Bundesministerium
für Bildung
und Forschung

TERENO
TERRESTRIAL ENVIRONMENTAL OBSERVATORIES

Coordination Team (CT) Biosphere

Mark Frenzel, Cornelia Baeßler, Mathias Scholz, Stefan Klotz

Helmholtz Centre for Environmental Research - UFZ
Dept. Community Ecology

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Energy | **Water** | **Matter**

Terrestrial Ecosystem

Physics ⟷ Chemistry

Organisms

(Composition, Interaction)

Atmosphere

Hydrosphere

Pedosphere

Biosphere

Energy | ***Water*** | ***Matter***

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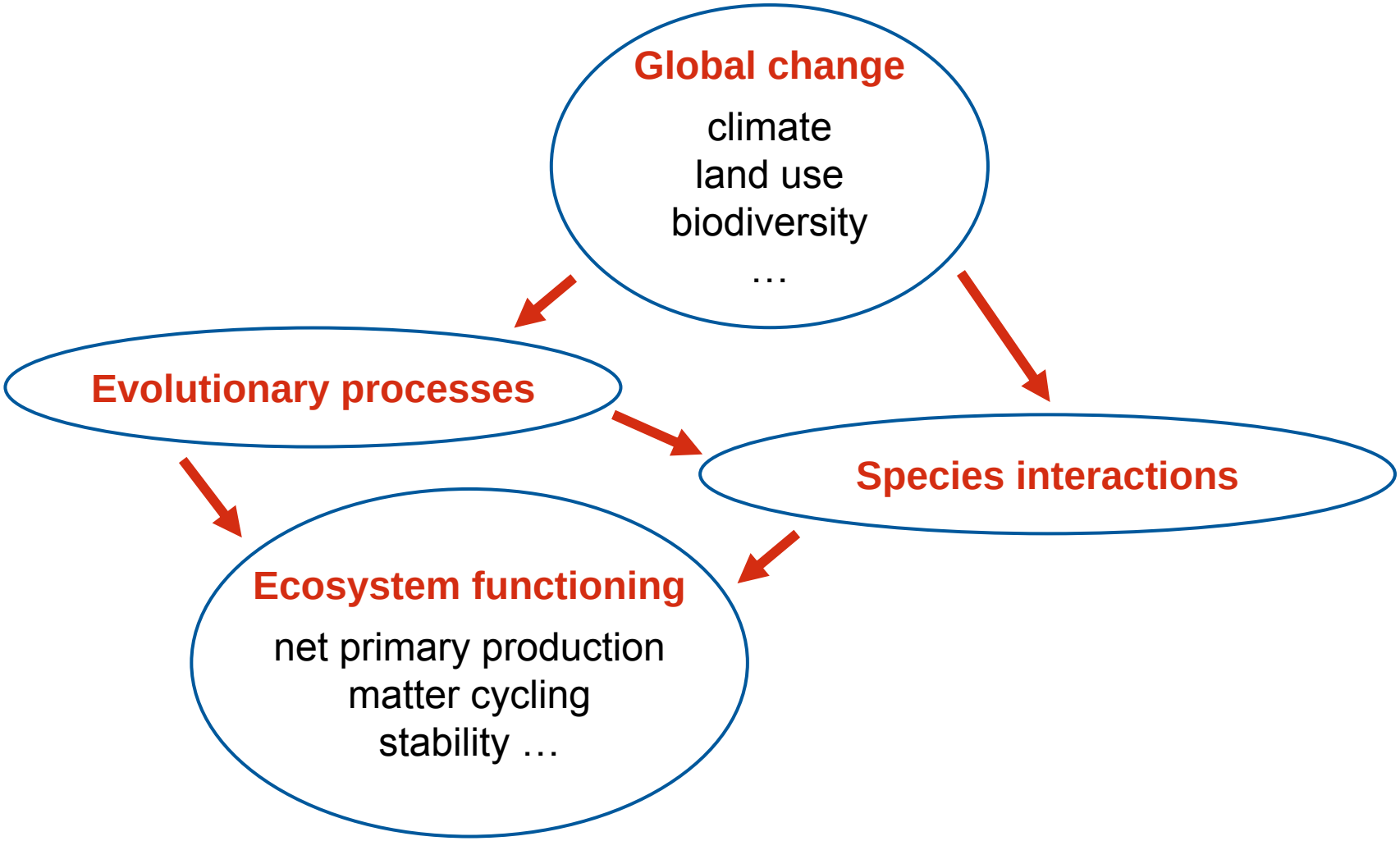
Issues of CT Biosphere



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CT Biosphere Hypotheses (Implementation Plan)

Climate and land use change influence…

1. … **local adaptation** => depends on genetic variation
2. … **population genetics** of plants => microevolutionary processes
3. … **areal shifts of species** => changes in existing communities
4. … **ecological communities** => consequences for ecosystem functions and services (productivity, erosion control, pollination)
5. …the **adaptability of selected ecosystems** in the long-term

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Cross-Observatory Activities

SoilCan

=> Influence of climate change on plant communities

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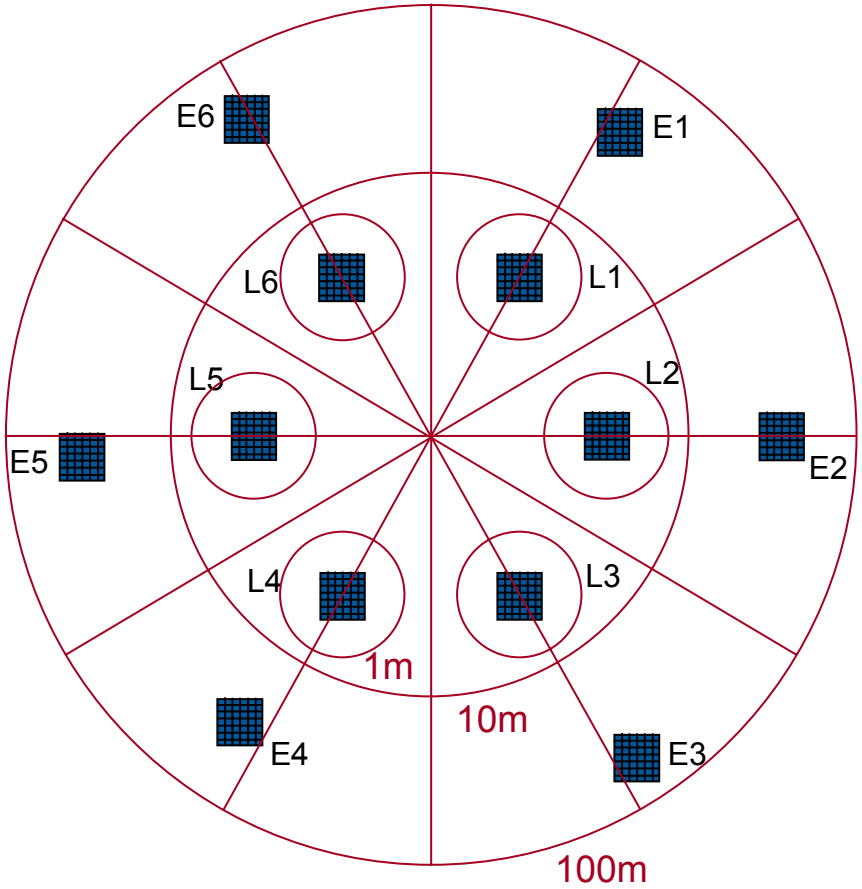
➢ **Assessment** of (changes in) biodiversity and its function in local and regional context along environmental gradients (temperature, precipitation)



1. Quadrates inside (L) and outside (E) 80x80 cm; Raster = 10x10 cm
   - presence-absence of each species per raster (every year)
2. 1 circle around each lysimeter in a distance of 1m
   - depart from the centre 1 circle of 10m Ø & 1 circle of 100m Ø
   - presence-absence mapping of all species every 2-3 years
3. Cutting at least once (twice) a year => Biomass production

➢ Δ ecosystem functions (species traits – due to soil characteristics and water availability)

➢ Δ ecosystem services (e.g. productivity)

➢ Δ species diversity and community composition

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Single-Observatory Activities : Harz /Central German Lowland (UFZ)

1. Bode Catchment (Hydrology and Biodiversity)
2. Biodiversity core sites (6 sites, 4x4 km)
3. Satellite sites (to cover the area)
4. Process-related experiments (Observatory; Floodplains **G**lobal **C**hange **E**xperimental **F**acility - GCEF)

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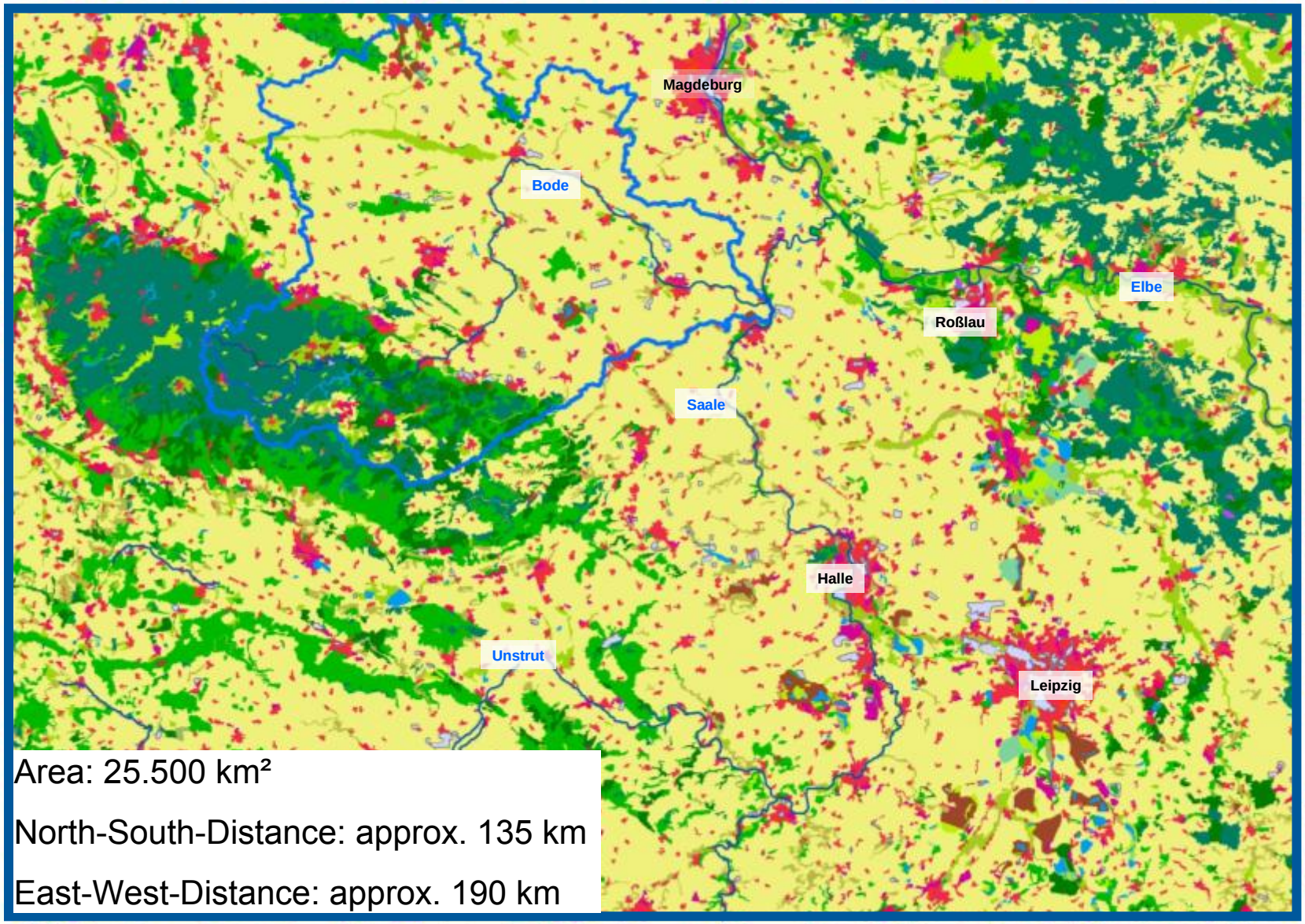
Harz /Central German Lowland (UFZ)



Area: 25.500 km²

North-South-Distance: approx. 135 km

East-West-Distance: approx. 190 km

LTZ
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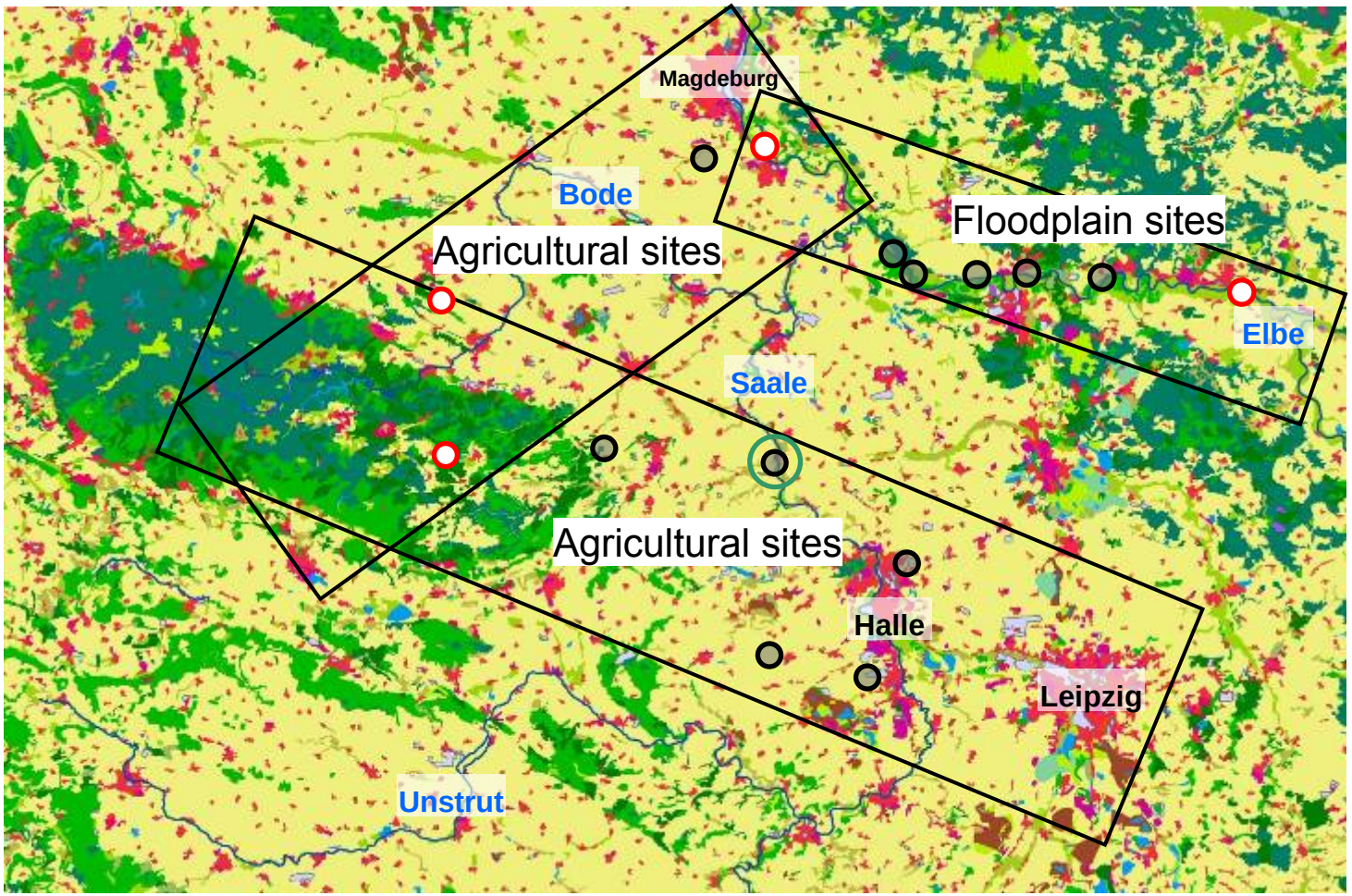

- Core sites with (historical) data held by UFZ
- Core sites established in 2009

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Concept for biodiversity research

OBJECTIVE

Assessment of biodiversity and its function in the regional, landscape and local context along broad environmental gradients as a basis for understanding impacts on and sustainable management of biodiversity under global change

APPROACH

Field-site network along gradients used for **MONITORING** and **EXPERIMENTS**.

Focus on cultural landscapes including semi-natural habitats (grasslands, forests) and landscape elements (hedges, field margins).

GRADIENTS:

- landuse intensity
- climatic conditions (temperature, precipitation)
- species richness / species pools

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I.
Monitoring and Observation Approaches

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Assessment targets

- **Landscape structure -** types of land use, land use intensity, configuration, fragmentation
- **Soil** - type, depth, quality, water retention
- **Vegetation analyses -** composition, productivity
- **Monitoring of selected organisms groups**
  - **Vascular plants** => Primary producers (overall biodiversity indicators)
  - **Bees & Hoverflies** => Important pollinators (ecosystem service agents)
  - **Butterflies** => Indicators for habitat quality, pollinators
  - **Birds** => Highly mobile, sensitive to landscape context, integrative on landscape scale
- **Genetic** variation of selected species, microevolution

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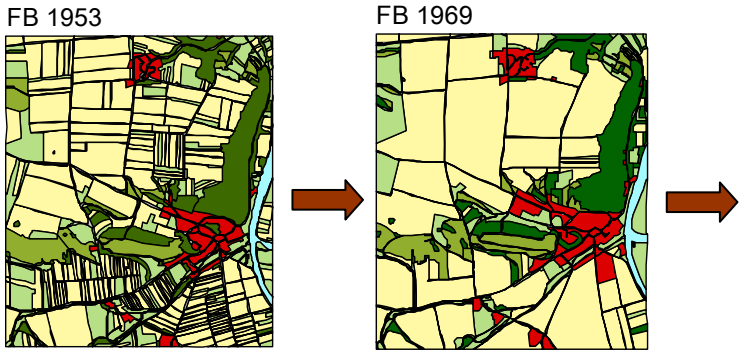
Landscape structure (Core site Friedeburg)



Period	Nitrogen (N; kg/ha)	Phosphorus (P_2O_5; kg/ha)
1950s	35	31
1970s	124	61
2000	178	32

Period	Shannon Diversity	Share semi-natural habitats	PROX whole landscape (*10³)	Mean size arable fields (ha)
1950s	0.97	36.1	1.6	1.6
1970s	0.85	29.8	3.4	8.1
2000	0.77	25.8	4.8	10.5

Baessler & Klotz 2006

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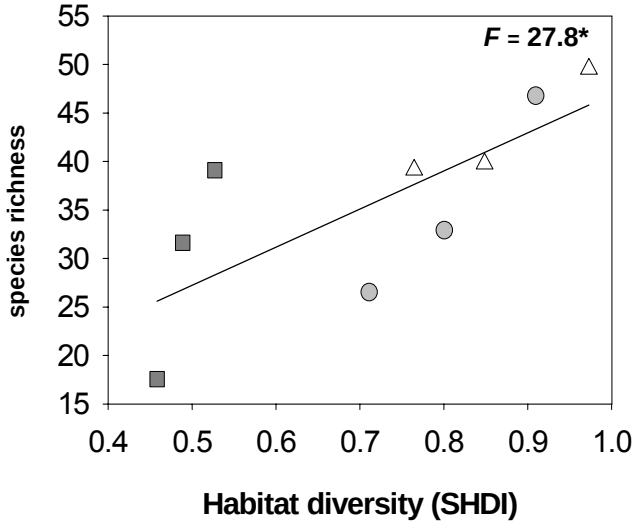
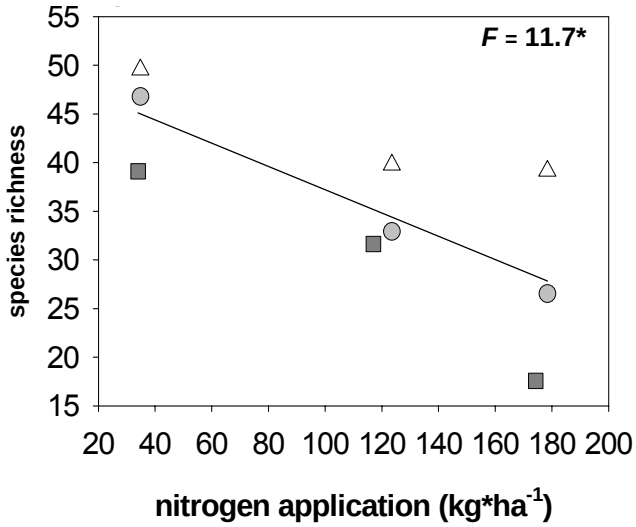
Vegetation analyses: arable weeds species richness (3 core sites)

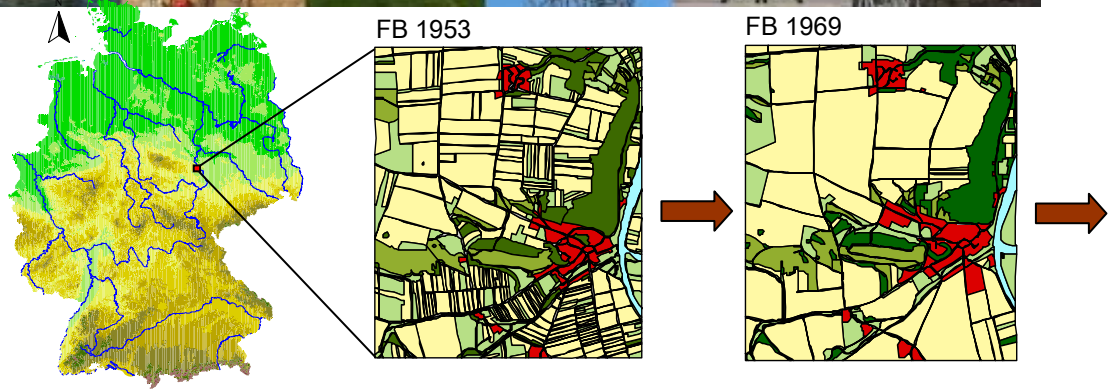




Dates of relevés: 50ties, 70ties, 2000

- High habitat diversity => high species richness
- High nitrogen application => low species richness

Baessler 2008



Policy (EU, national)

Land-use Intensity

PRESSURE
landscape structure
fertilizer applications

Biodiversity

ecosystem function

Soil conditions
Water balance
Species composition (traits)

ecosystem services

Soil erosion
Water quality
Species – Gene pool
Pollination

Social, Environmental and Economic value

Baessler 2008

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Satellite image of core site Harsleben

Protocol Plant Survey

Tested method: GREENVEINS protocol (EU FP5 project)

- **Aim**: representative sampling of all patches
- **Stratified random sampling**
  - (1) patches of natural /semi-natural vegetation
  - (2) patches of arable fields and cultivated grasslands
  - (3) linear elements
- **Number of plots** per LTS (4x4 km) => about 150-250 plots
- **Size of plots**: 10x10 m = 100 m²; different in linear elements (still 100m², but rectangular)
- **Abundance** according to Braun-Blanquet
- **Frequency**: every 3 years

Protocol Bird Monitoring

Tested method: GREENVEINS protocol (EU FP5 project)

- **Aim**: to register the bird communities within 9 km² in a single morning session
- **Sampling points:** 20 points, 500 m distance, 5 minutes watching (Point-stop method)
- **Sampling dates**: 3 times (April, May, June)
- **Sampling time**: sunrise + 3 hours
- Noting of behaviour, registering singing and seen birds
- **Frequency**: every 3 years

Insect Monitoring

1. **Butterfly** monitoring according to the TMD (Tagfalter Monitoring Deutschland) scheme (www.tagfalter-monitoring.ufz.de); Frequency: yearly

2. **Other pollinators**: Combined flight trap sampling according to modified protocols of EU projects BIOASSESS (rapid biodiversity assessment) and GREENVEINS

Protocol Insect monitoring: Combined flight traps

Tested method: GREENVEINS protocol (EU FP5 project)

- **Aim and focus**: representative samples of pollining insects => Hoverflies, bees

- **Number of traps**: One trap / km² => border (ecotone) between semi-natural habitat and arable field (**16 traps / site** of 4x4 km)

- **Operating schedule** (emptying interval 14 days)**:**
  - Start at week 2–7 after full bloom of *Taraxacum officinale* (phenological indicator) => 3x emptying
  - Stop in mid-summer
  - Continuation at week 15 – 20 => 3x emptying

- **Frequency**: yearly

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II.
Experimentation on different scales

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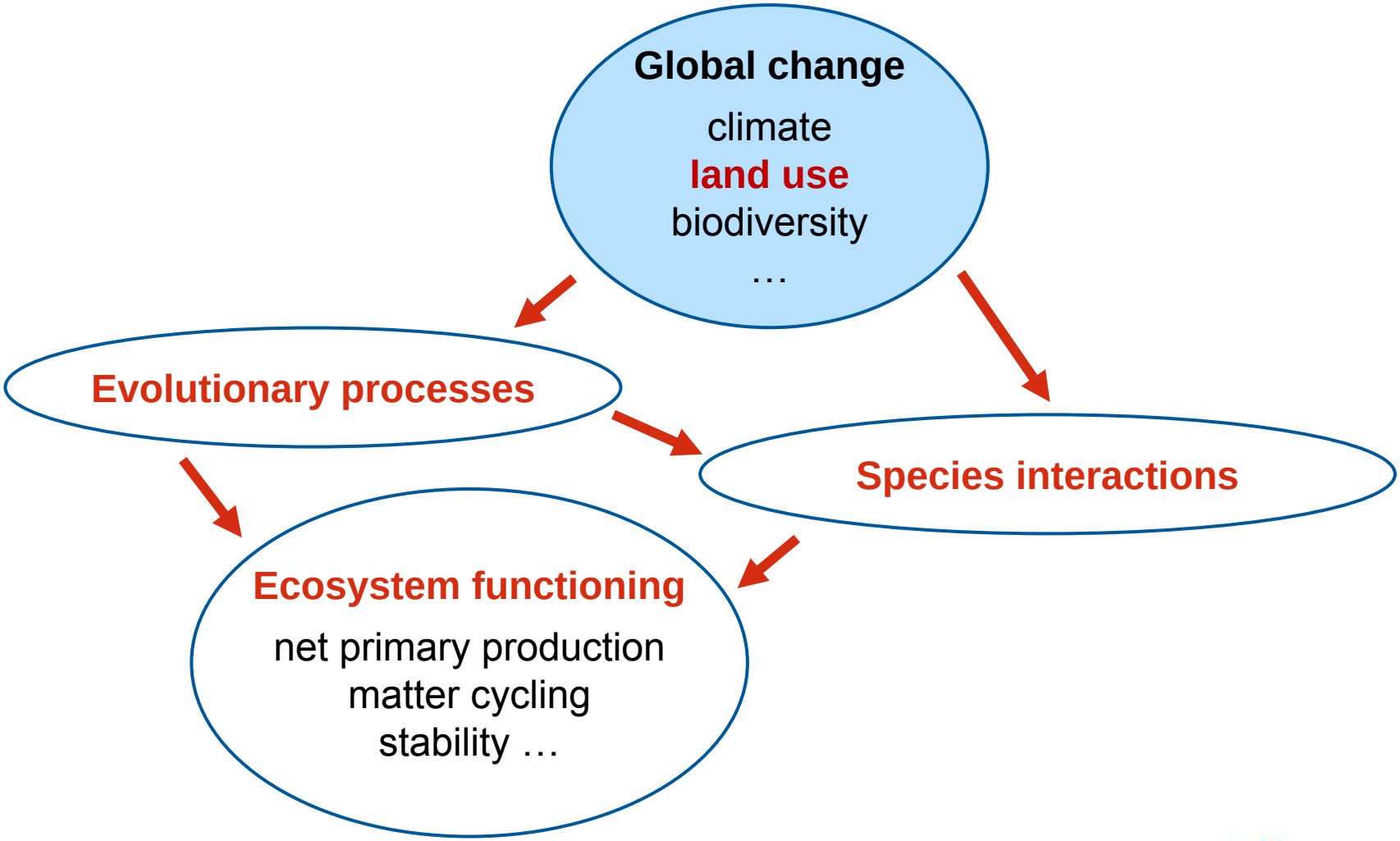

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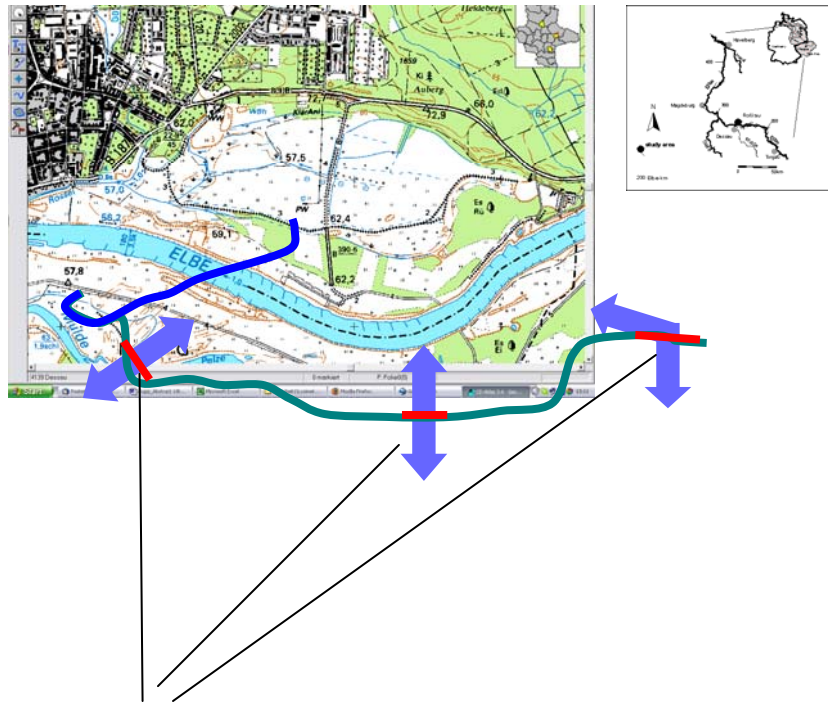
Dike relocation „Roßlauer Oberluch“ Middle Elbe – tracing extreme events

- First dike replacement in Saxony- Anhalt – 2006
- Construction of a new dike
- Opening of the old dike
- Reconnecting of 140 ha former floodplain
- Arable land has already been changed into grassland and forest



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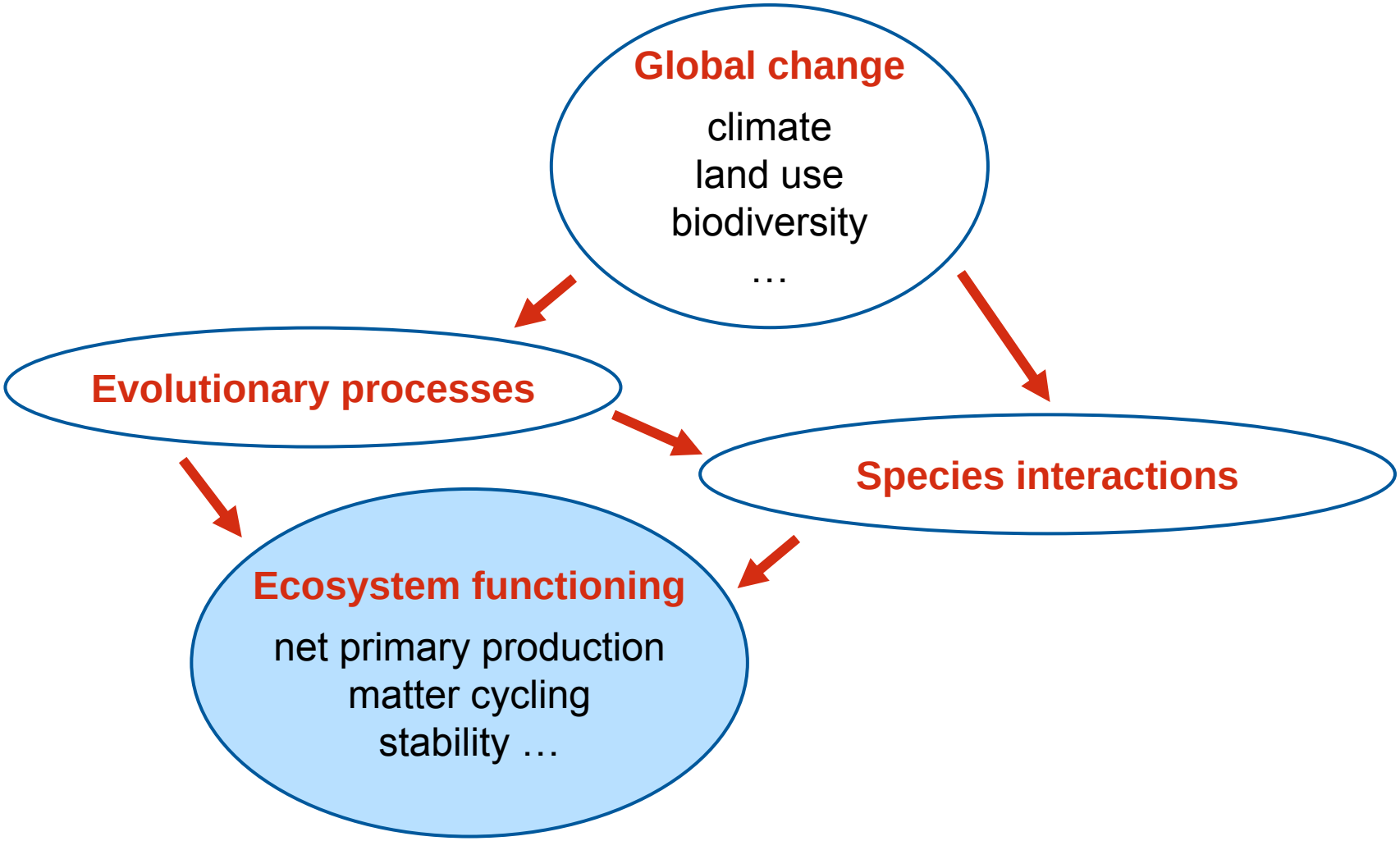

Quantifying ecosystem functioning

Selected plant: *Papaver rhoeas* (Poppy), annual plant occurring in or close to arable fields. Flowering from June to September

Problem: hundreds of very small seeds
Solution: high-resolution scanning and computer-processing => counting of seeds, calculation of size parameters, frequency distribution of size classes

Test for effect of pollinators on seed production by **exclosure of pollinators** during flowering (bagged flowers)

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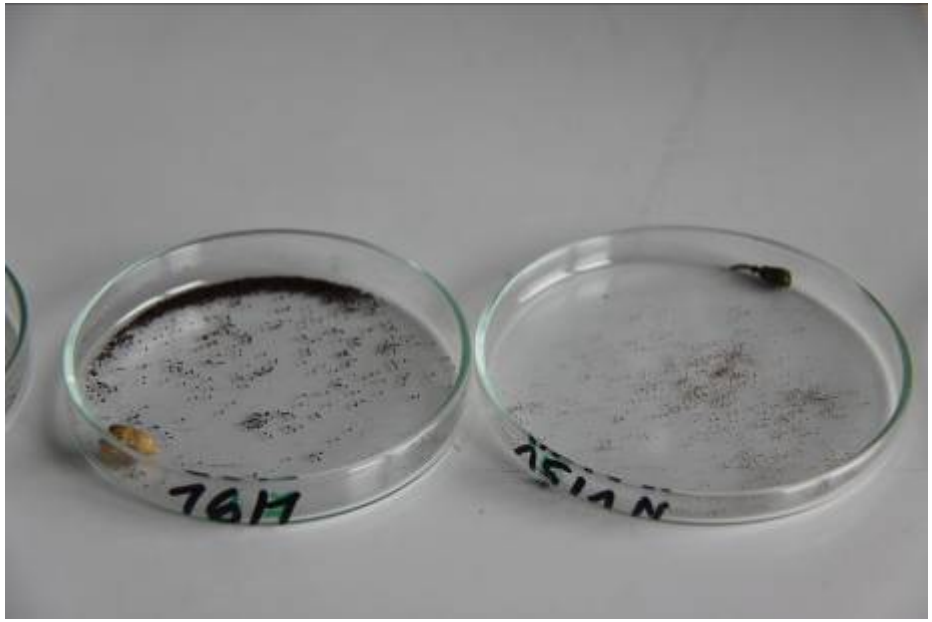

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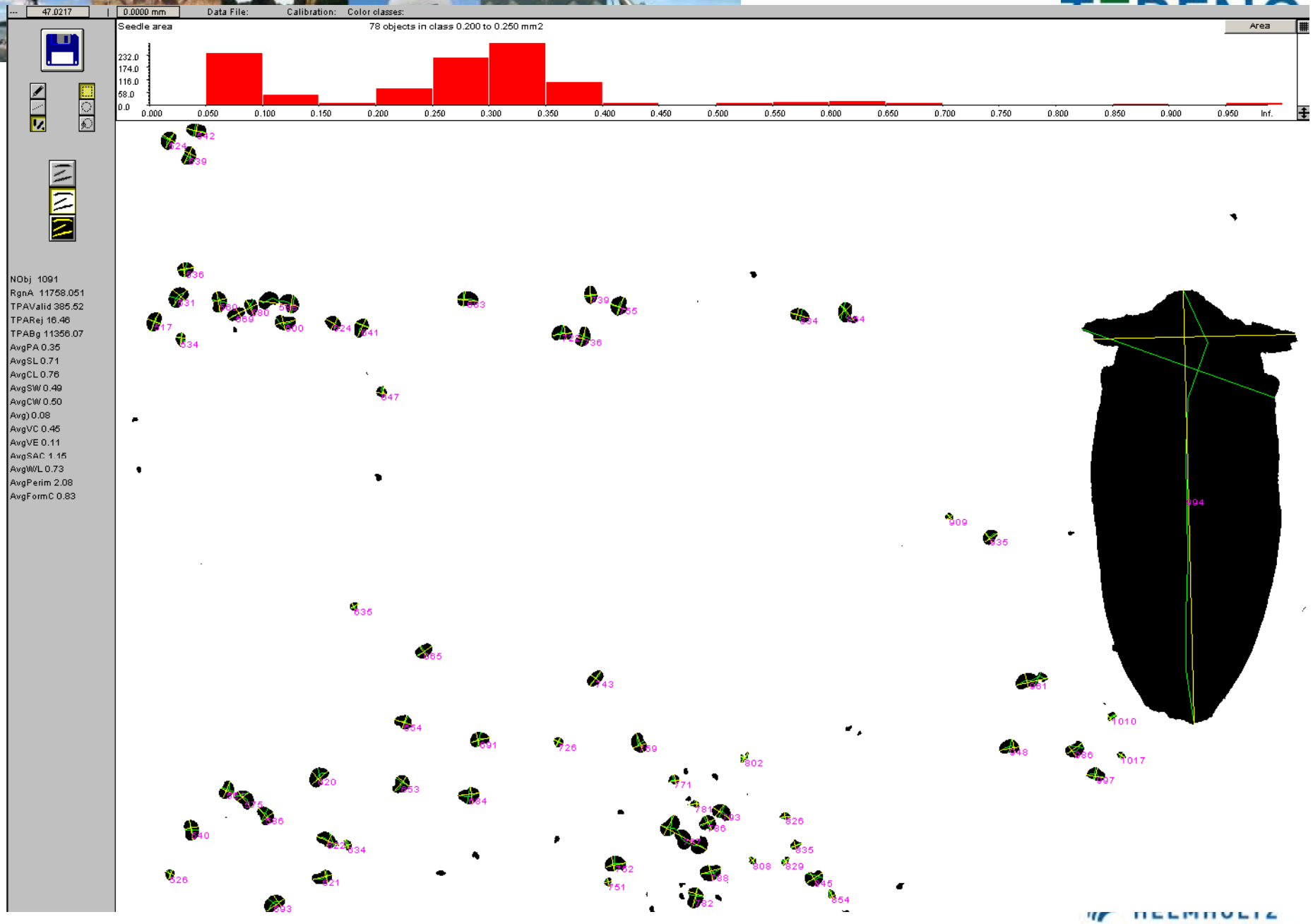
47.0217
0.0000 mm
Data File:
Calibration:
Color classes:
Seedle area
78 objects in class 0.200 to 0.250 mm2
Area
232.0
174.0
116.0
58.0
0.0
0.000
0.050
0.100
0.150
0.200
0.250
0.300
0.350
0.400
0.450
0.500
0.550
0.600
0.650
0.700
0.750
0.800
0.850
0.900
0.950
Inf.
NObj 1091
RgnA 11758.051
TPAValid 385.52
TPARej 16.46
TPABg 11356.07
AvgPA 0.35
AvgSL 0.71
AvgCL 0.76
AvgSW 0.49
AvgCW 0.50
Avg) 0.08
AvgVC 0.45
AvgVE 0.11
AvgSAC 1.15
AvgWL 0.73
AvgPerim 2.08
AvgFormC 0.83

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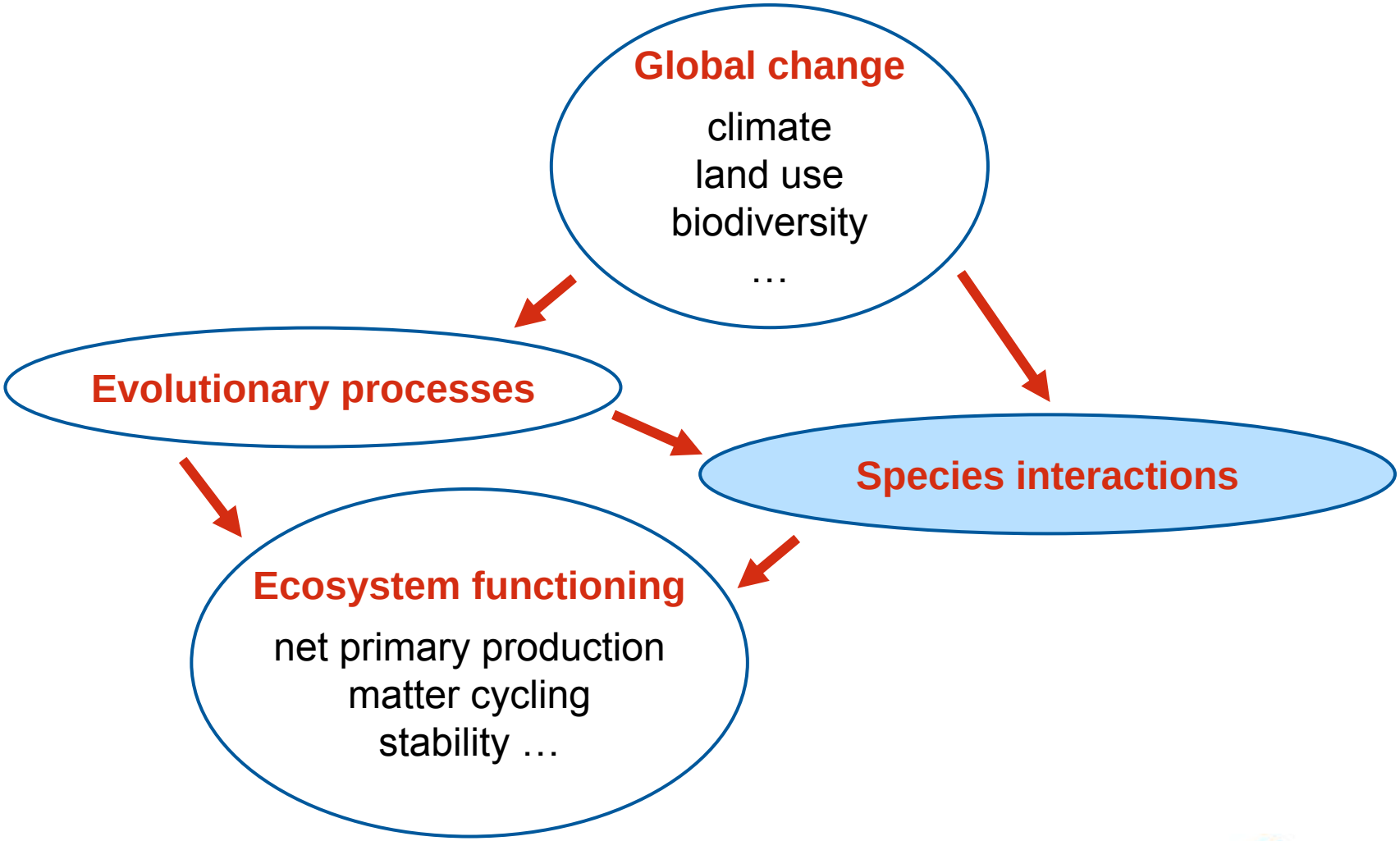

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Ecological interactions among species

Greenhouse experiments

- pot or microcosm experiments
- microbes: sterilization / inoculation
- herbivores & predators: cages

Field experiments

Manipulation of

- plant species: composition or diversity
- soil microbes: inoculation or fungicides
- herbivores: fences or pesticides

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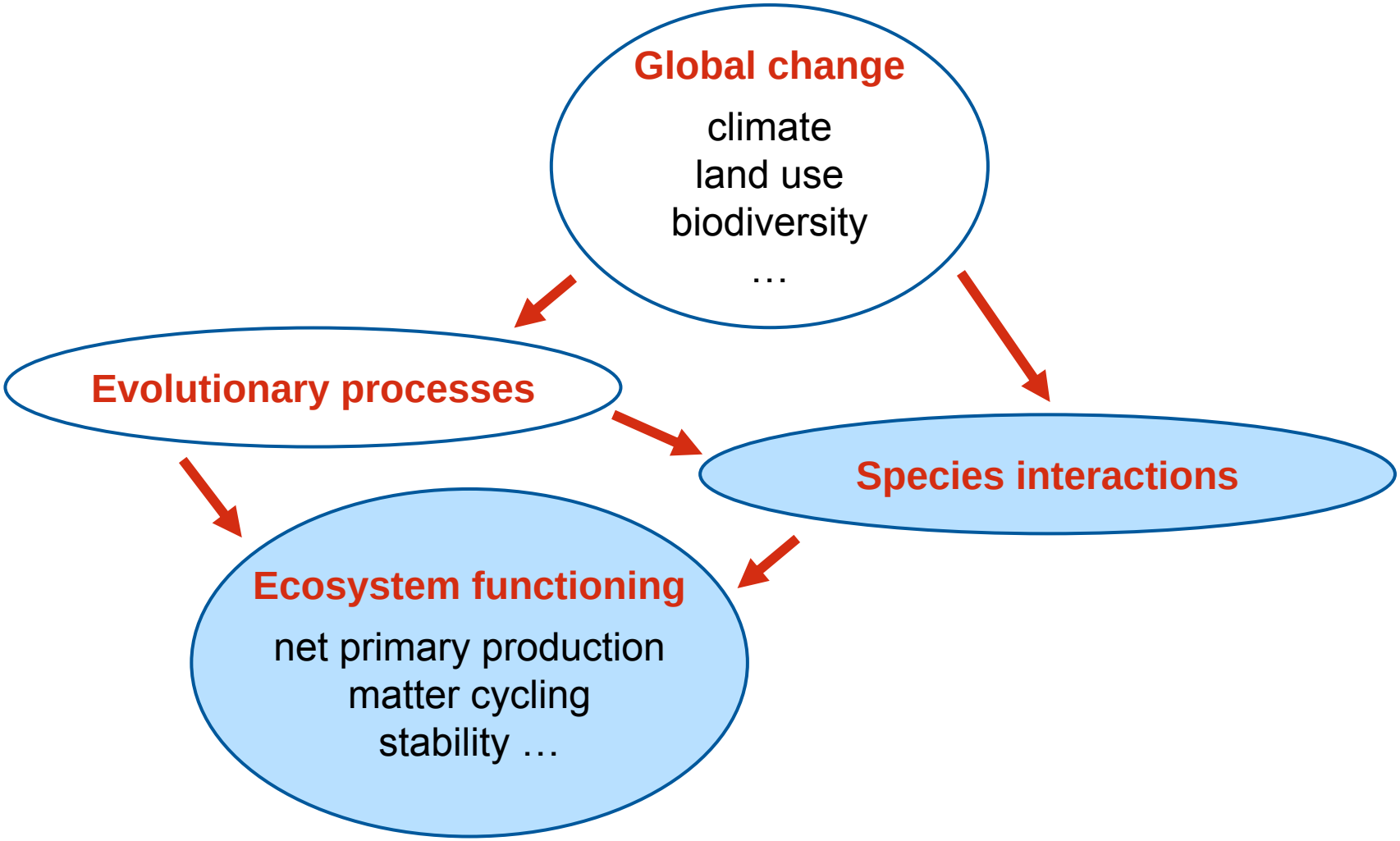

Effects of herbivory and biological invasions on **diversity** and **productivity** of grasslands

Factorial experiment replicated across 3 regions

Montana | California | C Germany

Collaborators: C. Stein & K. Suding, UC Berkeley
J. Maron, U Montana, & D. Pearson, US Forest Service
I. Hensen, MLU Halle

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HIGRADE

DAAD Deutscher Akademischer Austausch Dienst German Academic Exchange Service

GLOBAL INVASIONS NETWORK

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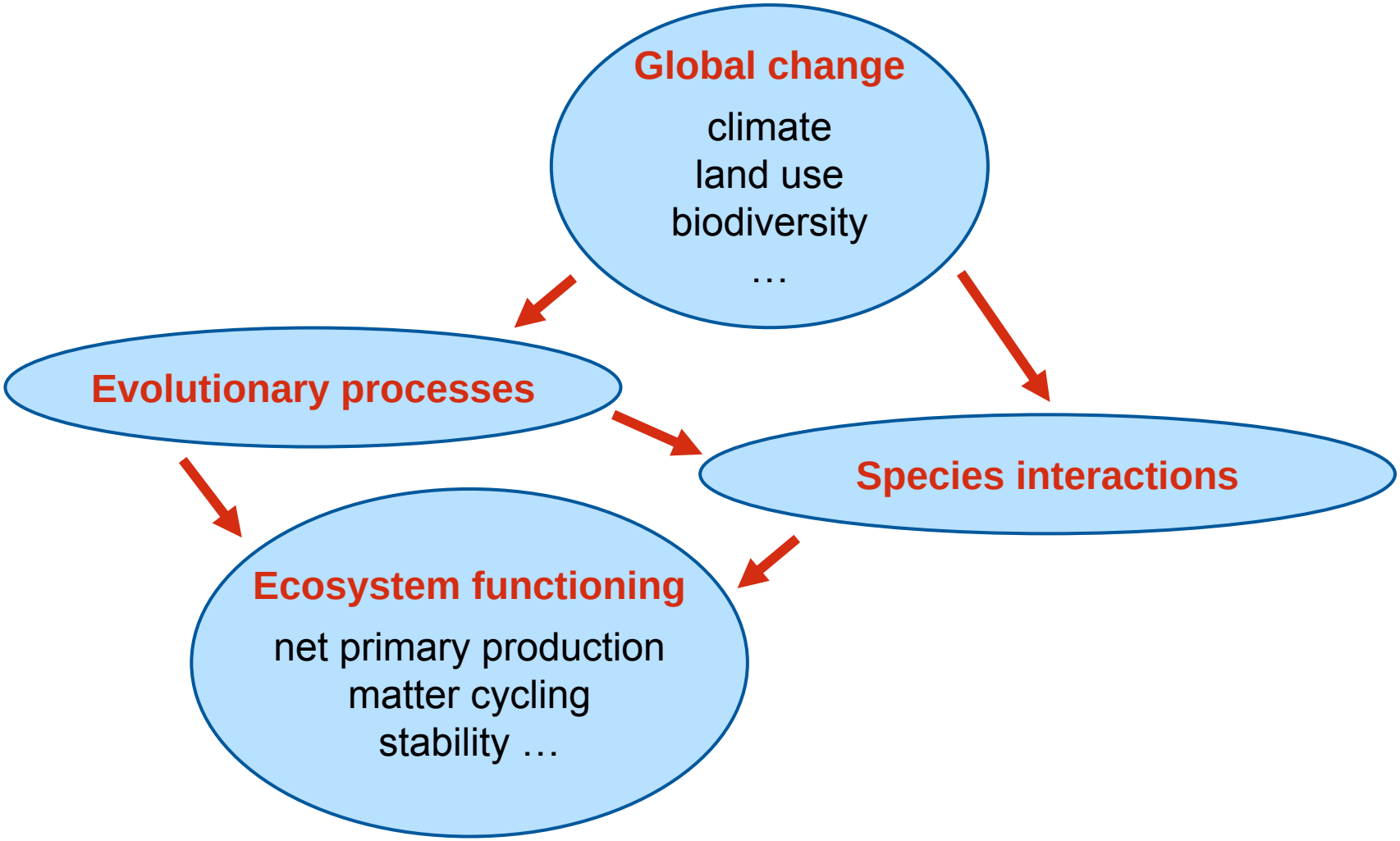

Global Change Experimental Facility

Bad Lauchstädt

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Prototype construction 2010

- Mobile roof and side panels (east and west)
- Time control (independent for roof and each panel)
- Control by rain sensor possible
- Irrigation system

30 replicates!

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LAND USE SCENARIOS

- intensive *vs.* extensive
- food *vs.* energy crops
- fallow land *vs.* agriculture

CLIMATE CHANGE SCENARIOS

- ambient *vs.* projected temperature
- ambient *vs.* projected precipitation
- modifying factors (CO_2, nutrients, invasions)

New generation of experiments:

- Assessment of scenarios
- Interactions with land use

Requirements:

- Interdisciplinarity
- Long-term research
- Larger scale

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Outlook:
Integration across CT‘s

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Synergism with other projects: Benefits for LTER sites

www.enveurope.eu

ENVEurope: Environmental quality and pressures assessment across Europe: The LTER network as an integrated and shared system for ecosystem monitoring

Involved TERENO members: UFZ, FZJ

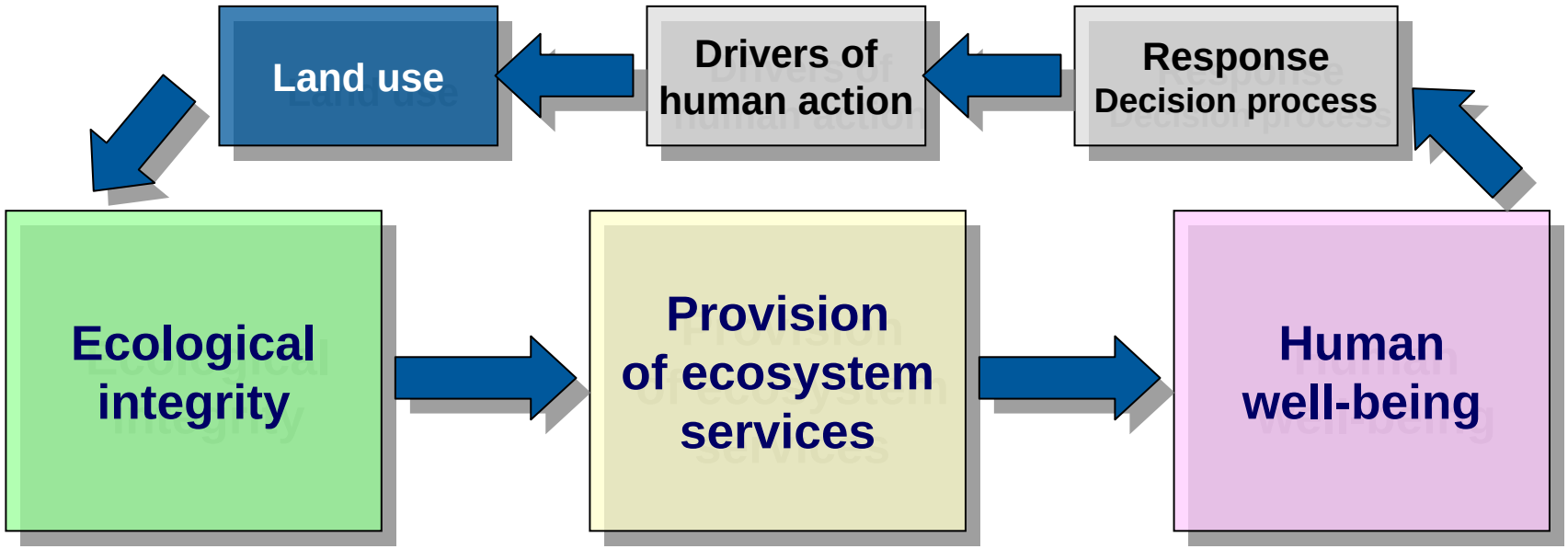
Product: Conceptual framework for indicator selection
(Benjamin Burkhard, Felix Müller; Universität Kiel)

Concepts I: DPSIR

PRESSURE
Human influence…

DRIVER
Need for…

RESPONSE
Improve or mitigate



STATE
of Ecosystems

IMPACT
Decline (or improvement)

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Connection Ecol. Integrity - Ecosystem Services

STATE → ESS → HUMAN WELFARE

Ecosystem structures
- biotic diversity
- abiotic heterogeneity

Ecosystem processes
- energy balance
- water balance
- matter balance

Regulating services
- climate regulation
- water purification
. . .

Provision services
- food
- fuels
. . .

Cultural services
- inspiration
- genetic ressources
. . .

Social well-being
- health
- social security
- education
- nutrition
- accommodation
- leisure
. . .

Economy
- employment
- spending power
- infrastructure
- progress
. . .

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ECOLOGICAL INTEGRITY

Ecosystem Structures	Biotic Diversity / Processes and Interactions		flora diversity
			fauna diversity
			habitat structure
			additional variables
	Abiotic Heterogeneity		soil heterogeneity
			water heterogeneity
			air heterogeneity
			habitat heterogeneity
			additional variables
Ecosystem Process	Energy Budget	input	exergy capture
		storage	exergy storage
		output	entropy production
		additional state variables	meteorology
		efficiency measures	metabolic efficiency
	Matter Budget	input	matter input
		storage	matter storage
		output	matter loss
		additional state variables	element concentrations
		efficiency measures	nutrient cycling
	Water Budget	input	water input
		storage	water storage
		output	water output
		additional state variables	element concentrations