My point of departure

Land use change

- affecting habitats
- threatening species

Milestones in the debate on sustainability

Silent Spring

THE LIMITS TO growth

Convention on Biological Diversity

SUSTAINABLE DEVELOPMENT GOALS

Carl von Carlowitz 1713

Sylvicultura oeconomica

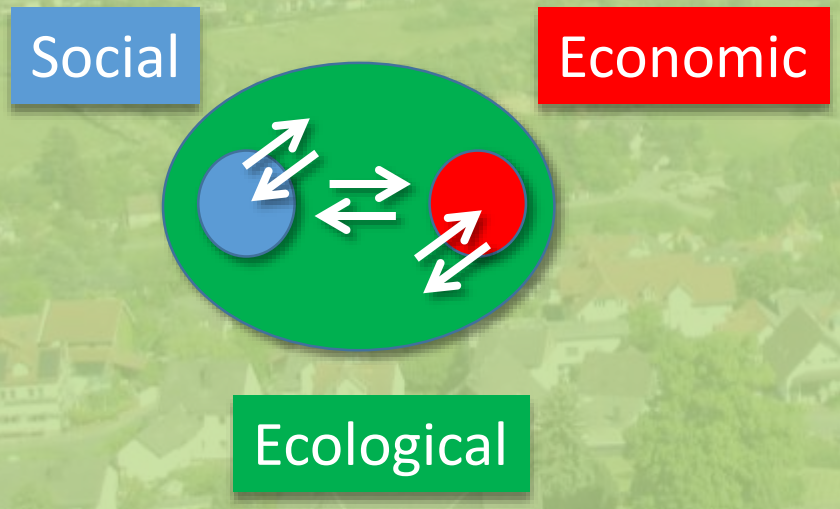
ipbes
Science and Policy for People and Nature

MILLENNIUM ECOSYSTEM ASSESSMENT

Human-nature-relationships

Integrating theory and practice across disciplines

Theory



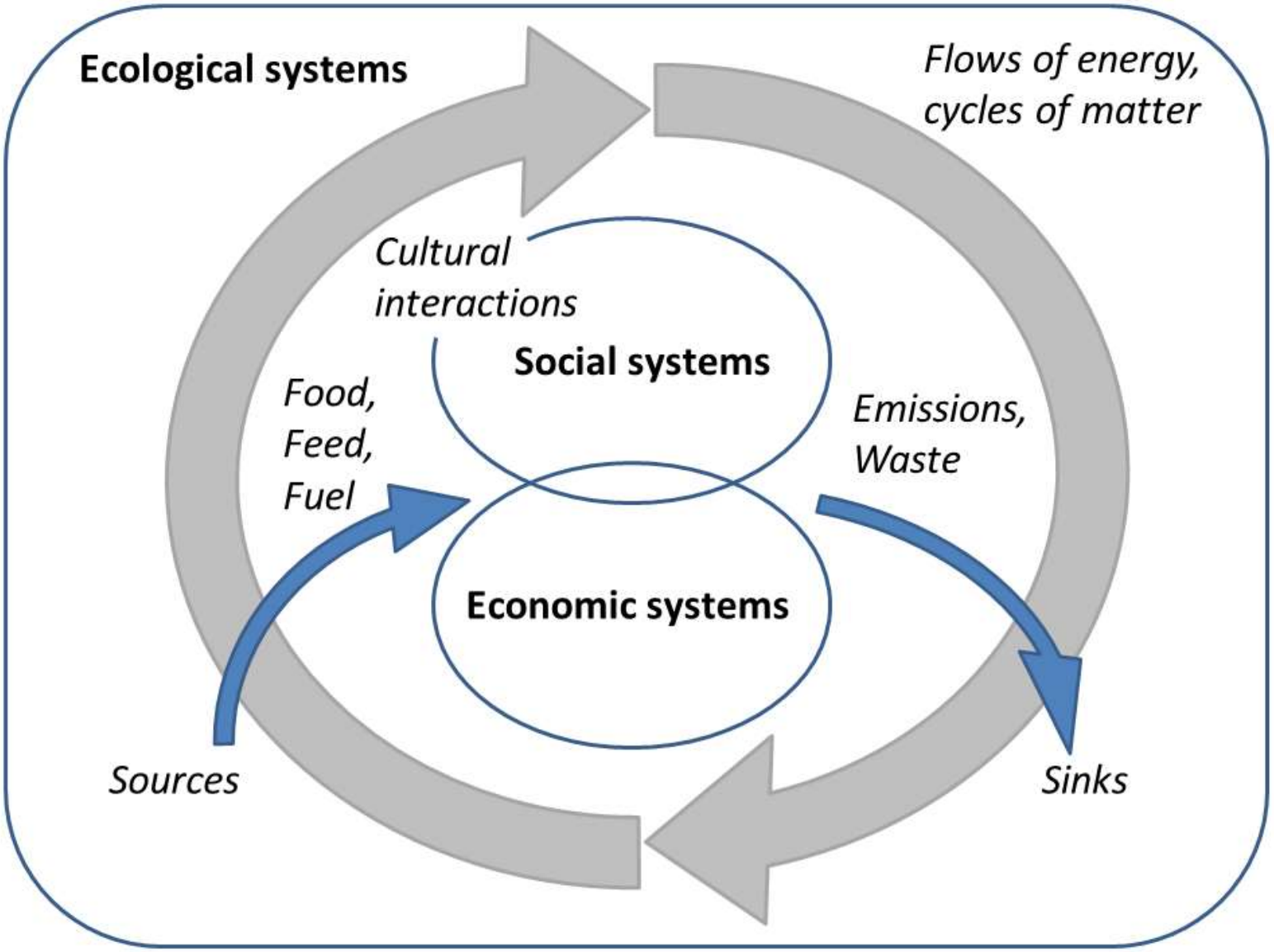
Complex system dynamics

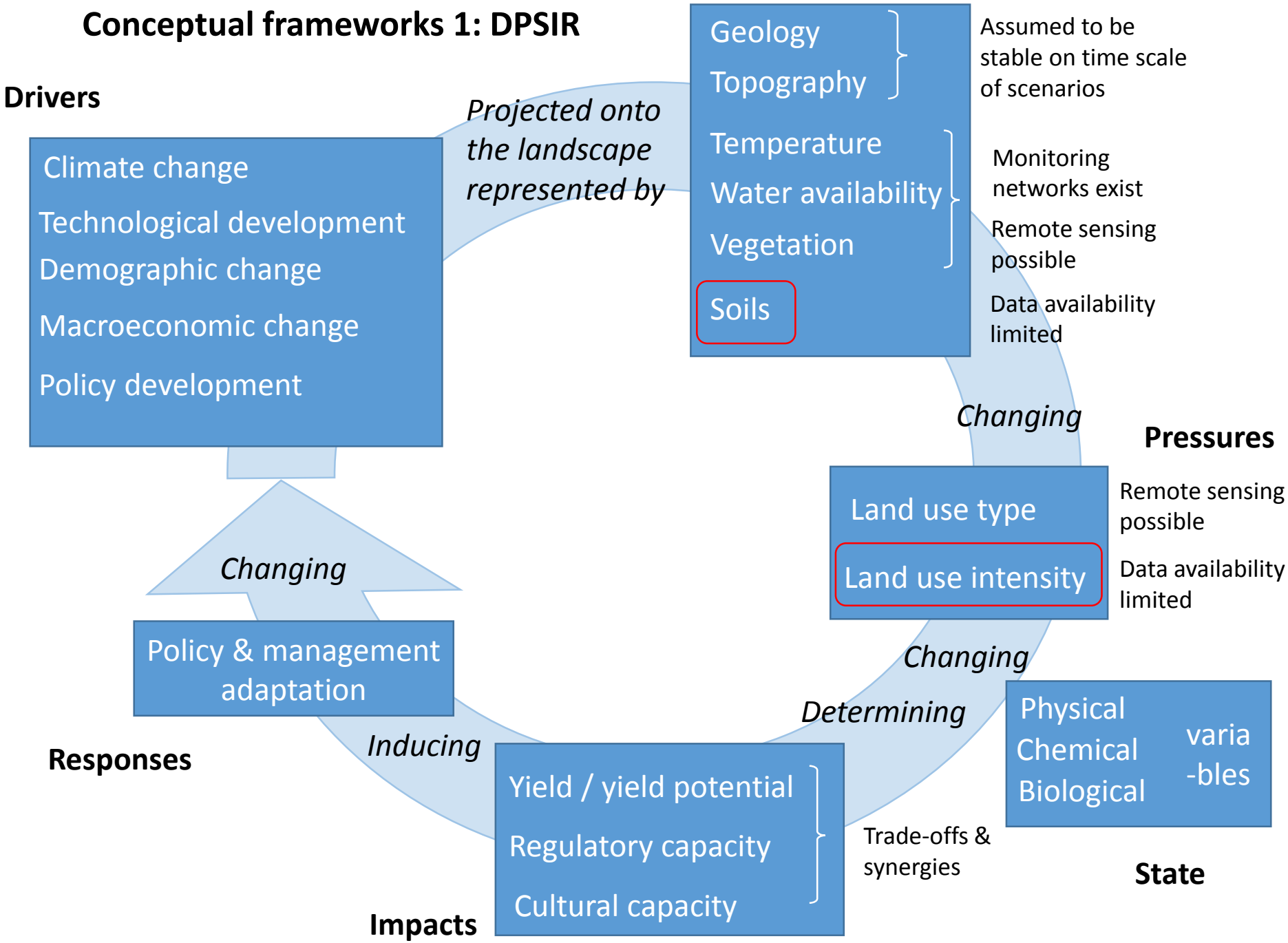
Practice

Ecological and socio-economic data, monitoring

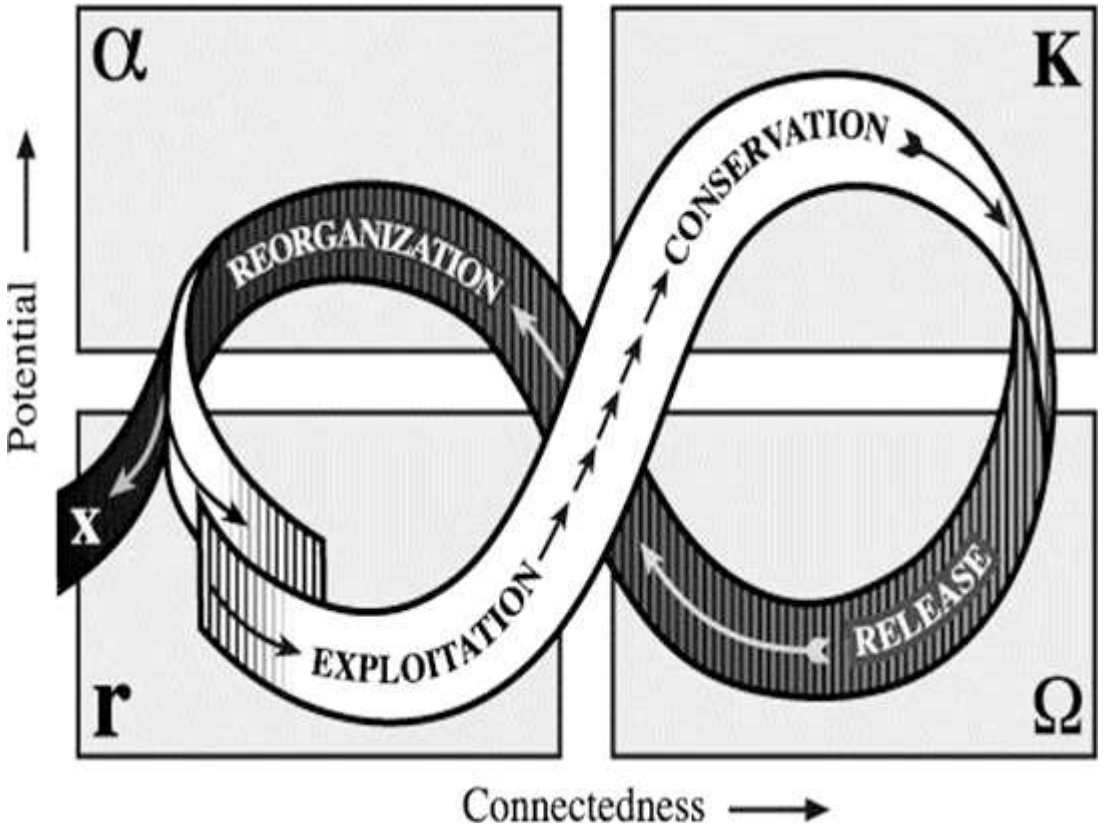
Individual & collective behaviour

Human-nature-relationships: zooming in




Conceptual frameworks 1: DPSIR
Drivers
Climate change
Technological development
Demographic change
Macroeconomic change
Policy development
Projected onto the landscape represented by
Geology
Topography
Temperature
Water availability
Vegetation
Soils
Assumed to be stable on time scale of scenarios
Monitoring networks exist
Remote sensing possible
Data availability limited
Changing
Pressures
Land use type
Land use intensity
Remote sensing possible
Data availability limited
Changing
Determining
Physical
Chemical
Biological
varia-bles
State
Trade-offs & synergies
Inducing
Yield / yield potential
Regulatory capacity
Cultural capacity
Impacts
Changing
Policy & management adaptation
Responses

Conceptual frameworks 2: Adaptive cycles

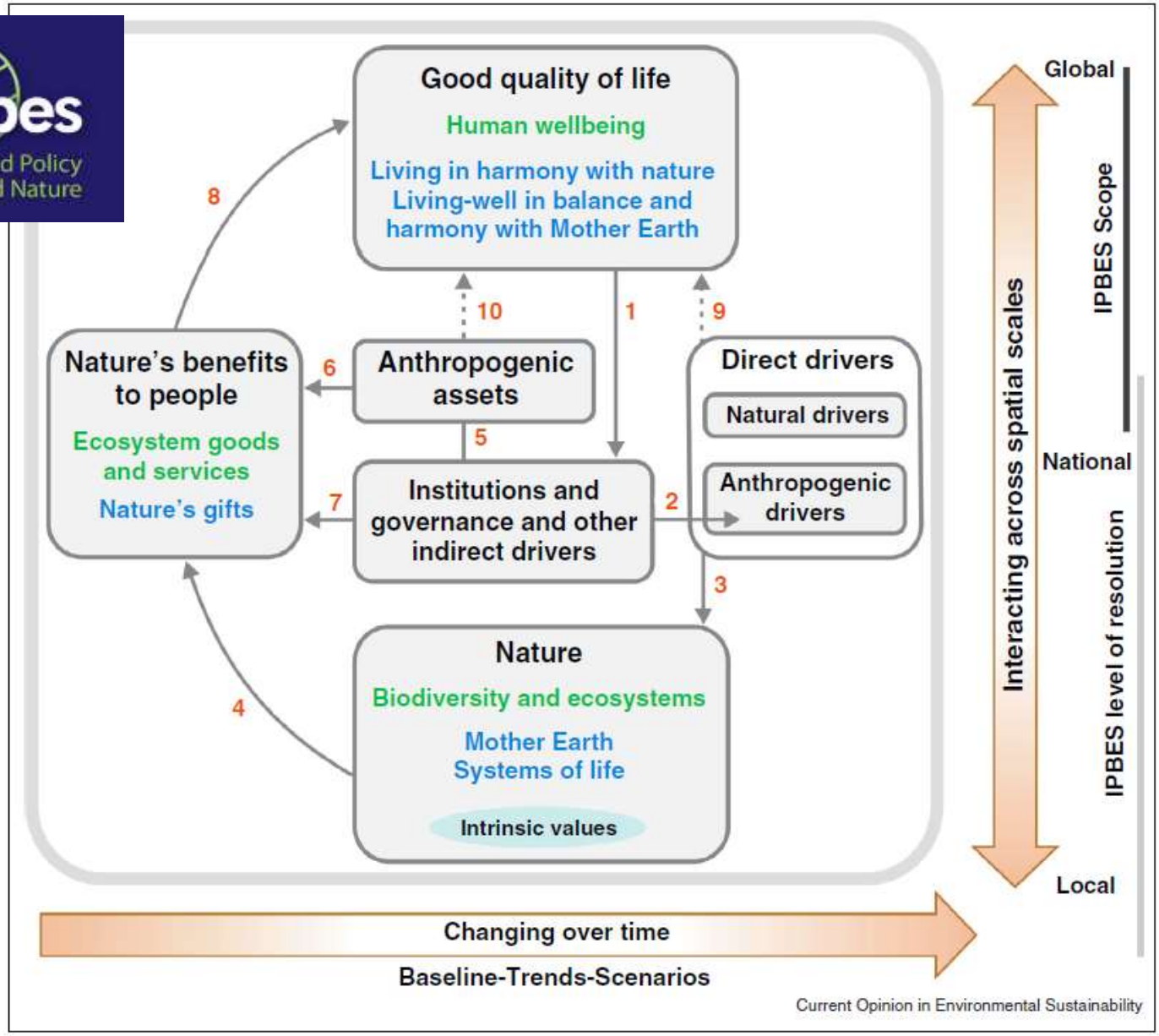


1. Growth or exploitation (r)
2. Conservation (K)
3. Collapse or release (omega)
4. Reorganization (alpha)

Resilience Alliance

http://www.resalliance.org/adaptive-cycle

Conceptual frameworks 3: the IPBES approach



Diaz et al. 2015

Models

- a simplified representation of a more complex / larger entity

Trade-offs in modelling

- Realism vs. runtime
- Complexity vs. traceability
- etc.

Types of models used in the analysis of human-nature relationships

- Integrated Assessment Models
- Land use change models
- Process-based models of ecosystem functions and ecosystem services
- etc.

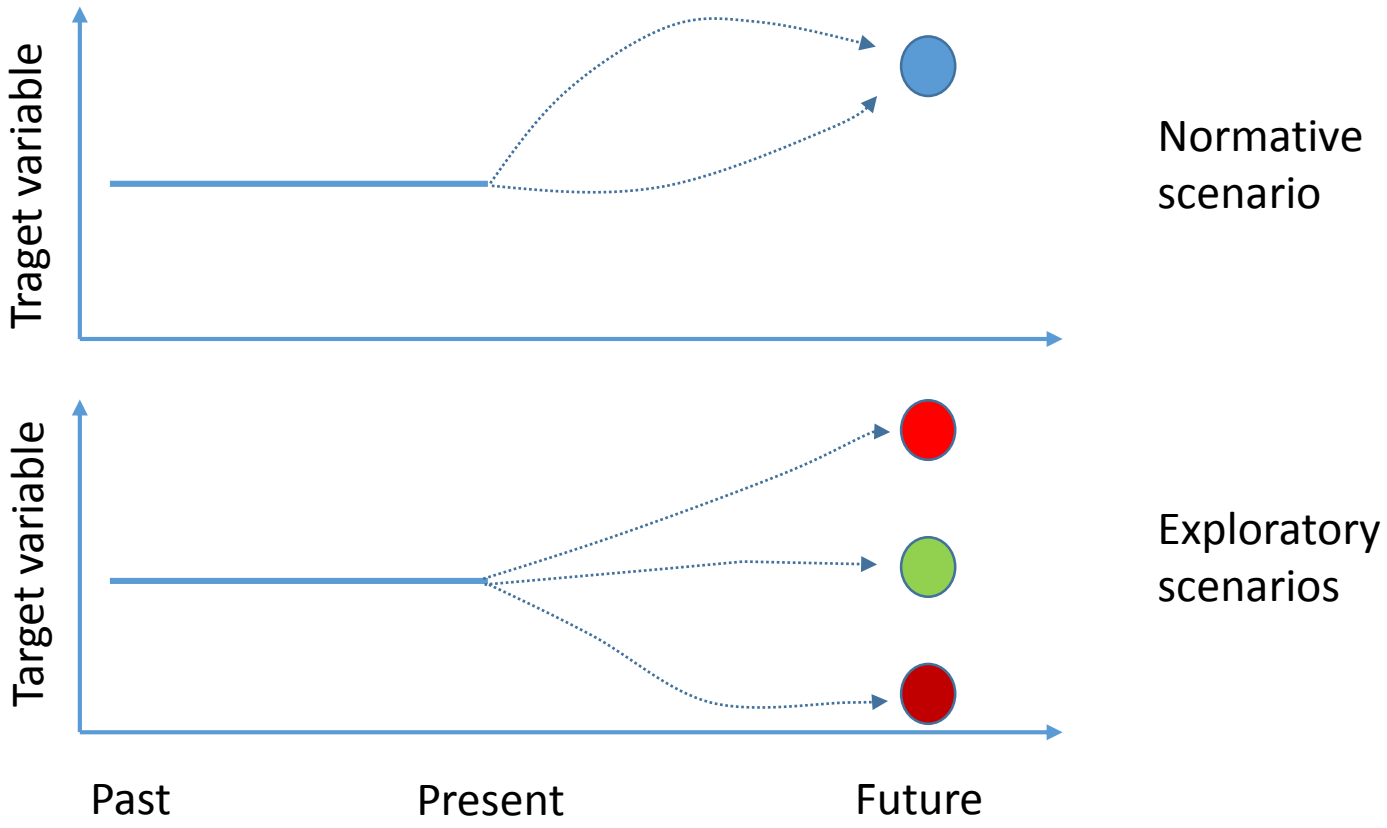
Criticism: IAMs are problematic and 'close to useless as tools for policy analysis'

Pindyck (2015). NBER (Working Paper No. 21097). doi:10.3386/w21097

Scenarios

- a description of what might happen in the future, given a set of coherent assumptions about drivers of change

Storylines / qualitative scenarios Quantitative scenarios / models



Two tricky concepts merged

Biodiversity

Convention on Biological Diversity

Genes, species, ecosystems

Quantifying diversity

Number of different entities at the same hierarchical or functional level

Number and relative abundance of different entities at the same hierarchical or functional level -> diversity indices

Diversity of an area : Alpha- and Gamma-diversity

Difference in diversity between two areas: Beta-diversity

Fundamental hypothesis: biodiversity affects ecosystem functioning
-> productivity, stability, resilience…

Two tricky concepts merged

Ecosystem services

Different concepts, classifications and terminologies

- Nature‘s benefits to people
- Goods and services derived from ecosystems
- Nature‘s gift

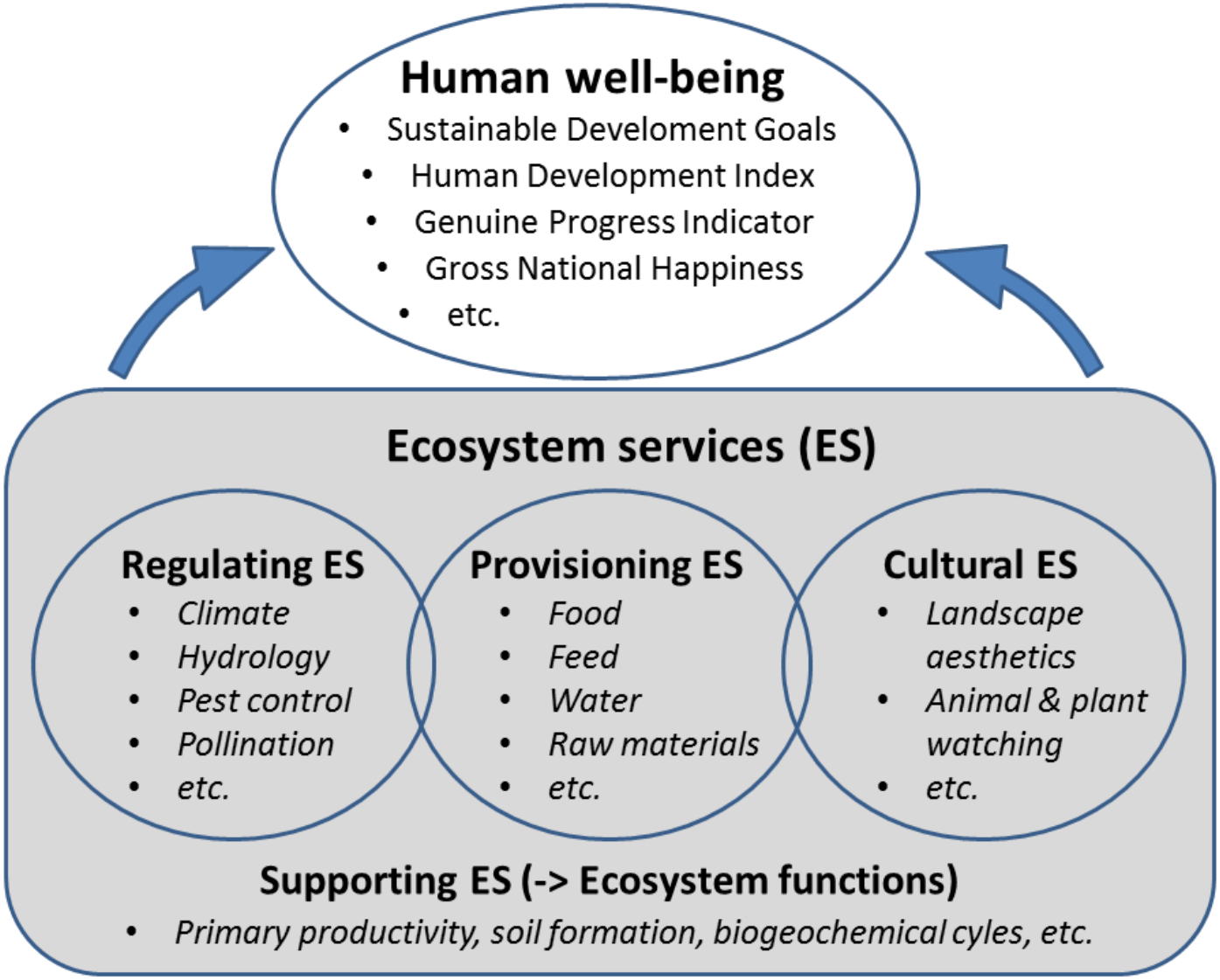
Linked to human perception of ‘value’

Different methodologies for measuring ‘value’

Ecosystem disservices

Fundamental hypothesis: ecosystem functioning affects ecosystem services
-> productivity, stability, resilience

Ecosystem service categories & measures of human well-being



MA terminology

Methods for establishing what is true

- Experience, tradition -> indigenous and local knowledge

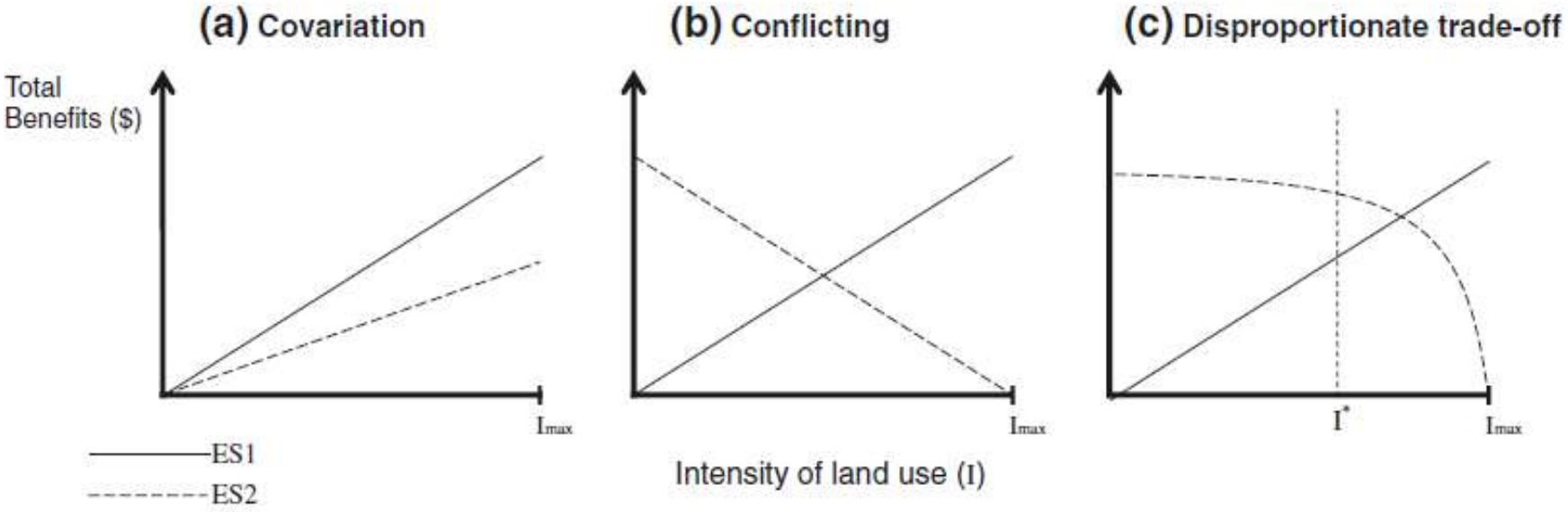
- Scientific method
  - Formulation of a hypothesis,
  - development of a methodology,
  - standardized collection of data through observational studies & experiments,
  - statistical analysis,
  - quantification of uncertainty,
  - repetition of study,
  - derivation of a theory

- Requirements for statistical inference: independence, replication

-> conditions difficult to satisfy in studies of biodiversity and ecosystem services

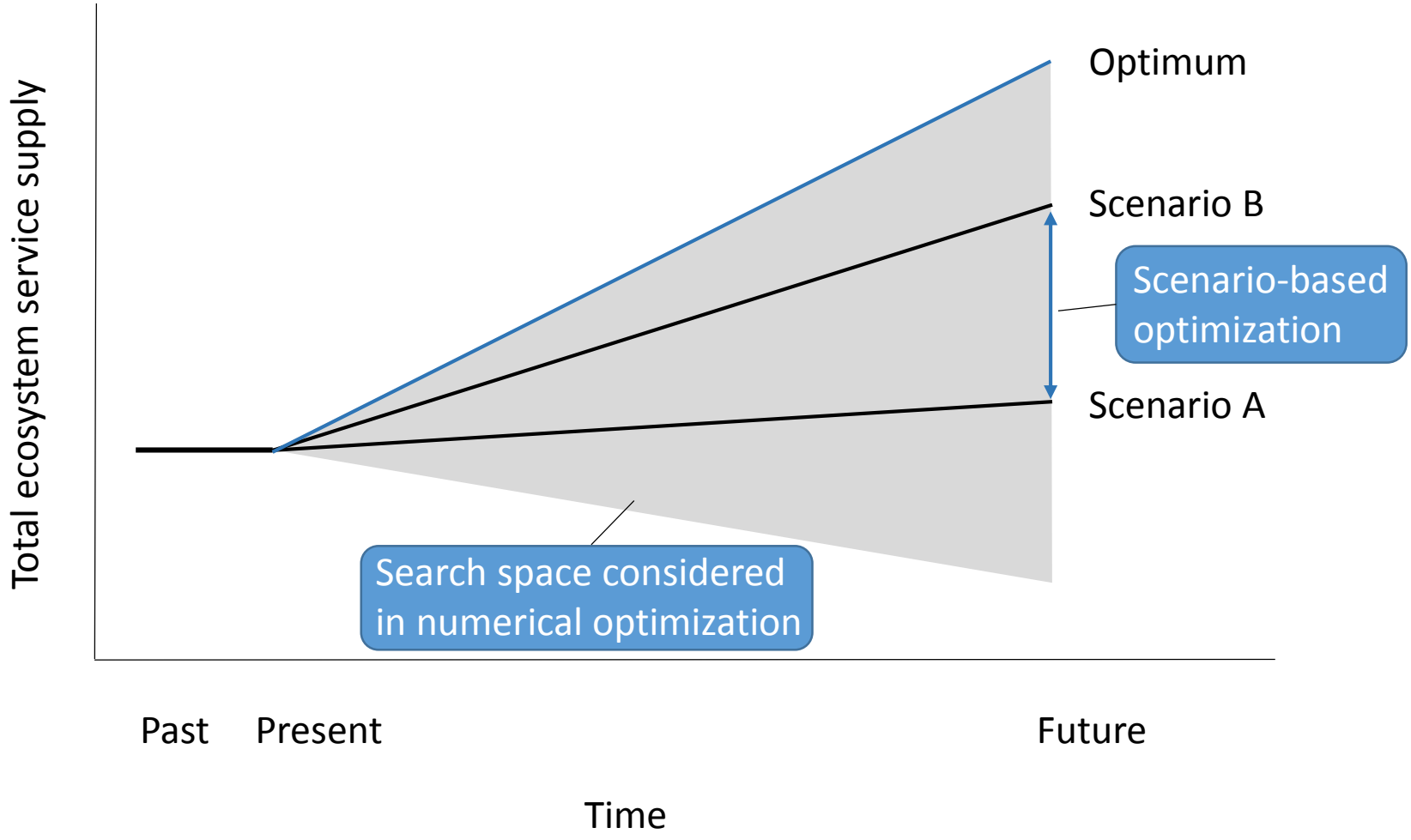
We can‘t have it all …

- Patterns of relationships between two ecosystem services



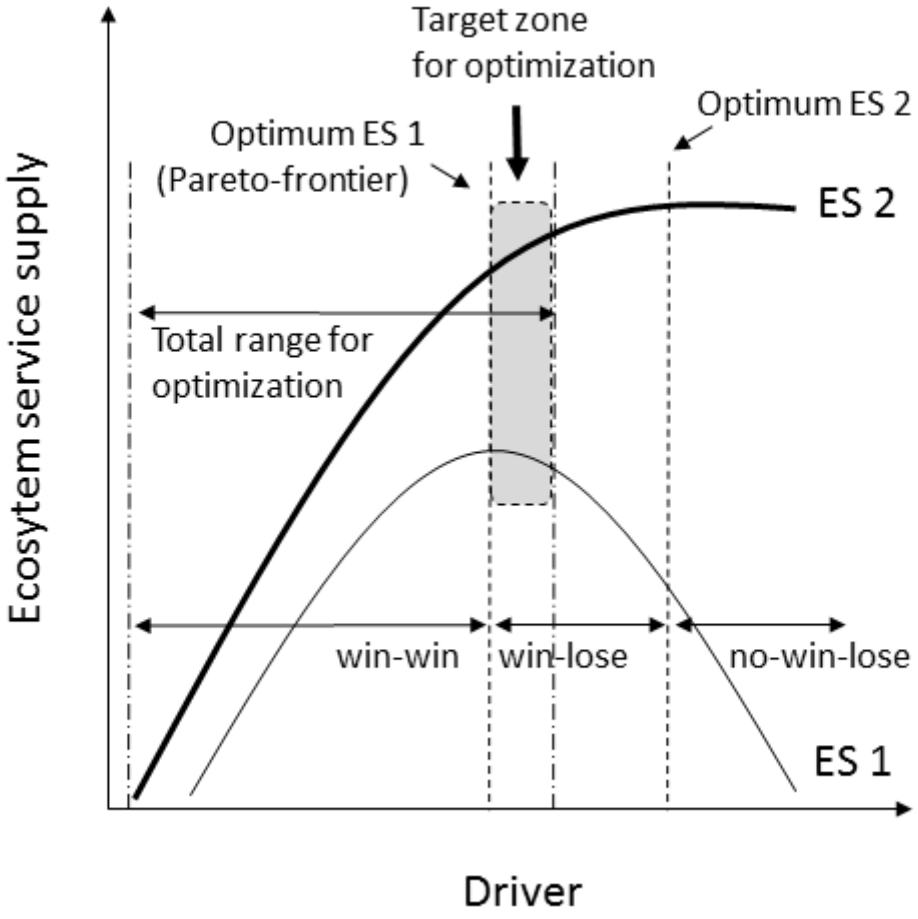
Setälä et al. 2014

…, but can we at least find the best possible solution?



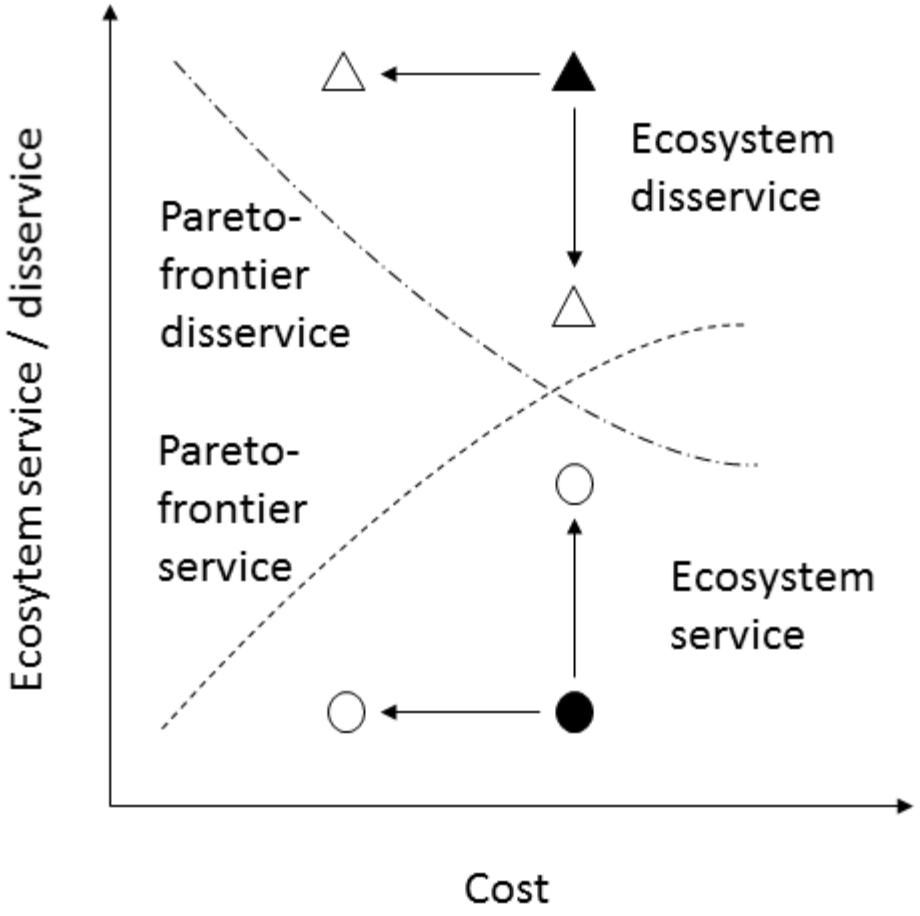
Hotes et al. submitted

Optimization of ecosystem services



Hotes et al. submitted

Optimization of services vs. disservices



ecosystem disservices

- loss of biodiversity
- loss of wildlife habitat
- nutrient runoff
- sedimentation of waterways
- pesticide poisoning
- greenhouse gas emissions

ecosystem services

- pest control
- pollination
- nutrient re/cycling
- soil conservation, structure and fertility
- water provision, quality and quantity
- carbon sequestration
- biodiversity

Hotes et al. submitted

Power 2010

LEGATO
RICE ECOSYSTEM SERVICES

Land-use intensity and Ecological Engineering – Assessment Tools for risks and Opportunities in irrigated rice based production systems

Ecological engineering for sustainable land management

Stefan Hotes, Josef Settele & the LEGATO consortium

Federal Ministry of Education and Research
FONA
SUSTAINABLE LAND MANAGEMENT
HELMHOLTZ ZENTRUM FÜR UMWELTFORSCHUNG UFZ
Philipps Universität Marburg

Project outline

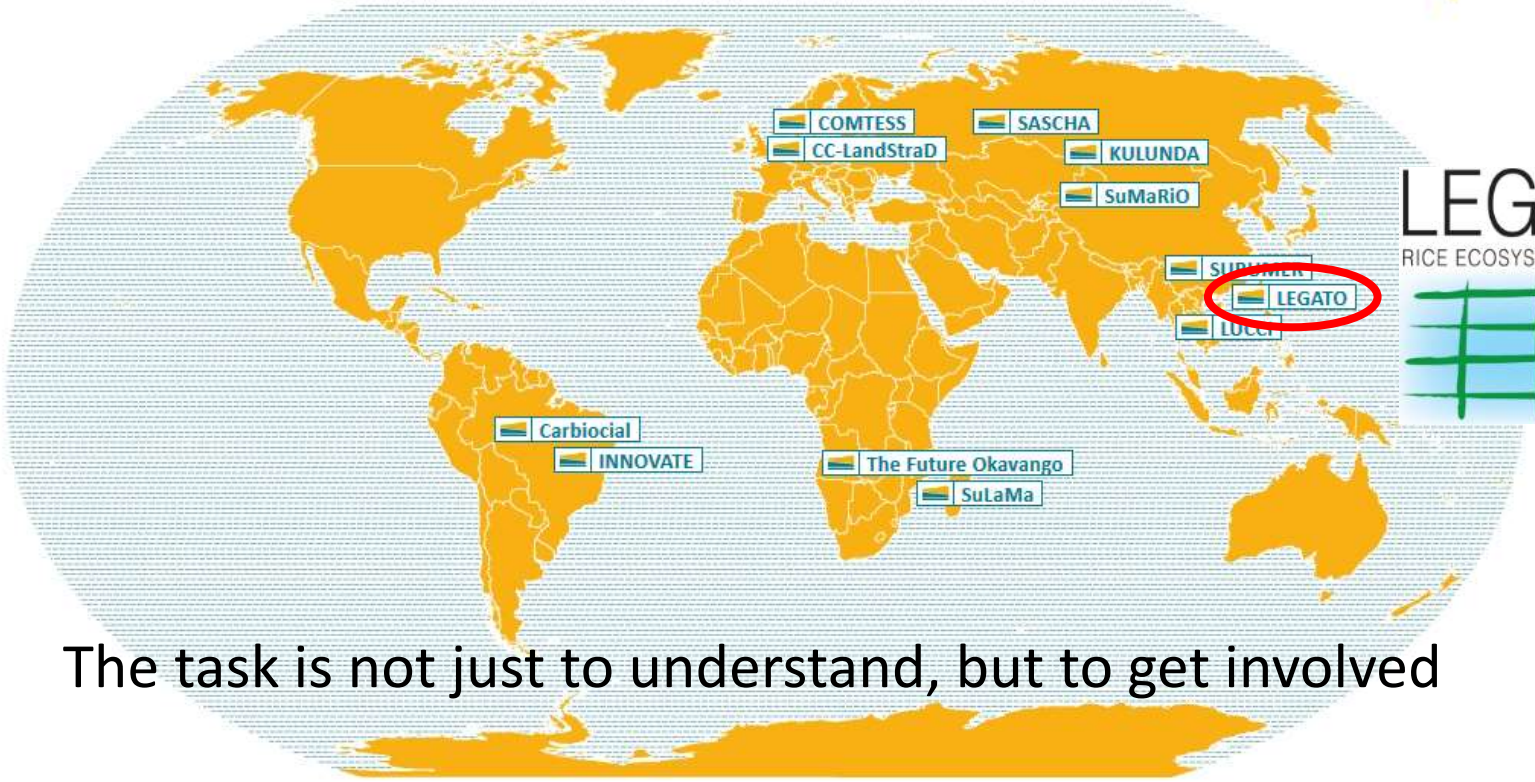
- Increasing demand for rice and other crops needs to be met
- Trade-offs between ecosystem services need to be considered when searching for land management solutions

Project outline

SUSTAINABLE LAND MANAGEMENT

http://nachhaltiges-landmanagement.de/en/

SPONSORED BY THE
Federal Ministry of Education and Research



LEGATO
RICE ECOSYSTEM SERVICES

The task is not just to understand, but to get involved

LEGATO study regions

Vietnam

Sapa (VN_3)

Vinh Phuc (VN_2)

Hai Duong (VN_1)

TienGiang (VN_4)

Philippines

Ifugao (PH_3)

Nueva Ecija (PH_2)

Laguna (PH_1)

Aims

- Quantify links between ecosystem functions and ecosystem services for rice-producing landscapes in the Philippines and Vietnam
- Provisioning ecosystem services: rice and other crops
- Regulating services: nutrient dynamics, biological pest control, pollination
- Cultural services: landscape aesthetics, local identity, ecotourism
- Explore, test and communicate ecological engineering techniques

Invertebrate fauna driving ecosystem services in rice-producing landscapes

Results from the LEGATO study regions in Luzon/Philippines and in Vietnam

Stefan Hotes (UMAR), Hannah Göbel (UMAR), Jörn Panteleit (UMAR), Lea Hofmann (UMAR), Nico Radermacher (UGOE), Anja Schmidt (UFZ), Sylvia Villareal (IRRI), Finbarr Horgan (IRRI), Leonardo Marquez (PhilRice), Gertrudo Arida (PhilRice), Jesus Victor Bustamante (Banaue), Nguyen Van Sinh (IEBR), Ho Van Chien (SRPPC), Martin Schädler (UFZ) & Roland Brandl (UMAR)

Core sites & sites

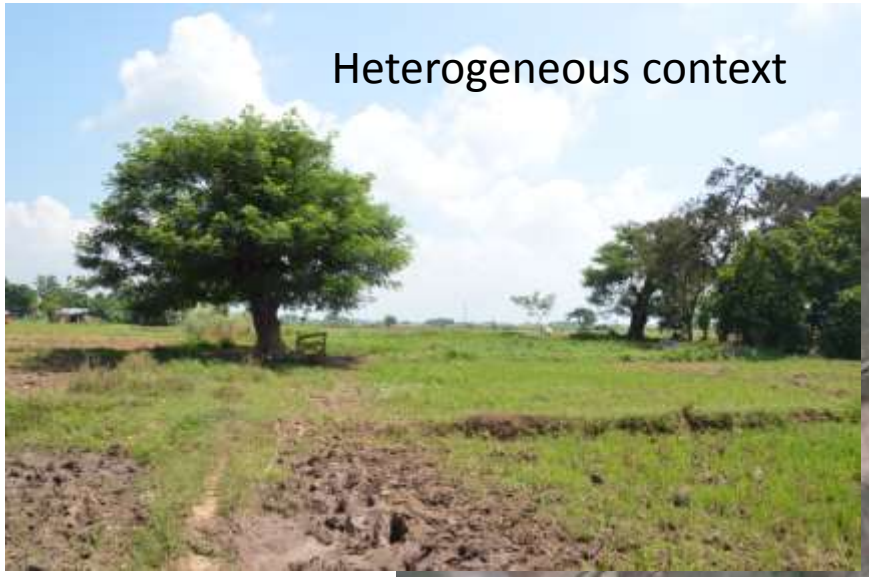
PH_2
Central Luzon
Nueva Ecija Province

Thimo Klotzbücher
Anika Marxen
(MLU Halle, UFZ)

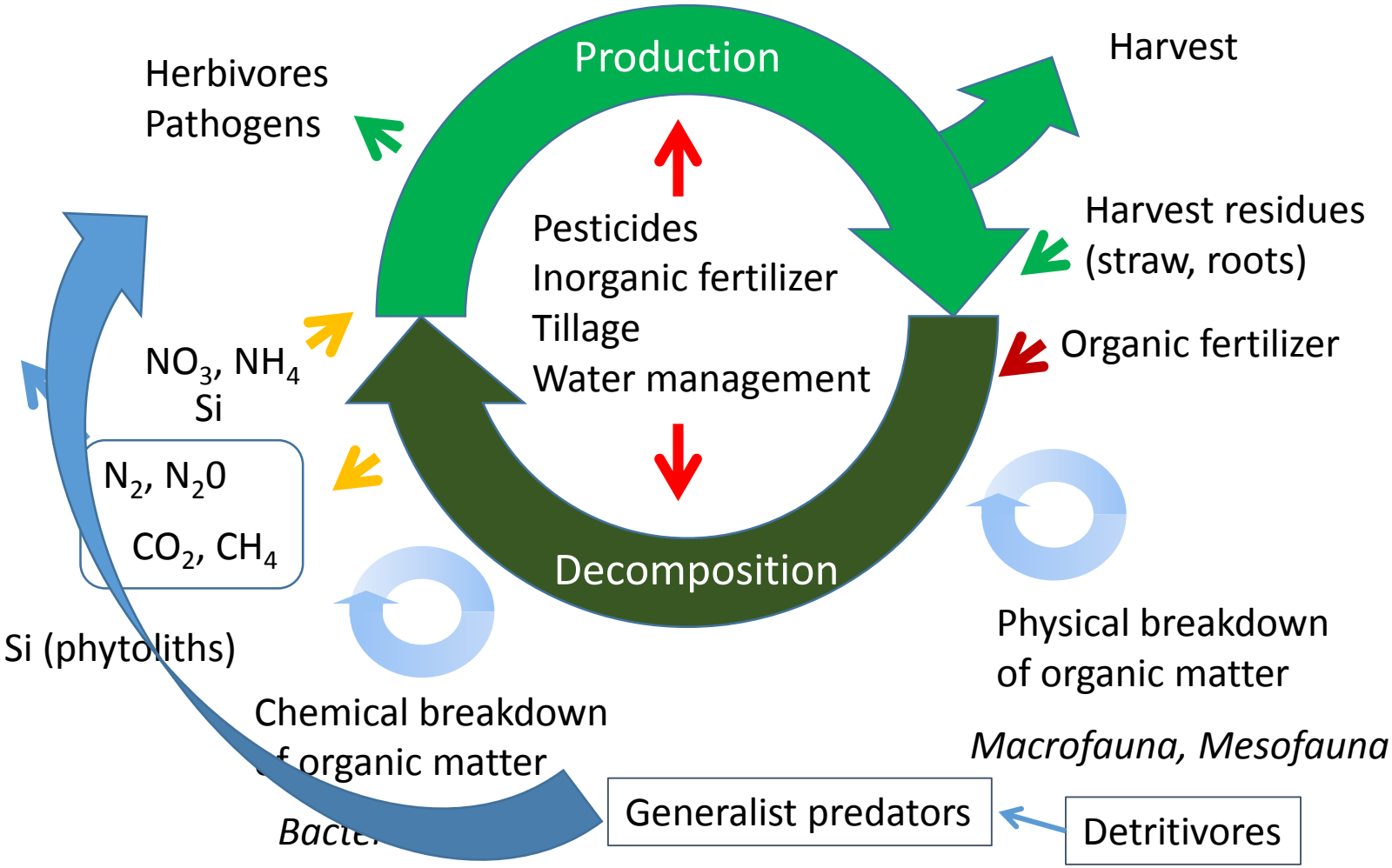
Leonardo Marquez
(PhilRice)

LEGATO
RICE ECOSYSTEM SERVICES

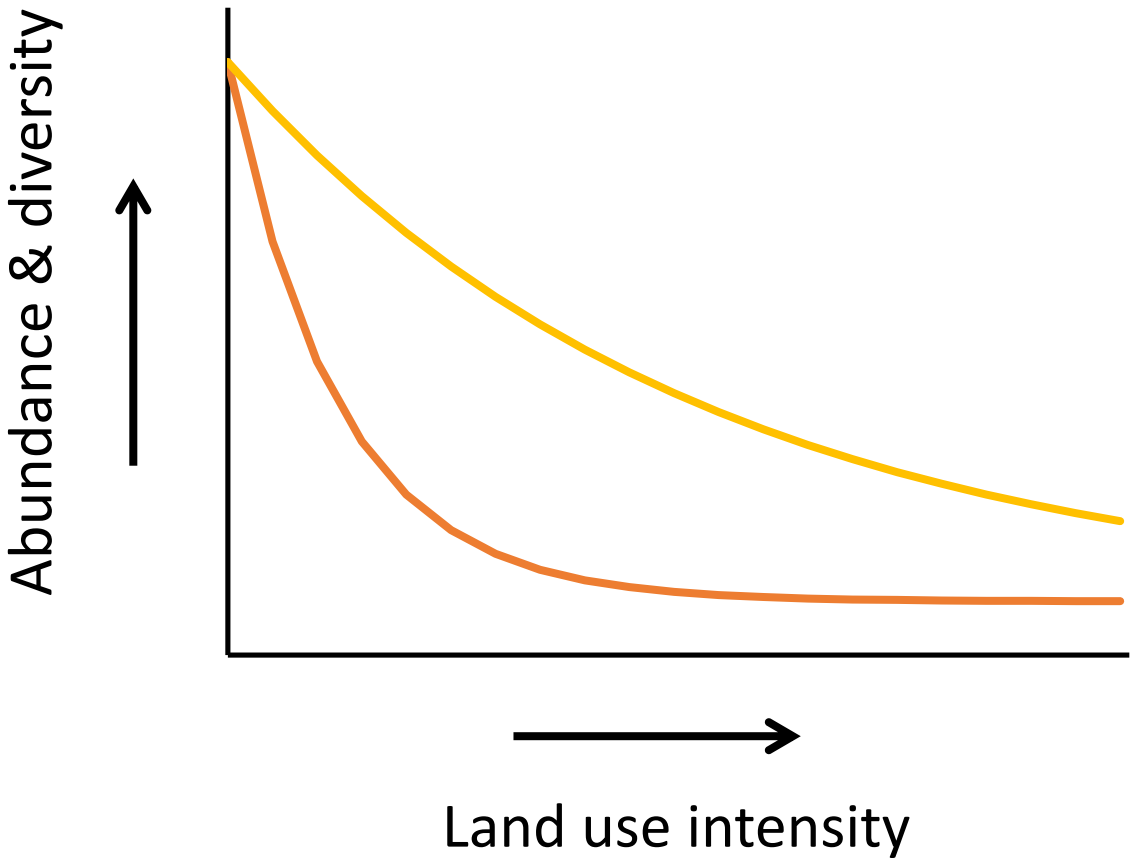
Selection of paddy fields



Decomposition and its role in agricultural ecosystems



Land use intensity and soil biota



- Abundance & diversity of soil biota generally decline with increasing land use intensity, but
- Variability in space and time is high!
- Nevertheless, responses of soil biota to intensification have been found to be similar across geographical regions

Tillage, water management, no. of cropping cycles, crop rotation, fertilizer use, pesticide application

Threat for sustainable land use?

Win-win-situation possible?

What happens to rice straw and harvest residues?

Rice straw as fodder (Central Luzon)

Rice straw as (temporary?) mulch & burning of stubbles (Mekong Delta)

Grazing post-harvest rice plants (Ifugao)

Snails grazing on wet rice straw (Ifugao)

Charcoal left after burning of rice straw

Unpopular annelids and gastropods?

Nueva Ecija

Ifugao

Litterbag experiment

Hypotheses

1. Decomposition rates differ between LEGATO study regions

- Environmental gradients: altitude, topography, climate, soil types
- Anthropogenic gradients: water management, tillage, fertilizer, biocides, landscape structure

2. Decomposition rates differ between the soil and the soil surface

3. Decomposition rates are affected by soil fauna

Experimental design

Litterbags with 10 g of straw of a standard rice variety (NSIC Rc222)

Test of the role of soil fauna
Two mesh sizes:
- 5 mm: allows access of (almost) all taxa of soil fauna
- 10 µm: allows access only of microorganisms

Test of the role of epigeic organisms vs. soil organisms
Two depths:
- soil surface: epigeic organisms
- 10 cm depth: soil organisms

Decomposition process over time
4 retrieval dates: 1 month, 3 months, 6 months, 12 months

Number of fields per region
3 fields in homogeneous landscapes
3 fields in heterogeneous landscapes

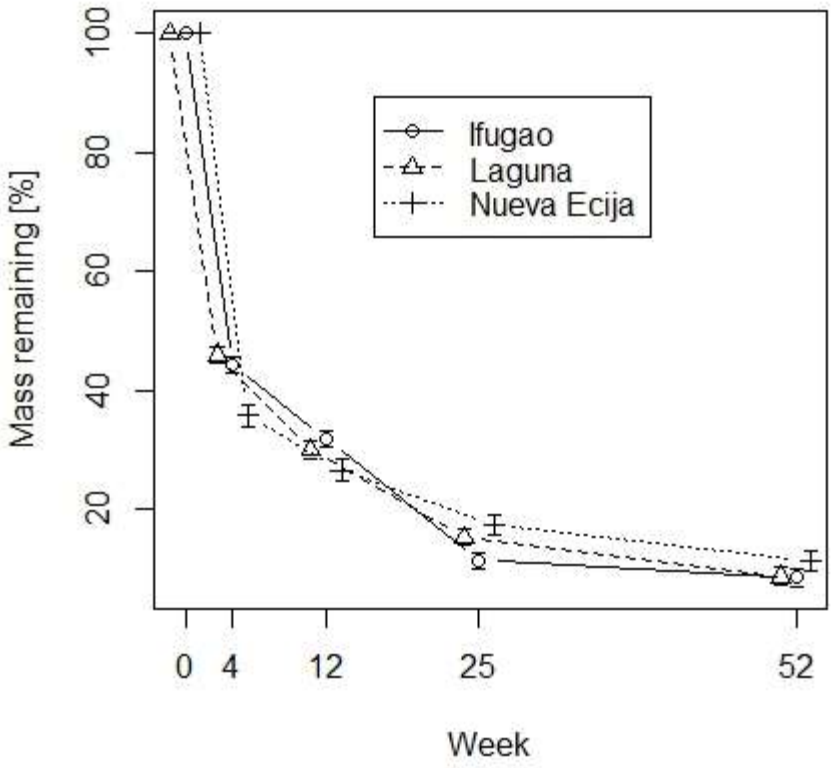
Number of replicates per field: 3

Experimental setup

Laguna Province

PH_1_R_4, 30 May 2012

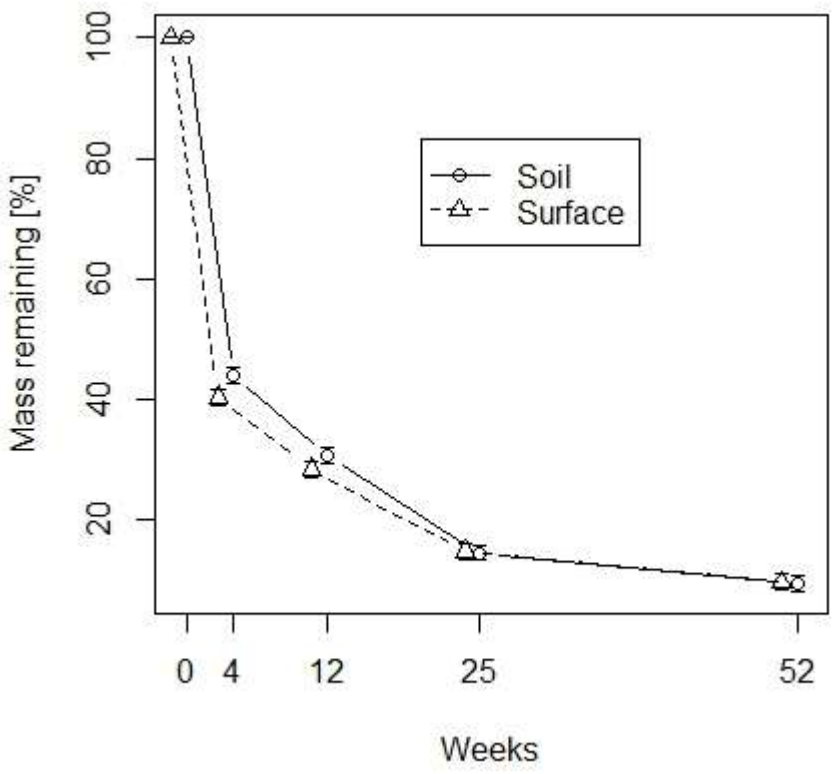
Study regions Philippines



Significant differences in decomposition between some regions on particular dates

No significant differences between regions over the whole period

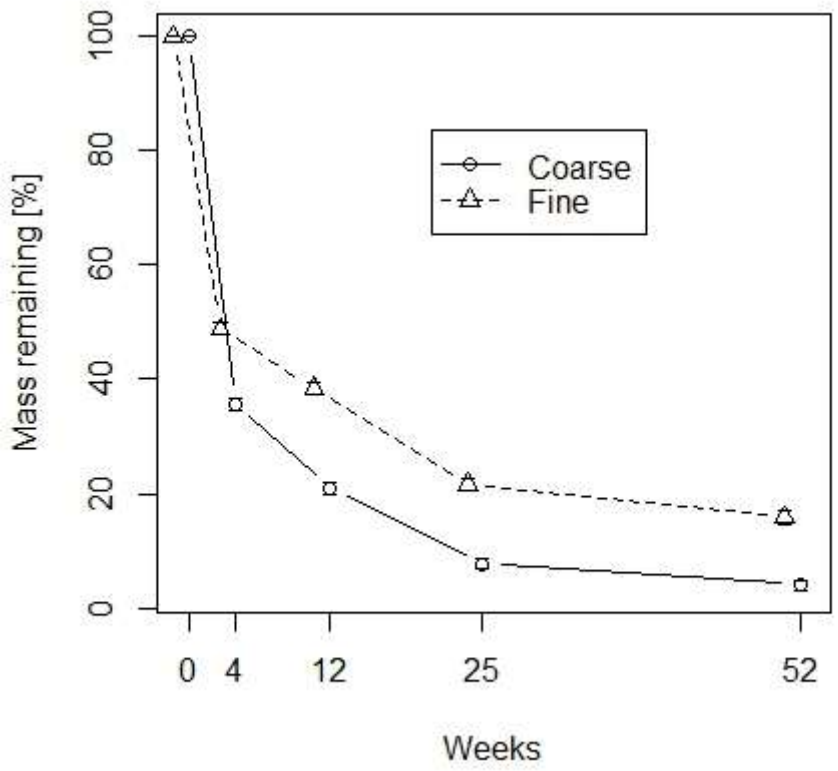
Soil vs. surface Philippines



Slightly faster decomposition at the surface initially

Difference disappeared after 6 months

Effect of fauna Philippines

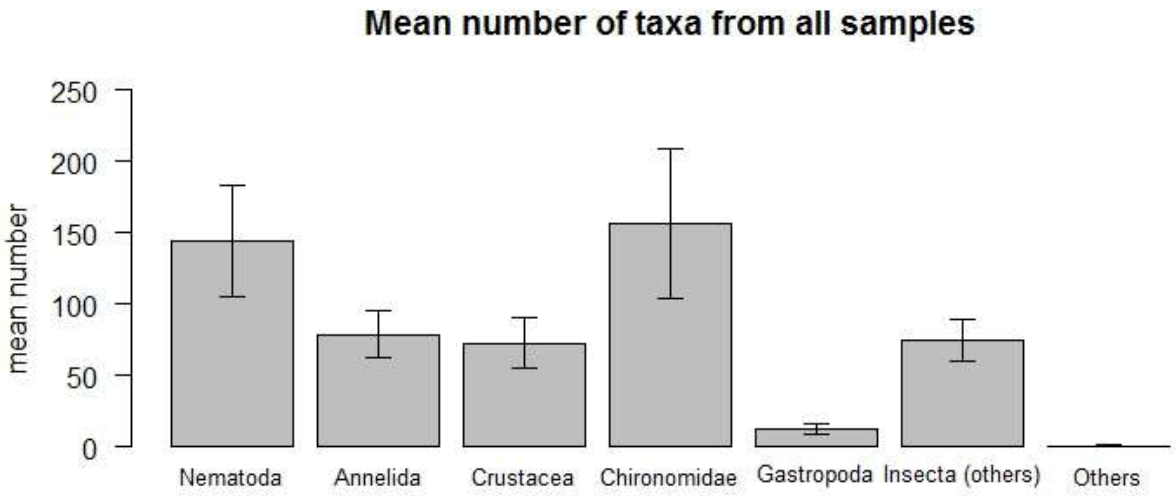


Fauna effect significant over 12 months

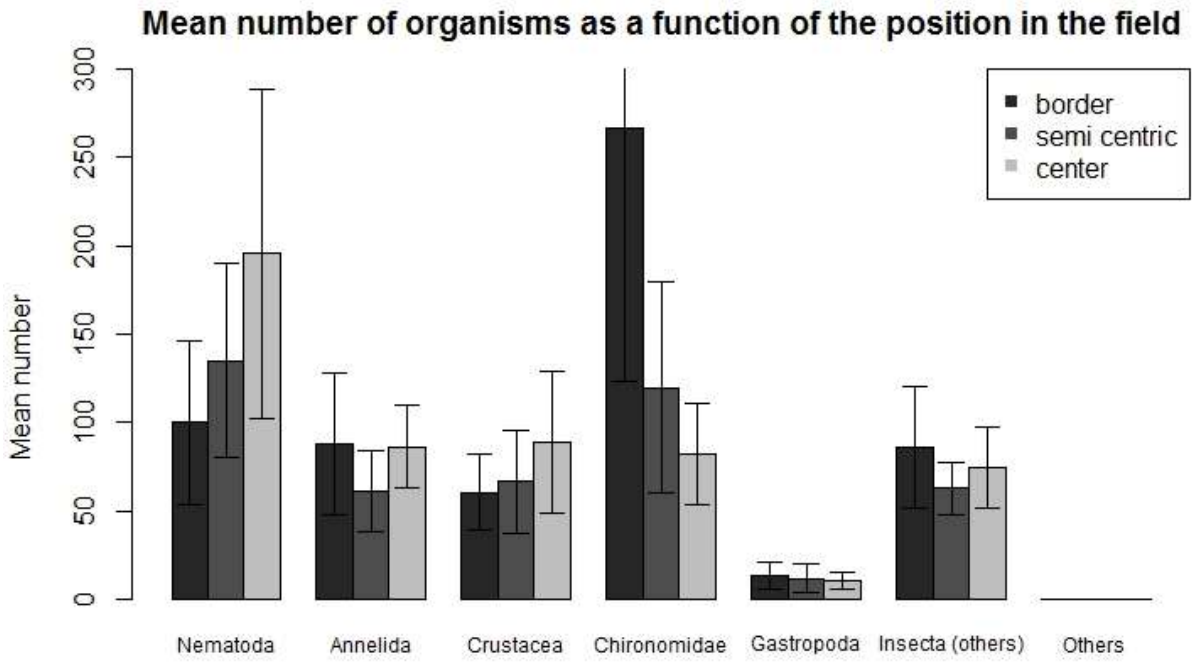
Invertebrate fauna in paddies

Dipnet sampling June – August 2012
Nico Radermacher, Göttingen University

- Close to bund
- Half way to center of field
- Center of field



Aquatic invertebrates in LEGATO fields



Scientific contribution & outreach

- Data on biodiversity, ecosystem function and ecosystem services
- Information on ecological engineering opportunities for optimizing ecosystem services
- Outreach to farmers through extension officers in partner countries
- Uptake by farmers ?

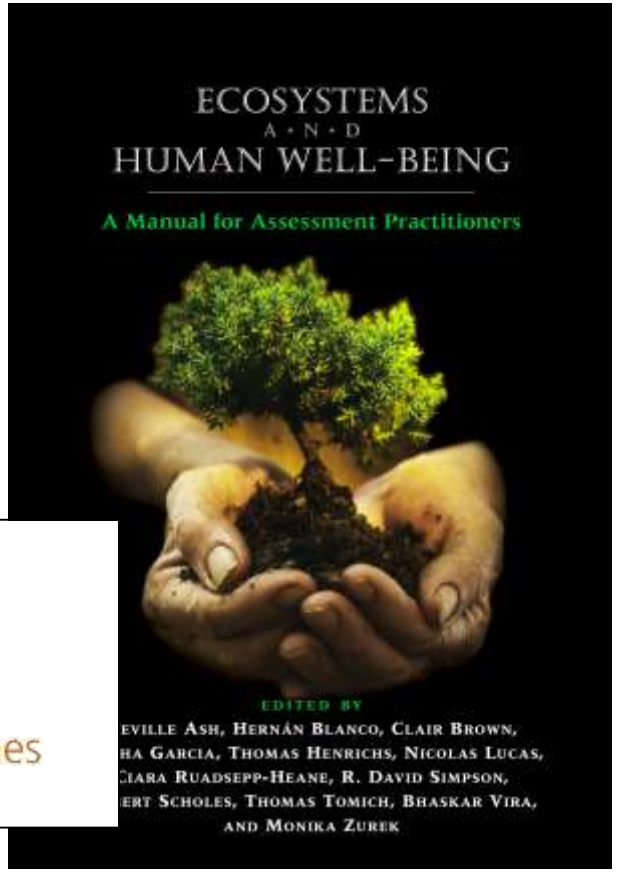
A fine line

producing scientific results that are policy-relevant, but not policy-prescriptive

Co-design of research including land managers and scientists is challenging

Requirements of both communities differ

Efforts to bridge the gap are not necessarily rewarded



WOCAT

World Overview of Conservation Approaches and Technologies

Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES)

Fourth IPBES Plenary, 22 – 28 February 2016, Kuala Lumpur, Malaysia

First assessment reports will be discussed

IPBES/4/3 - Deliverable 3(a): Summary for policy makers of the thematic assessment on pollination and pollinators associated with food production

IPBES/4/4 - Deliverable 3(c): Summary for policy makers of the methodological assessment on scenario analysis and modelling

Ongoing activities

- Regional Assessment for Asia-Pacific
- Stakeholder Engagement Strategy, Stakeholder Network

Opportunities for getting involved !

Many thanks to all farmers who have supported our research

and to you for listening !