Towards a sustainability process for GEOSS Essential Variables

11-12 June 2015, Bari-Italy

Societal Benefit Area: Ecosystems

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H2020 ECOPOTENTIAL: Improving future ecosystem benefits through Earth Observations

Coordinating an Observation Network of Networks EnCompassing saTellite and IN-situ to fill the Gaps in European Observations

Tales from afar

Hypokeimenon
Symbebekòs

Substantia
Accidens

Aristotéles,
Metaphysics
IV century BC

Tales from (less) afar

Hamiltonian (conservative) dynamical systems:
Action-Angle variables (e.g. solitons)

Thermodynamics and dimensional reduction

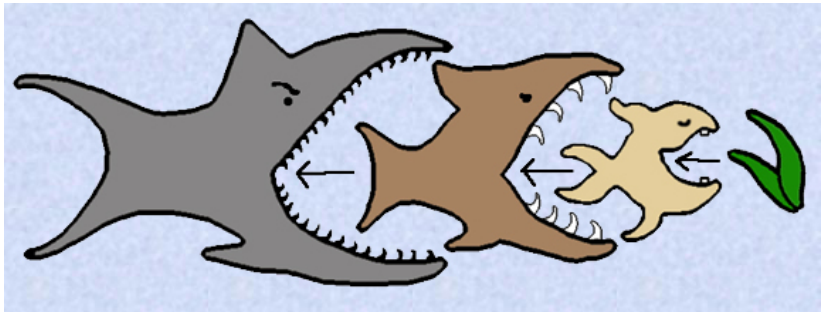
Spectral decompositions:
Fourier, normal modes, EOF, wavelets

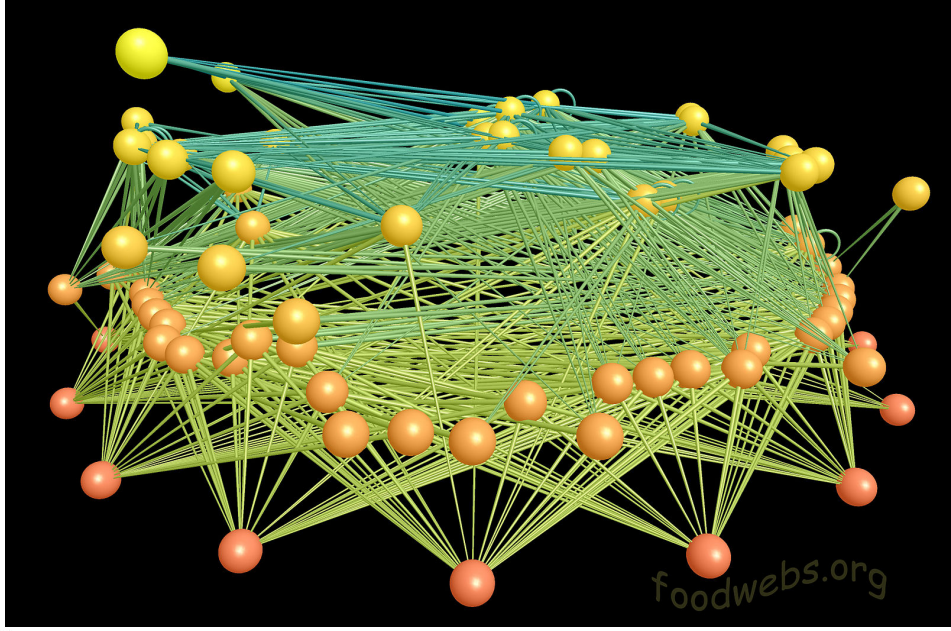
Dissipative systems: low-dimensional chaos

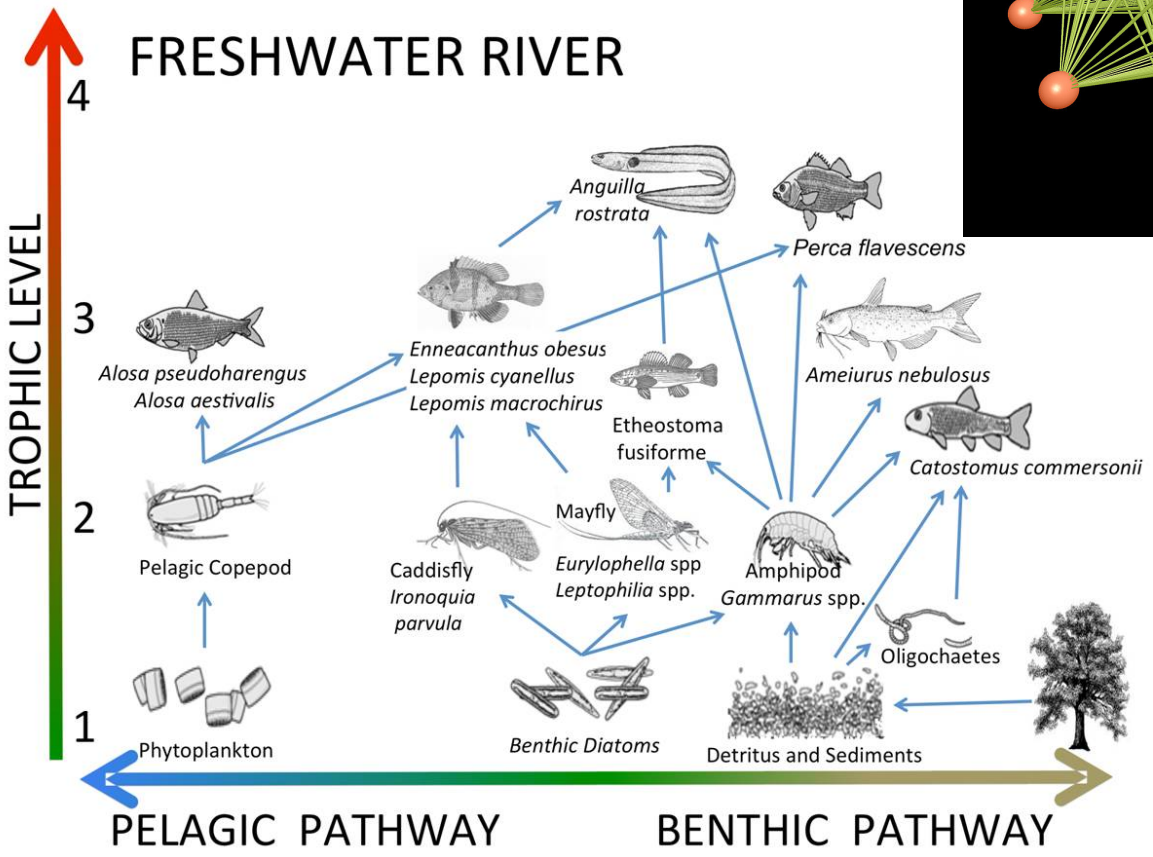
Slow manifold: a small number of slow variables – the fast variables are slaved

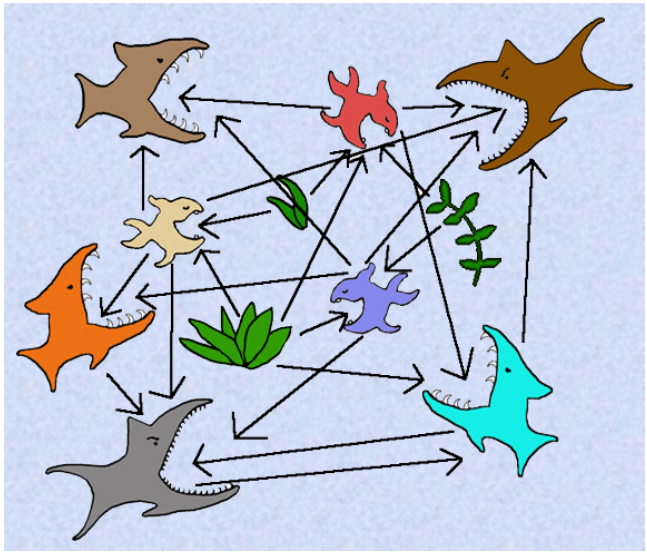
Example: A low-dimensional description of coherent structures (eg vortices in rotating fluids, plumes in convection)


What is an ecosystem?









Biotic components: the trophic web

Biodiversity is at the core of the biotic components of ecosystems

from D. deB. Richter and S. A. Billings,
New Phytologist, 2015

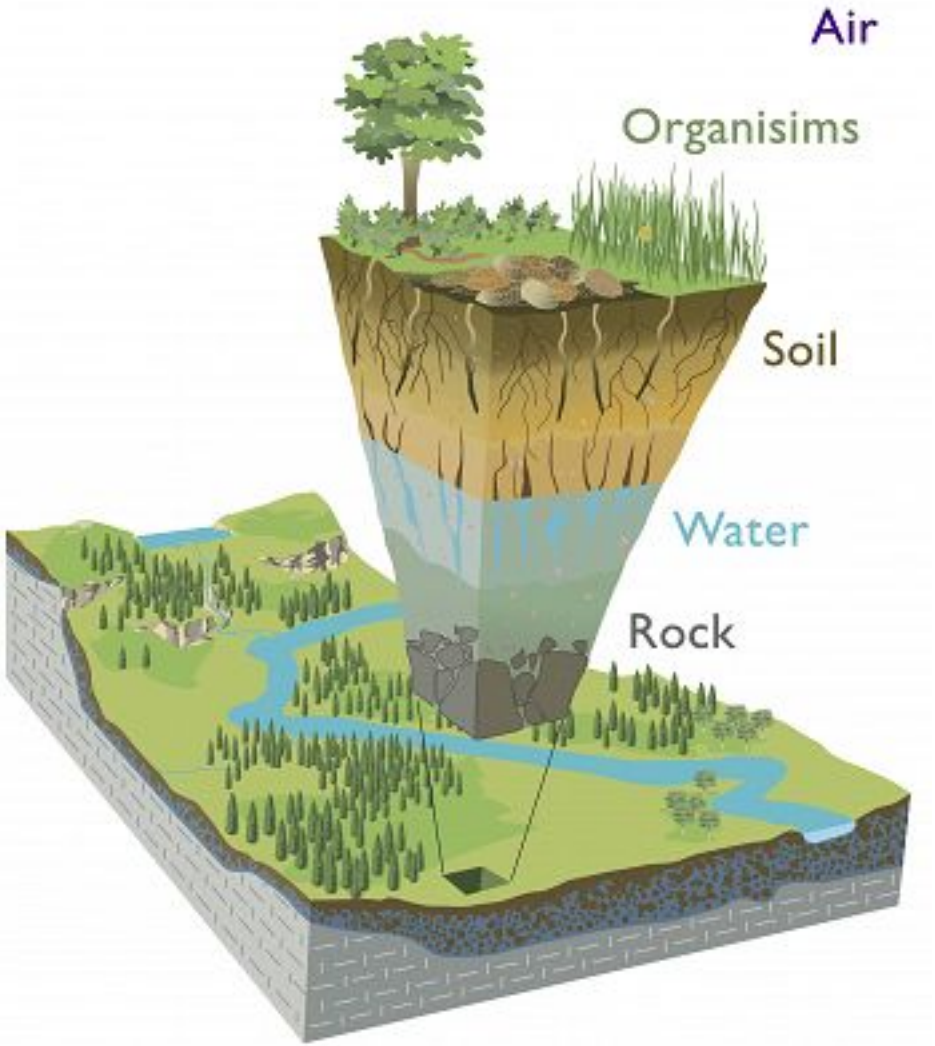
Arthur Tansley (1935), who briefly but substantively defined the ecosystem to be the integrated biotic–abiotic complex:

> the whole *system* (in the sense of physics), including not only the organism-complex, but also the whole complex of physical factors forming what we call the environment of the biome – the habitat factors in the widest sense.

Significantly, as if to emphasize what he meant by 'the whole system', Tansley (1935) added:

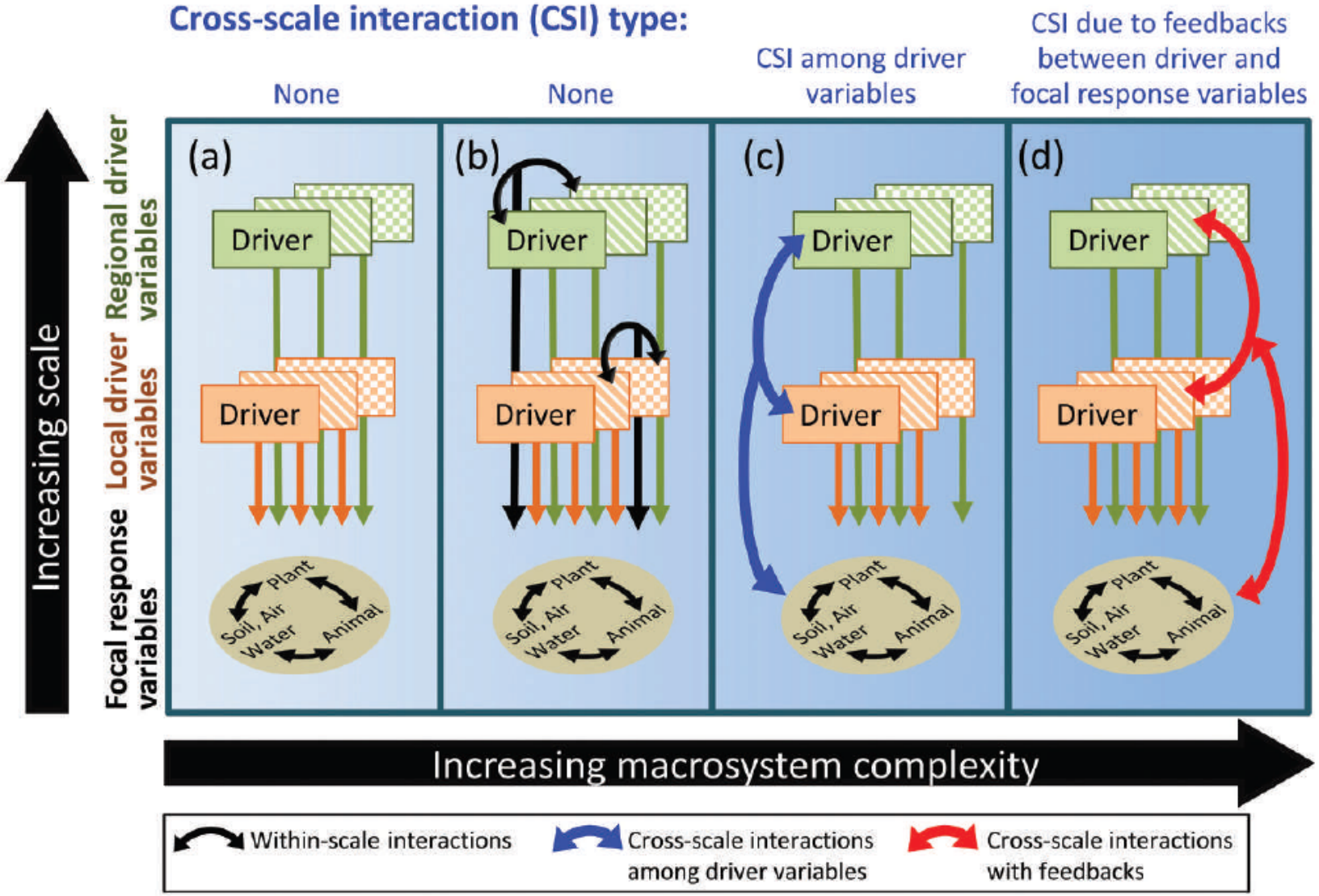
> Though (as biologists) the organisms may claim our primary interest, when we are trying to think fundamentally we cannot separate them from their special environment, with which they form *one physical system* (italics ours).

Ecosystems are complex adaptive systems



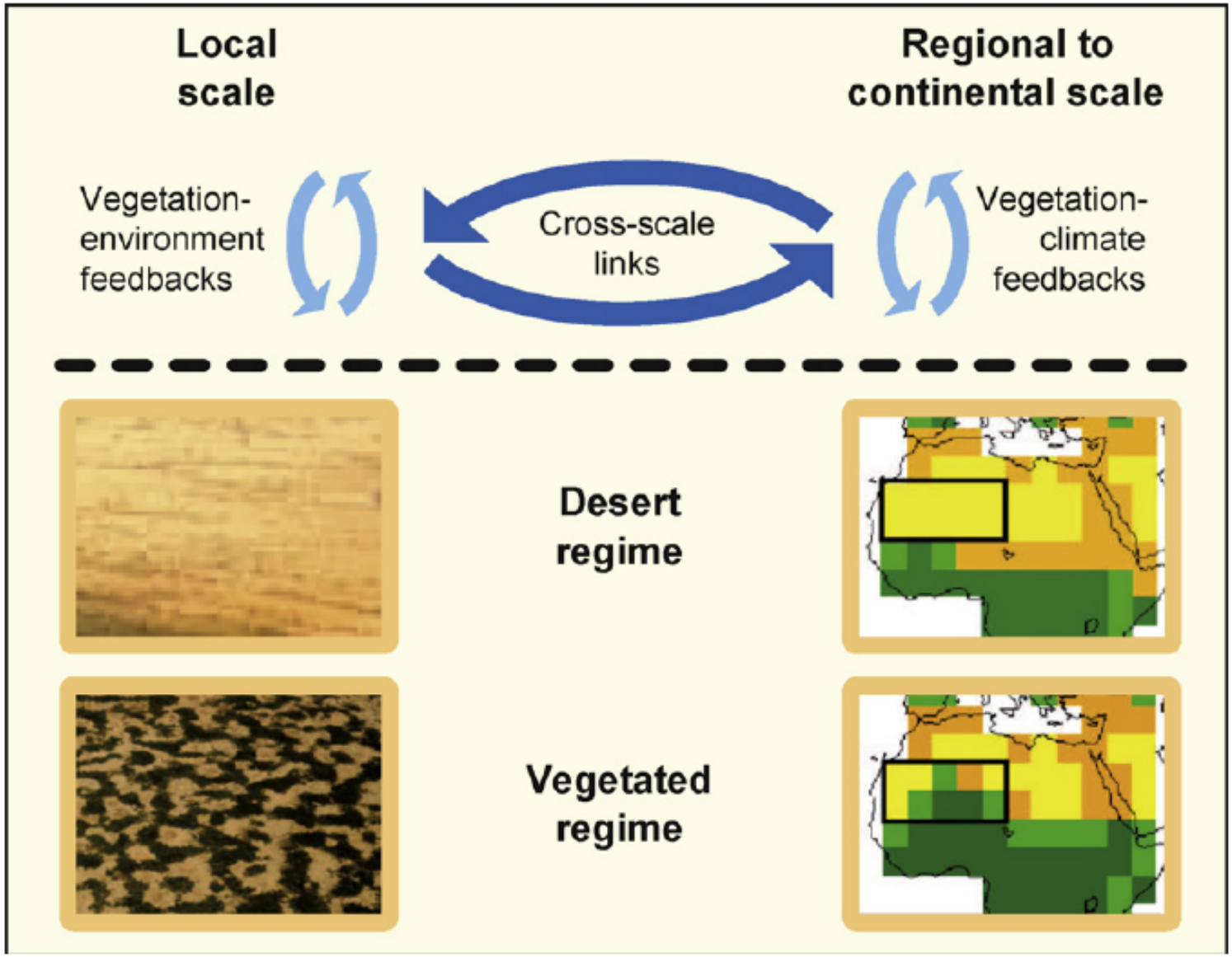
Biogeodynamical processes: the **Earth's Critical Zone**

Soranno et al. Frontiers Ecol. Env. 2014



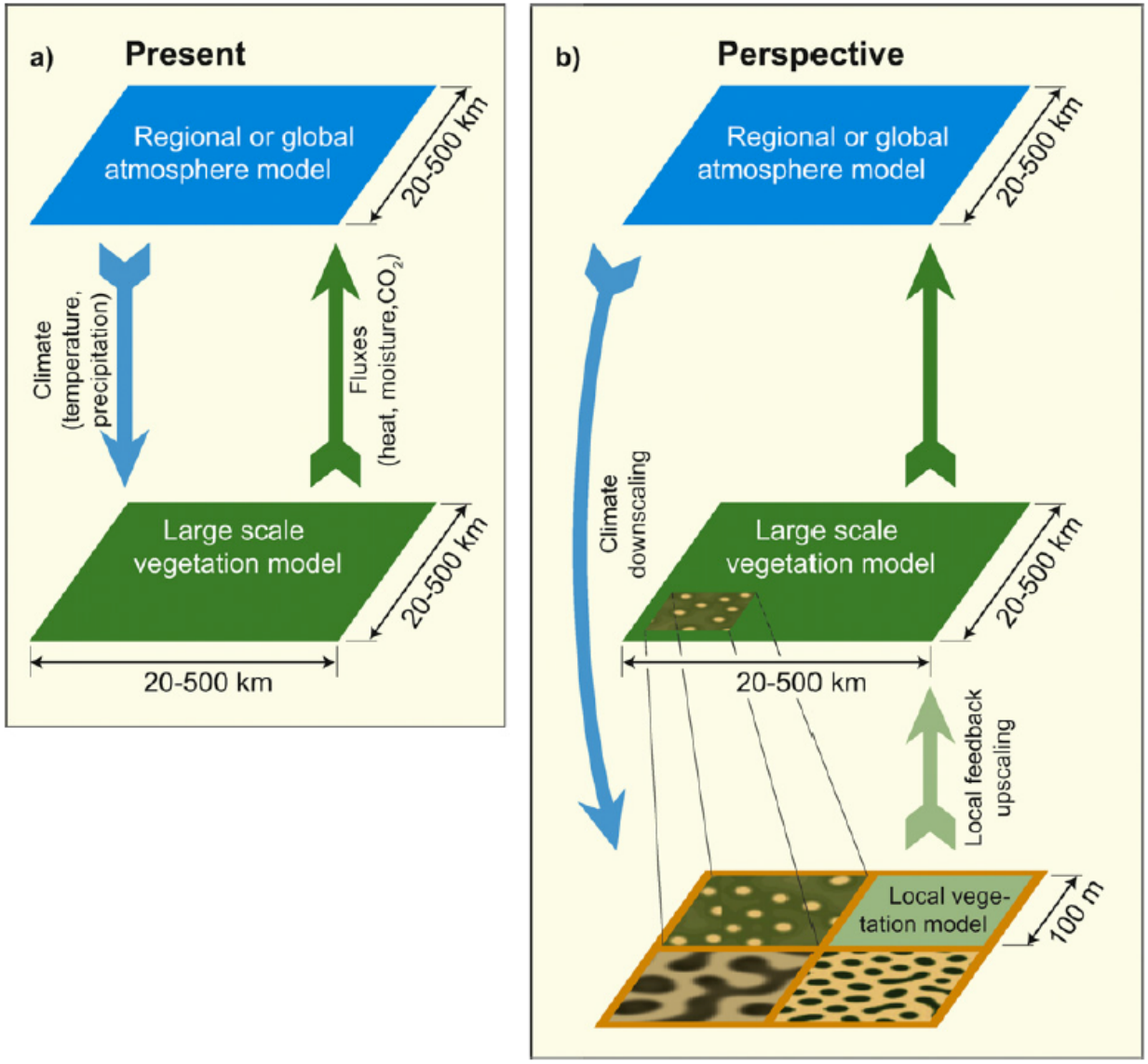
Macrosystems Ecology and cross-scale interactions

Rietkerk et al. Ecological Complexity 2011



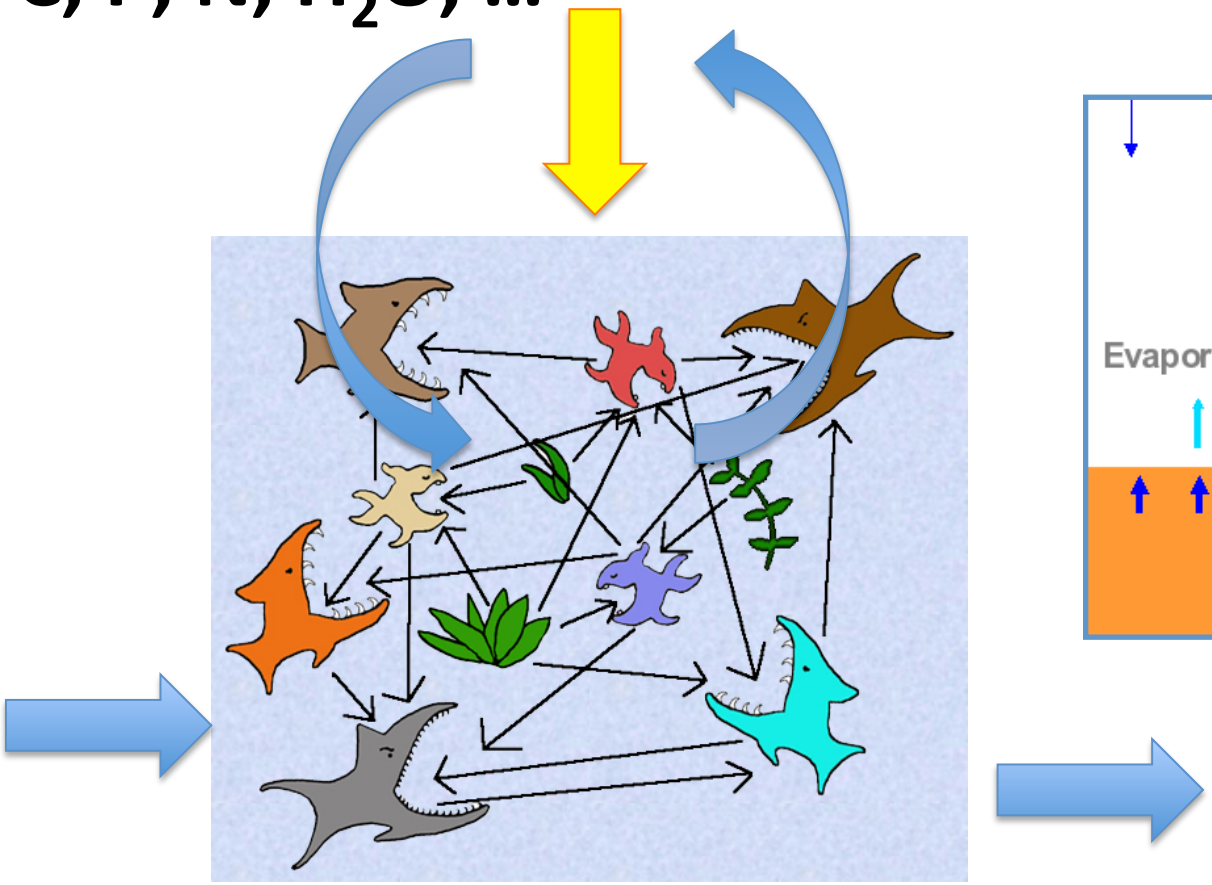
Cross-scale interaction and scale mismatch

Rietkerk et al. Ecological Complexity 2011

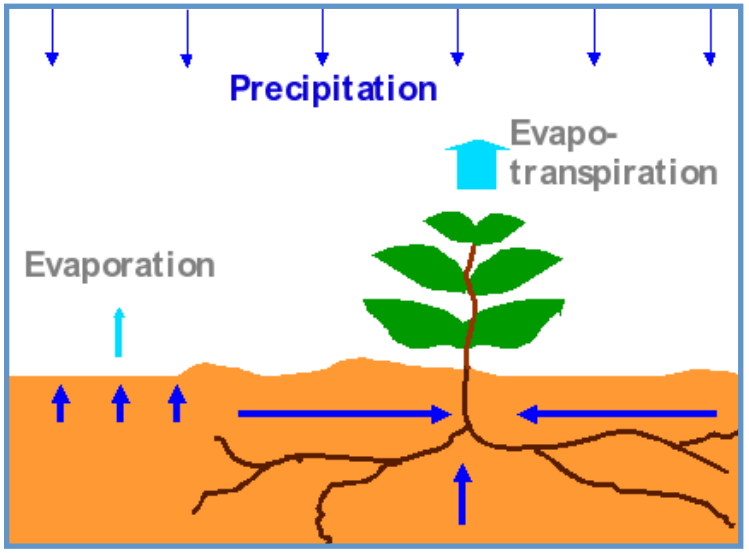


Cross-scale interaction and scale mismatch

C, P, N, H_2O, …



water fluxes



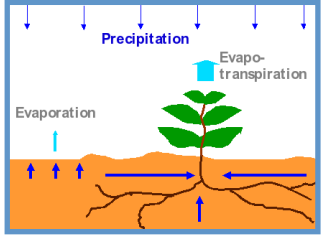
Fe, B, …

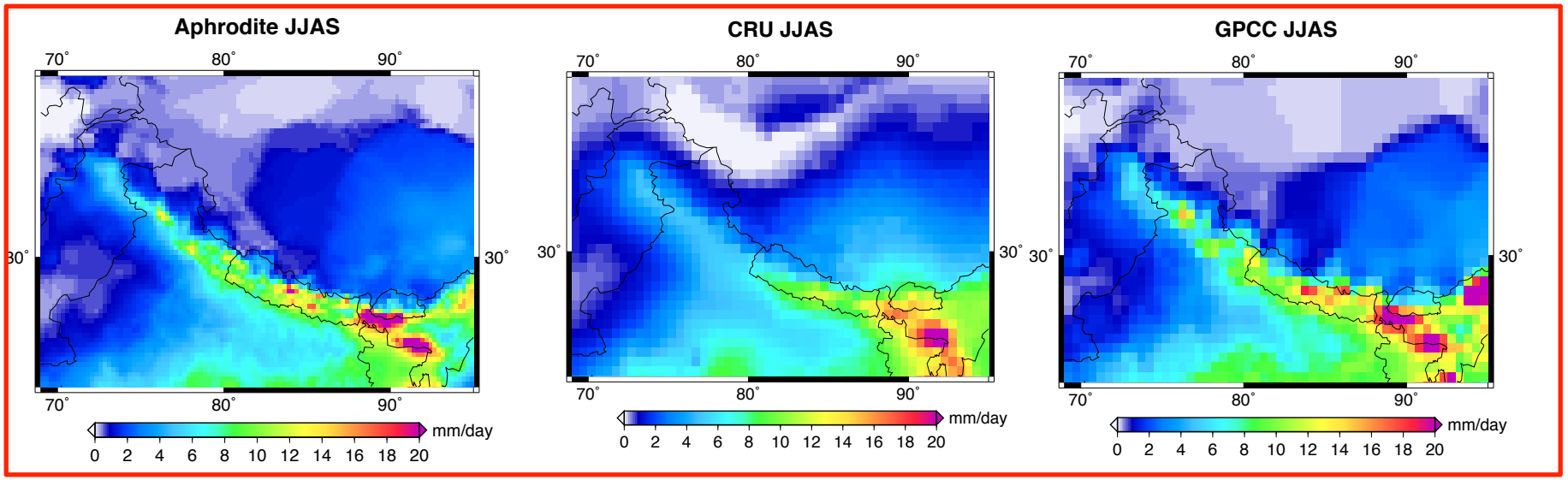
The example of rainfall: external driver or Essential Variable of ecosystems?

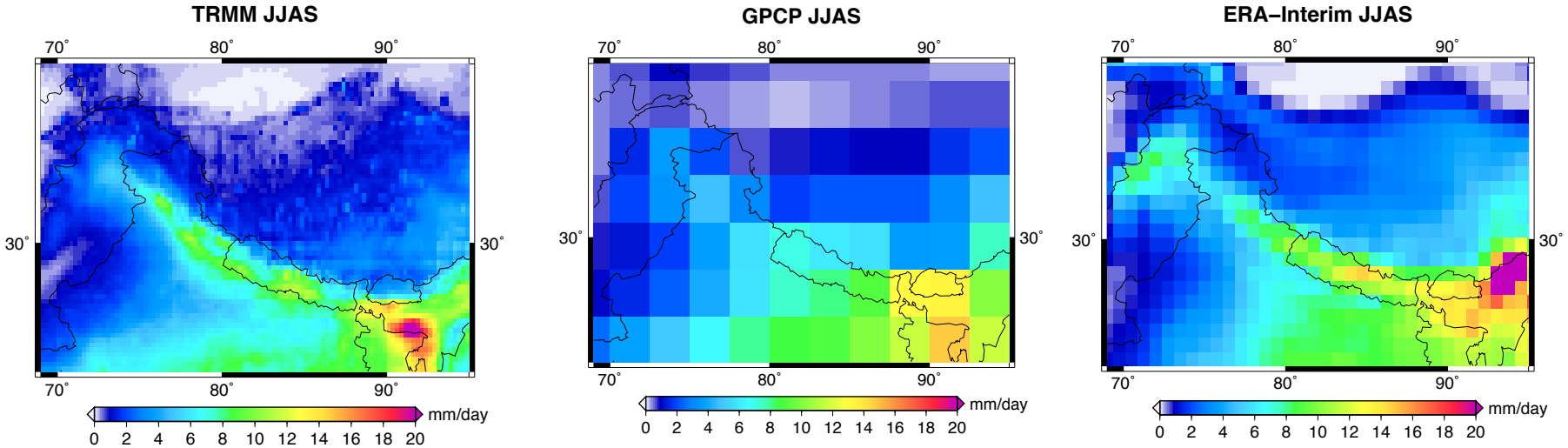
Fluxes inside and outside ecosystems

HKKH Summer precipitation (JJAS), Multiannual average 1998-2007

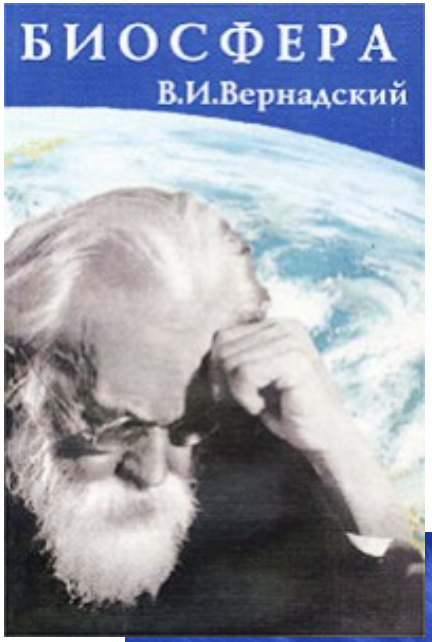
water fluxes







Oopss… uncertainties?



Ecosystem engineers, niche construction, complex adaptive landscapes and global biogeochemical cycles

Ecosystem services and their change

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This EnviroAtlas eco-wheel was created by Jessica Jahre, EPA contractor

Status of existing EVs in the domain

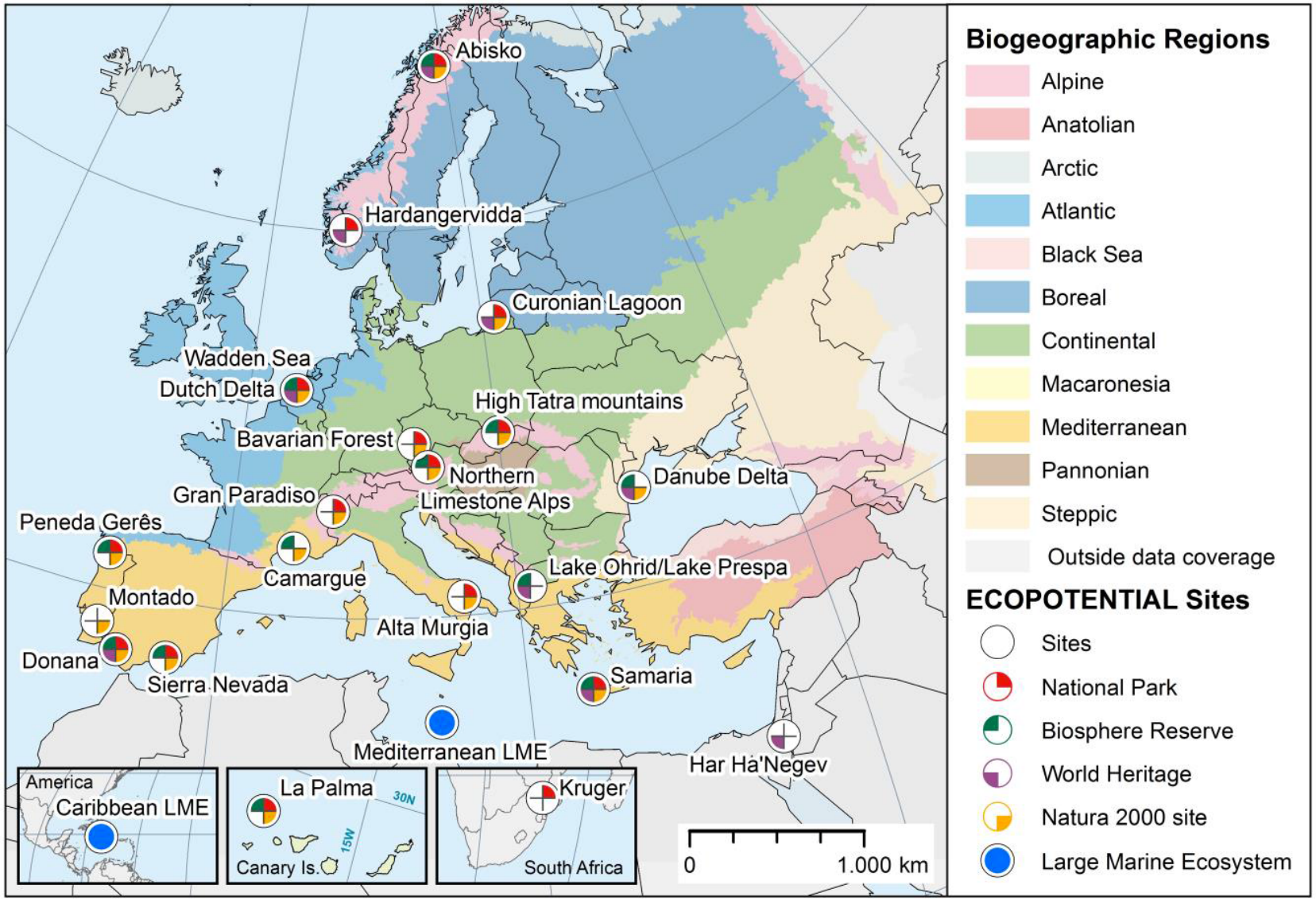
- *Is your community developing a set of area-specific EVs?*

Right now, EVs for Ecosystems (EVEs) are based on other Evs (ECVs, EOVs, EBVs, …). Maybe we need to develop/use specific EVEs for some of the issues mentioned before, including information from other areas. But better to fish for EVs from everywhere!

- *If not, is the community planning to start this in the near future?*

In the H2020 ECOPOTENTIAL project we plan to work on specific EVEs by using and/or extending the existing ones.

ECOPOTENTIAL: Improving future ecosystem benefits through Earth Observations



ECOPOTENTIAL: Ecosystem Services

Gran Paradiso (CNR)	Land use changes; climate change; natural system modifications; human disturbance.	Nutrition; materials from plants; water; mediation of flows and flood protection; maintenance of physical and biological conditions; gene pool protection; climate regulation; scientific, educational, heritage, cultural, aesthetic values.
Sierra Nevada (UGR)	Climate change; biogeochemical cycle changes; land use changes.	Water; feeding; landscape; geological materials; genetic pool; recreational activities; traditional knowledge; dampening of perturbations; water cycle regulation.
High Tatra (UNEP)	Mass tourism and tourism and sports infrastructure; human settlements (private housing); air pollution; environmental damages caused by historic mismanagement of land.	Surface water; water flow maintenance; flood protection; genetic materials from all biota; wood fuel; mass stabilisation and control of erosion rates; pollination and seed dispersal; soil formation and composition; climate regulation; wild plants and animals; scientific, educational, heritage, cultural, aesthetic values.
Samaria (FORTH)	Overgrazing and uncontrolled fires; poaching and uncontrolled abstraction of endemic species of flora; massive touristic flow.	Water; cultivated crops; reared animals; wild animals; mass stabilisation and control of erosion rates; pollination and seed dispersal; nursery populations and habitats; decomposition and fixing processes; experiential use of plants, animals and land-/seascapes; cultural benefits.
Danube Delta (UBC)	Fisheries; hunting; tourism; eutrophication; water transport.	Local climate and water flow regulation; water purification; nutrient and erosion regulation; pollination; energy (biomass); fodder; livestock; fibre; timber; wood; fisheries; aquaculture; wild foods; biochemicals/ medicine; freshwater; tourism; knowledge systems; religious and spiritual services; cultural/natural heritage.

ECOPOTENTIAL: Essential Variables

Essential Biodiversity Variables	Essential Climate Variables	Essential Ocean Variables	Essential Water Variables	Essential Social and Environmental Variables
Species Composition	Precipitation	Sea Surface Temperature	Runoff/streamflow/ river discharge	Population density
Functional groups traits	Temperature	Ocean acidification	Lakes/ reservoir levels	Resource use and management
Ecosystem extent & structure	Irradiance	Zooplankton composition	Glaciers front	Natural-areas accessibility

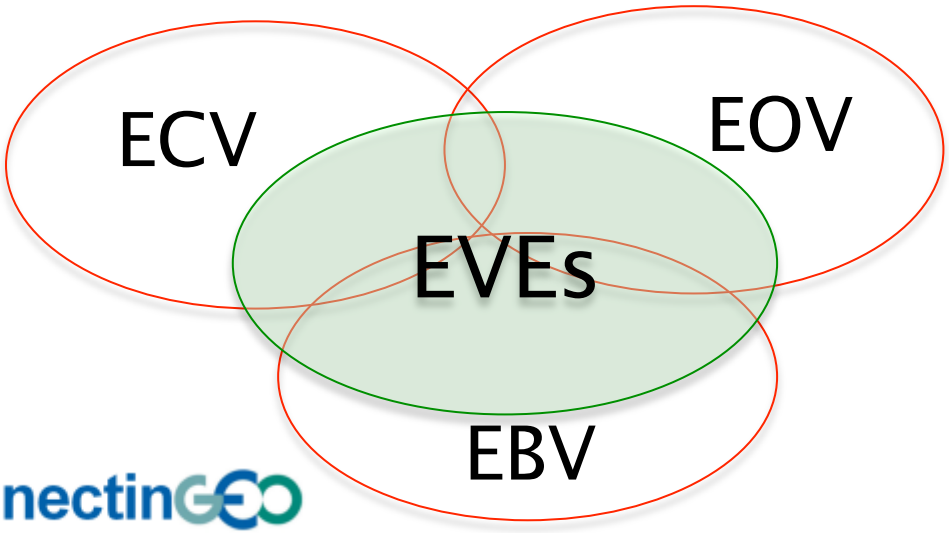
ECOPOTENTIAL thus aims to **develop widely applicable monitoring indicators for ecosystem status and trends, biodiversity change and ecosystem services** (including their socio-economic demand), creating a unified EV framework. This necessitates extending the already developed concepts of EBVs, ECVs etc. and include indicators that capture the major dimensions of ecosystem services supply and demand. Such indicators include,

A suite of remote-sensing and *in-situ* observation data will also be used to develop and define Essential Ecological and Environmental Protection Descriptors (EEPD) and the indicators of the current quality status in the PAs to be studied. To these indicators belong requirements such as: level of (bio)diversity (as being relevant for e.g. the description of the Good Environmental Status (GES) as used in the Marine Strategy Framework Directive (MSFD)), level of protection of key-species, improvement in numbers of (certain) species, habitat diversity, (minimal) size of the area, connectivity with other (protected) areas, and habitat quality. In particular, the parameters "habitat diversity", "size of the area" and "connectivity with other areas" will be mainly determined through EO data.

The process underlying EV definition

- *What criteria, methodology, and process are used to identify Evs?*

EO data driven approaches will be followed (we define what can be measured), together with **model-driven requirements** – in particular, requirements coming from the upscaling-downscaling needs



EVs validation and use

- *Are the EVs linked to applications and users?*
- *Who the users are?*

Define goals first.

Create an Ecosystem Community of Practice, composed by nature conservation officers, park personnel, environmental managers, etc. Define specific questions – probably different for each ecosystem type (essentiality?)

- *Are the EVs linked to an international body (i.e. a UN convention or similar) and is this body involved in accepting the EVs?*

In ECOPOTENTIAL we have UNEP and UNESCO, could be a starting point…

Describing the monitoring networks currently operational

- *Are the current operational networks operated by your community measuring the Evs?*

Are they? To my knowledge, most ecosystem observations are not linked with each other and some do not know about EVs… Even important experiences such as LTER have been only partially successful till now. This is why other strategies (e.g. NEON, ECZ observatories) have been followed elsewhere.

Concerns on “consensus science”…

Conclusions

- *Overlapping with EVs in other domains (SBA)*

EVEs build upon most of other EVs, they are not separate and do not need one more essential essentiality.

Question: Is the proliferation of EVs making them not that essential? Can we define “Essential Variables” for a complex system at all? What is essential and what is detail? (Subtantia et accidens)

- Future work: ECOPOTENTIAL+ConnectinGEO


Thank you for your attention