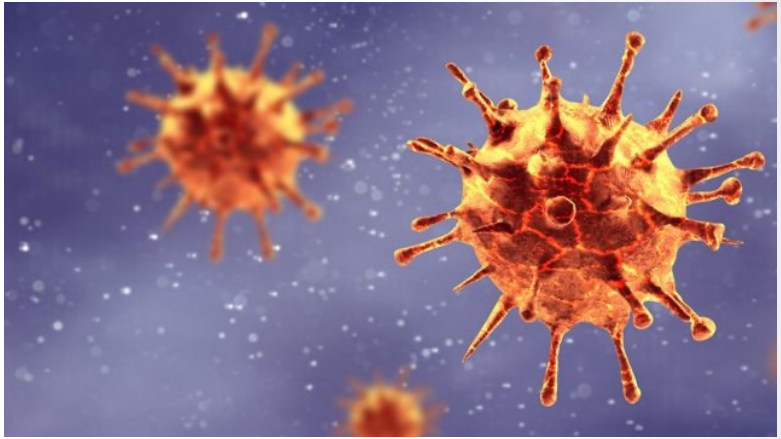
There is good and there is bad resilience



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Resilience is a property of systems

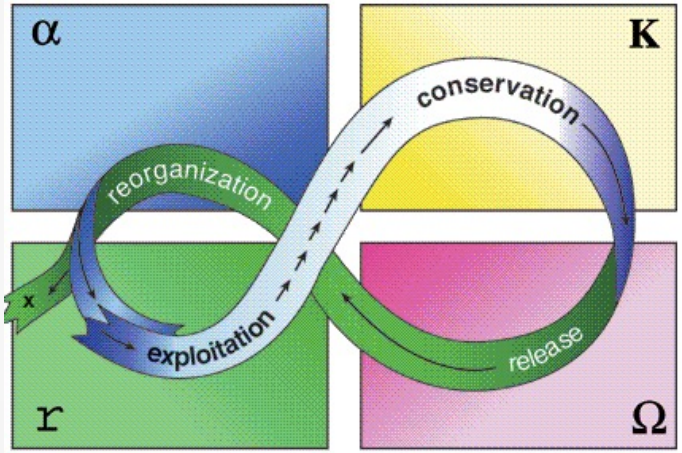
Three defining characteristics

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

(Carpenter et. al, 2006)

The adaptive cycle

Fore-loop and back-loop

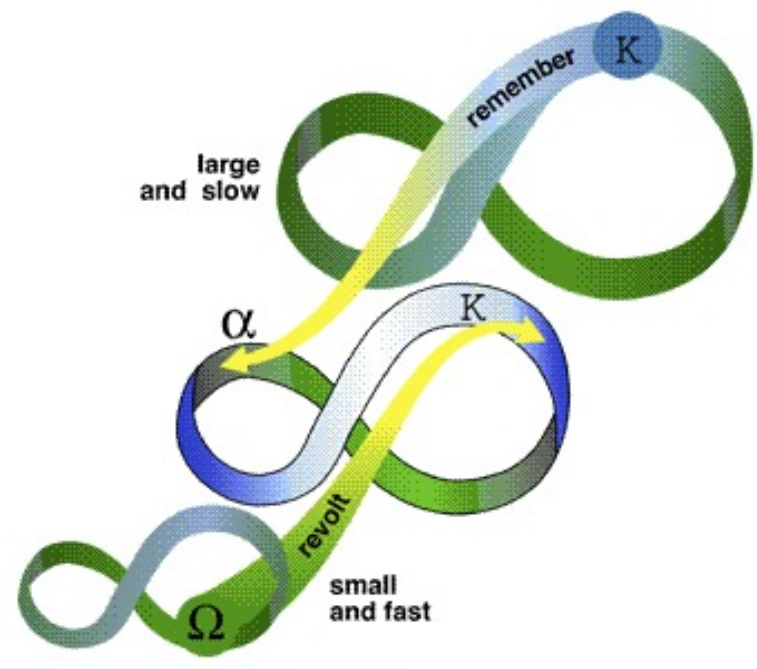


Fore-loop – growth and conservation, where resources become locked-up in the system's structure

Back-loop – rapid collapse, following a severe disturbance or shock that disrupts the system and releases resources, followed by a short re-organization phase – opportunity for system's reconfiguration

Source: (originally CS Holling, Adaptive Management Systems)
The Resilience Alliance
http://rs.resalliance.org/wp-content/uploads/2007/02/4box-adaptive-cycle.gif)

Panarchy



A nested hierarchy of adaptive cycles (Holling and Gunderson, 2002)

Emphasizes the unpredictability

Interplay between change and persistence

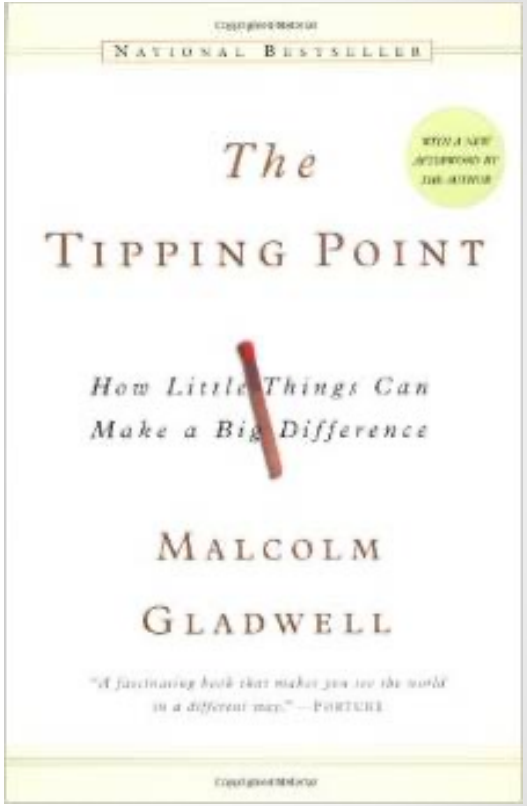
How things can change and yet remain more or less the same (Holling, 2001)

THRESHOLDS

Thresholds are breaking points in a system

At a threshold there is an abrupt change in a system quality, property or phenomenon.

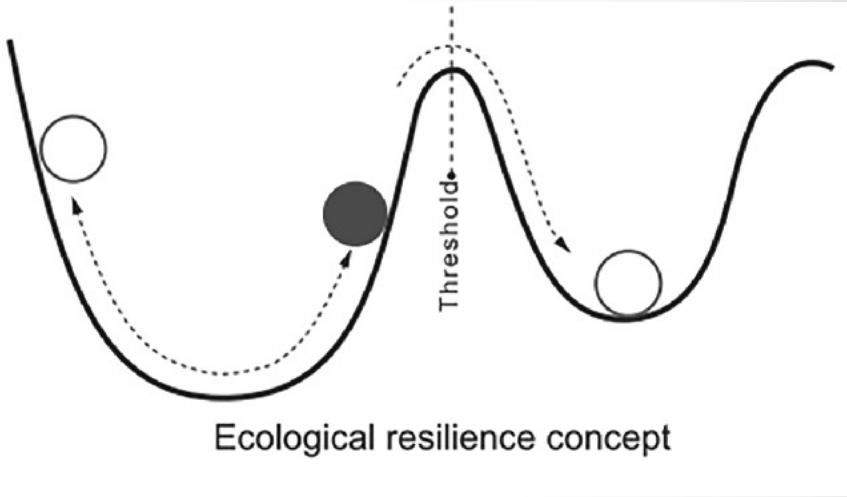
Thresholds can be detected at different spatial, temporal or functional scales.



Thresholds and alternate stable status

Resilient thinking assumed that **socio-ecological systems have alternate states and exhibit abrupt change**, as opposed to conventional environmental management that assumes smooth and predictable change

In resilient thinking management of thresholds is essential to ensure the system remains at a desired state, or if change occurs into an undesirable state, conditions exist to transform the system to a state that is desirable



Ecological resilience concept

Slootweg and Jones, 2011 (IAPA, December)

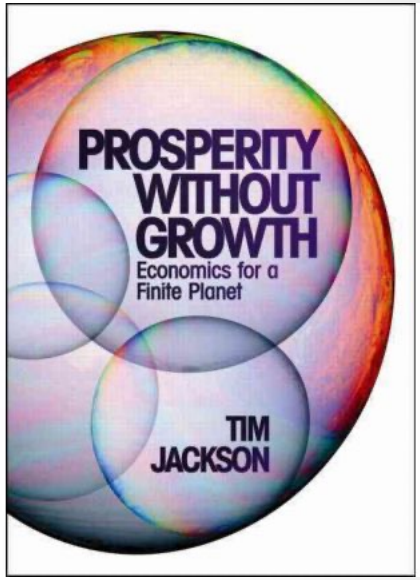
The question of limits (Tim Jackson, 2009) - uncertainty -

Three distinct phases:

late 18th century - Malthus, Essay on Population – sooner or later population expands beyond the “means of subsistence” and some people – the poorest inevitably – will suffer. …..global population is now 6x bigger and the economy 68x bigger than in 1800 – technological change explain

1970’s - Club of Rome, Limits to Growth – sooner or later the resource base would collapse (due to resource extraction rates and available reserves) …Resource scarcities before the Millennium did not happen as expected…but they were not far

currently – climate change and peak oil – problem of “sinks” – the capacity of the planet to “assimilate” the environmental impacts of economic activity. Climate change is one of these sink problems. Though it came late to the party, the climate may turn out to be the mother of all limits



Iron cage of consumerism (Tim Jackson, 2009)

Beyond limits (Tim Jackson, 2009)

Ecological limits linked to resource scarcity or climate change include:

- rapid deforestation
- biodiversity loss
- collapse of fish stocks
- water scarcity
- pollution of soil and water supplies

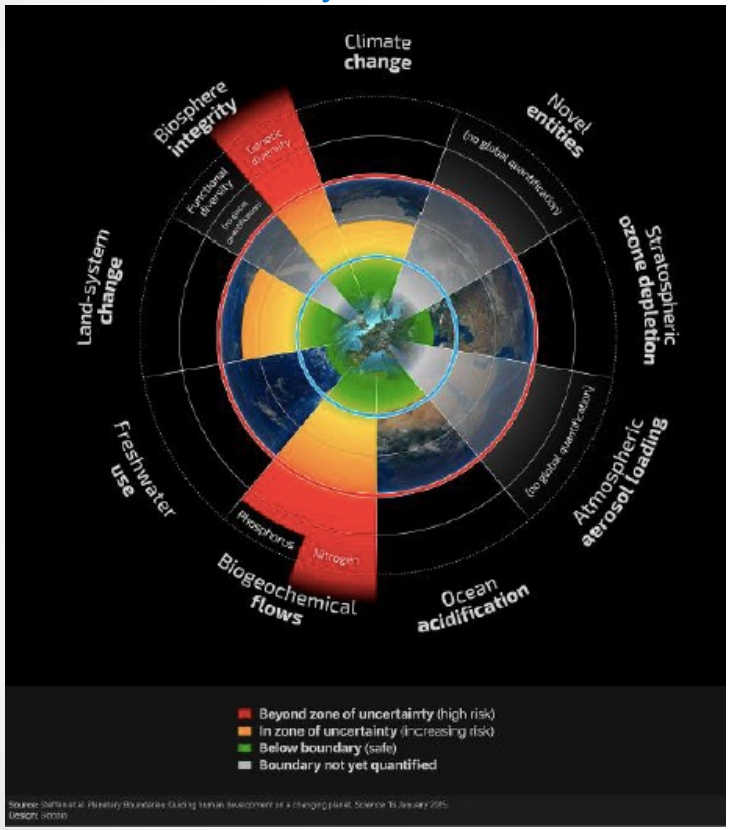
60% of the world ecosystem services have been degraded or over-used since the mid-20th century

In the same period of time the global economy has grown more than 5 times.

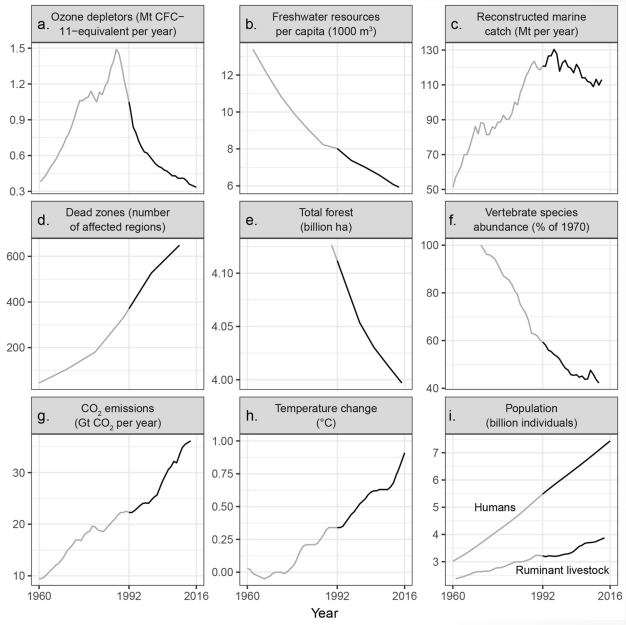
If growth rate continues it will be 80 times bigger in 2100 than it was in 1950.

THRESHOLDS

Planetary boundaries



Second notice from scientists (Nov 2017)



From: World Scientists' Warning to Humanity: A Second Notice
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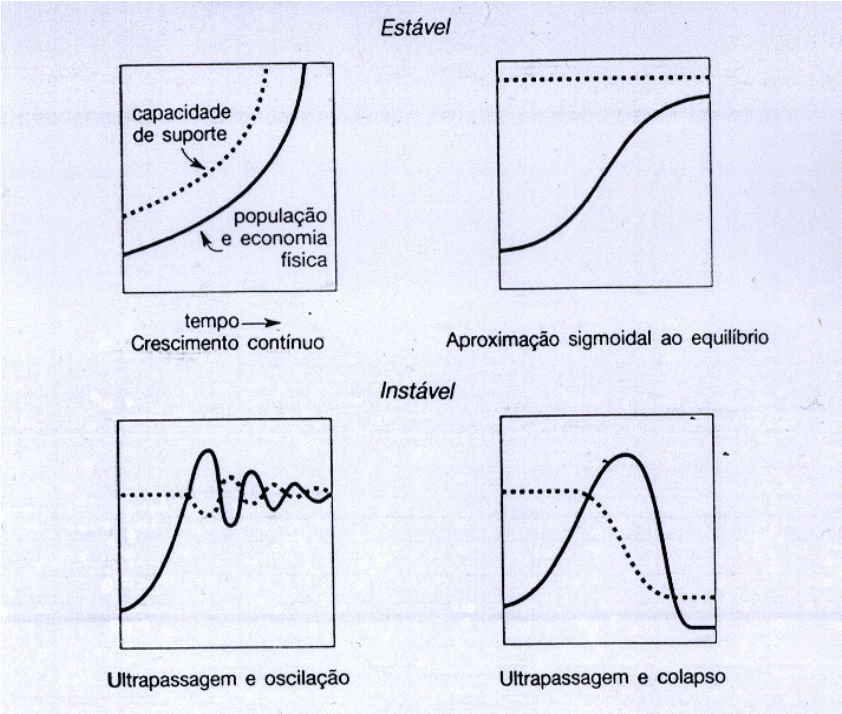
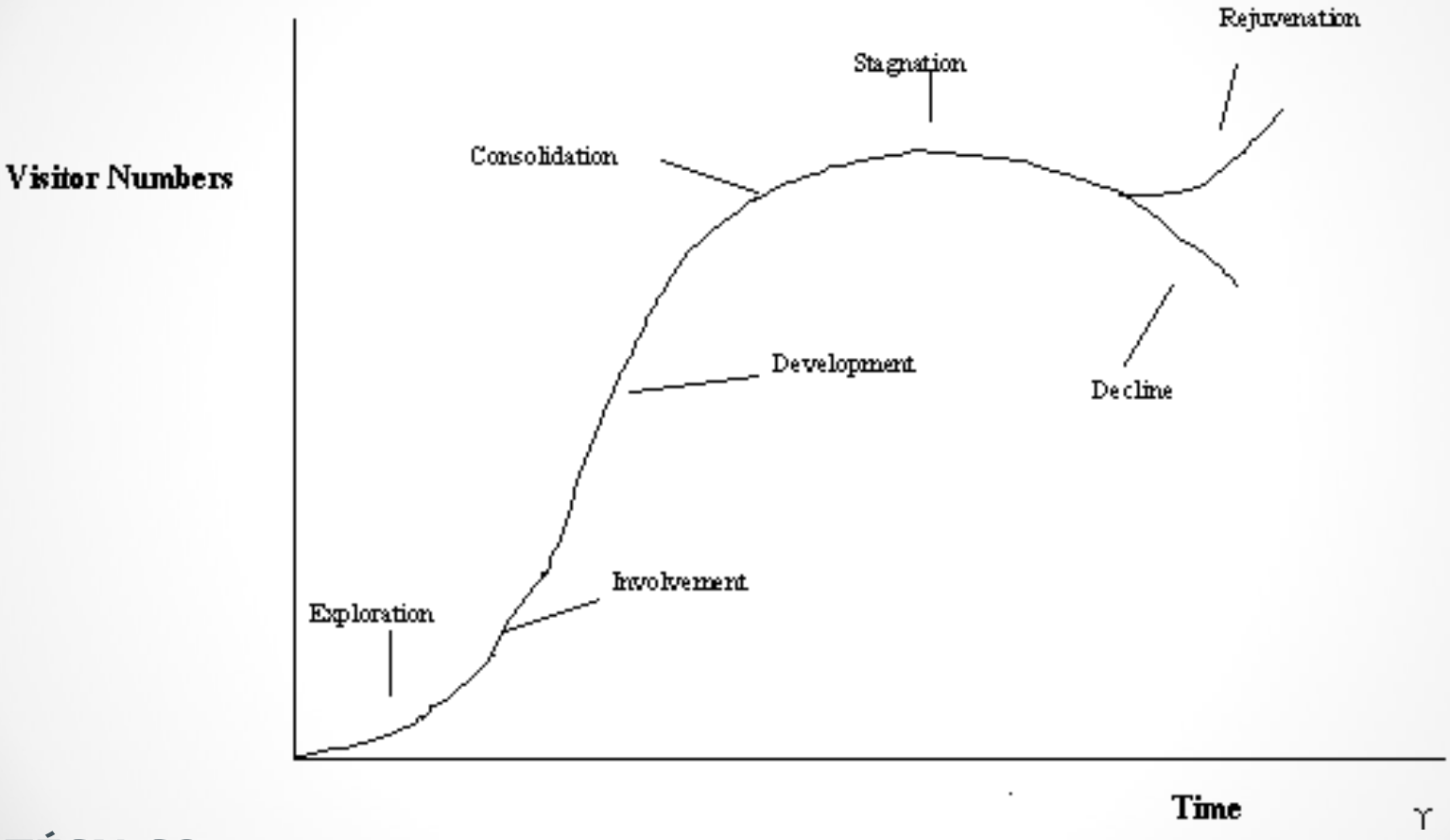
Carrying capacity models (Meadows, 2002)



Tourism carrying capacity (Butler, 1980)



LIMITS OF ACCEPTABLE CHANGE

Concept that attempts to overcome the technical limits of the carrying capacity concept, taking advantage of its political opportunity

Reformulated approaches to carrying capacity, that attenmpts to integrate social dimensions.

Enables the consideration of the interaction between natural and human systems, at any level: from thresholds objectively assessed to desirable or political acceptable conditions.

Objective management approaches

READ for next week:

EU Climate Strategy