OPERAs

Ecosystem Science for Policy & Practice

How much do we know about multiple ecosystem services?

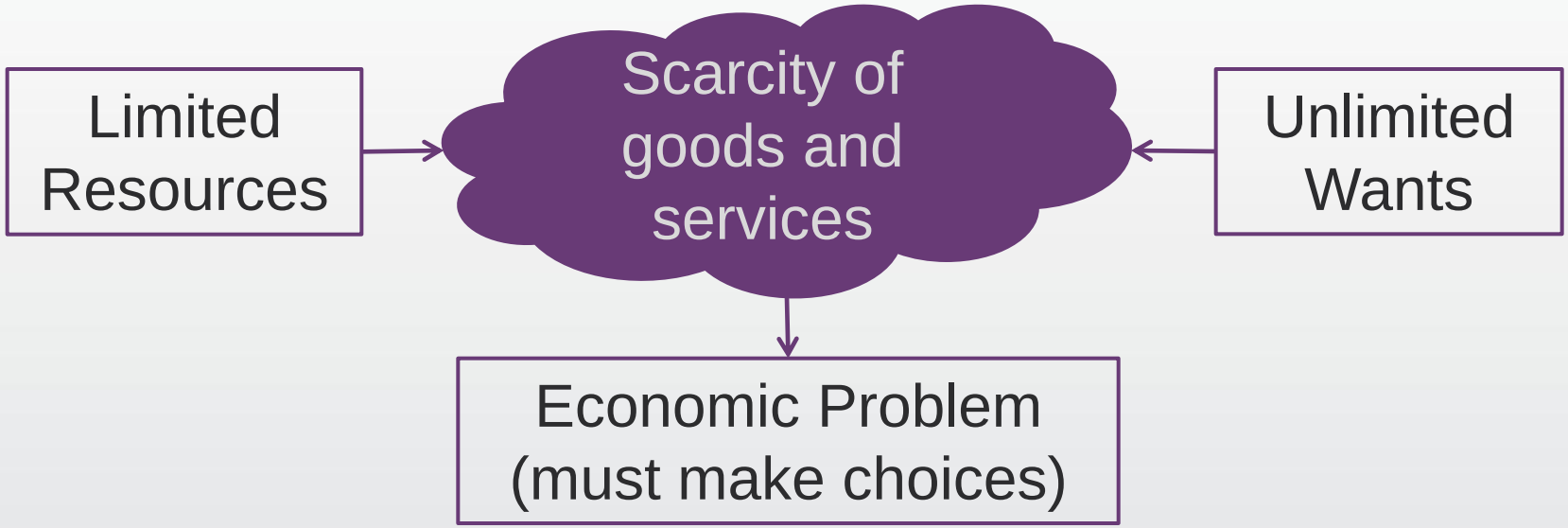
A Quantitative Review of Relationships Between Ecosystem Services

Heera Lee
Institute of Geodesy and Geoinformation
University of Bonn

universitätbonn

Dec 11 2014, Washington D.C.
ACES 2014

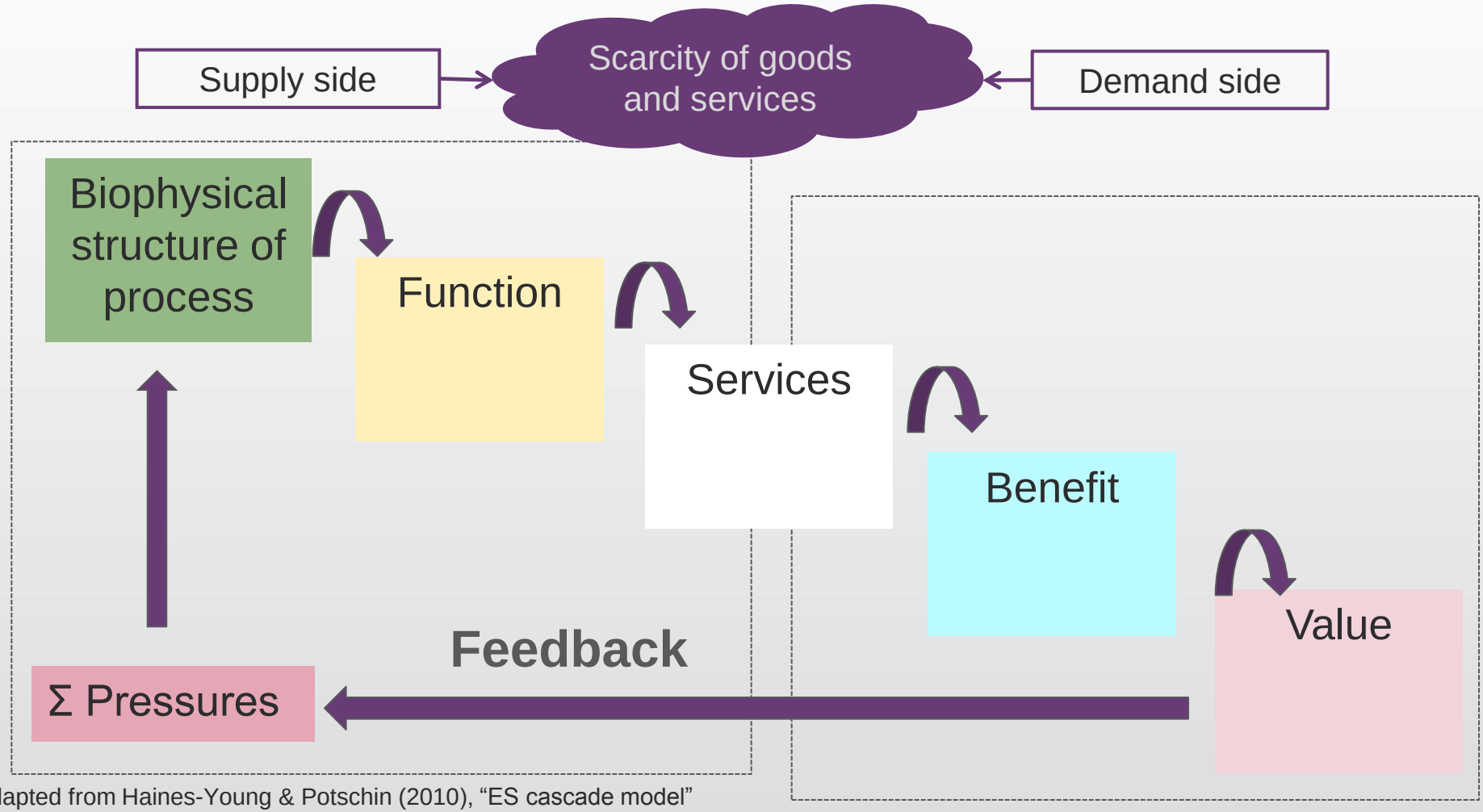
Trade-off occurs in a decision making process



<u>Trade-offs in natural resource management</u>

Attempts to optimize a single service often lead to reductions or losses of other services (Holling and Meffe 1996)

Trade-off occurs in a decision making process



Adapted from Haines-Young & Potschin (2010), "ES cascade model"

Trade-offs in ES Researches

Supply

Trade-offs between services
(food production vs. water regulation)

Trade-offs between locations
(competition for space, telecoupling etc.)

Trade-offs between management options
(cost/benefits)

Trade-offs between beneficiaries
(winners and losers)

Demand

A quantitative review: **Hypotheses**

1. Pairs of ES show **a dominant relationship**

2. This relationship is influenced by ***the scale*** at which the relationship had been studied as well as by ***the land system***

3. This relationship is further influenced by ***the method*** applied to characterize this relationship

Literature search and classification

A Bootstrap approach

Data preparation	Defining the relationship
• Assess the quantity of ES	• Analysis of the data

ES classification

- CICES V 4.3 (Jan 2013)

Scale

- Plot, Landscape, Regional, National, Continental, Global

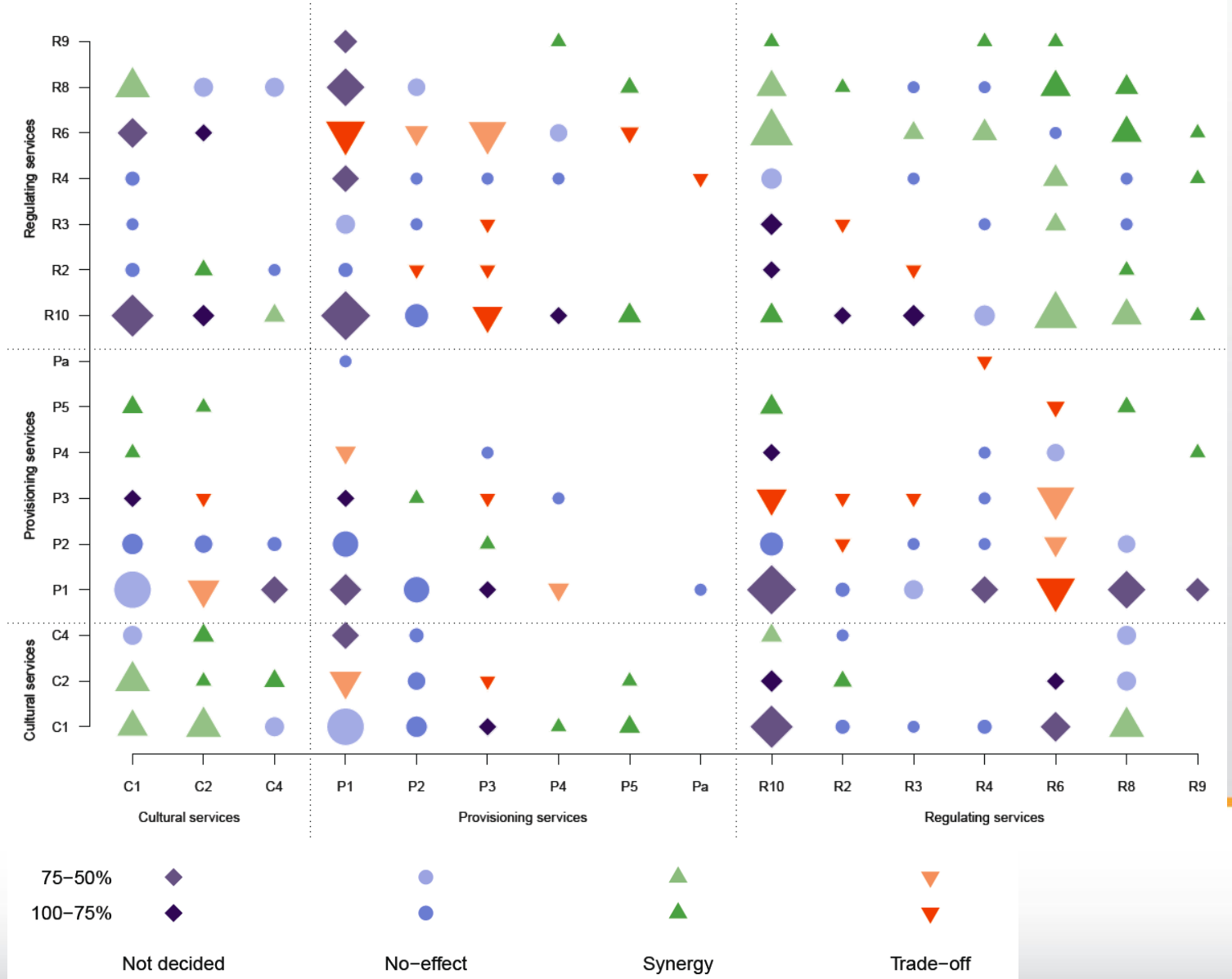
Land System Archetype (LSA) (Václavík et al. 2013)

- Combinations of land-use intensity, environmental conditions and socioeconomic factors

Methods used

- Descriptive, Correlation, Regression model, Multivariate statistics, others

1. The empirical pattern of relationships between Ecosystem Services

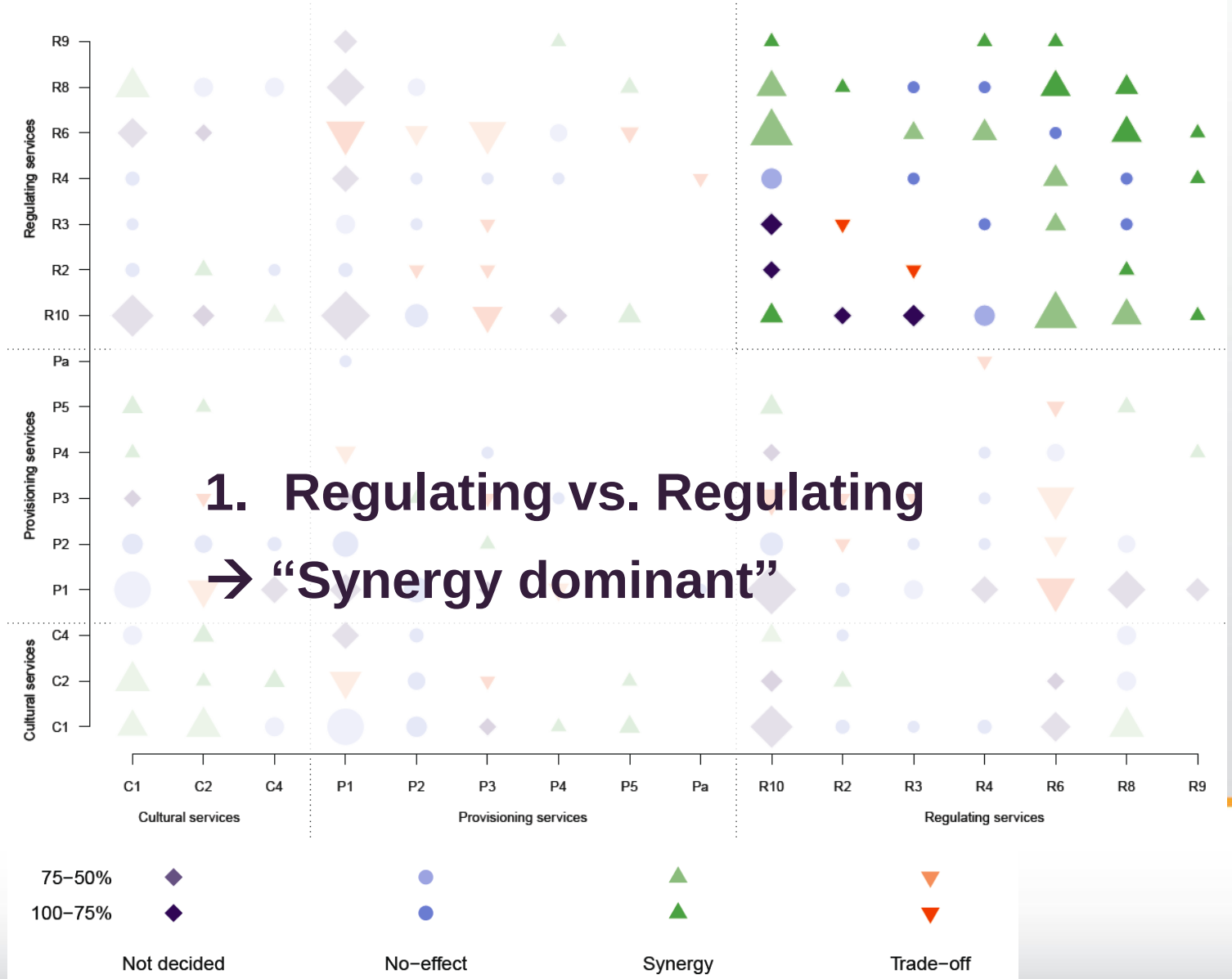


ES CODE

C1: tourism
C2: education
C4: existence
P1: food
P2: water
P3: fodder
P4: non-drink water
P5: energy
Pa: abiotic
R10: carbon
R2: filtration
R3: erosion
R4: flood protection
R6: habitat
R8: soil
R9: water condition

universitätbonn

1. The empirical pattern of relationships between Ecosystem Services



1. **Regulating vs. Regulating**

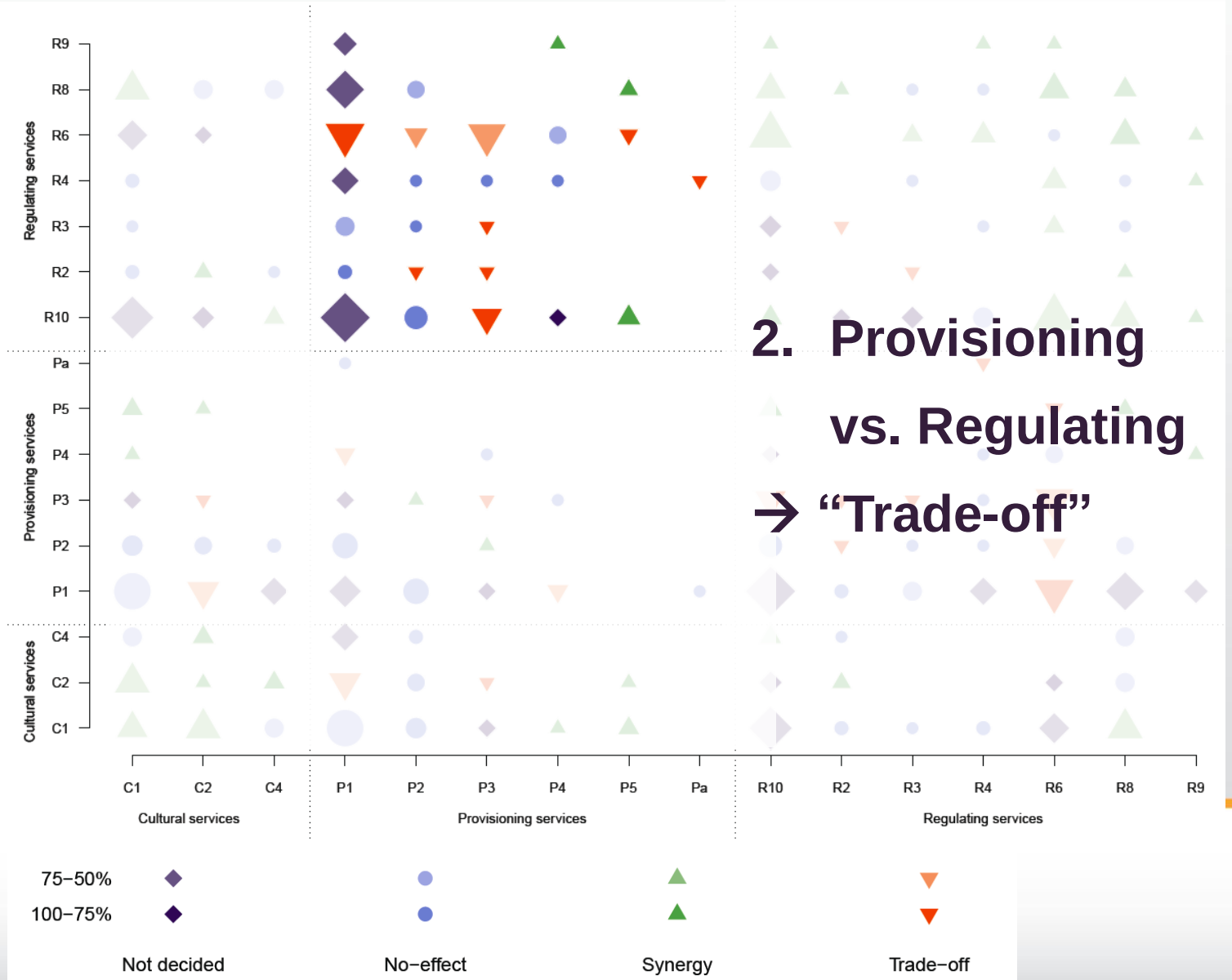
→ "Synergy dominant"

ES CODE

C1: tourism
C2: education
C4: existence
P1: food
P2: water
P3: fodder
P4: non-drink water
P5: energy
Pa: abiotic
R10: carbon
R2: filtration
R3: erosion
R4: flood protection
R6: habitat
R8: soil
R9: water condition

universitätbonn

1. The empirical pattern of relationships between Ecosystem Services



2. Provisioning vs. Regulating

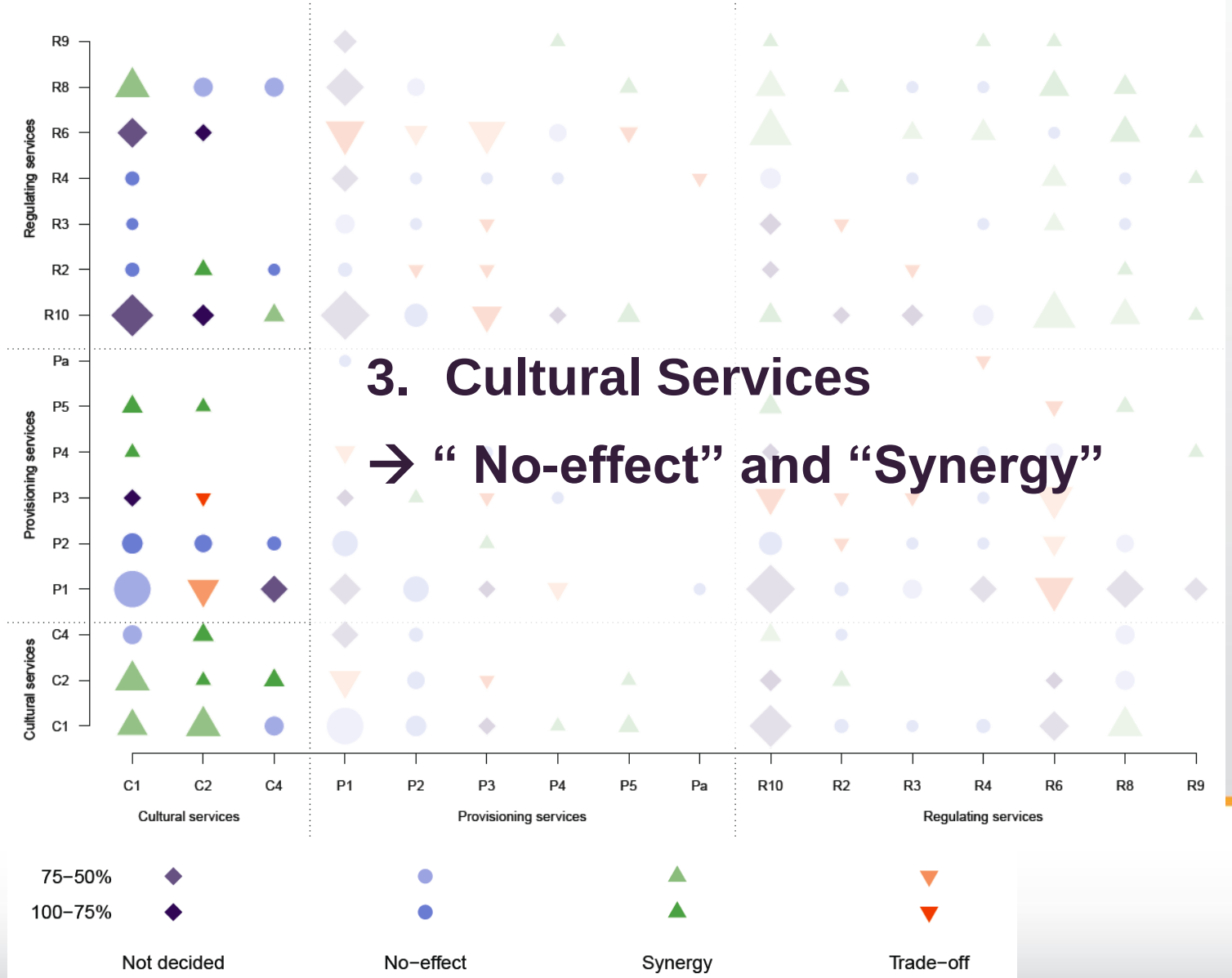
→ "Trade-off"

ES CODE

C1: tourism
C2: education
C4: existence
P1: food
P2: water
P3: fodder
P4: non-drink water
P5: energy
Pa: abiotic
R10: carbon
R2: filtration
R3: erosion
R4: flood protection
R6: habitat
R8: soil
R9: water condition

universitätbonn

1. The empirical pattern of relationships between Ecosystem Services



3. Cultural Services

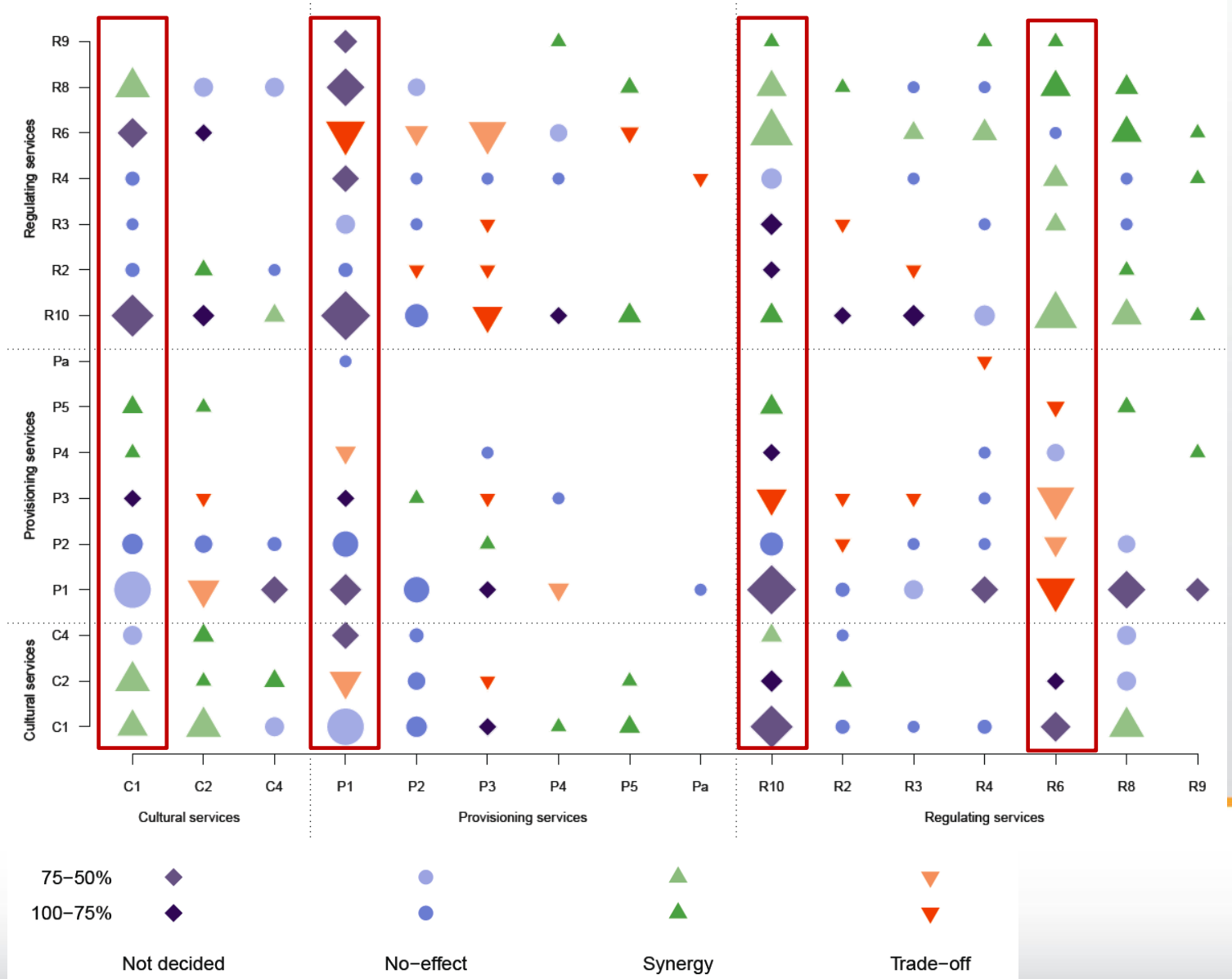
→ " No-effect" and "Synergy"

ES CODE

C1: tourism
C2: education
C4: existence
P1: food
P2: water
P3: fodder
P4: non-drink water
P5: energy
Pa: abiotic
R10: carbon
R2: filtration
R3: erosion
R4: flood protection
R6: habitat
R8: soil
R9: water condition

universitätbonn

1. The empirical pattern of relationships between Ecosystem Services



ES CODE

C1: tourism
C2: education
C4: existence
P1: food
P2: water
P3: fodder
P4: non-drink water
P5: energy
Pa: abiotic
R10: carbon
R2: filtration
R3: erosion
R4: flood protection
R6: habitat
R8: soil
R9: water condition

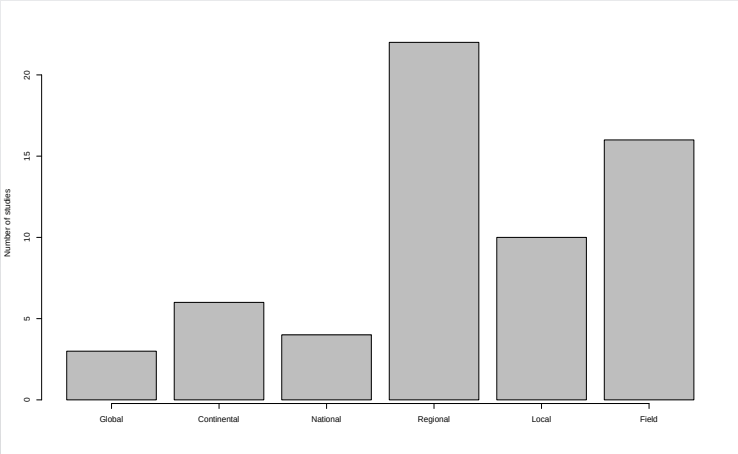
universitätbonn

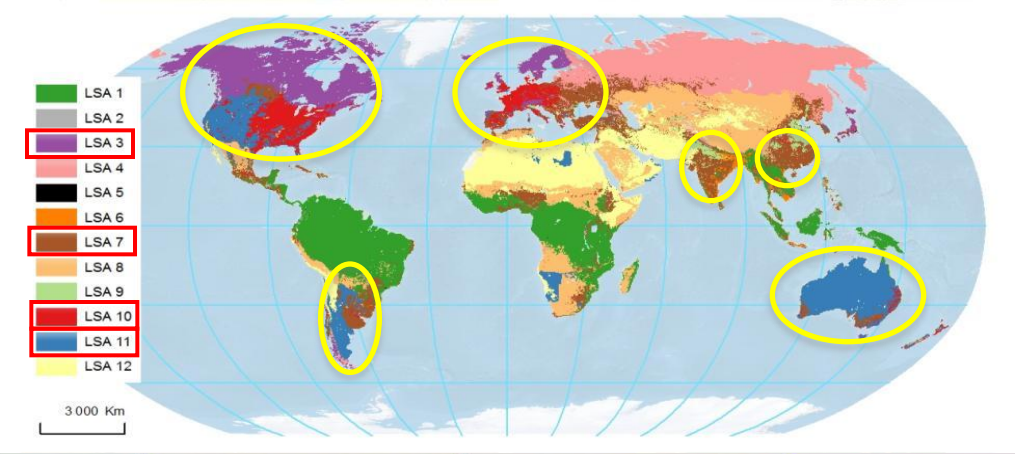
2. Is the dominant relationship different at each scale and in LSA?

The answer: **NO!** (not significant from the similarity measure)

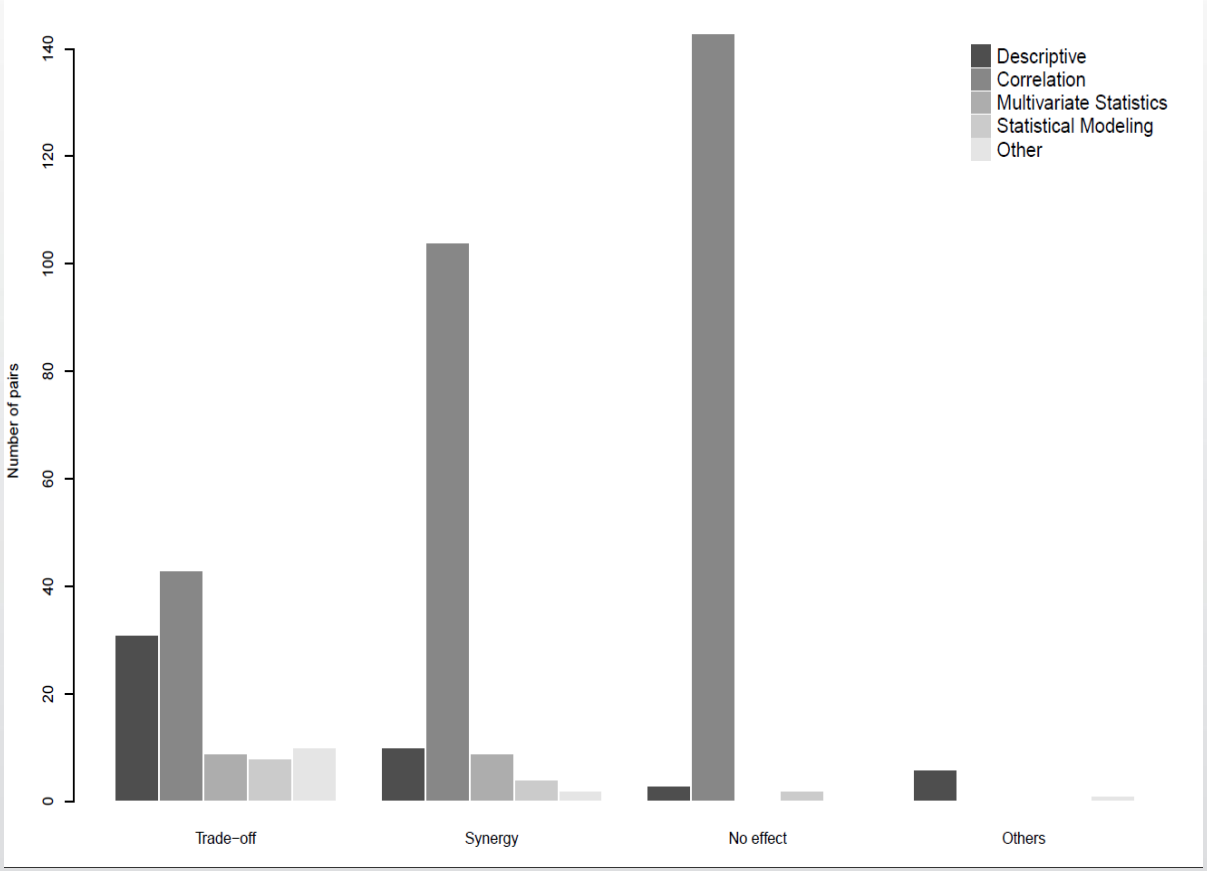
- Scale and LSA: unevenly spread
- One pair (climate regulation vs food provisioning) showed different results at each scale

(synergy (small), trade-off (regional), no-effect (large))





3. Is the relationship influenced by the method applied?



- The choice of methods used influences the results
- Correlation methods were frequently used
- Multivariate statistics did not identity „No-effect“

Summary

1. The empirical relationships between ES

- Regulating services vs. Regulating services → Synergy
- Regulating services vs. Provisioning services → Conflict
- Different supporting ratio
- Uneven distribution of ES

2. Scale and Land System Archetype (LSA)

- Scale and LSA: unevenly distributed
- The relationship between ES was not significantly different at each scale and in different LSAs

3. Methods and ES studies

- Research methods may influence the results

4. Implications

- It may provide a first-check list and important hints for future uses

www.operas-project.eu • info@operas-project.eu

OPERAsProject

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement number 308393.

OPERAs

universitätbonn

Thanks to
My supervisor Prof. Sven Lautenbach,
Project partners: Prof. Ralf Seppelt, Prof. Carsten Dormann, Anne-Christine Mupepele, Stefan Schmidt, Astrid J.A. van Teeffelen, Prof. Peter Verburg

Thank you for your attention !

Heera Lee

Land use modelling and Ecosystem Services
Institute of Geodesy and Geoinformation
University of Bonn
hlee@uni-bonn.de

OPERAs

universitätbonn

The **Common International Classification of Ecosystem Services** (**CICES**)

Group	CODE	Class
Biomass	**P1**	Cultivated crops
		Reared animals and their outputs
		Wild plants, algae and their outputs
		Wild animals and their outputs
		Plants and algae from in-situ aquaculture
		Animals from in-situ aquaculture
Water	**P2**	Surface water for drinking
		Ground water for drinking
Biomass	**P3**	Fibres and other materials from plants, algae and animals for direct use or processing
		Materials from plants, algae and animals for agricultural use
		Genetic materials from all biota
Water	**P4**	Surface water for non-drinking purposes
		Ground water for non-drinking purposes
Biomass-based energy sources	**P5**	Plant-based resources
		Animal-based resources
Mechanical energy	**P6**	Animal-based energy

Mediation by biota	**R1**	Bio-remediation by micro-organisms, algae, plants, and animals
		Filtration/sequestration/storage/accumulation by micro-organisms, algae, plants, and animals
Mediation by ecosystems	**R2**	Filtration/sequestration/storage/accumulation by ecosystems
		Dilution by atmosphere, freshwater and marine ecosystems
		Mediation of smell/noise/visual impacts
Mass flows	**R3**	Mass stabilisation and control of erosion rates
		Buffering and attenuation of mass flows
Liquid flows	**R4**	Hydrological cycle and water flow maintenance
		Flood protection
Gaseous / air flows	**R5**	Storm protection
		Ventilation and transpiration
Lifecycle maintenance, habitat and gene pool protection	**R6**	Pollination and seed dispersal
		Maintaining nursery populations and habitats
Pest and disease control	**R7**	Pest control
		Disease control

Soil formation and composition	**R8**	Weathering processes
		Decomposition and fixing processes
Water conditions	**R9**	Chemical condition of freshwaters
		Chemical condition of salt waters
Atmospheric composition and climate regulation	**R10**	Global climate regulation by reduction of greenhouse gas concentrations
		Micro and regional climate regulation
Physical and experiential interactions	**C1**	Experiential use of plants, animals and land-/seascapes in different environmental settings
		Physical use of land-/seascapes in different environmental settings
Intellectual and representative interactions	**C2**	Scientific
		Educational
		Heritage, cultural
		Entertainment
		Aesthetic
Spiritual and/or emblematic	**C3**	Symbolic
		Sacred and/or religious
Other cultural outputs	**C4**	Existence
		Bequest

universitätbonn