TERENO conference,
Bonn, 29th Sept – 2nd Oct 2014

"The European landscape of biodiversity and ecosystem research infrastructures: status, perspectives and TERENO´s role as "best practice" example for terrestrial RIs."

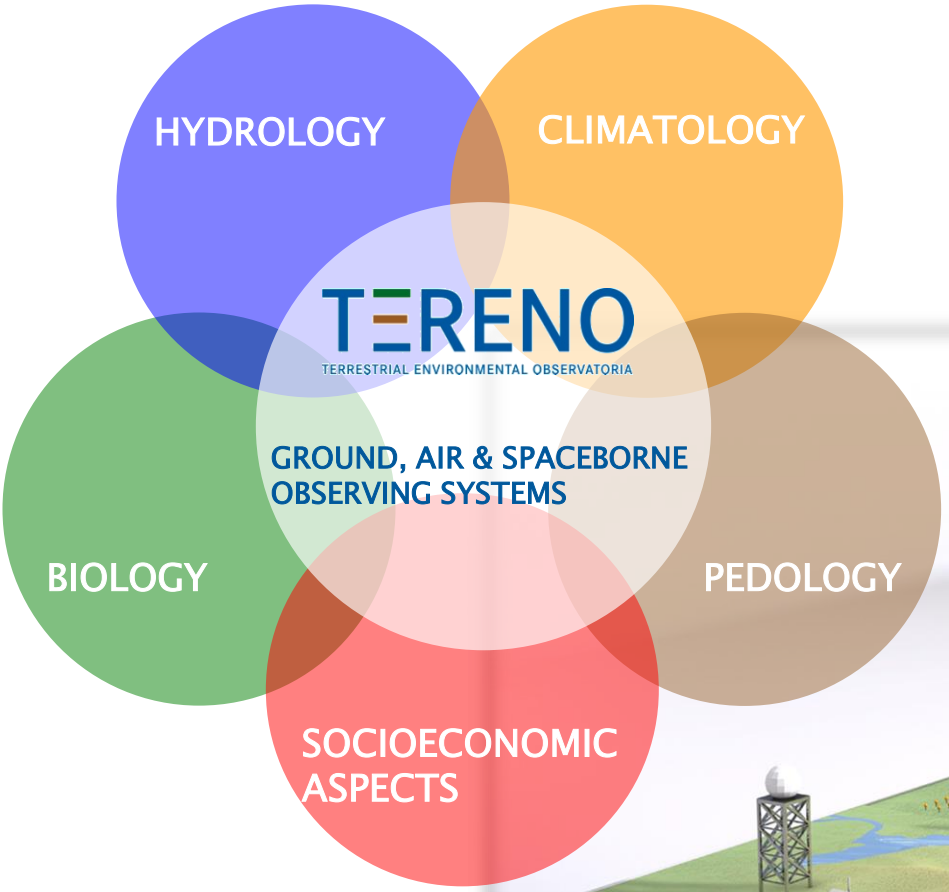
Michael Mirtl
Environment Agency Austria

ExpeER
Ecosystem Research

Background, mission & technicalities

- BD&ES RIs = Bio**diversity** & Eco**system** Research Research Infrastructures
- **Based on:**
  - ENVRI 1/ ERIS: „Environmental Research Infrastructures 2030“ strategy paper
  - Summary report: WS Biodiversity and ecosystem Research Infrastructures in Europe, Brussels, March 2013
  - **ExpeER: integrating experimental and observational research: WP on creating a sustainable network (AnaEE & LTER-Europe)**
  - ALTER-Net Infrastructure Task Group
  - ESFRI meetings 22nd May, Paris (Env SWG); 25th Sept, Triest (Roadmap 2016 launch)

TERENO, Germany




Geophysics


Groundwater monitoring


Wireless soil moisture sensor network


Lysimeters


Biodiversity monitoring


Mobile Mesocosms


Water quality monitoring

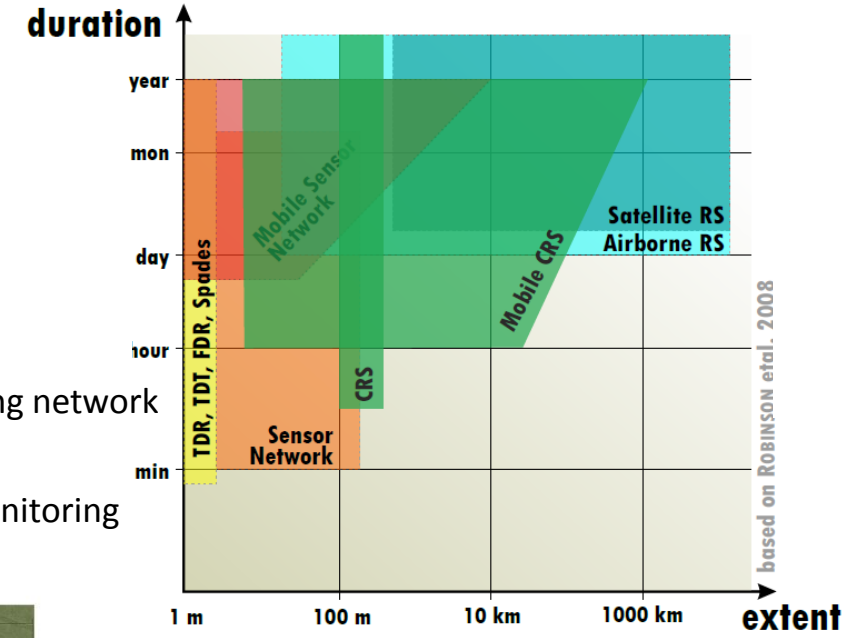

Eddy-Flux-Tower


Rainscanner


Remote Sensing


Modelling Platform

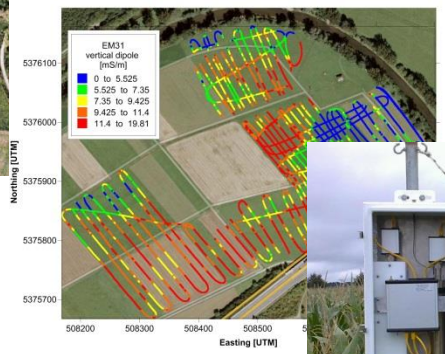
Landscape Water Balance
"Schäfertal Catchment"



lysimeters

wireless soil water content monitoring network

geophysical monitoring campaigns

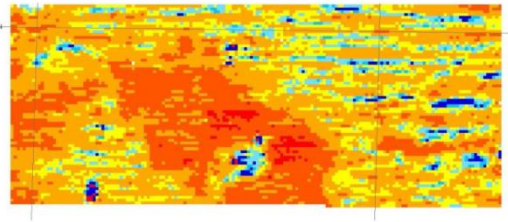


cosmic ray probes

point scale

airborne & spaceborne remote sensing

Near surface soil moisture, 2008-05-26

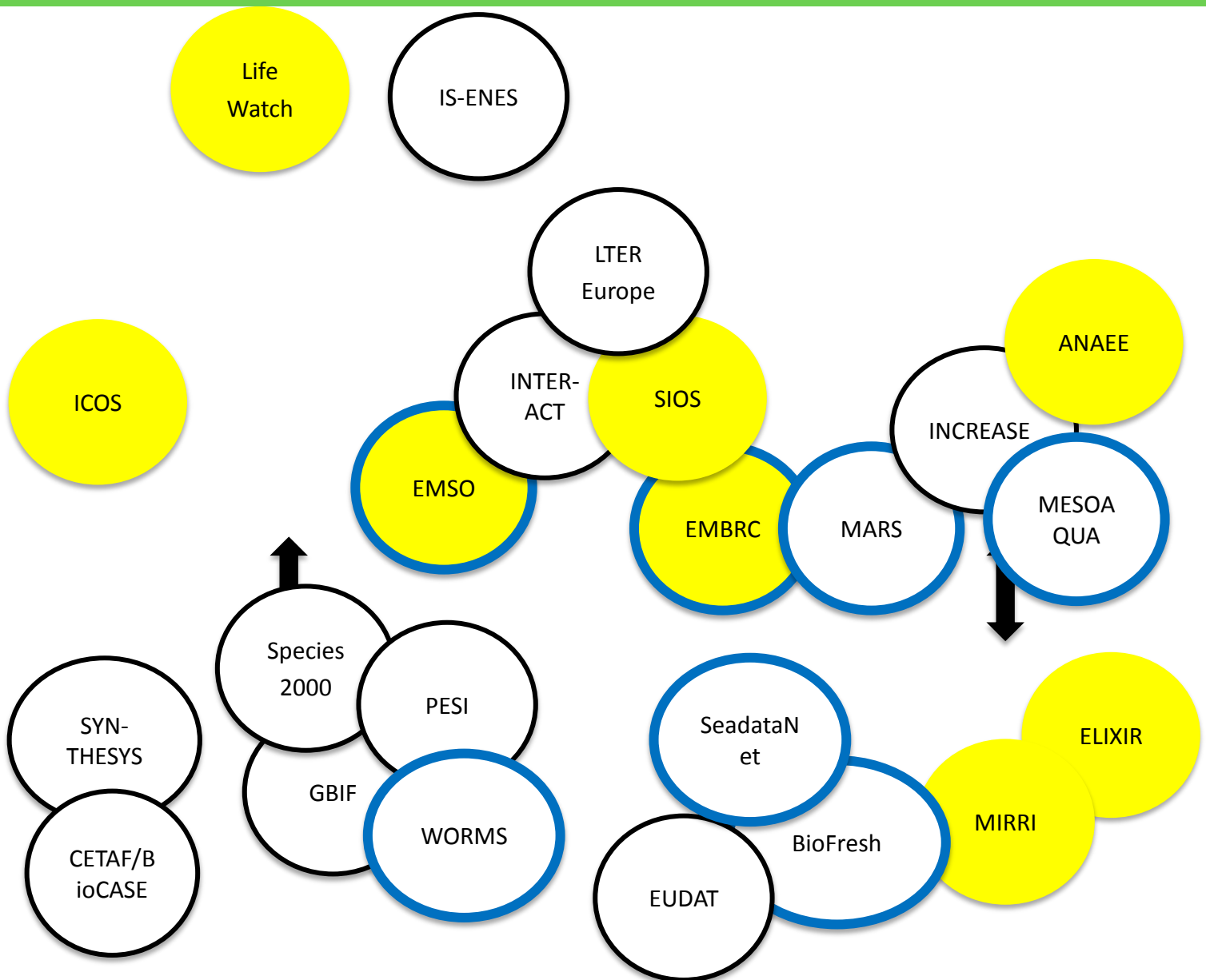


Multi-scale approach for monitoring soil water content (& snow)

small catchment scale

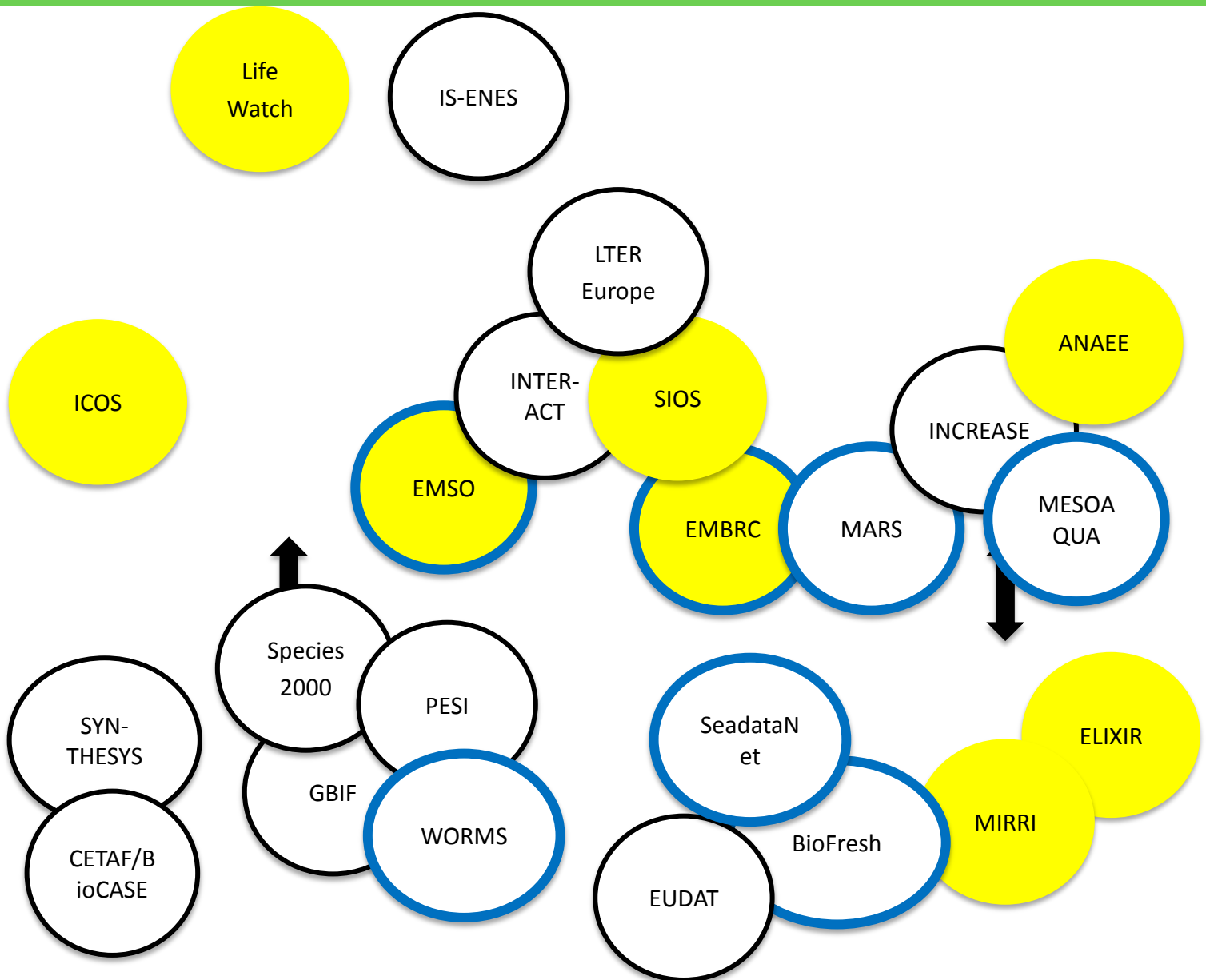
Courtesy of S. Zacharias (UFZ)

The European landscape of BD&ES RIs

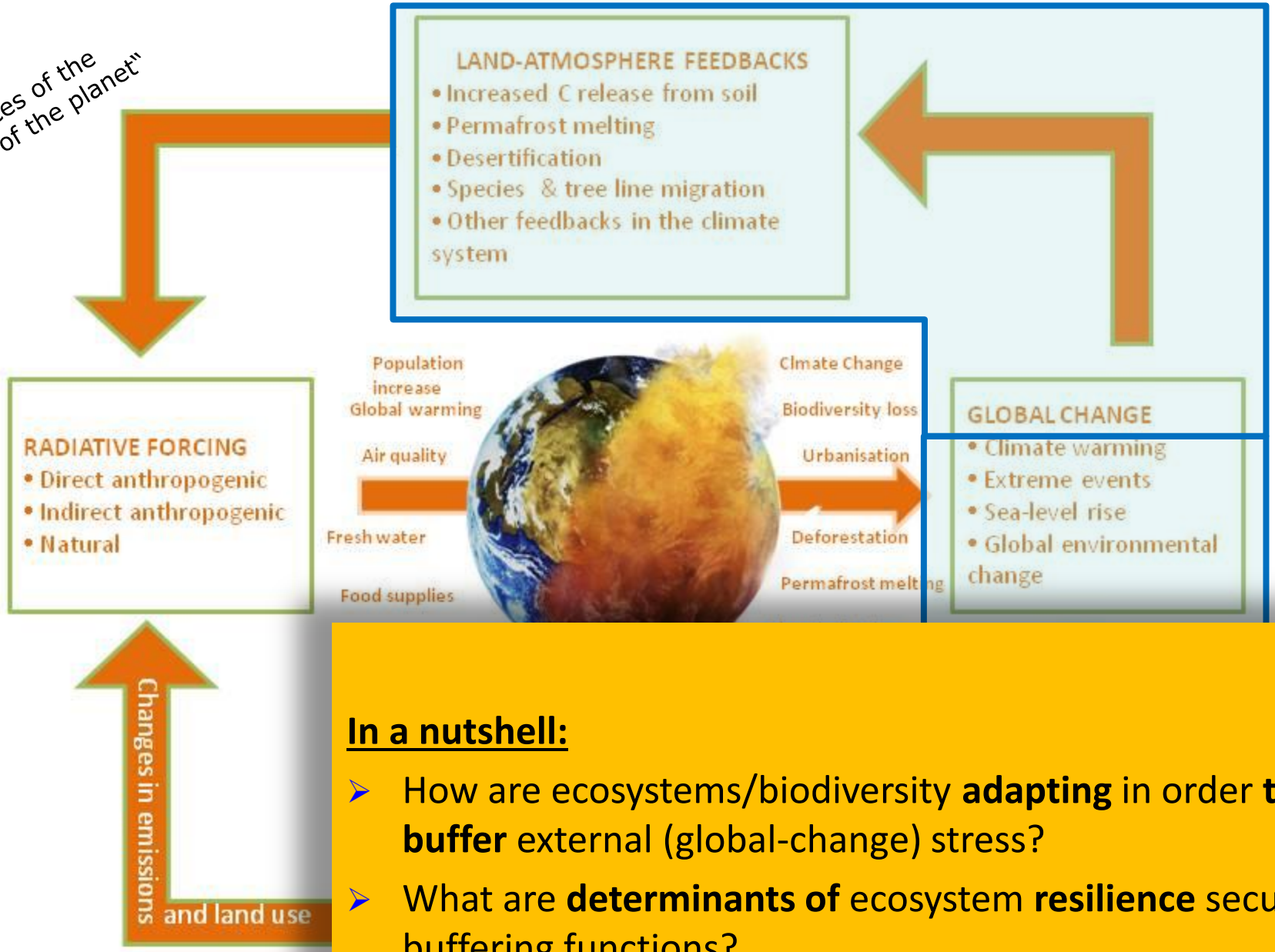


The grand challenges for environmental research

...and the answer?



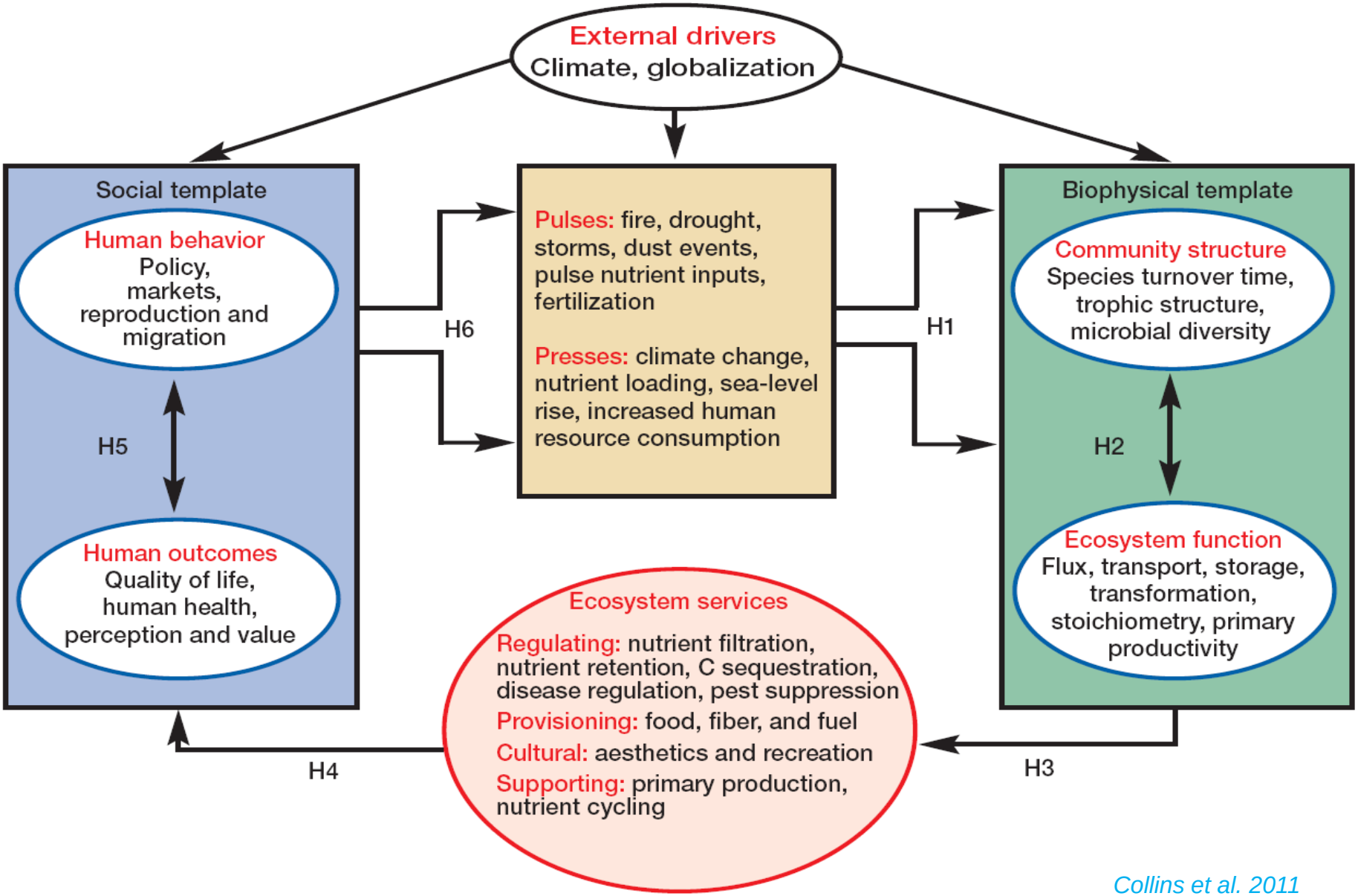
Many faces of the „Model of the planet"



In a nutshell:

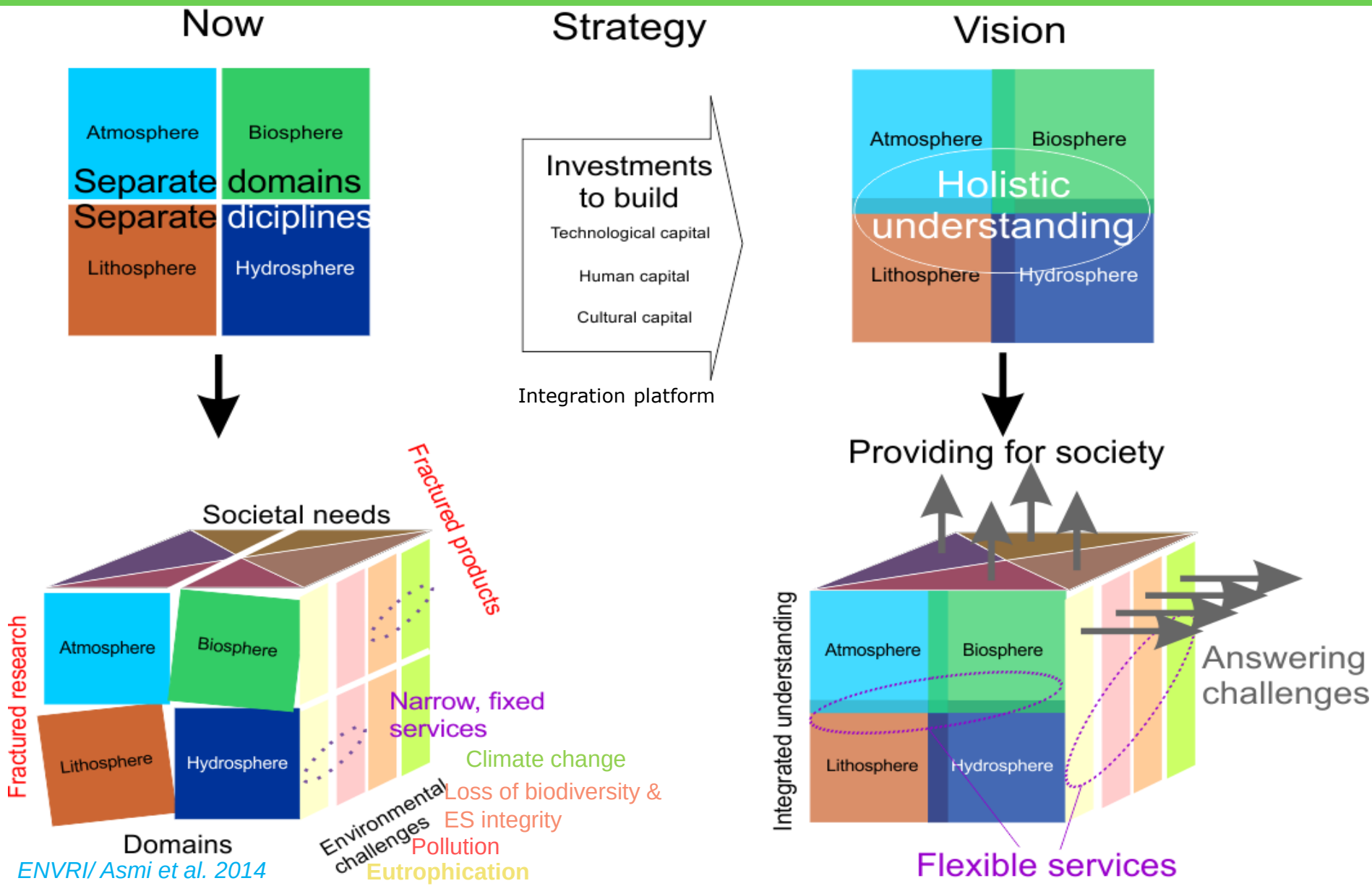
- How are ecosystems/biodiversity **adapting** in order **to buffer** external (global-change) stress?
- What are **determinants of** ecosystem **resilience** securing buffering functions?
- What are **treshold interactions** resulting in **system shifts**?

PPD Framework for anchoring research qeustions tackled at a site

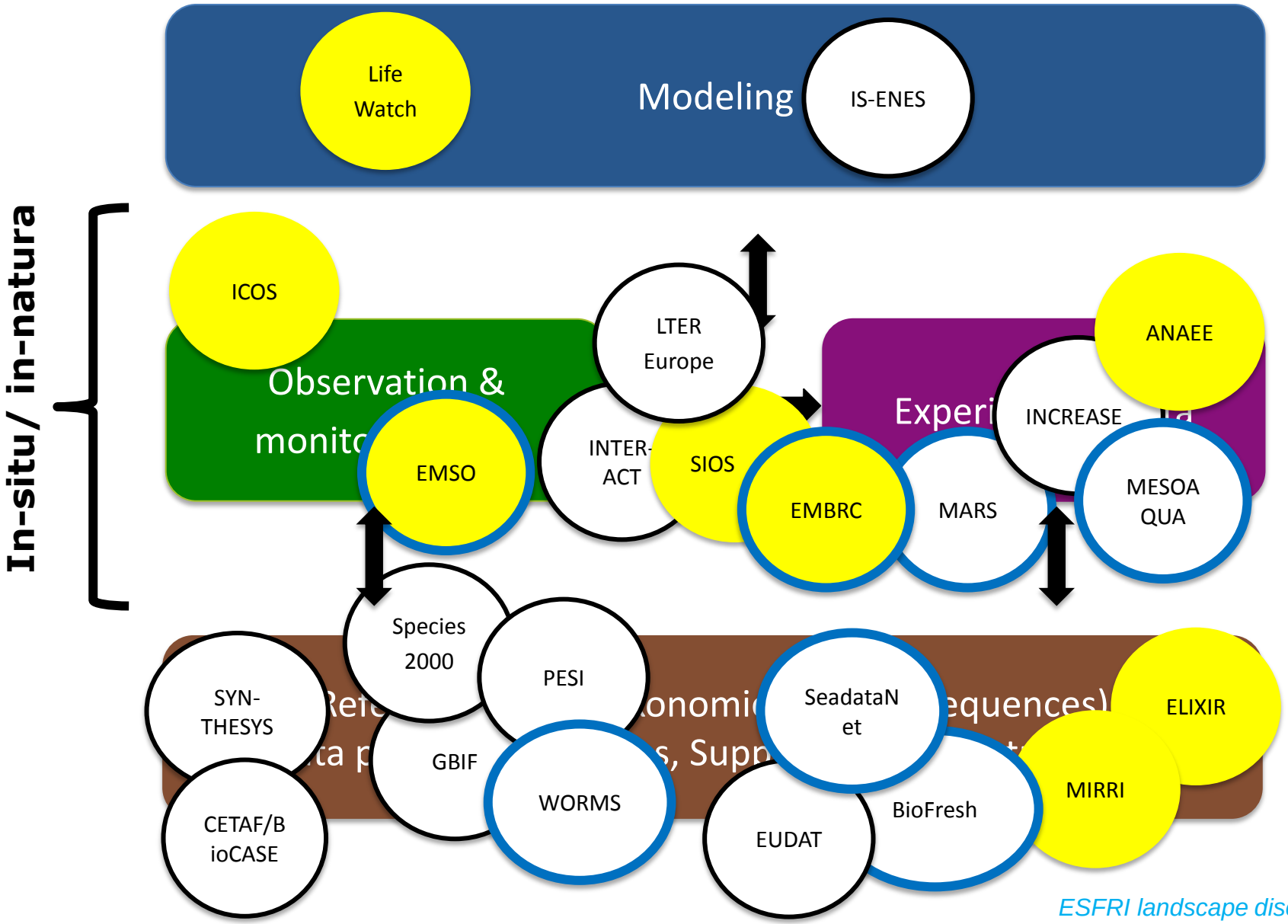


Collins et al. 2011

Better organizing domain interactions (ENVRI/ ERIS)



Roles of RIs


Life Watch
Modeling
IS-ENES
In-situ/ in-natura
ICOS
Observation &
LTER Europe
ANAEE
EMSO
INTER-ACT
SIOS
INCREASE
EMBRC
MARS
MESOA QUA
Species 2000
PESI
SYN-THESYS
SeadataNet
ELIXIR
GBIF
WORMS
MIRRI
BioFresh
CETAF/BioCASE
EUDAT

Summary of the state (BD&ES RIs WS, March 2013)

- The European environmental research landscape has been **severely modified by construction of RIs and by long-term committments of national governments**. The RIs are envisioned as the long-term actors in the Earth System sciences.
- Most of the current **RIs are originally based on bottom-up processes** some in individual disciplines and Earth System domains others related to one or more of the Grand Challenges. **Cross-disciplinary and cross-RI coordination is seen as important** by the RIs.
- **Computational challenges are common** to all RIs. **Data usage barriers are significant**. Problems related to data discovery, access and understanding remain to be solved.
- **Diversity of the RIs brings great potential for observation** of the Earth System, but often also makes it **difficult to integrate knowledge**. **Many of the environmental and societal challenges** are strongly connected to several Earth System domains and **require integrated multidisciplinary understanding**.

Why operating long-term RIs (ENVRI/ ERIS)

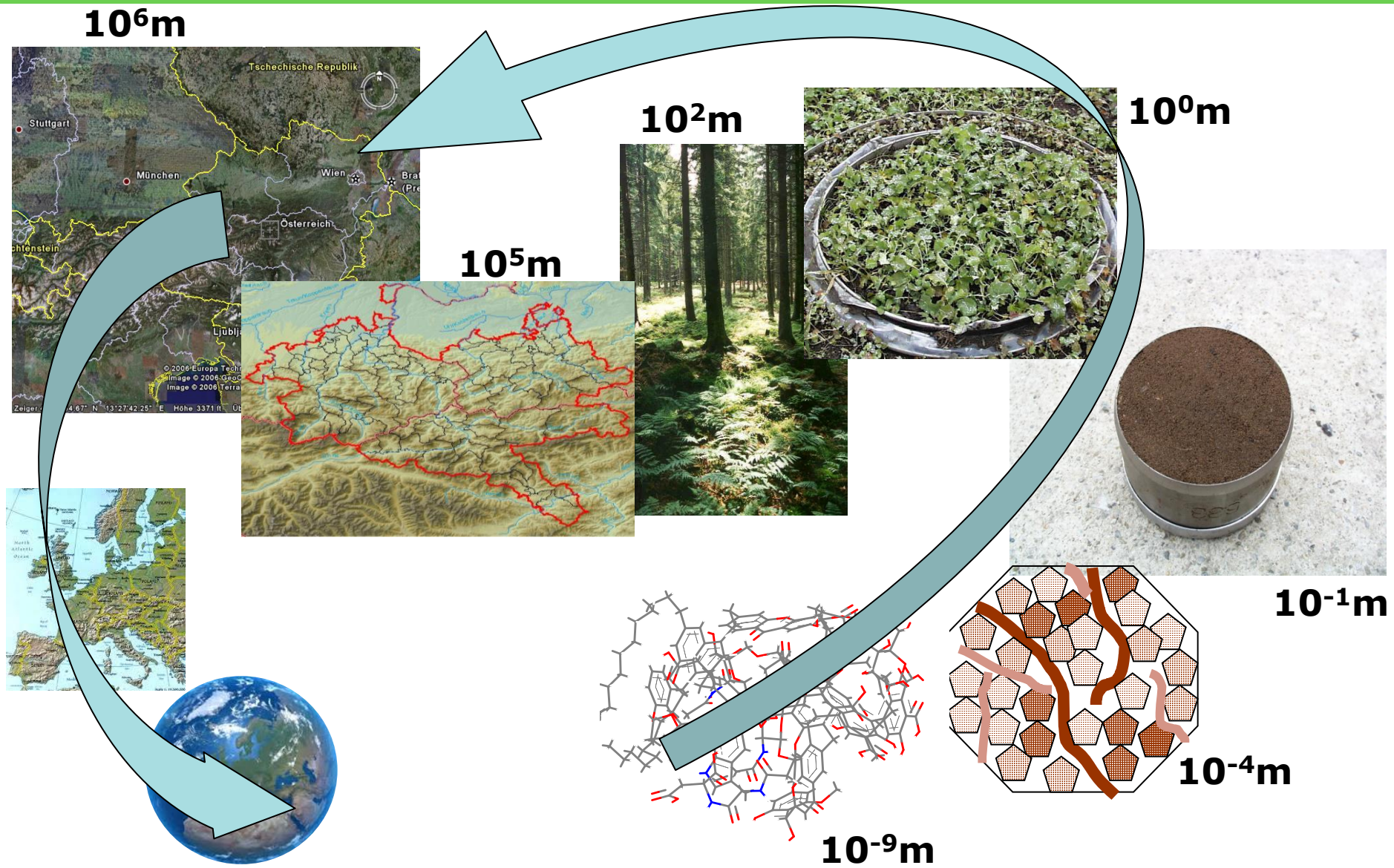
"Environmental RIs are designed as long-term entities in order to meet the requirements of continuous environmental observation. This **longevity makes the environmental research infrastructures ideal structures to support long-term development in environmental sciences**." (Asmi et al., 2014)

Specifically, in cultural landscapes the **ecological and socio-ecological profile of sites** can only be judged on the basis of long-term trend data PLUS good knowledge of the environmental history.

Challenges of *in-situ* BD&ES infrastructures: the site and individual RIs network level

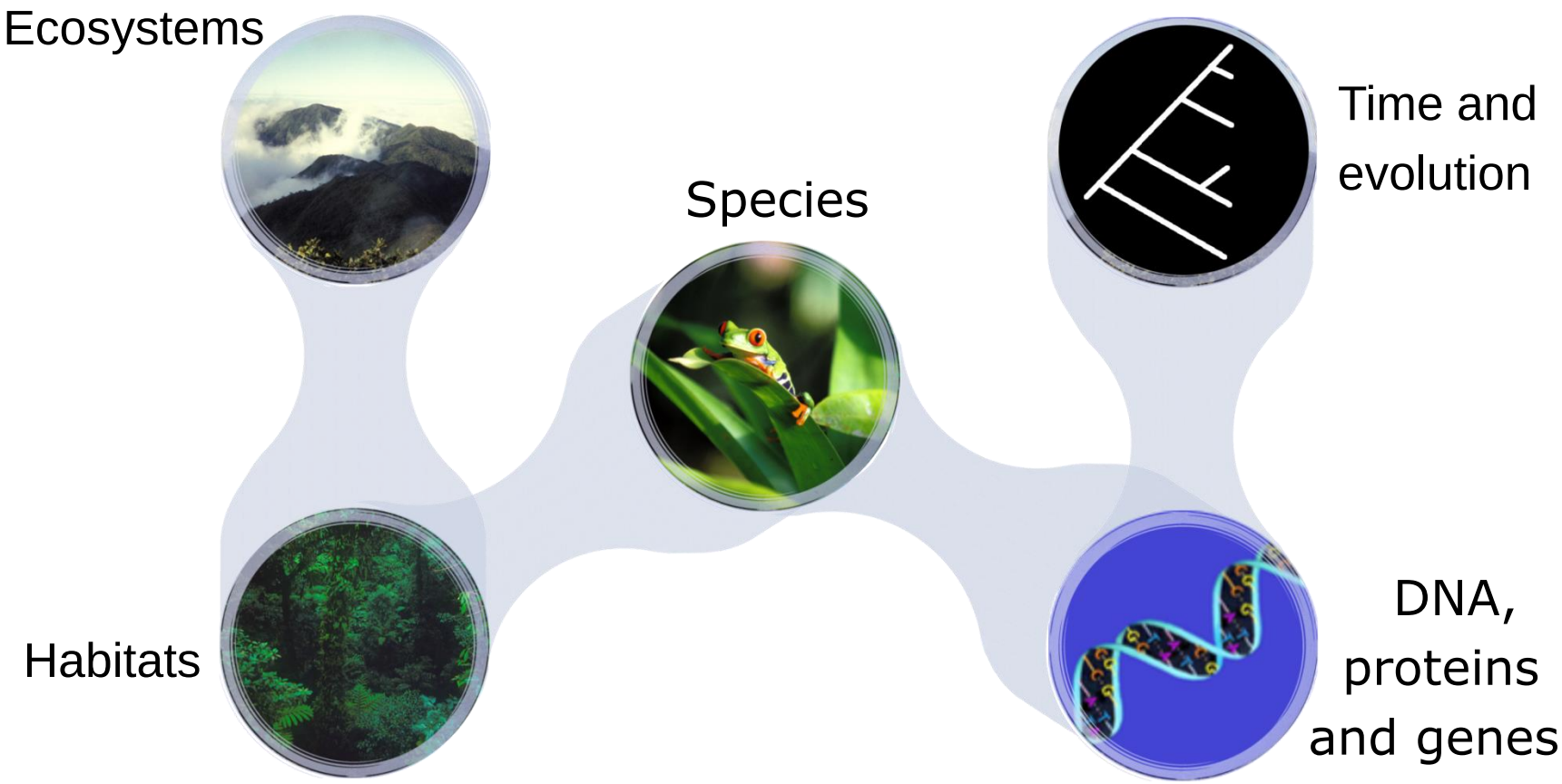
- Scale (plot up to regional research on ESS/e.g. LTSER)
- Vertical integration as fostered by CZ
- Horizontal integration (landscape level) and answers relevant for management and local decision making
- Disciplinary integration: interdisciplinary approaches across domains
- Integration of observation, experimentation and modelling
- Heterogeneity
- Linkage with large scale monitoring schemes (high quality baseline monitoring data not necessarily generated at distributed research sites; → differing purposes, partly difficult access)
- Coverage and representativity
- Organization from sites to networks and relations between related RIs

Methodological approaches and designs need to consider appropriate spatial scales

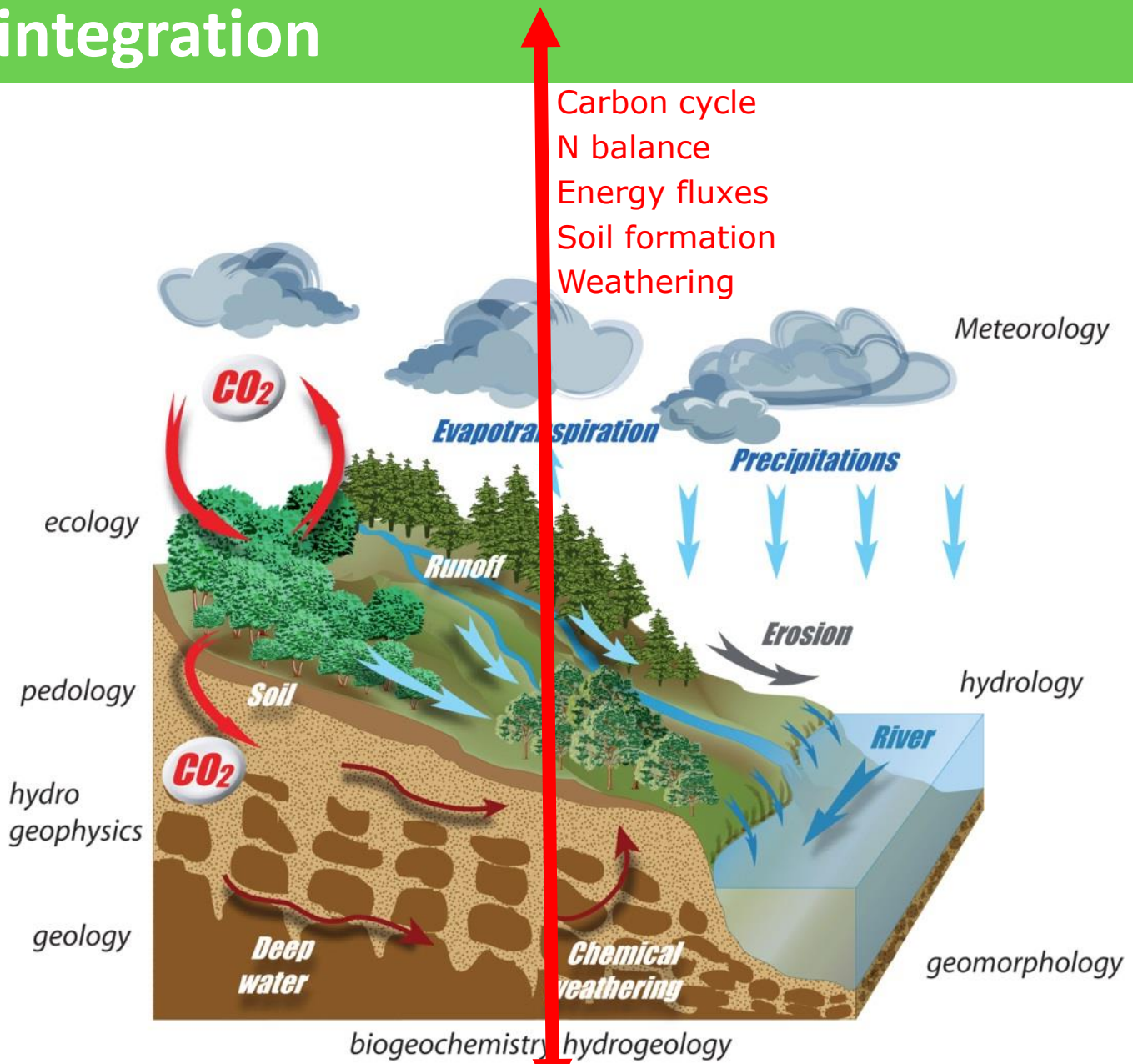


M. Gerzabek, BOKU Vienna; ammended

Biodiversity research across scales



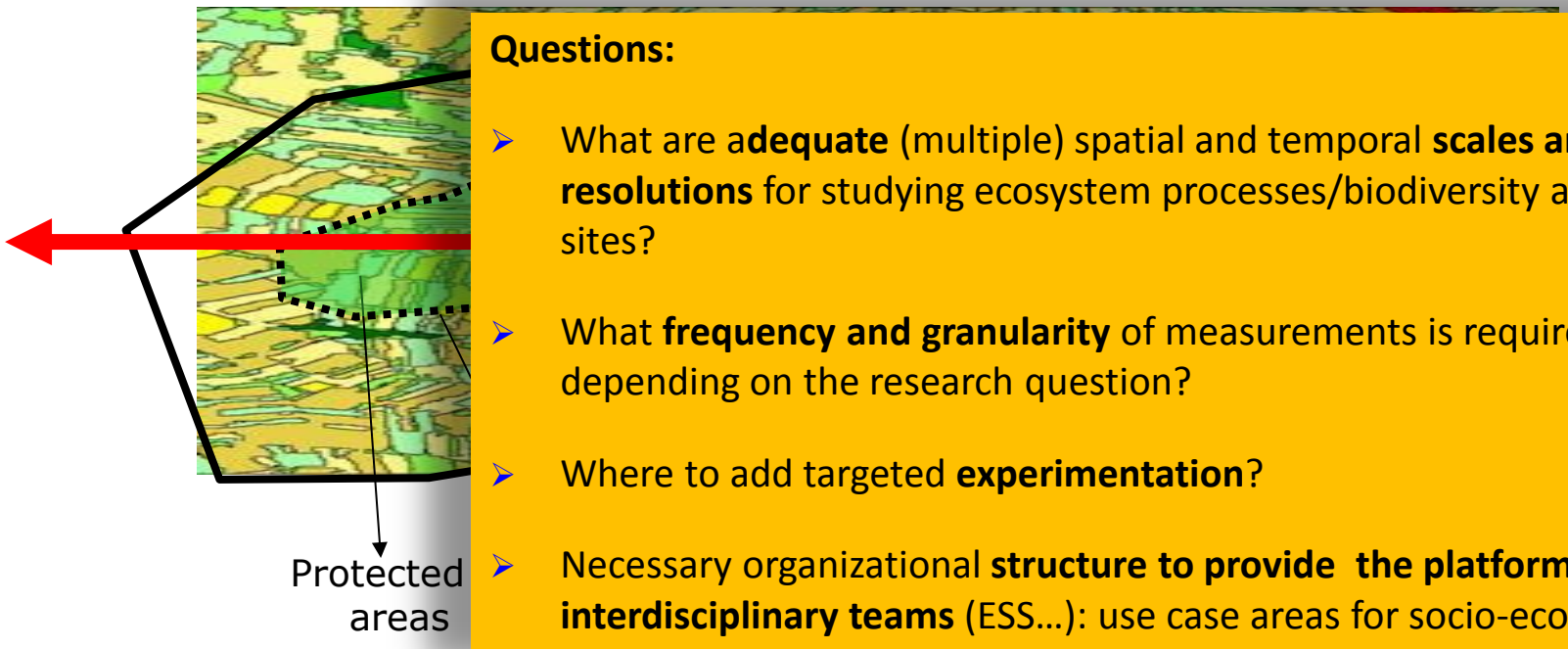
Vertical integration



Courtesy of J. Gaillardet (Critical Zone Research)

Horizontal integration

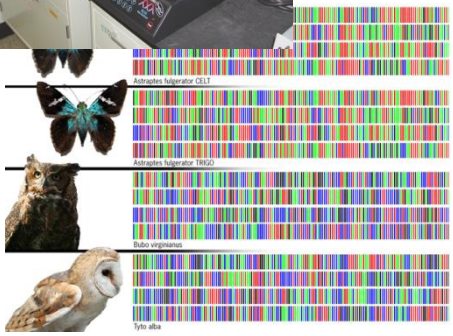
- Green infrastructures / connectivity
- Land use change & ecosystem services trade offs in cultural landscapes
- Integrated regional effects of protected areas (e.g. Natura2000)



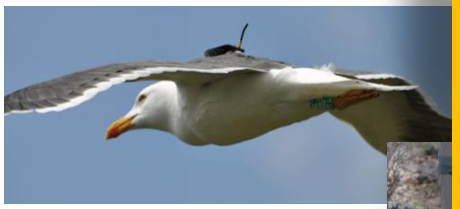
Questions:

- What are a**dequate** (multiple) spatial and temporal **scales and resolutions** for studying ecosystem processes/biodiversity at research sites?
- What **frequency and granularity** of measurements is required, depending on the research question?
- Where to add targeted **experimentation**?
- Necessary organizational **structure to provide the platform for interdisciplinary teams** (ESS…): use case areas for socio-ecological research

Physical infrastructure



Facilities for monitoring (species and functional) diversity



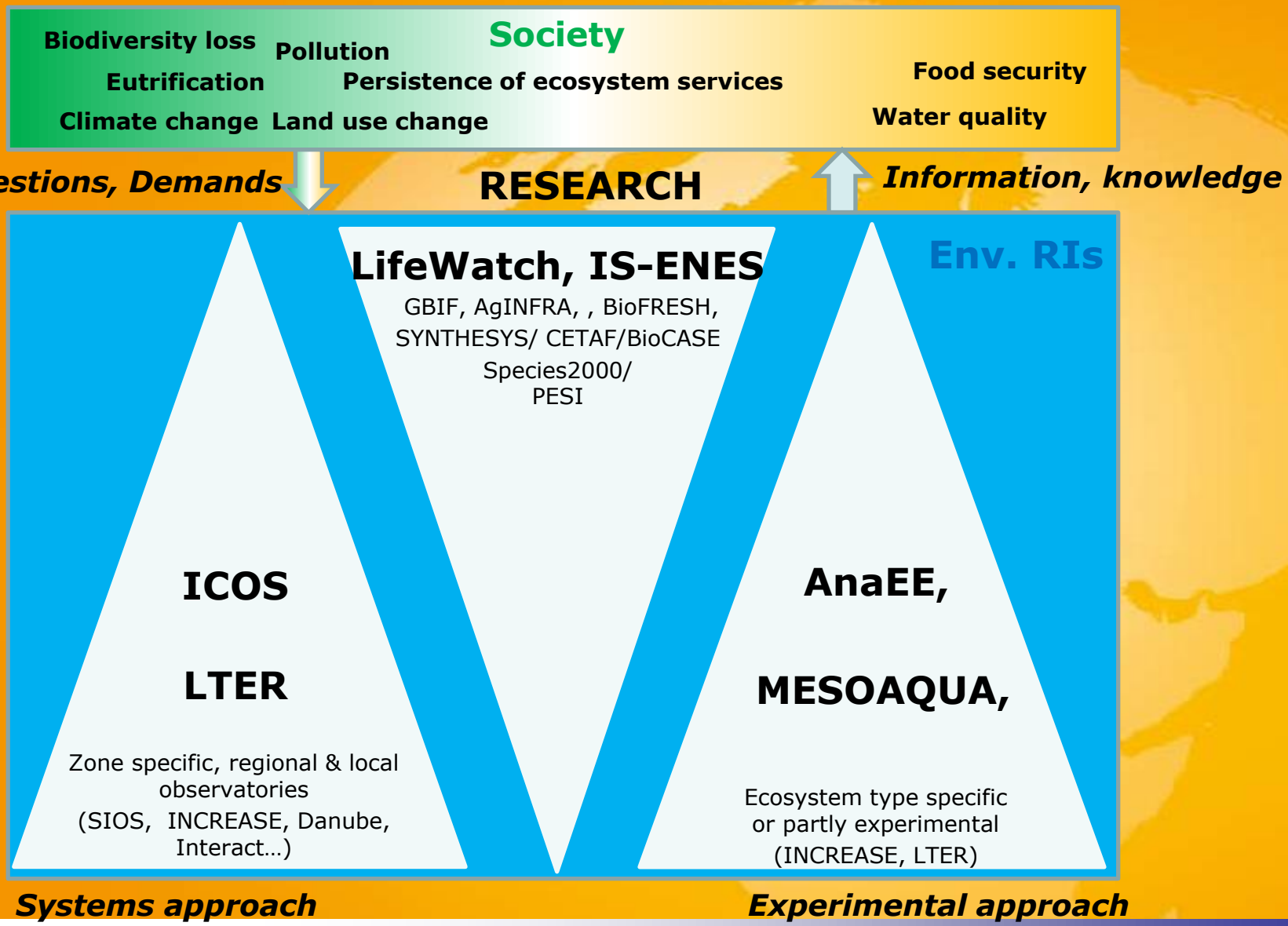
New generations of (wireless) sensors (DNA sequence based, etc)

Building blocks:

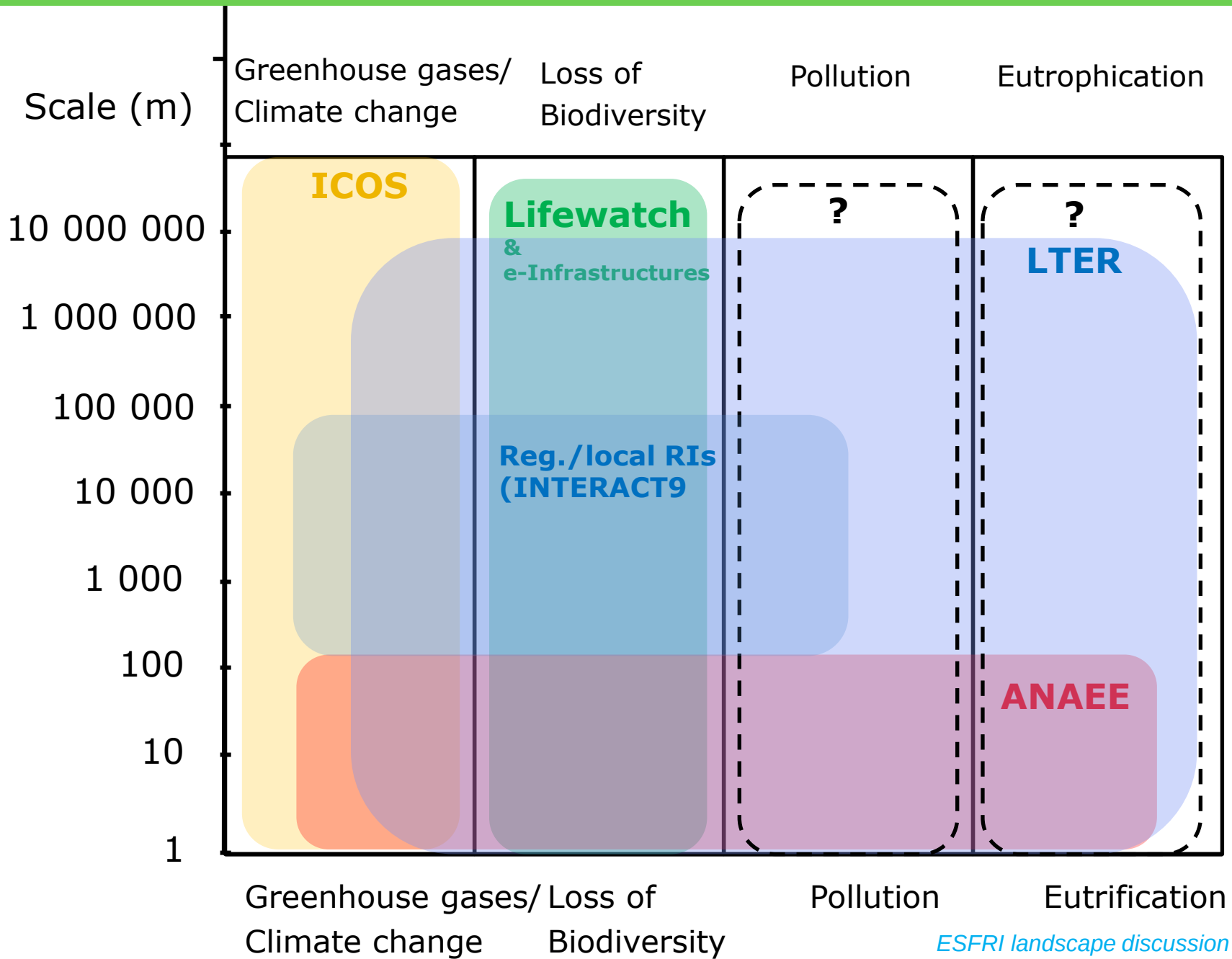
- **General & conservative components**: Basic physical infrastructure at highly instrumented sites (atmospheric towers...)
- **Specific & dynamic components:**
  - Domain specific sensors (e.g. nano sensors for sequencing, experimental equipment)
  - Interaction with RS

→ **Technical maintanence** by individual sites often a data quality bottleneck

Landscape of RI for Biodiversity and Ecosystems



European scale BD&ES RIs, Grand Challenges and Scale



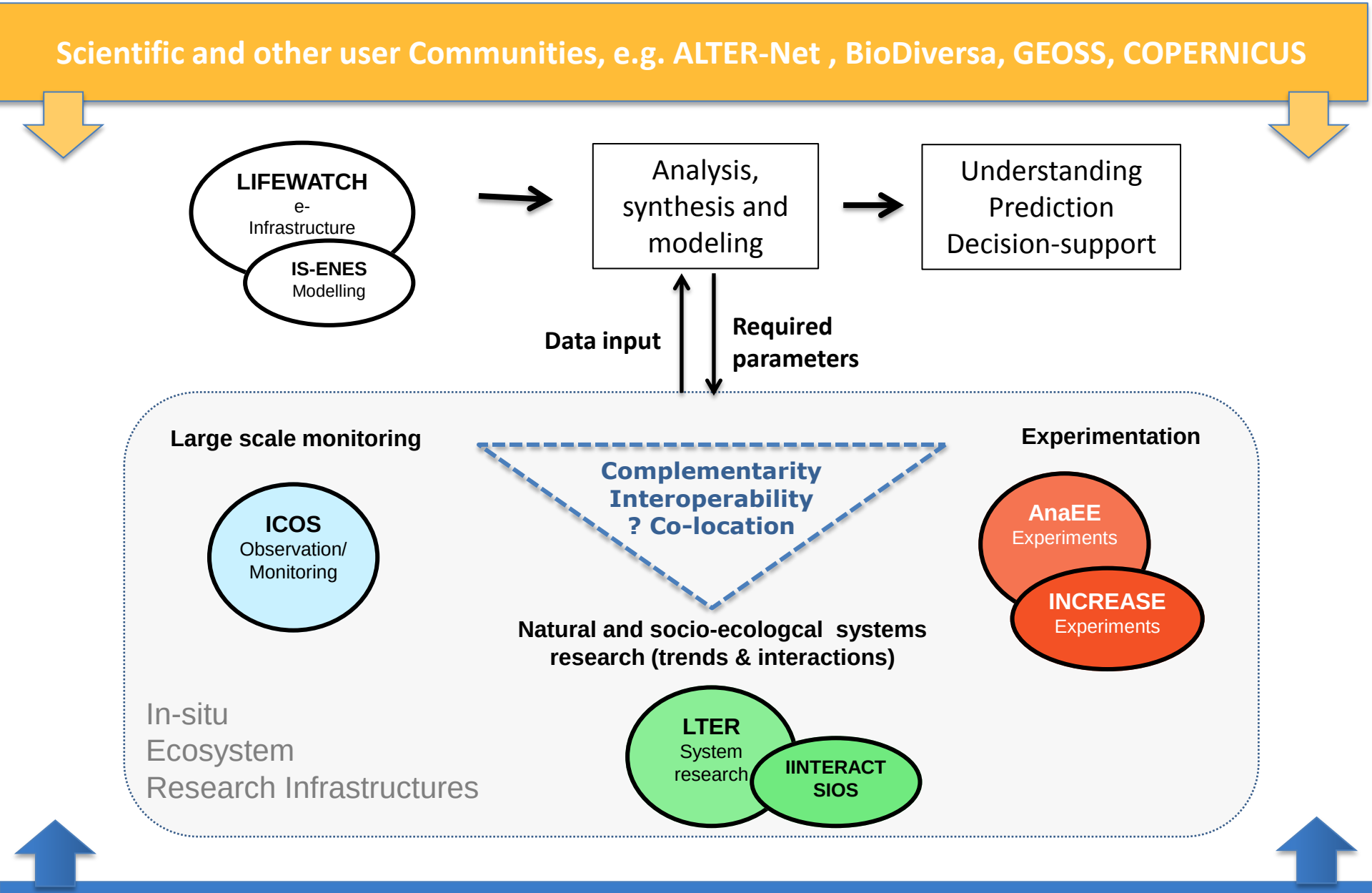
today: ESFRI Roadmap 2010

Social and Cultural Innovation (5)	Health and Food (13)		Environmental Sciences (9)		Energy (7)	Analytical Facilities (6)	Physics Science and Engineering (10)		e-Infra-structures (1)
SHARE	BBMRI	ELIXIR	ICOS	EURO-ARGO	ECCSEL	Euro-FEL	ELI	TIARA*	PRACE
European Social Survey	ECRIN	INFRAFRONTIER	LIFEWATCH	IAGOS	Wind-scanner	EMFL	SPIRAL2	CTA	
CESSDA	INSTRUCT	EATRIS	EMSO	EPOS	EU-SOLARIS	European XFEL	E-ELT**	SKA	
CLARIN	EU-OPEN-SCREEN	EMBRC	SIOS	EISCAT_3D	JHR	ESRF Upgrade	KM3NeT	FAIR	
DARIAH	Euro Bio-Imaging	ERINHA		COPAL	IFMIF	NEUTRON ESS	SLHC-PP*	ILC-HIGRADE*	
	ISBE	MIRRI			HiPER	ILL20/20 Upgrade			
	ANAEE				MYRRHA				

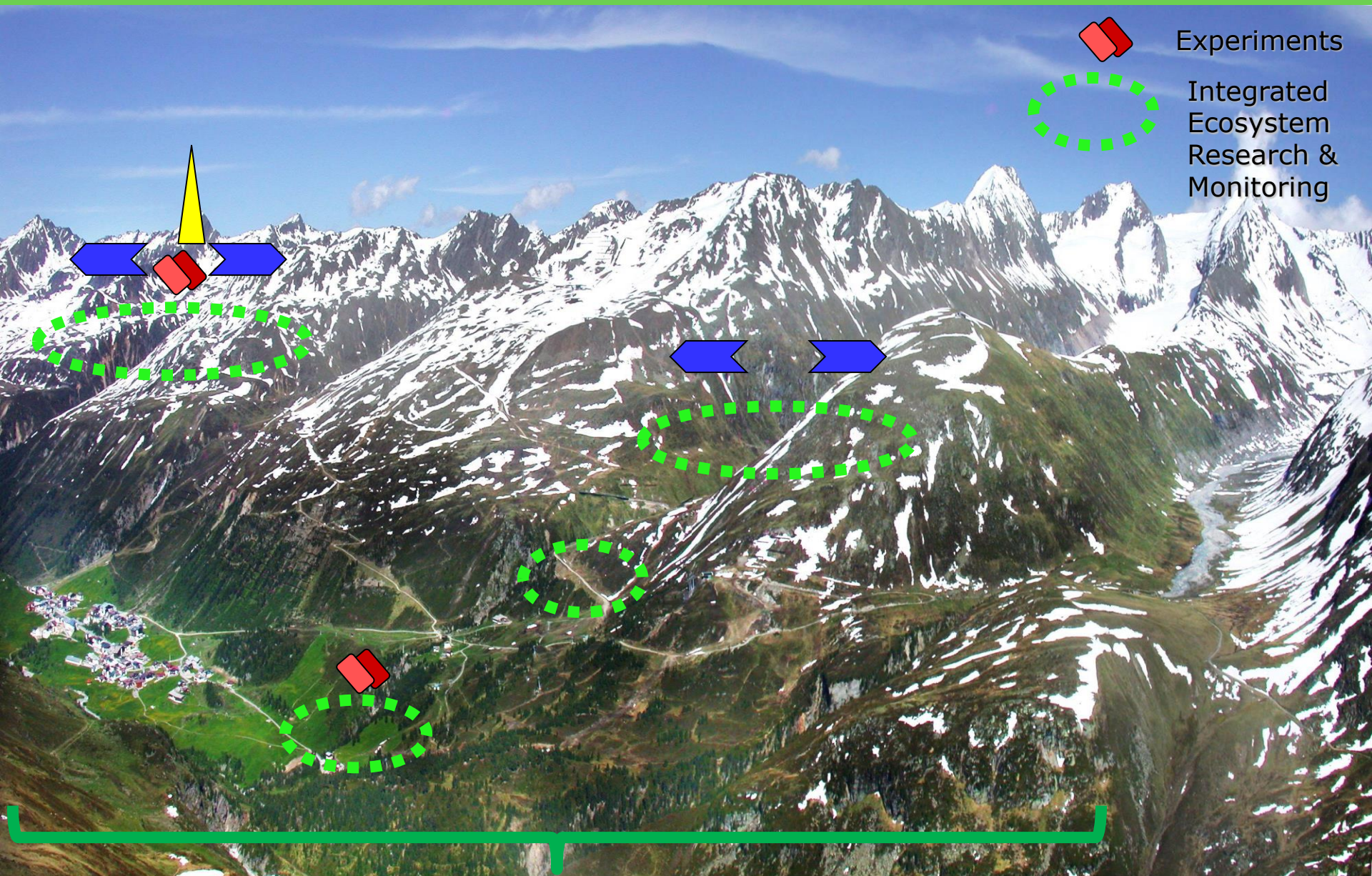
Distributed research infrastructures

Single sited research infrastructures

ENV RIs: *Red: 2006 Roadmap*, *Black: 2008 Roadmap*


Scientific and other user Communities, e.g. ALTER-Net , BioDiversa, GEOSS, COPERNICUS
LIFEWATCH
e-Infrastructure
IS-ENES
Modelling
Analysis, synthesis and modeling
Understanding
Prediction
Decision-support
Data input
Required parameters
Large scale monitoring
ICOS
Observation/ Monitoring
Complementarity
Interoperability
? Co-location
Experimentation
AnaEE
Experiments
INCREASE
Experiments
Natural and socio-ecologcal systems research (trends & interactions)
LTER
System research
IINTERACT
SIOS
In-situ
Ecosystem
Research Infrastructures
Generic supporting e-Infrastructures (e.g. EUDAT) and reference data (e.g. Species2000)

A modular „landscape“



To achieve this: Building blocks for integration and interoperability

- **Technology**
  - capacity to measure, observe, compute
  - analytical and modelling platforms (cooperation with e-Infrastructures, virutal labs)
  - technologies for machine-machine interaction

- **Enhanced data provision and usage culture**
  - workflows, metadata & data annotation
  - open data acces
  - documentation of data
  - licences, IPR and citation agreements

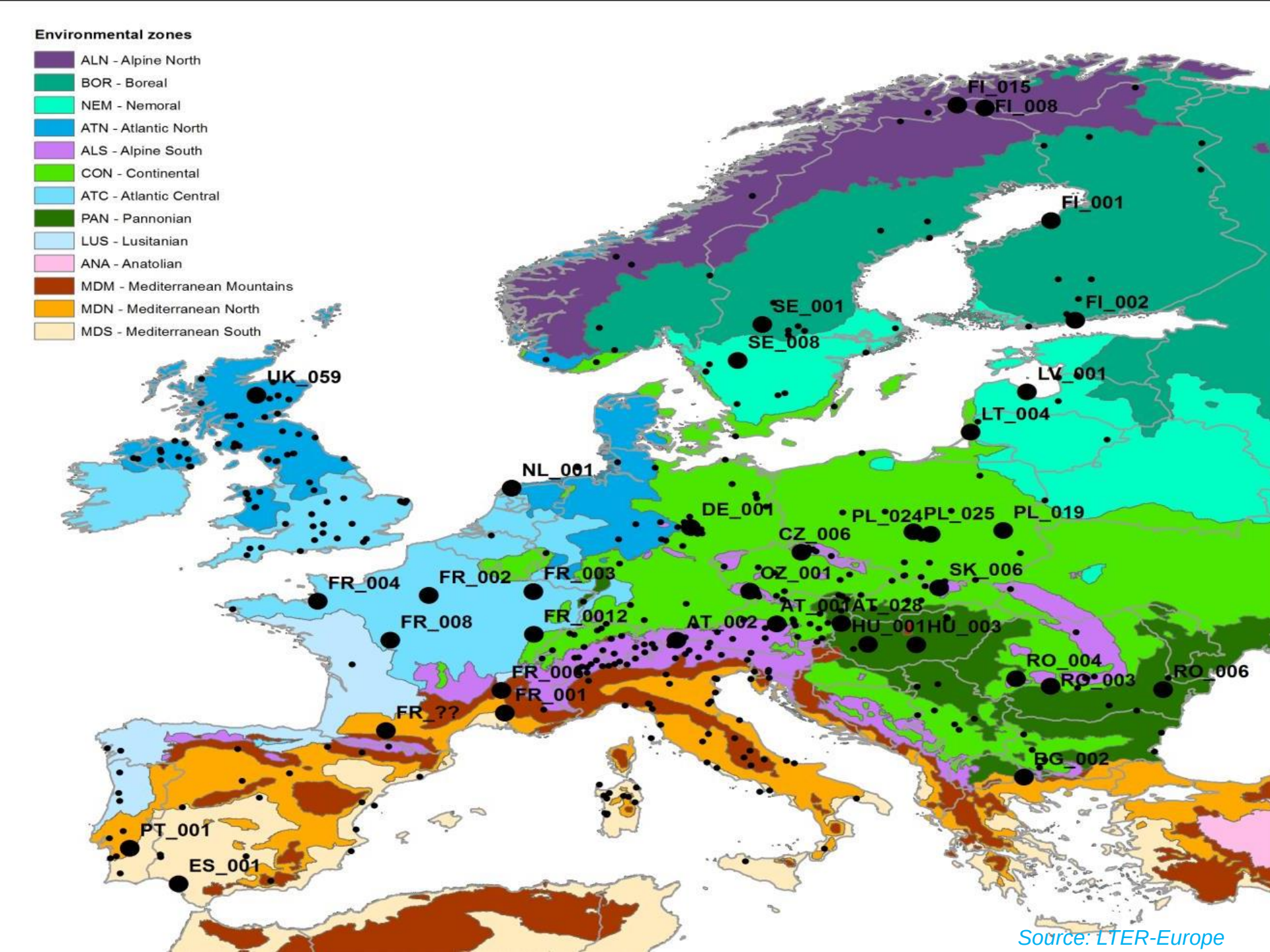
- **Human capital**
  - citizen science
  - mobility
  - recognition of a wide range of roles in the modular/distributed research process
  - appropriate incentives
  - working culture

- **Networking and integration platform(s)**
  - **conceptualize** RI integration/interoperability
  - **organization** of integration process: cooperation and communication methods and platforms for RIs within and across countries
  - strategic and **lobbying** work
  - multidirectional **communication** with stakeholders, research, individual RIs targeted at modular implementation in the long-term (nationally) → **MULTIPLE-USE**

Multiple use: step 1 – what´s out there?

Requirements

- Covered research topics and monitoring components
- Design
- Equipment
- Data legacy

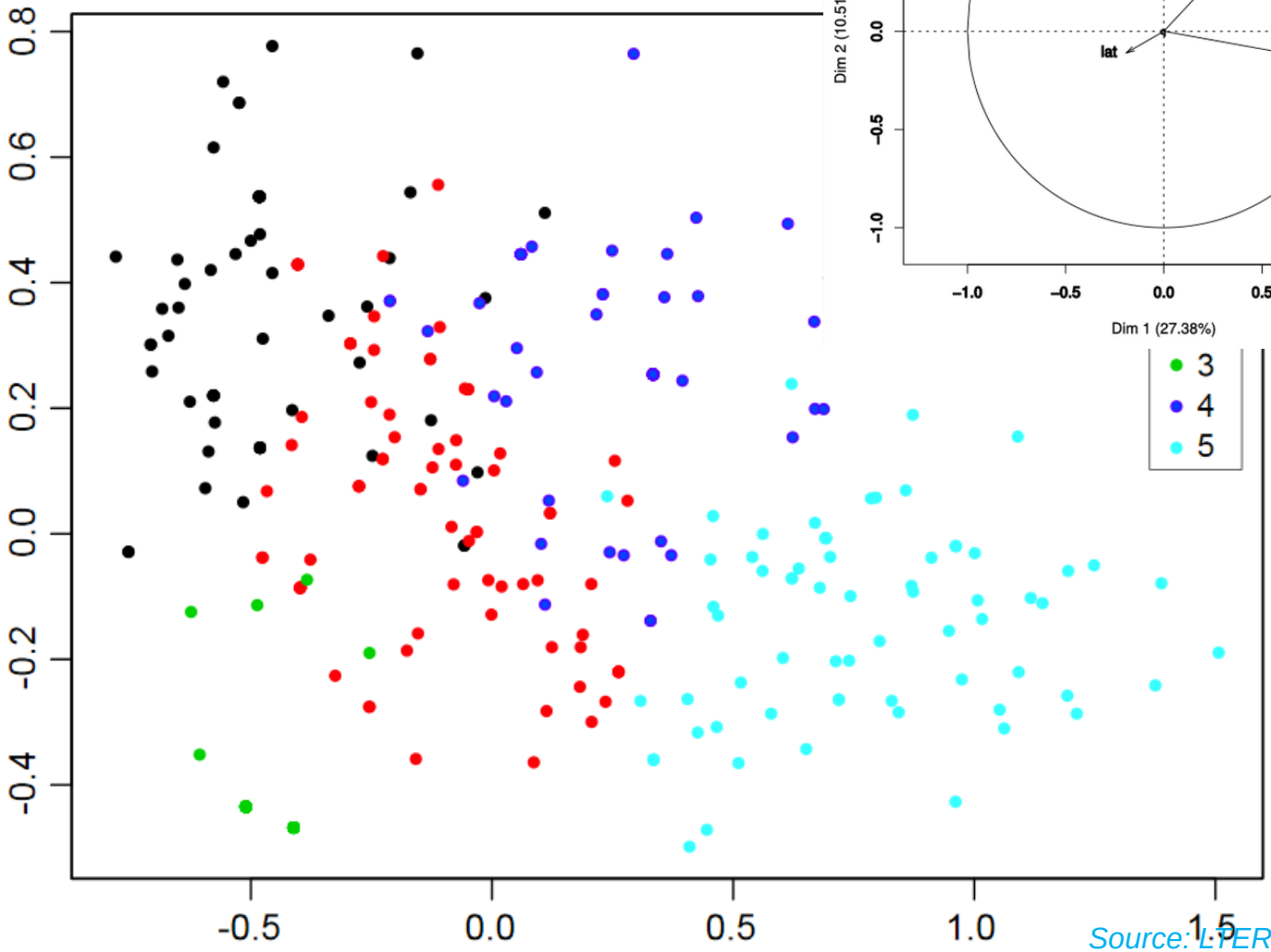


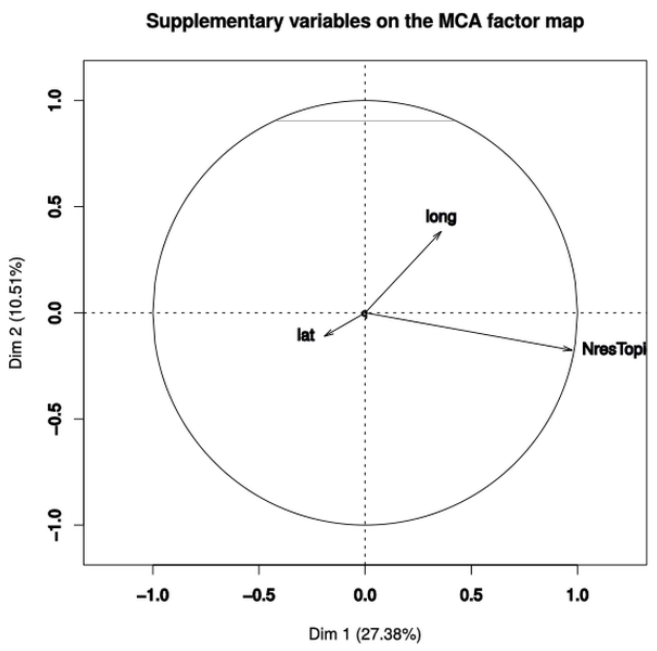
Source: LTER-Europe





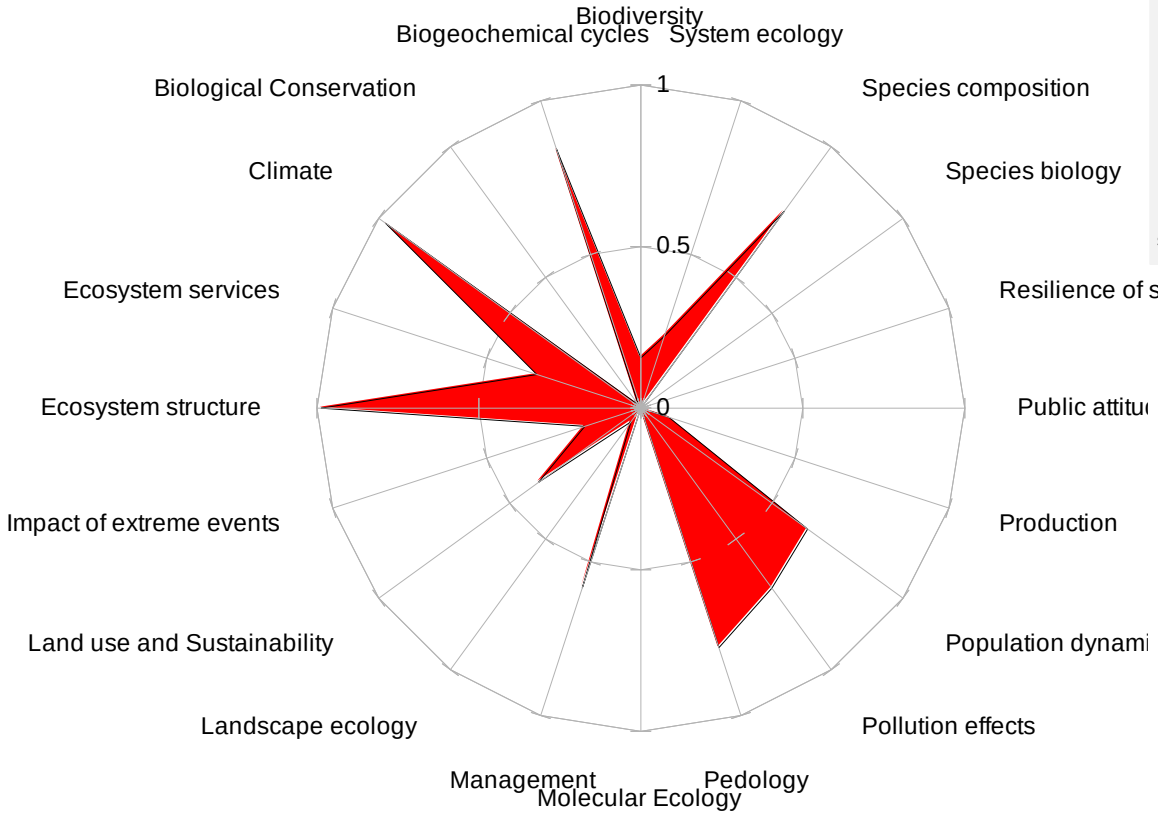

Topical LTER Site clusters from MCA

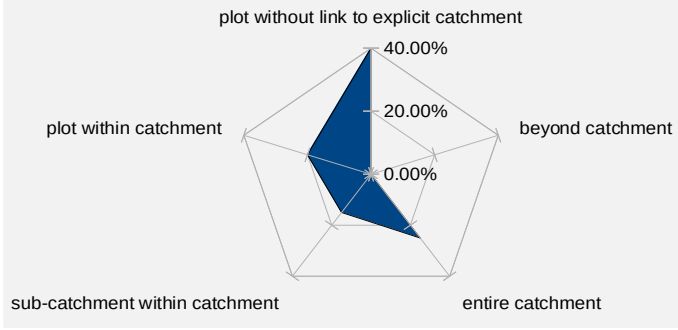


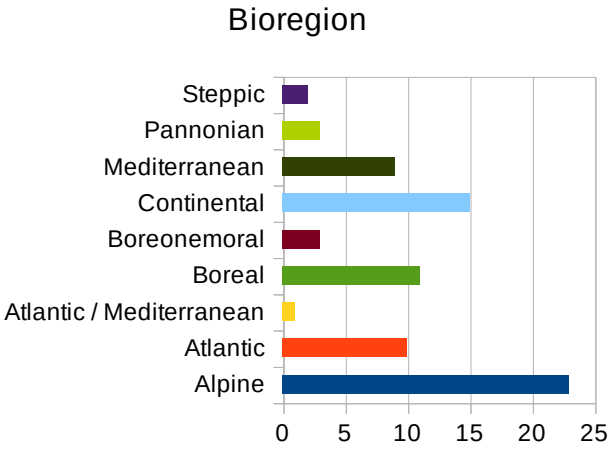


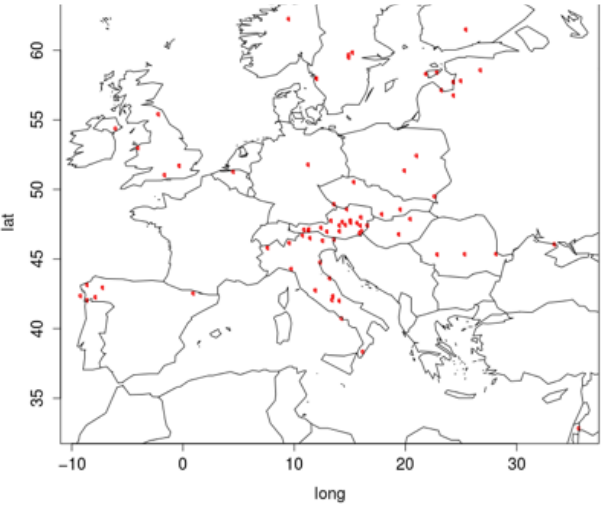
Source: LTER-Europe

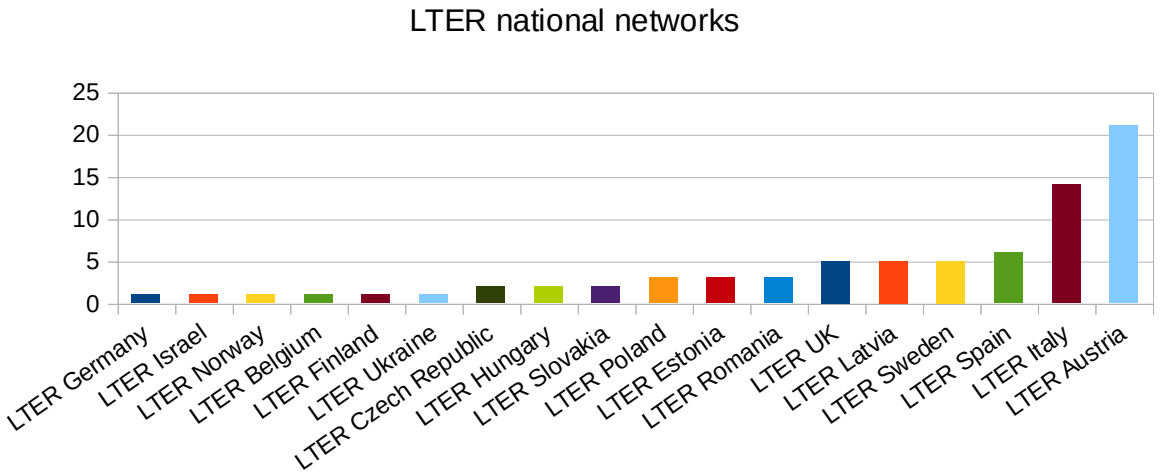
Cluster 2





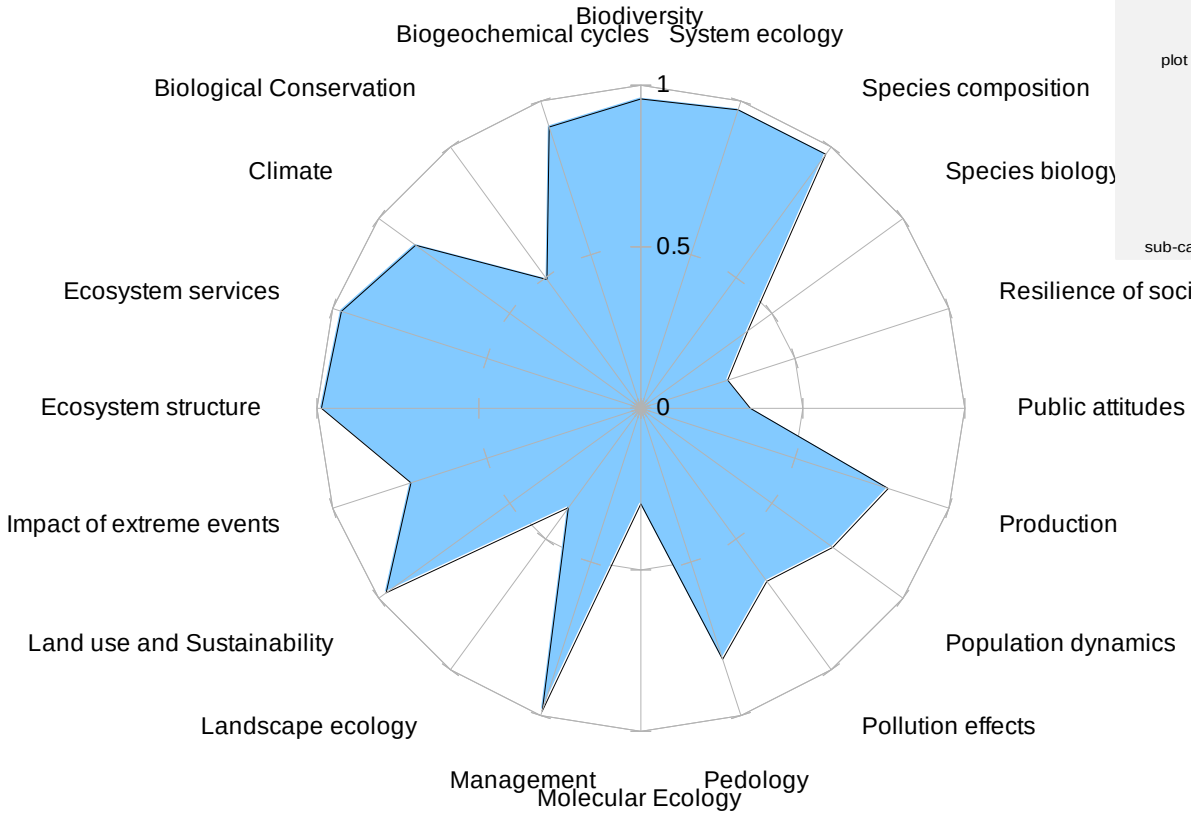


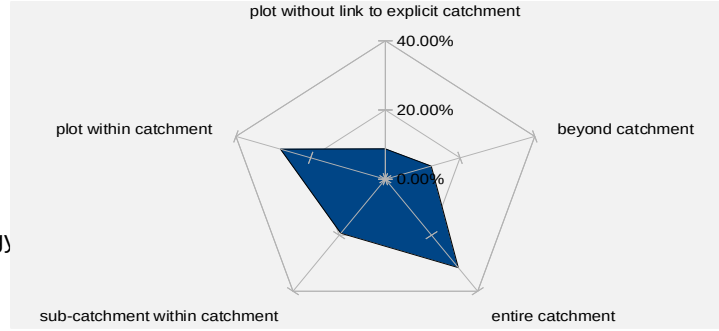


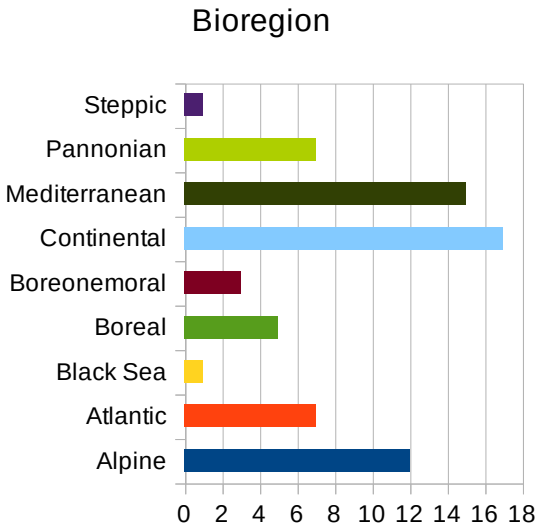


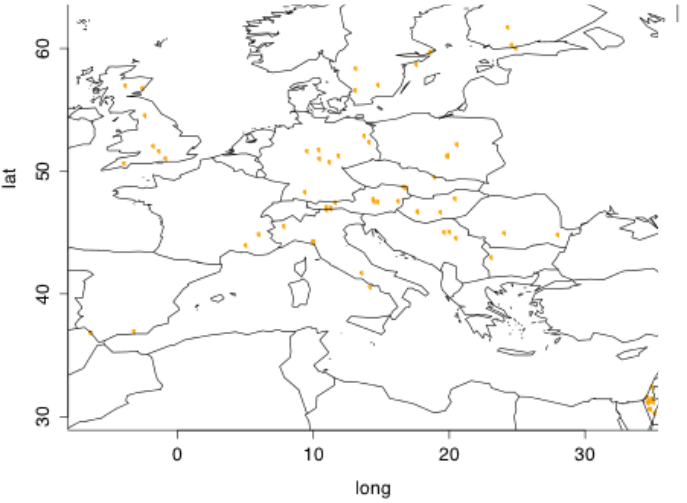
Source: LTER-Europe

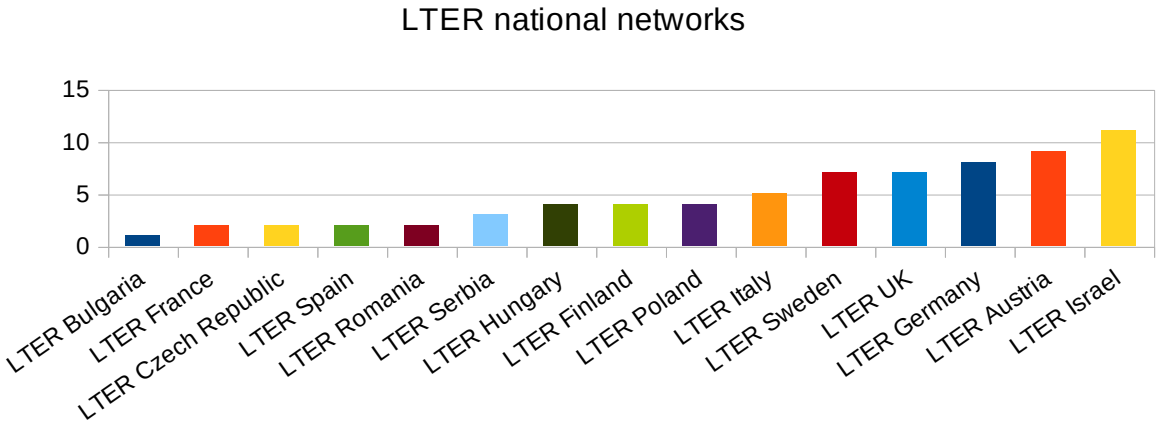
Cluster 5





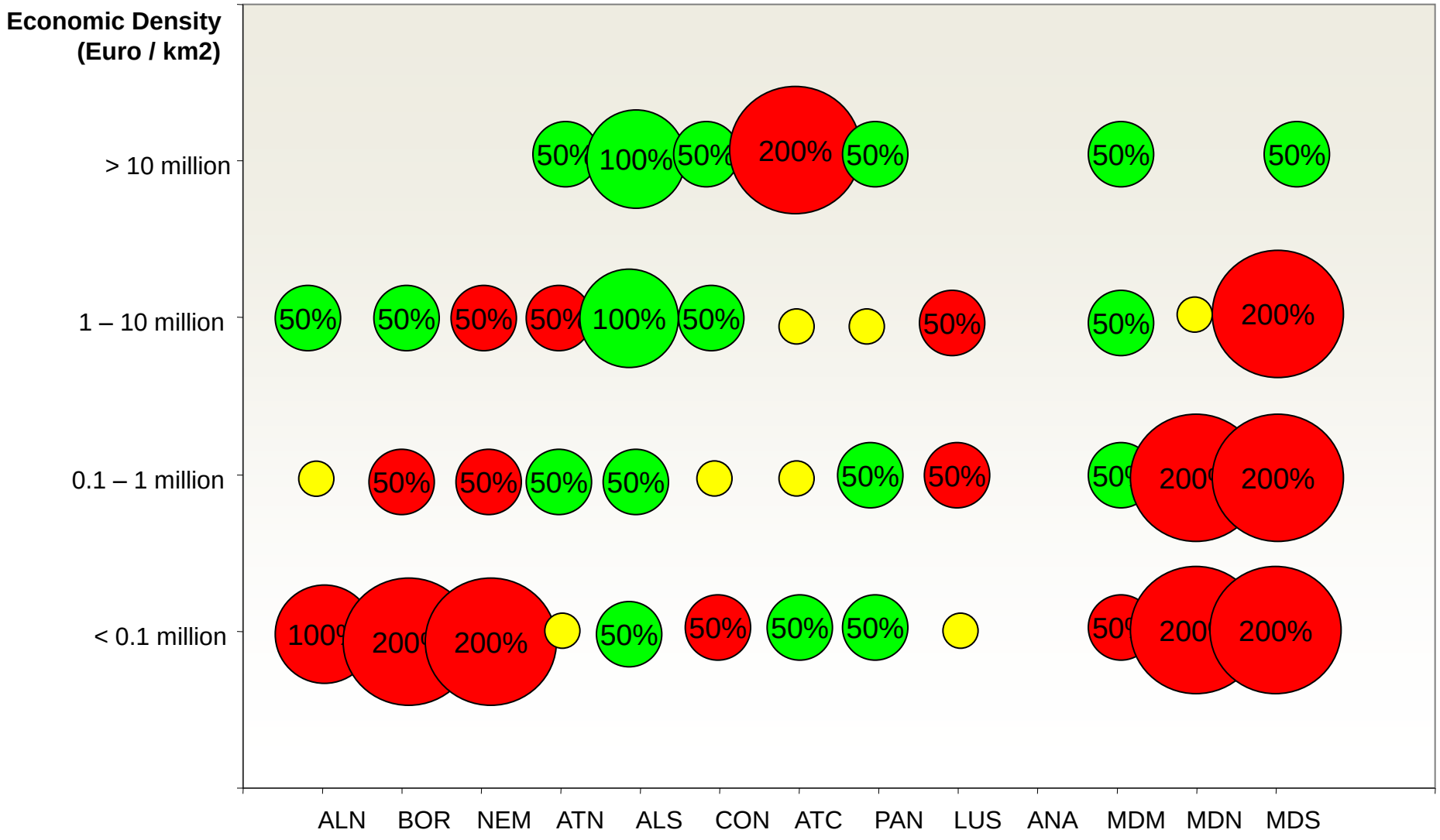






Source: LTER-Europe

Step 2: gap analysis (example)



Source: LTER-Europe

Step 3: top down

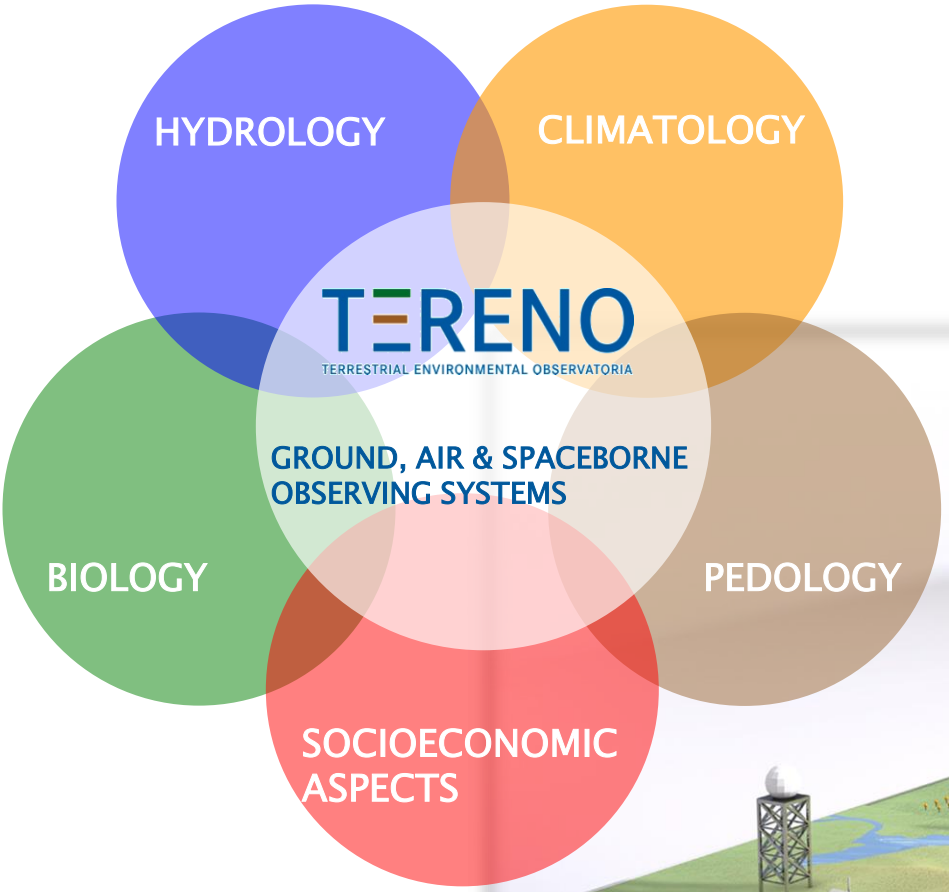
- Necessary ammendments
  - *design*
  - *equipment*
- Network gap closures

Key challenges for the European scale

- Organisational differences across countries
- Interaction between RI catagories (ESFRI, non-ESFRI, national, European, global)
- Opportunistic behaviour of sites/projects/institutions

→ added value?

TERENO, Germany



Thanks!


Geophysics


Groundwater monitoring


Remote Sensing


Wireless soil moisture sensor network


Lysimeters


Biodiversity monitoring


Mobile Mesocosms


Water quality monitoring


Eddy-Flux-Tower


Rainscanner


Modelling Platform