Anforderungen an die Modellierung durch Multifunktionalität und Vielfalt der Zukunftsoptionen

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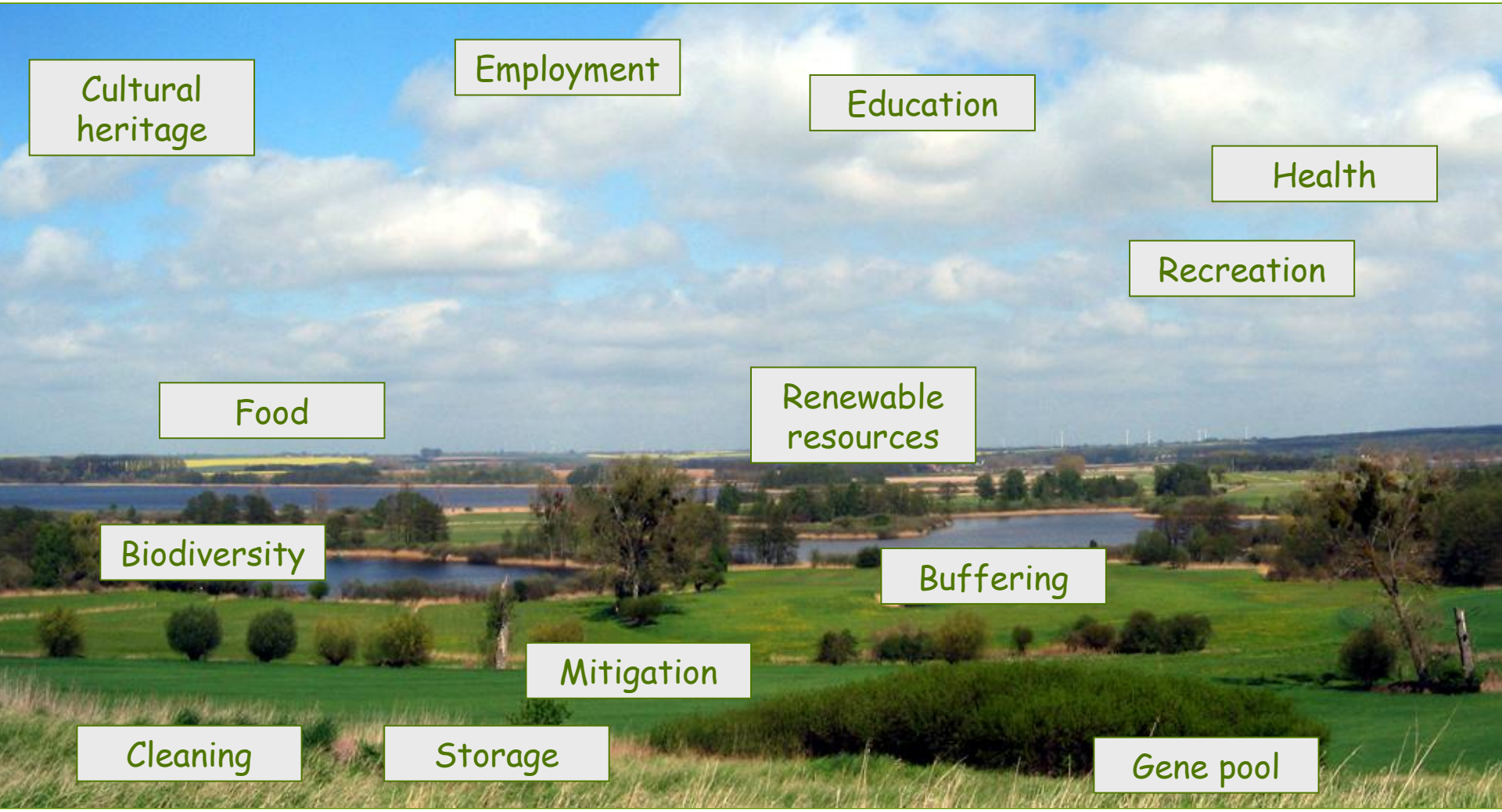
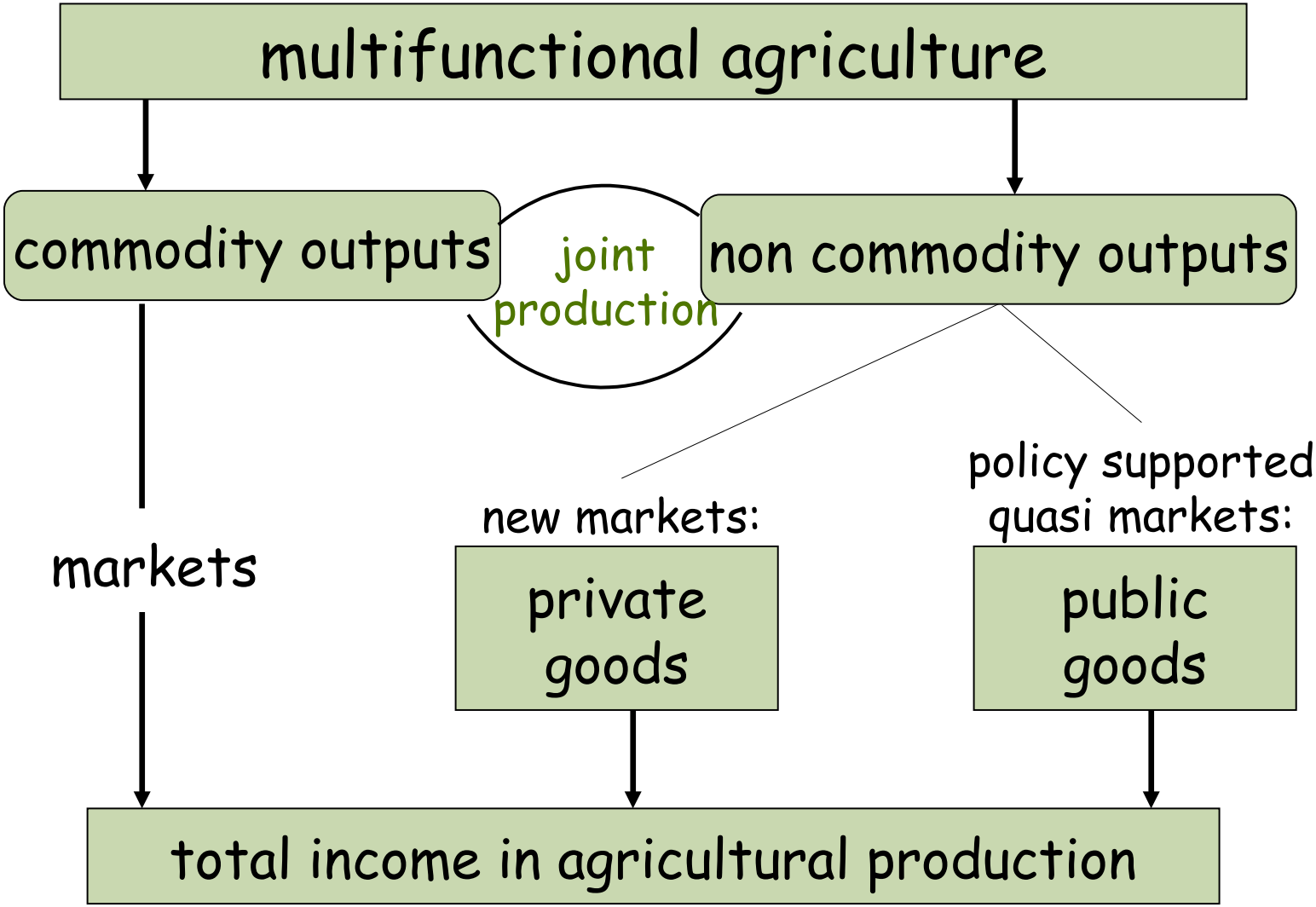
Multifunktionale Land(wirt)schaft



Multifunktionalität: Commodities + Non-commodities



Jointness of agricultural production

Commodities

(Examples)

- **Beef**
- **Milk**
- **Pork**
- **Wool**
- **etc.**

- **Grains**
- **Oil**
- **Seed**
- **Forage**
- **Fibre**
- **etc.**

Non-Commodities

(Examples of positive and negative externalities)

+	-
+ Scenic vista (Cows on a meadow) **+ Biodiversity** (Pastures and meadows as wildlife habitats)	**- Odor** (Liquid manure application) **- Emissions** (Greenhouse gases like Methane etc.)
+ Scenic vista (Yellow blossoms of rape) **+ Biodiversity** (Agricultural fields as wildlife habitats)	**- Water erosion** (High in row crops like corn or sugar beets) **- Nitrate leaching** (High nitrogen demand of rape)

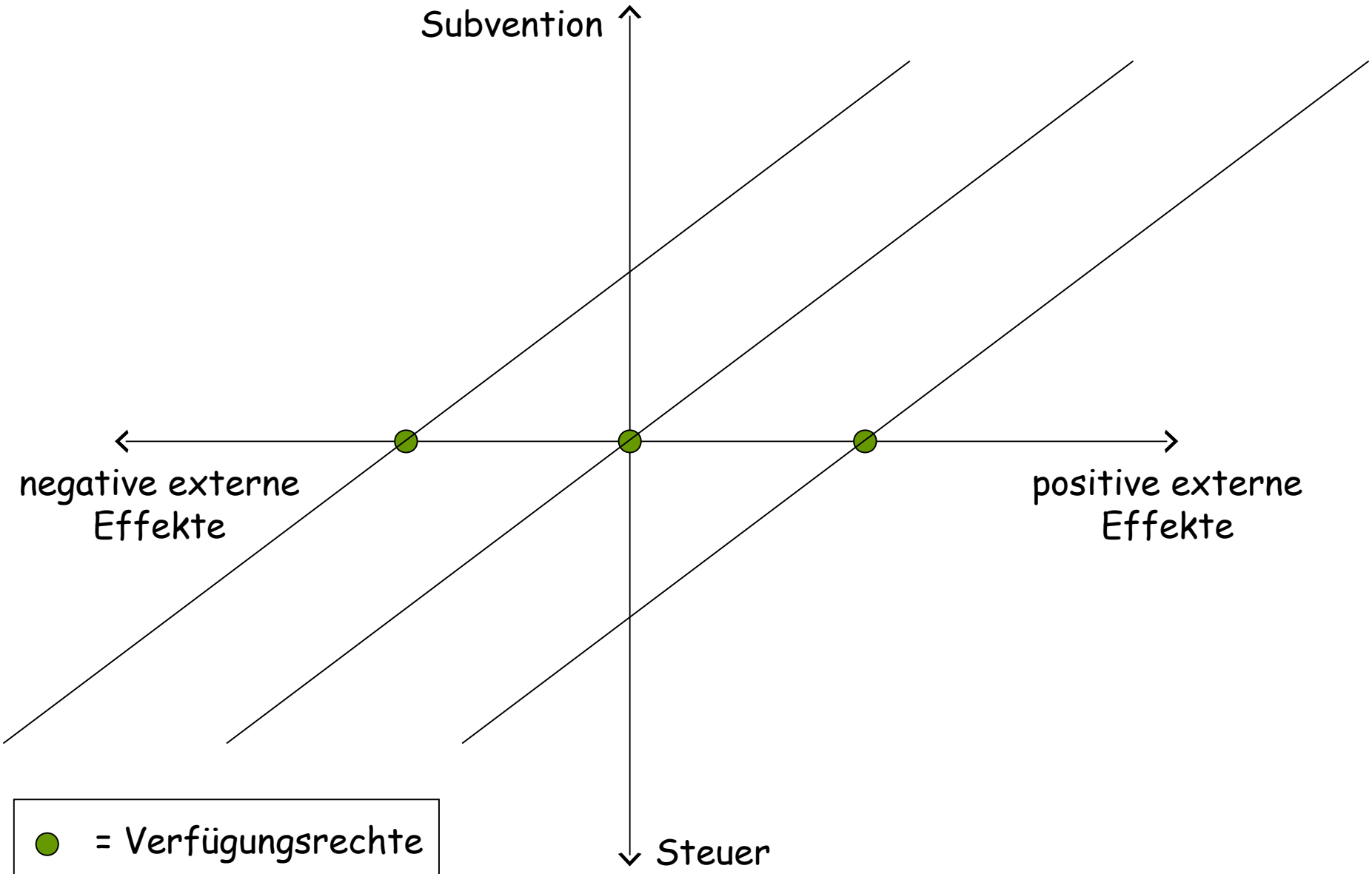
Cross-relationships

Cross-relationships

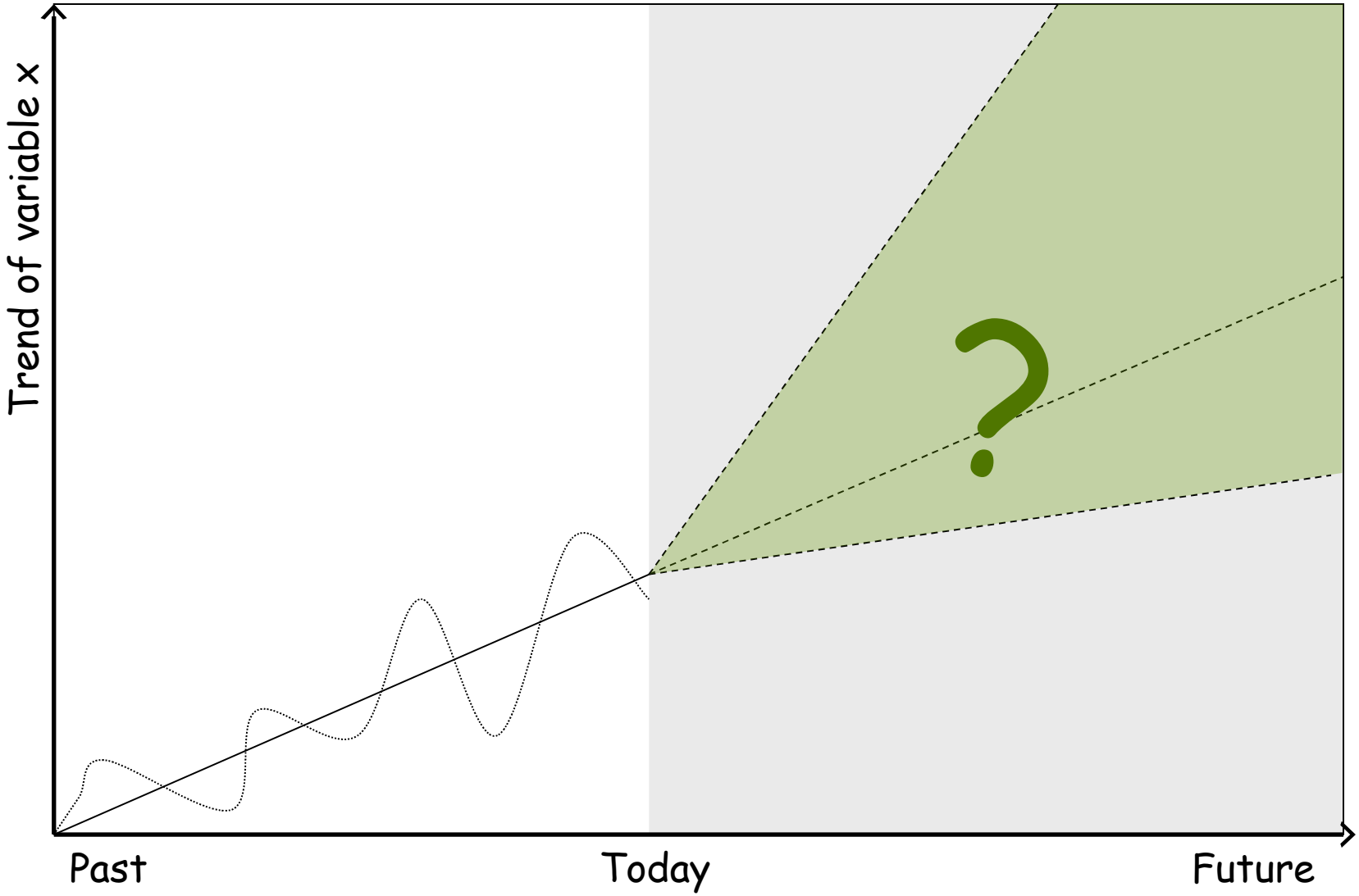
Cross-relationships

Cross-relationships

Multifunktionalität: Verfügungsrechte



Vielfalt der Zukunftsoptionen



→ ex-ante assessment of policies!

Vielfalt der Zukunftsoptionen (2)

→ **Abbildung durch Szenarien!**

Vorgehensweise:

- Problembereich bestimmen und eingrenzen (Skalen, etc.)
- Ziele definieren (Fragestellungen im Detail)
- Optionen zur Problemlösung (Szenariendefinition)
- Bewertung der Optionen (Szenarienrechnungen)
- Vergleich der Optionen (Szenarienvergleich)
- Empfehlungen ableiten

SEC (2005: 4), EC Impact Assessment Guidelines

Problembereich?

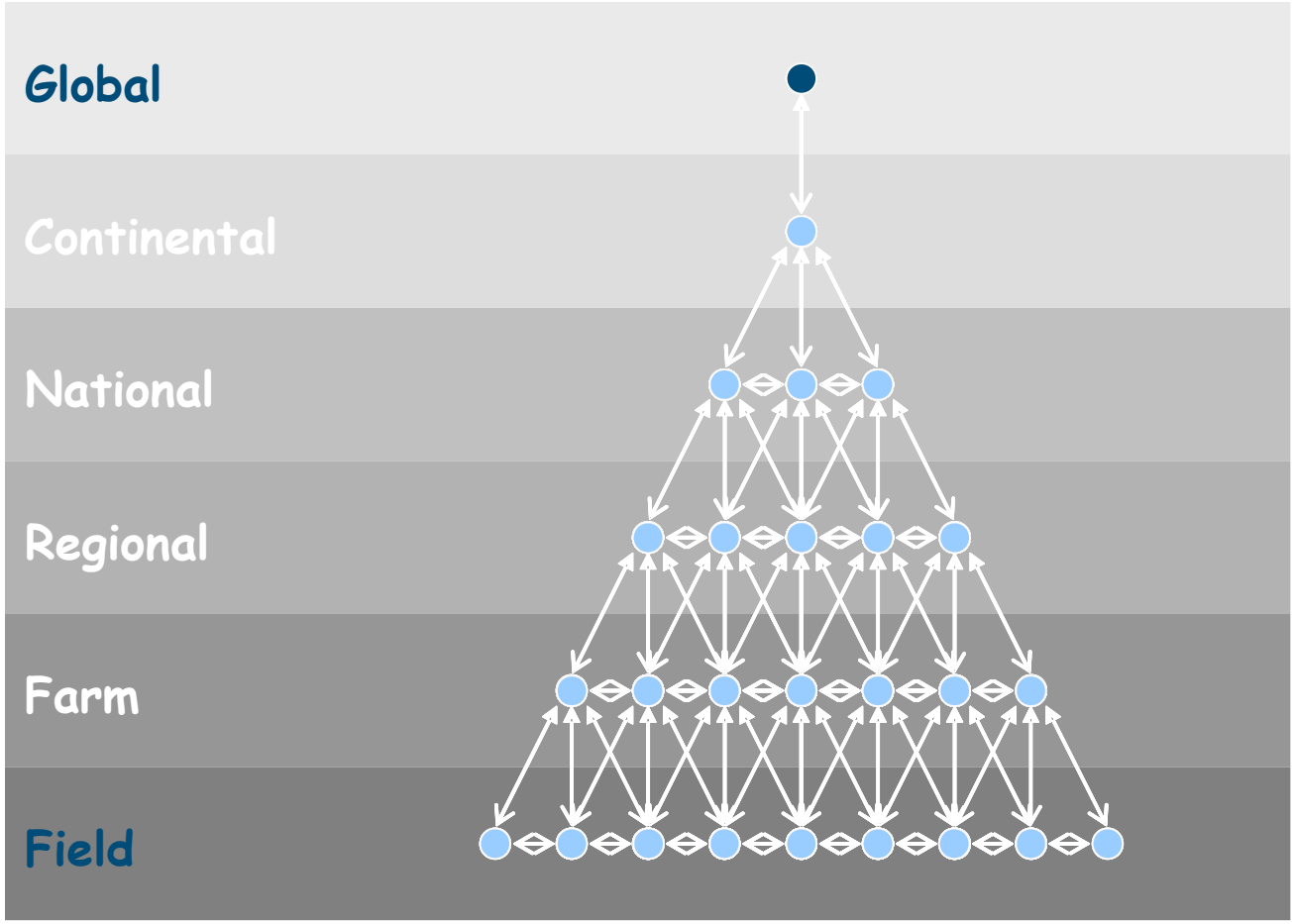
by sectors:

by biomes:

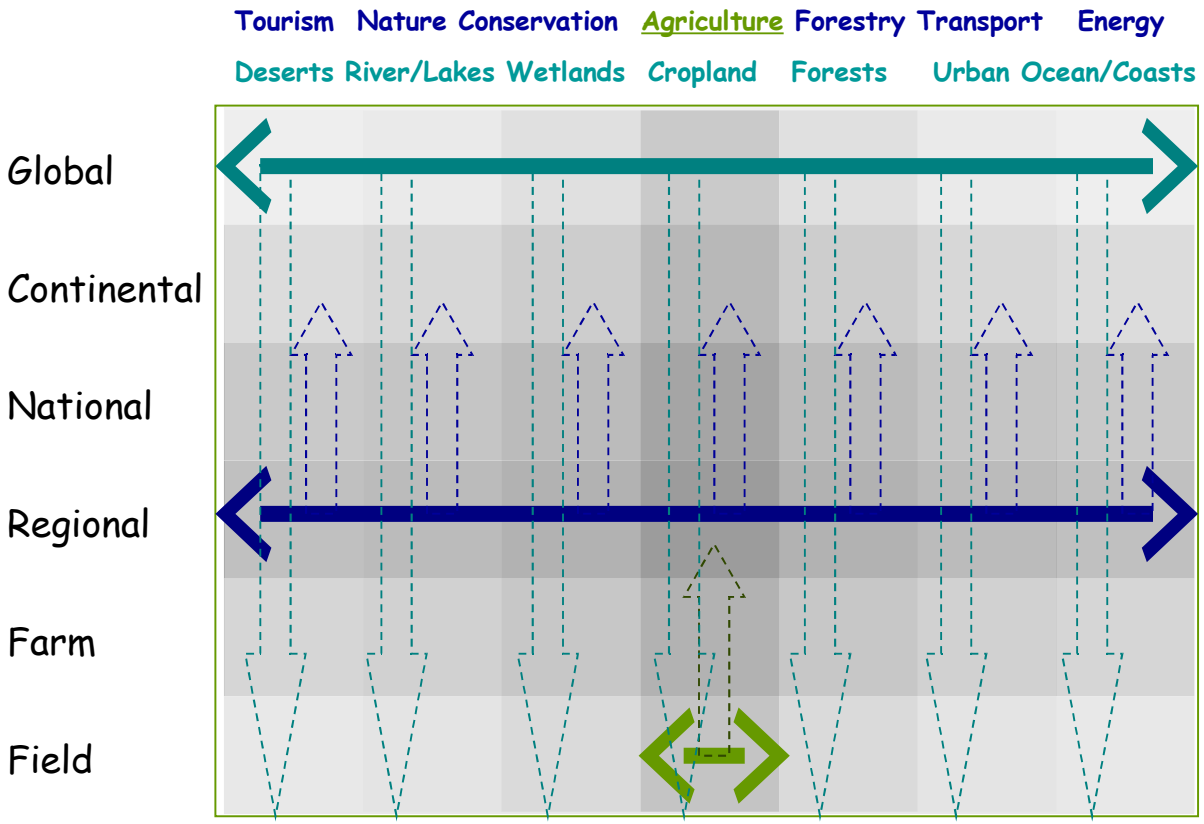
by …:

Tourism	Nature conservation		Agriculture	Forestry	Transport	Energy	…
Deserts	River/Lakes	Wetlands	Cropland	Forests	Urban	Ocean/Coasts	…
…							

Raumskalen?



3 Modellierungsansätze



MIMES

SENSOR

MEA-Scope

MEA-Scope – Projekt

Steckbrief

Name: Micro-economic instruments for impact assessment of multifunctional agriculture to implement the Model of European Agriculture

Partner: 11 Partner

Laufzeit: 2004-2007

Ziele: Entwicklung von Instrumenten (Modellen) zur Beurteilung der Multifunktionalität landwirtschaftlicher Produktion unter verschiedenen sozioökonomischen und ökologischen Bedingungen am Beispiel von 7 europäischen Regionen

Träger: Europäische Union

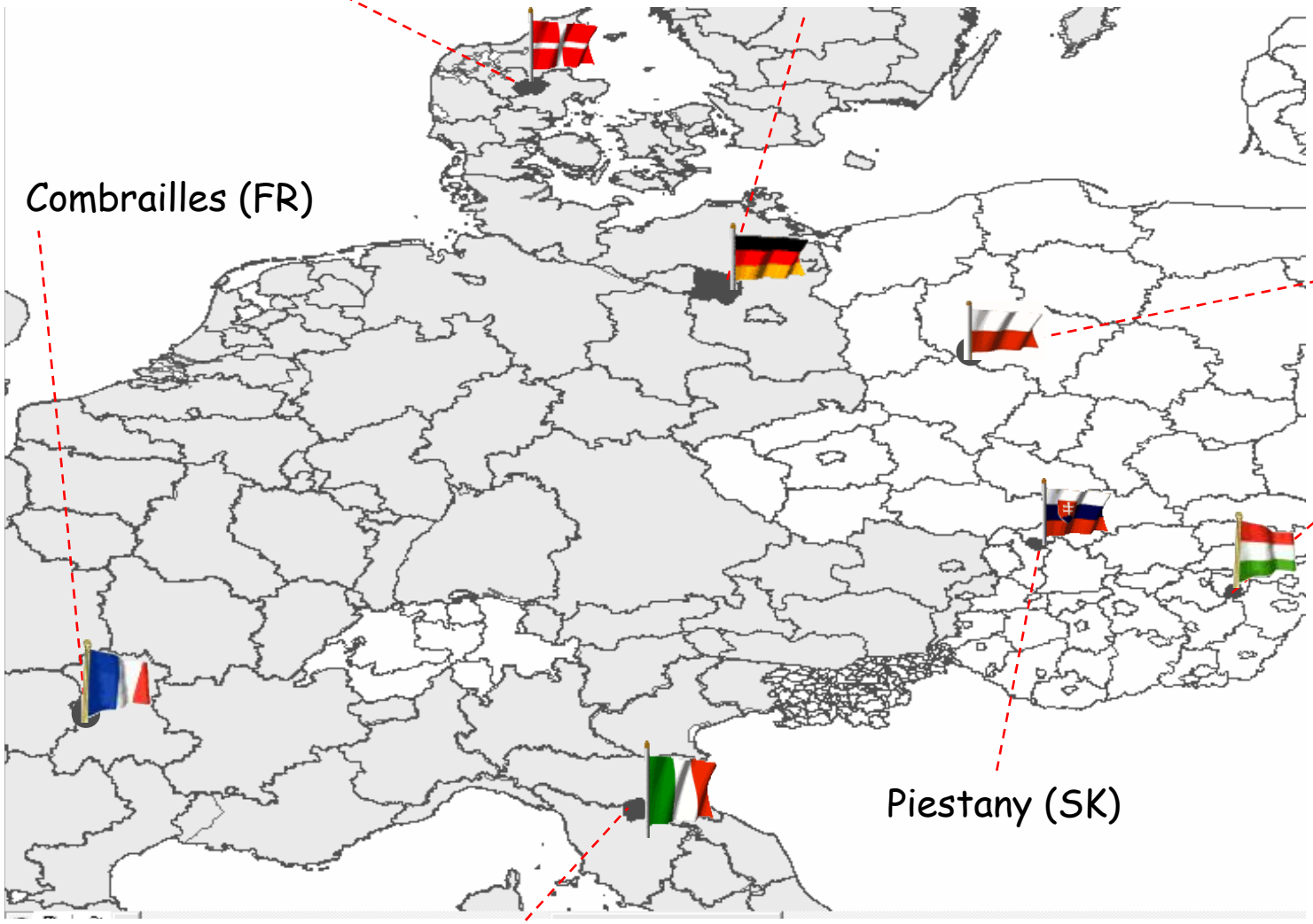
Modelle: AgriPoliS, MODAM, FASSET

Datengrundlagen: u. a. FADN, Corine Land Cover, ESDB

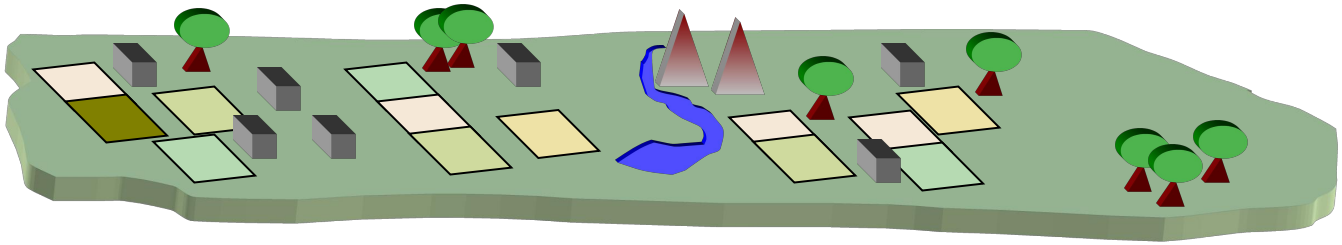
Bewertung: Expertenwissen

Webpage(s): www.mea-scope.eu, www.mea-scope.org, www.modam.eu

MEA-Scope – regions

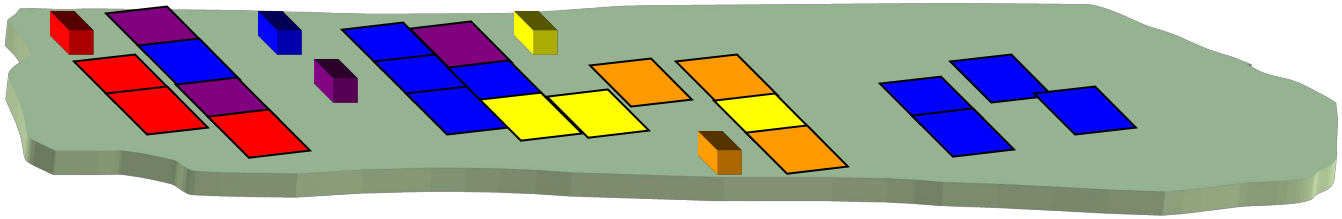


MEA-Scope – modeling approach



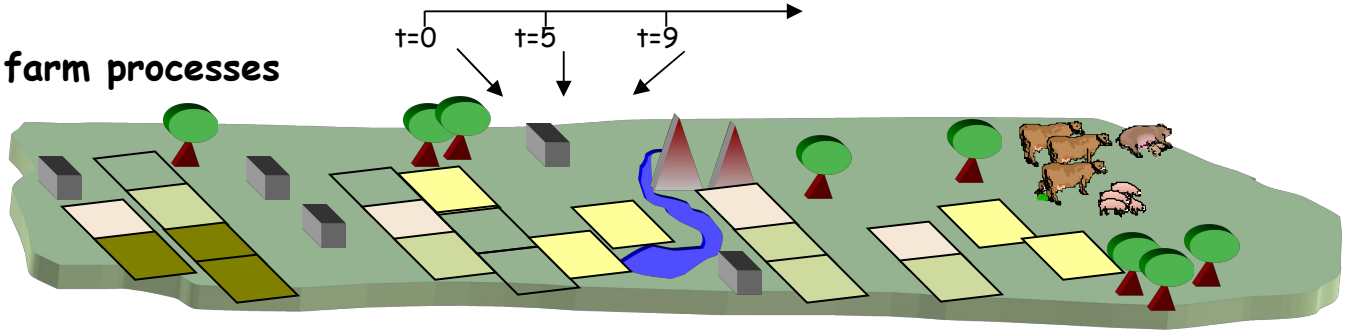
Complex reality

Structural Change



AgriPoliS

On-farm processes



MODAM + FASSET

MEA-Scope: multifunctionality indicators

Economic:

(e.g. farm income, etc.)

Social:

(e.g. total labor in agriculture, share of family labor in total labor, etc.)

Environmental:

(e.g. share of extensive grassland, risk indices for several abiotic and biotic indicators, etc.)

MEA-Scope: scenarios

	1st pillar	2nd pillar
BAS	Agenda 2000 ∅ 190-290 EURO/ha set aside constraints	AEP 130-200 Euro/ha Natura 2000 200 – 450 Euro/ha
REF	Decoupled single farm payment (SFP)	AEP 130-200 Euro/ha Natura 2000 200 – 450 Euro/ha
S1	no	AEP 130-200 Euro/ha Natura 2000 200 – 450 Euro/ha
S2	no	no

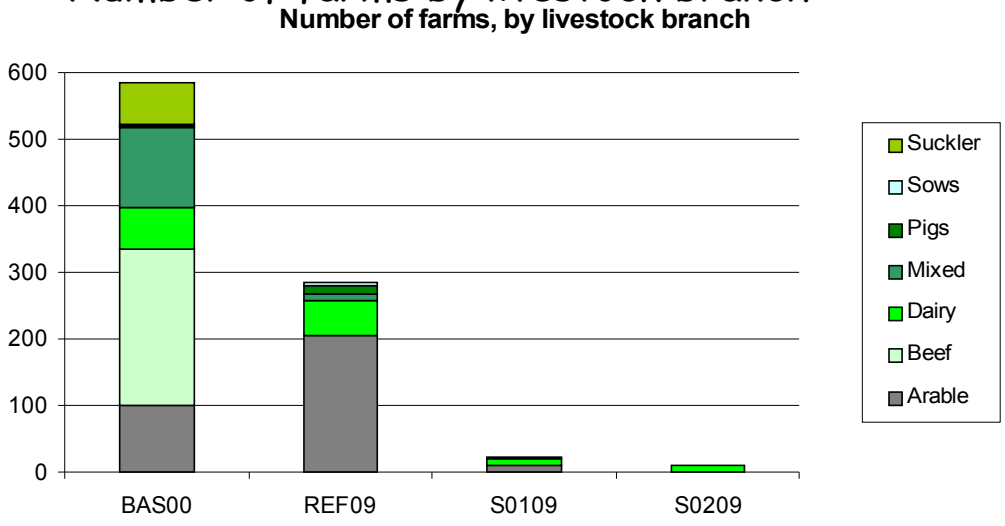
→ EU-end user workshop

MEA-Scope – exemplary results

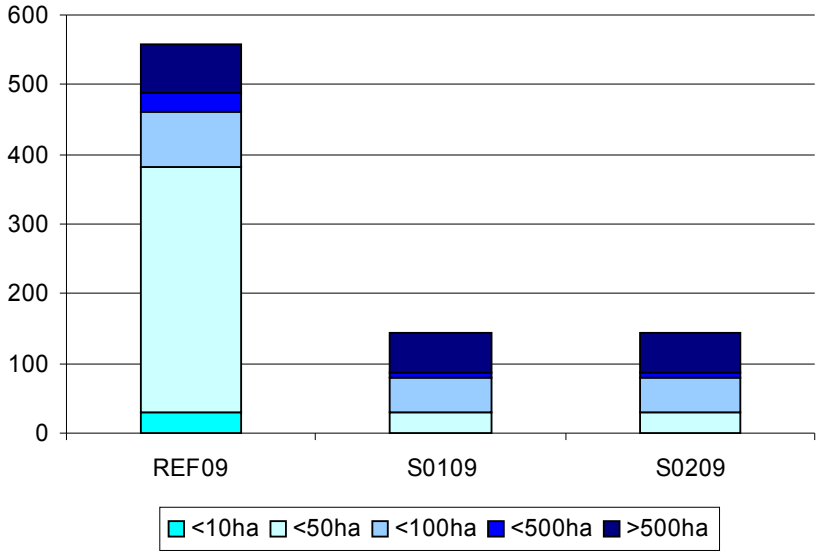
Economic:

- Structural change of farms (farm type and size class)

Number of farms by livestock branch



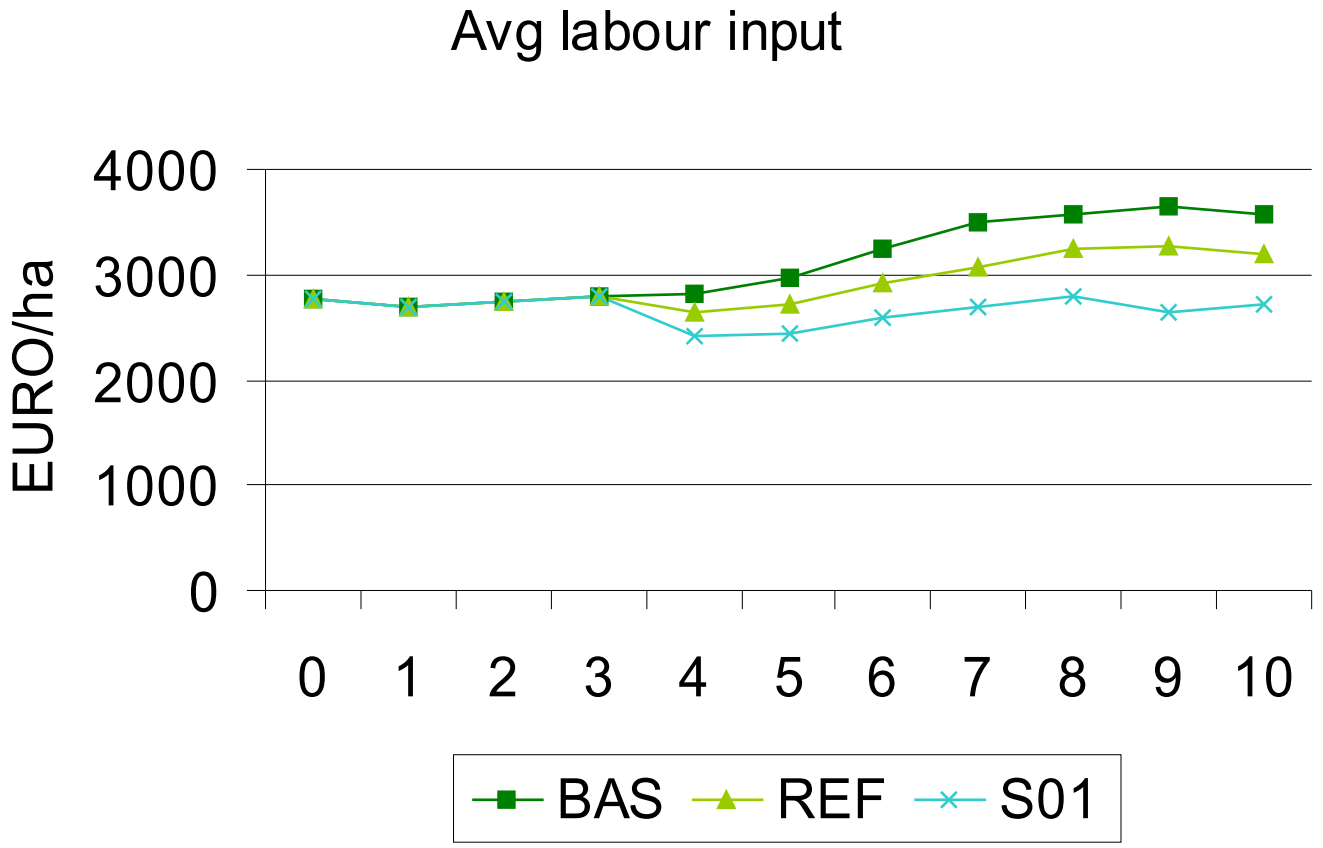
Number of farms by size class



MEA-Scope – exemplary results (2)

Social:

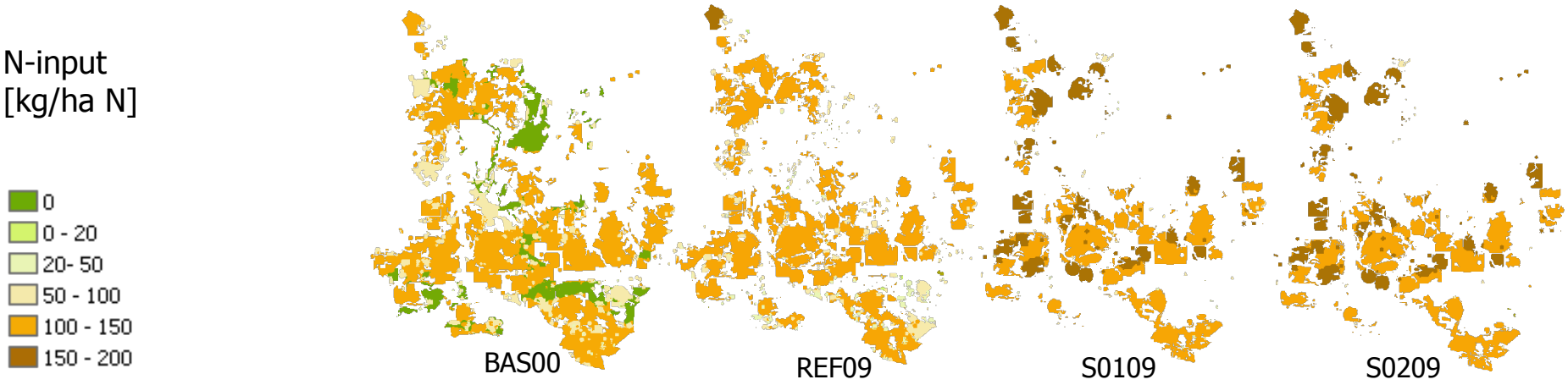
- total labor in agriculture

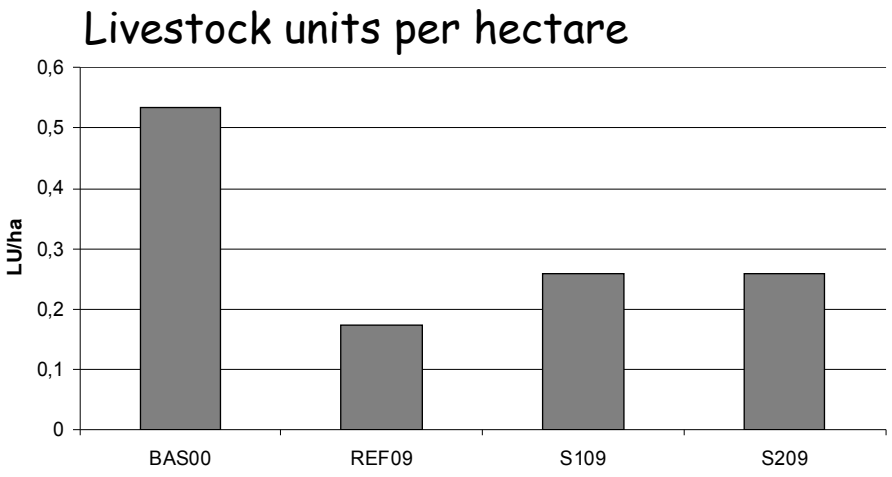


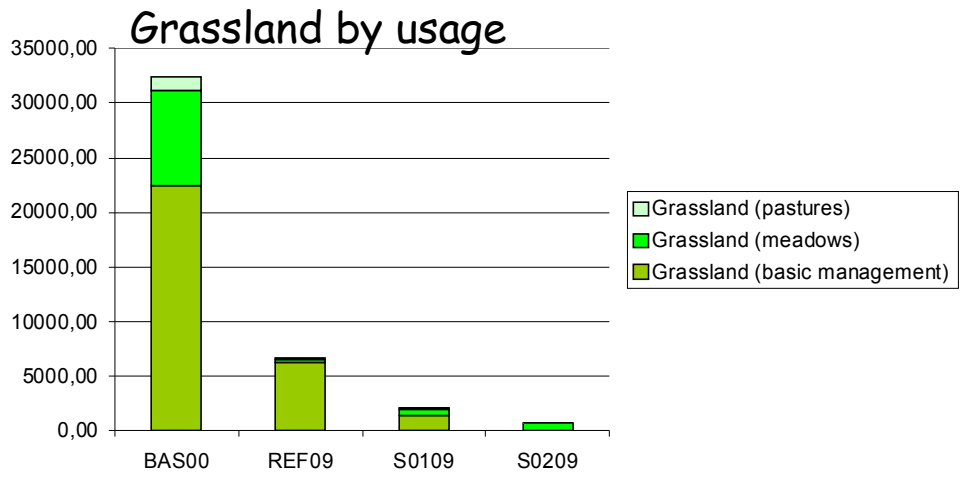
MEA-Scope – exemplary results (3)

Environmental:

- N-input per hectare (→ risk of nitrate leaching)







SENSOR - Project

Steckbrief

Name: Sustainability impact assessment: tools for environmental, social and economic effects of multifunctional land use in European regions

Partner: 36 Partner

Laufzeit: 2004-2009

Ziele: Entwicklung von Werkzeugen für die Folgenabschätzung von politischen Landnutzungsentscheidungen hinsichtlich ihrer Nachhaltigkeitswirkung in Europäischen Regionen

Träger: Europäische Union

Tools: SIAT (Sustainability Impact Assessment Tool), FOPIA (Framework for Particpatory Impact Assessment)

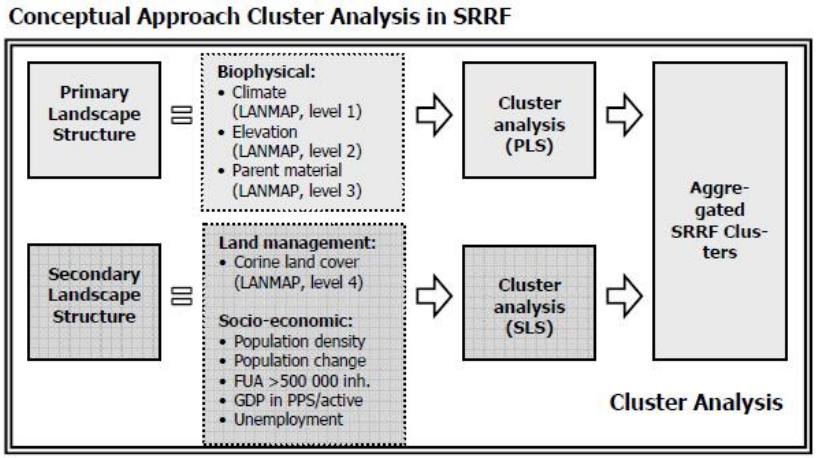
Modelle: NEMESIS, EFISCEN, DYNA-CLUE, CAPRI

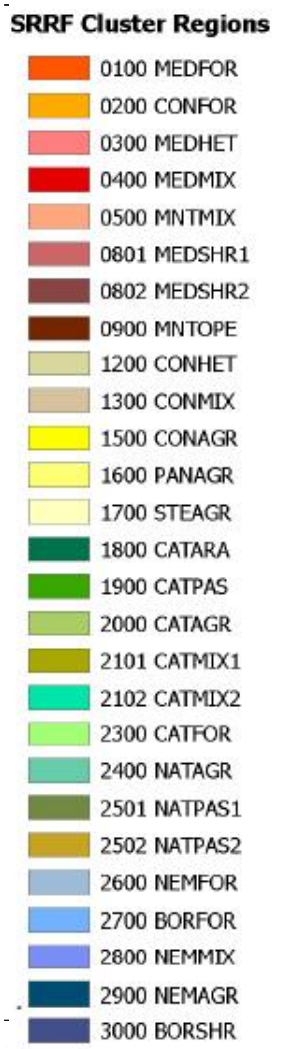
Datengrundlagen: u. a. Eurostat, UN, IPCC, OECD

Bewertung: Expertenwissen

Webpage: www.sensor-ip.eu

SENSOR - regions





SENSOR - SIAT

Driver

- Global socio-economic trends, policy cases
- Scenario storylines

Assumptions

Pressure

- Economic adjustments
- Land use changes

Models

State

- Bio-geophysical indicators
- Socio economic indicators

Impact

- Land Use Functions
- Sustainable development

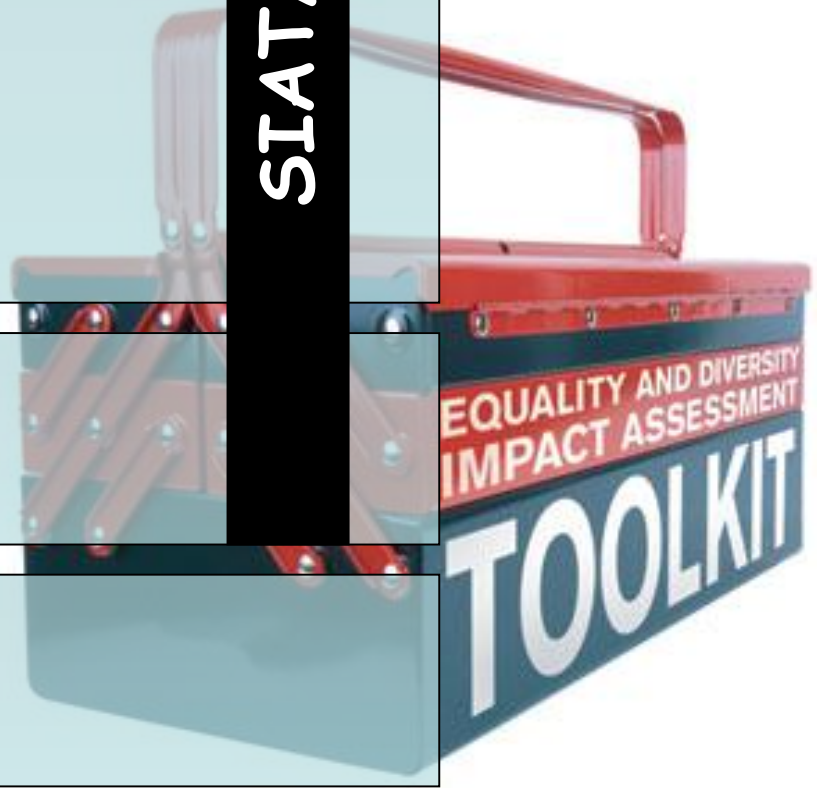
Values

Response

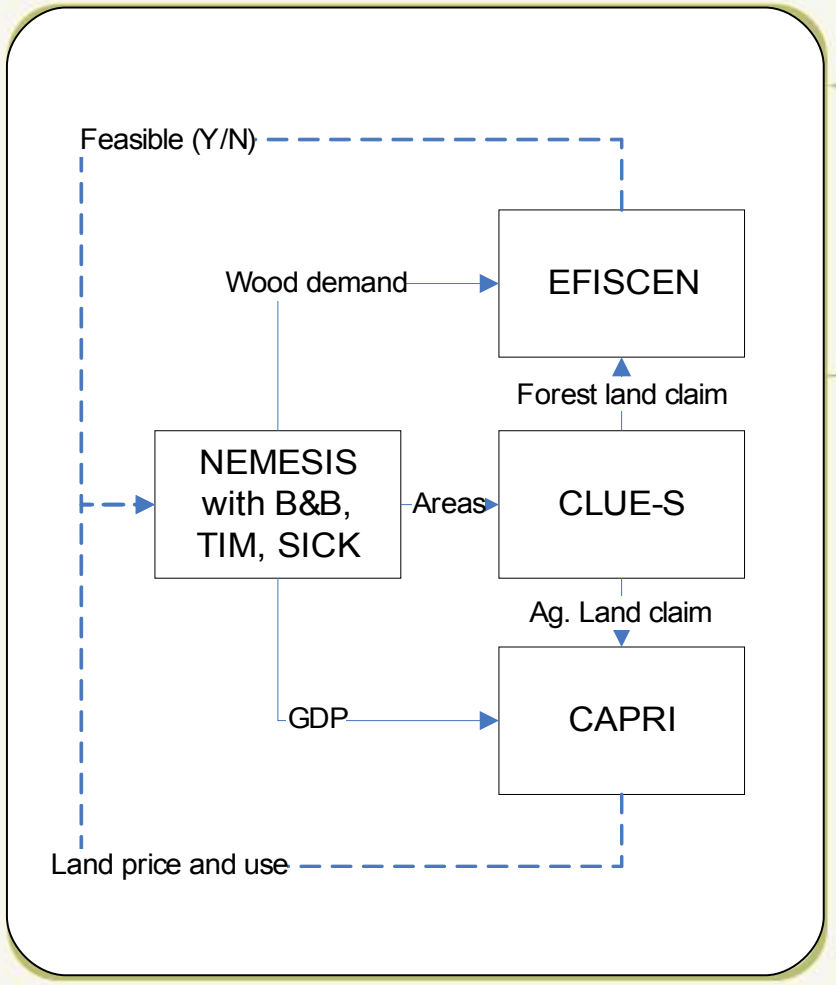
- End user decisions

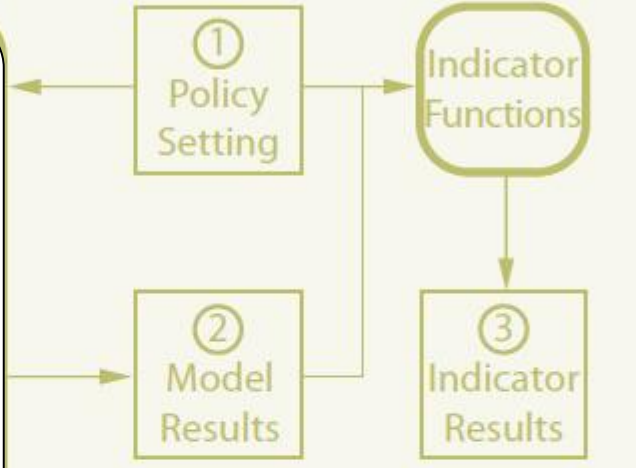
Actions

SIAT/FOPIA



SENSOR - modeling approach





Legend:

A	Land use per sector and member state
A_a	Agricultural land use per NUTSx
A_f	Forest area per NUTSx
W	Input price indices
T	Technical progress indices
Y	Consumer expenditure
D_f	Wood demand
λ	Land rent
Q_a	Total agricultural output
P_a	Price index of agricultural outputs
B	Change in expenditure in CAP pillar I
S	Excess demand of wood (infeasibility)

Source: JANSSEN (2008)

SENSOR – land use functions

- land use functions (LUF) = "goods and services provided by the different land uses"
- calculated by "response functions" (indicator → LUF)
- any spatial scale (regional, national or EU)

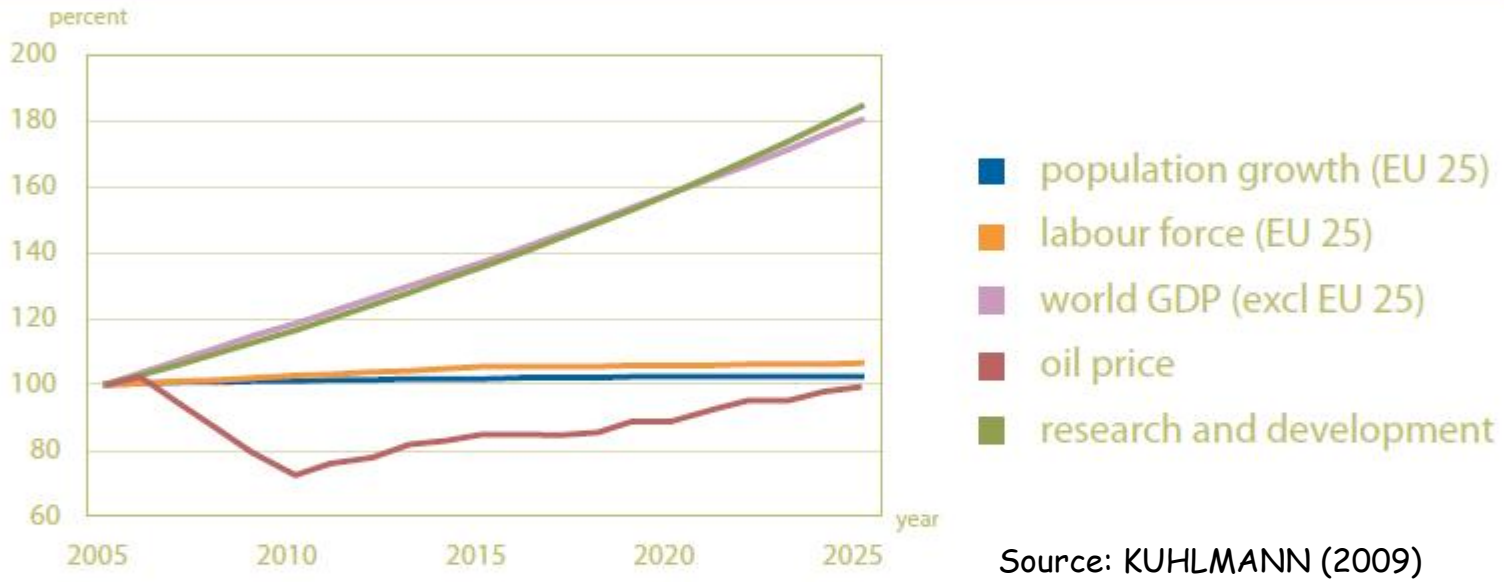
Social:
1. Provision of work
2. Human health & recreation
3. Cultural

Economic:
4. Residential and land independent production
5. Land-based production
6. Transport infrastructure

Environmental:
7. Provision of abiotic resources
8. Provision of habitat
9. Maintenance of ecosystem processes

SENSOR – scenarios

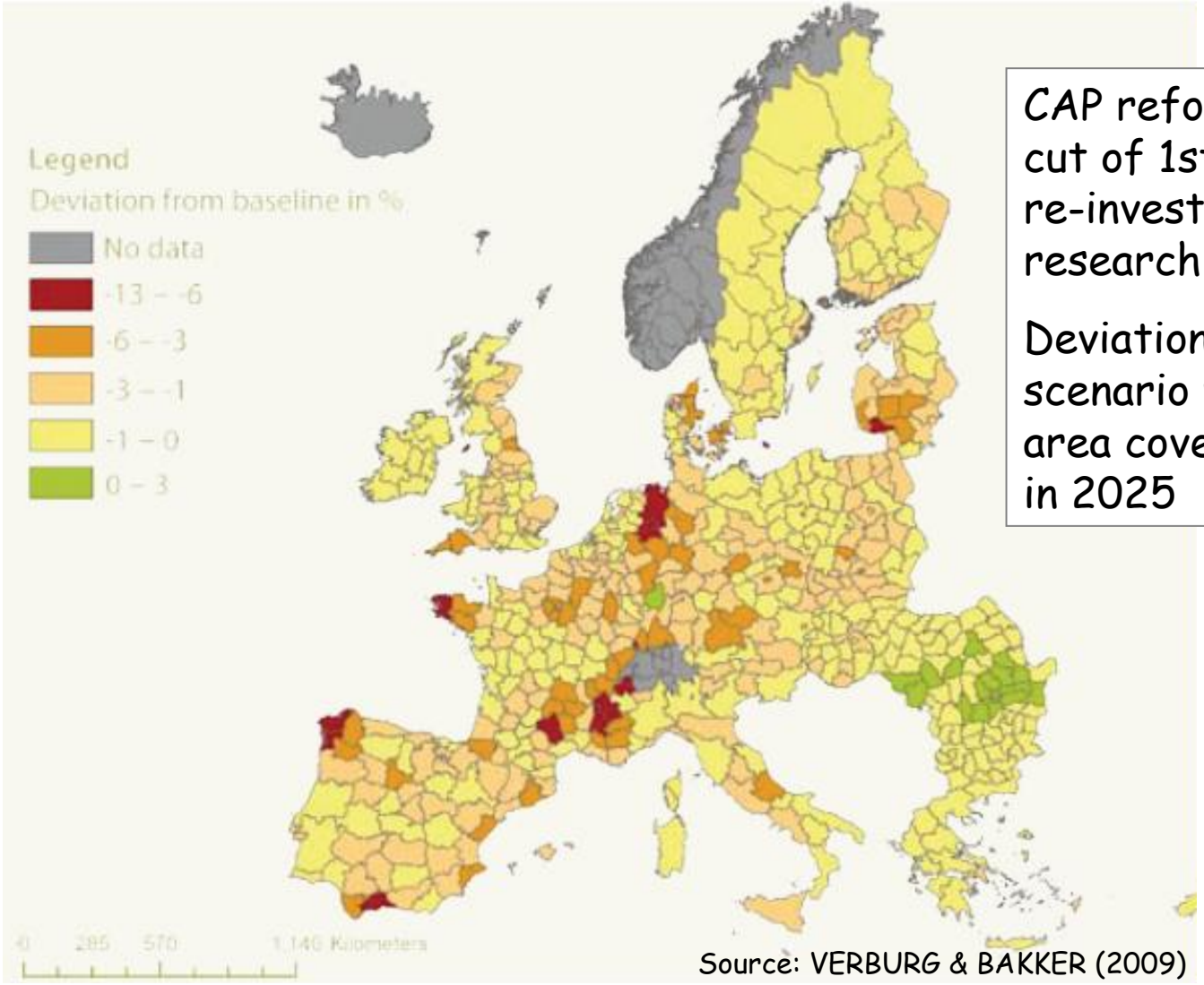
- "baseline scenario" (no policy change, extrapolation of existing data) vs. possible future "policy scenarios"
- projection year = 2025
- 5 driving forces for socio-economic situations considered:



Source: KUHLMANN (2009)

→ SENSOR modeling chain was employed to translate these driving forces into pressures of land use changes

SENSOR – exemplary results (1)



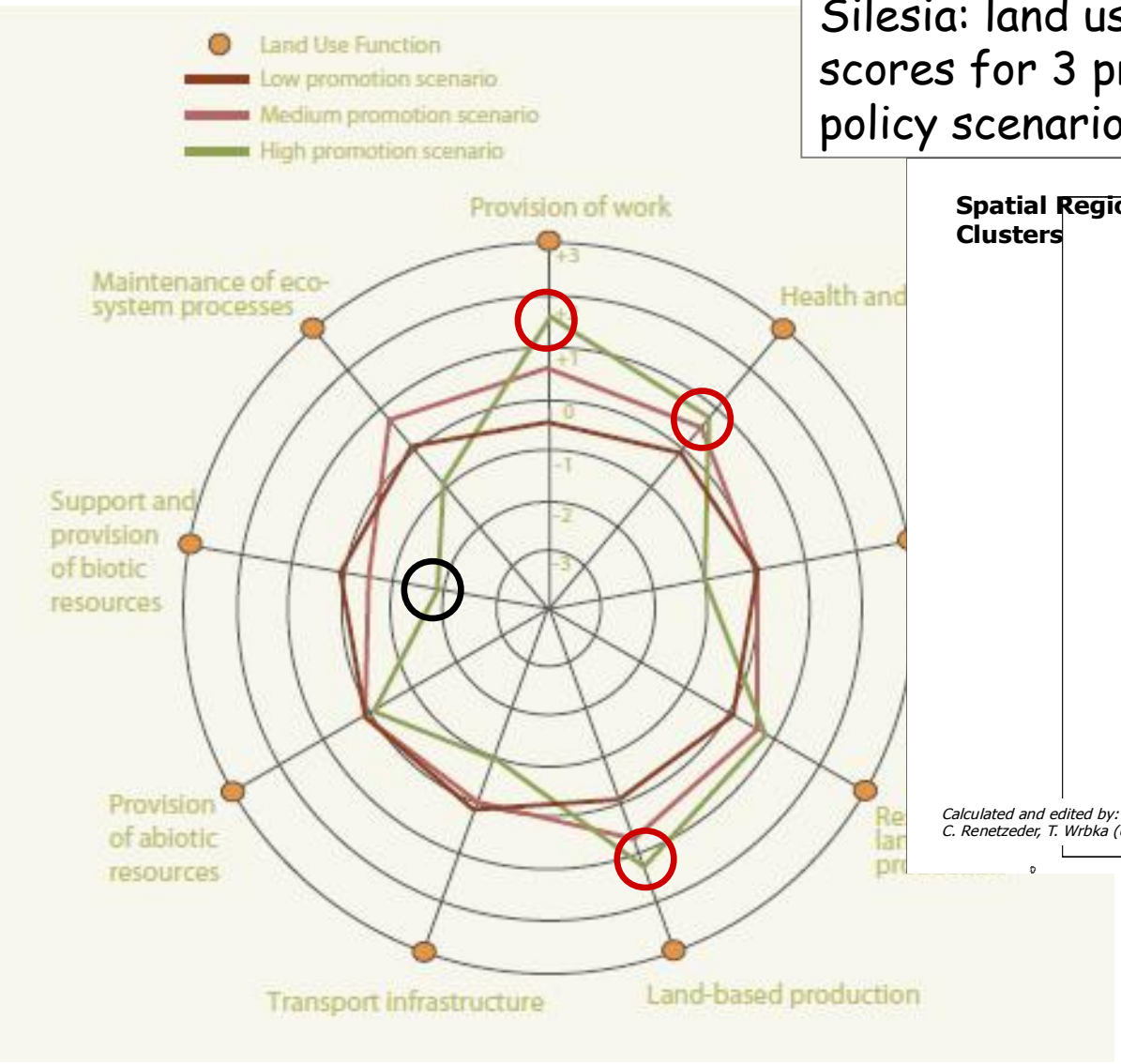
Source: VERBURG & BAKKER (2009)

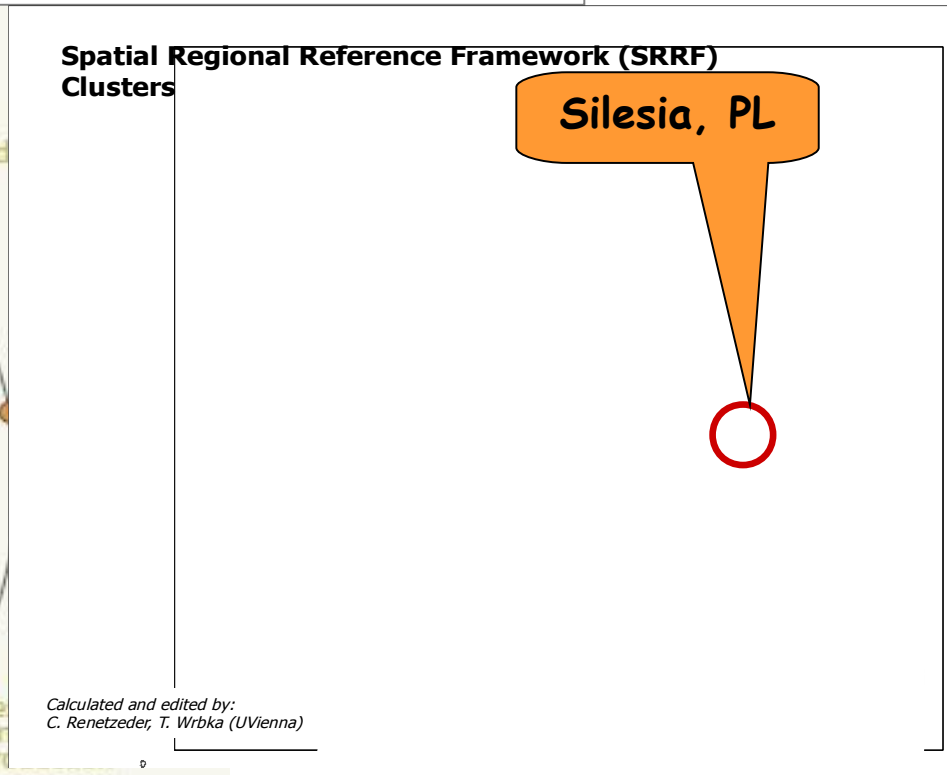
CAP reform scenario: 100% cut of 1st pillar measures, re-investment of savings in research and development

Deviation from the baseline scenario with respect to the area covered by arable land in 2025

SENSOR – exemplary results (2)

Bio-energy promotion in Silesia: land use function scores for 3 promotion policy scenarios in 2025





Quelle: STUCZINSKY (2009)

MIMES – general information

Steckbrief

Name: Multi-scale Integrated Models of Ecosystem Services

Institute: Gund Institute for Ecological Economics, University of Vermont, USA

Aim: MIMES is a suite of models that enables understanding of the contributions of ecosystem services by quantifying the effects of varying environmental conditions derived from land use change. MIMES evaluates land use changes and subsequent effects on ecosystem services on global, regional and local levels.

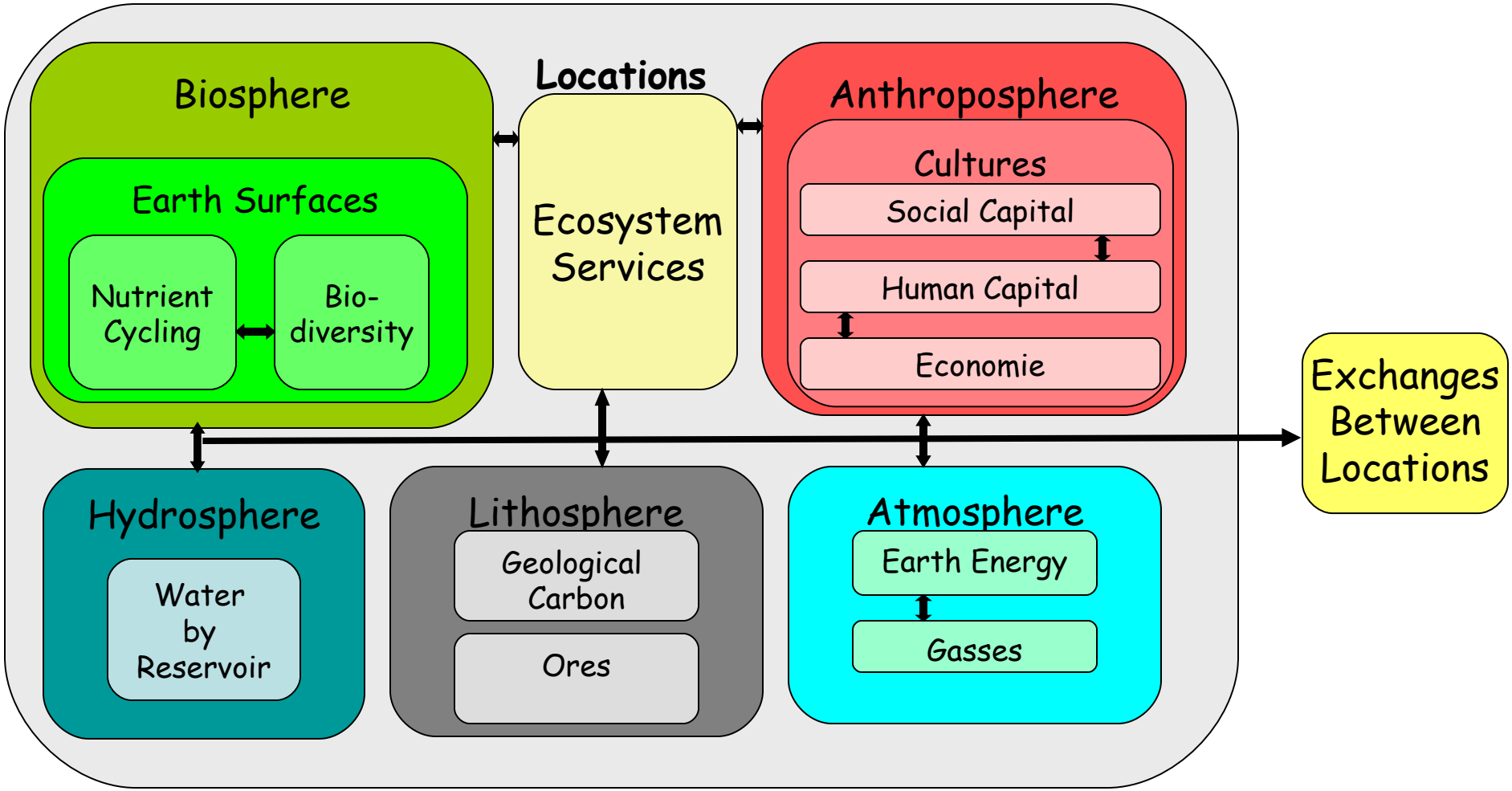
Models: modular modeling framework (SIMILE software), models are organized into 5 different spheres: anthroposphere, atmosphere, biosphere, hydrosphere, and lithosphere

Data basis: statistical data, data from literature studies, expert knowledge

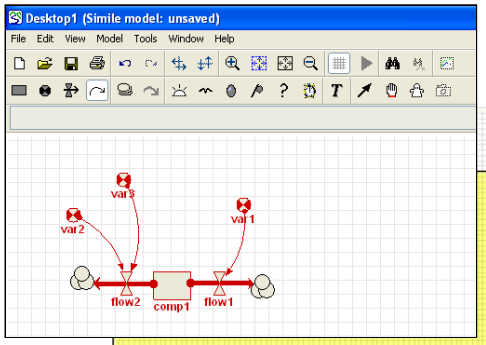
Valuation methods: e.g. direct and indirect market pricing, contigent valuation, group valuation (cf. de Groot et al. 2002)

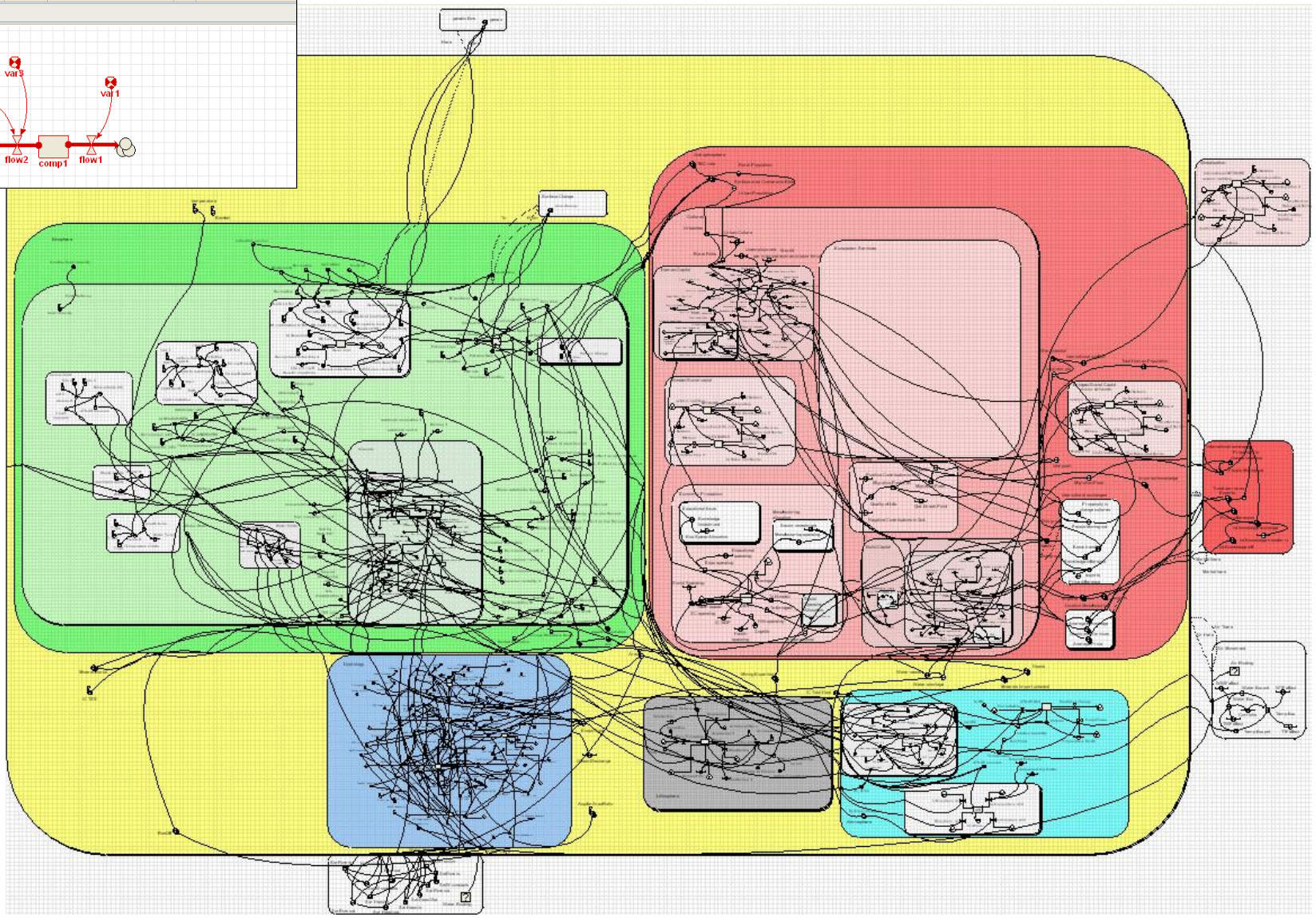
Webpage: www.uvm.edu/giee/mimes

MIMES – modelling approach



MIMES – modelling approach (2)





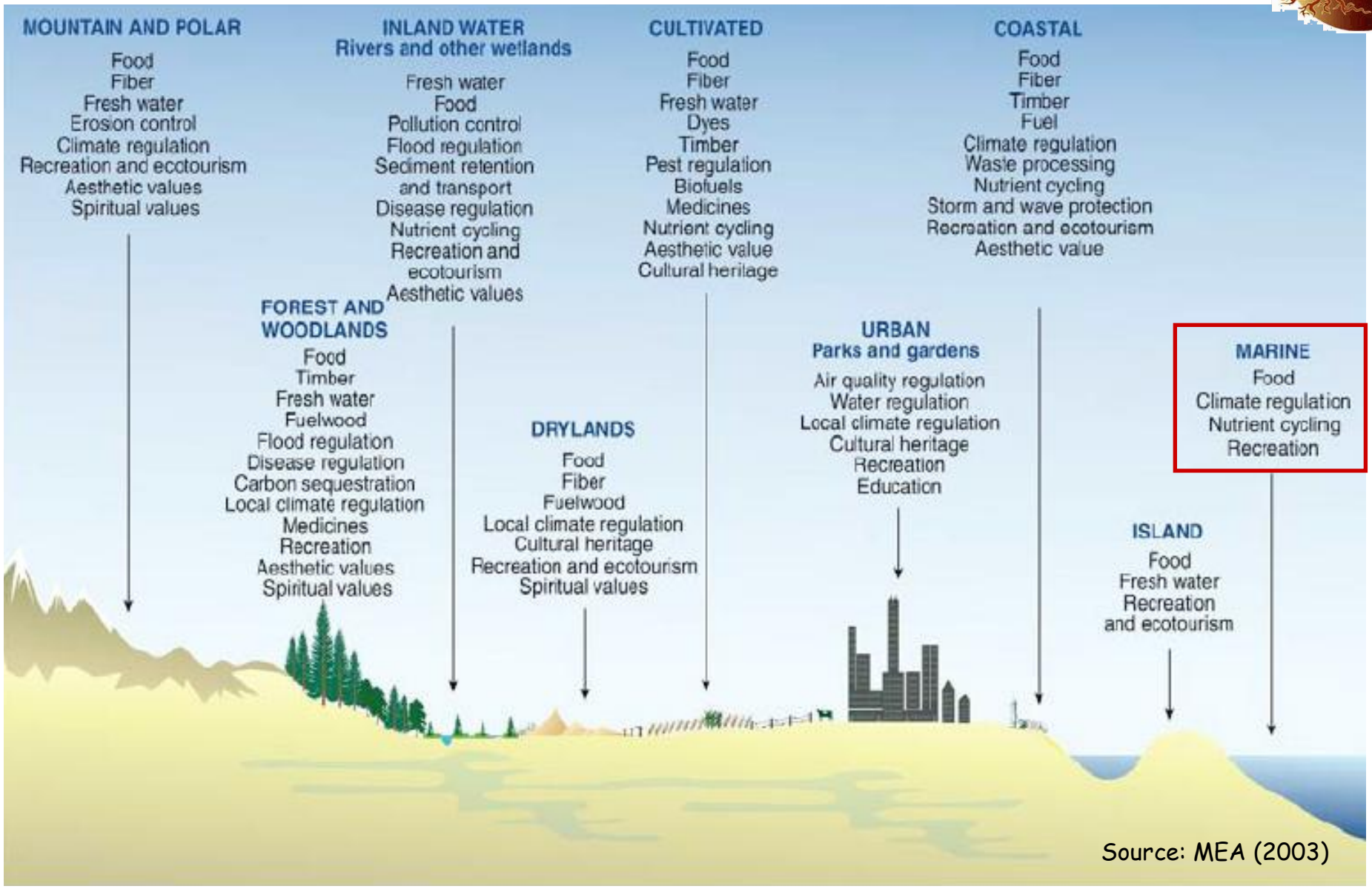
MIMES – ecosystem services (ES)

Ecosystem services are defined as those functions of ecosystems that support (directly or indirectly) human welfare

Regulation functions	Ecosystem goods and services (examples)
1 Gas regulation	1.1 UVb-protection, 1.2 Air quality, 1.3 Influence on climate
2 Climate regulation	2.1 Maintenance of a favorable climate
3 Disturbance Influence	3.1 Storm protection, 3.2 Flood prevention
4 Water regulation	4.1 Drainage and natural irrigation, 4.2 Medium for transport
5 Water supply	5.1 Provision of water for consumptive use
6 Soil retention	6.1 Maintenance of arable land, 6.2 Prevention of damage from erosion/siltation
7 Soil formation	7.1 Maintenance of productivity on arable land, 7.2 Maintenance of natural productive soils
8 Nutrient regulation	8.1 Maintenance of healthy soils and productive ecosystems
9 Waste treatment	9.1 Pollution control/detoxification, 9.2 Filtering of dust particles, 9.3 No noise pollution
10 Pollination	10.1 Pollination of wild plant species, 10.2 Pollination of crops
11 Biological control	11.1 Control of pests and diseases, 11.2 Reduction of herbivory (crop damage)
Habitat functions	
12 Refugium function	12.1 Maintenance for biological & genetic diversity
13 Nursery function	13.1 Hunting, gathering of fish, fruits, 13.2 Small-scale subsistence farming & aquaculture
Production function	
14 Food	14.1 Building & manufacturing (lumber), 14.2 Fuel and energy, 14.3 Fodder and fertilizer
15 Raw materials	15.1 Improve crop resistance to pathogens & pests, 15.2 Other applications (e.g. health care)
16 Genetic resources	16.1 Drugs and pharmaceuticals, 16.2 Chemical models & tools, 16.3 Test- and essay organisms
17 Medicinal resources	17.1 Variety in (bio)-chemical substances for medicinal uses
18 Ornamental resources	18.1 Resources for fashion, handicraft, worship, decoration, orchids, butterflies, shells, etc.)
Information function	
19 Aesthetic	19.1 Enjoyment of scenery
20 Recreation	20.1 Travel to natural ecosystems for eco-tourism, outdoor sports, etc.
21 Cultural and artistic	21.1 Use of nature as motive in books, film, painting, architect, advertising, etc.
22 Spiritual and historic	22.1 Use of nature for religious or historic purposes
23 Science and education	23.1 Use of natural systems for school excursions, scientific research

Source: DE GROOT et al. (2002)

MIMES – ES by land cover type



Source: MEA (2003)

MIMES – ES valuation (2)

Relationship between ecosystem functions and monetary valuation techniques

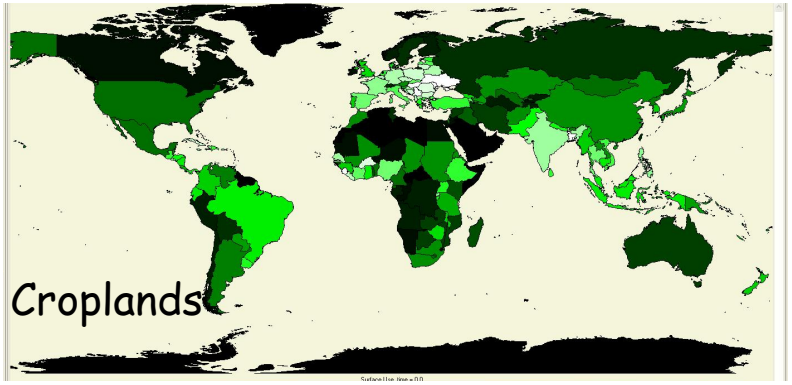
Ecosystem functions (and associated goods and services (see Table 1)	Range of monetary values in US$/ha year	Direct market pricing[b]	Indirect market pricing					Contingent valuation	Group valuation
			Avoided cost	Replacement cost	Factor income	Travel cost	Hedonic pricing		
Regulation functions									
1. Gas regulation	7–265		+++	0	0			0	0
2. Climate regulation	88–223		+++	0	0			0	0
3. Disturbance regulation	2–7240		+++	++	0		0	+	0
4. Water regulation	2–5445	+	++	0	+++		0	0	0
5. Water supply	3–7600	+++	0	++	0	0	0	0	0
6. Soil retention	29–245		+++	++	0		0	0	0
7. Soil formation	1–10		+++	0	0			0	0
8. Nutrient cycling	87–21 100		0	+++	0			0	0
9. Waste treatment	58–6696		0	+++	0		0	++	0
10. Pollination	14–25	0	+	+++	++			0	0
11. Biological control	2–78	+	0	+++	++			0	0
Habitat functions									
12. Refugium function	3–1523	+++		0	0		0	++	0
13. Nursery function	142–195	+++	0	0	0		0	0	0
Production functions									
14. Food	6–2761	+++		0	++			+	0
15. Raw materials	6–1014	+++		0	++			+	0

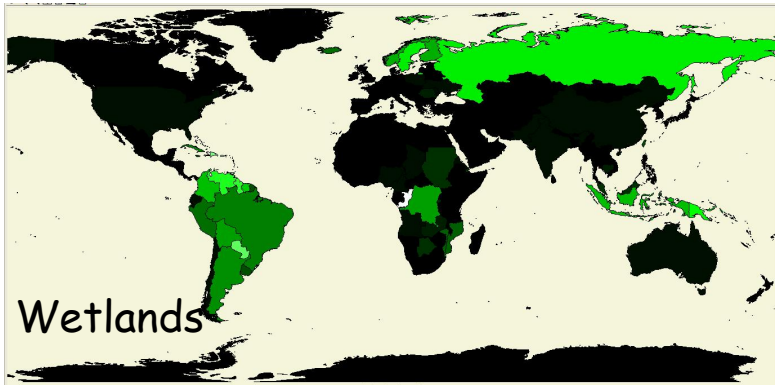
R.S. de Groot et al. / Ecological Economics 41 (2002) 393–408

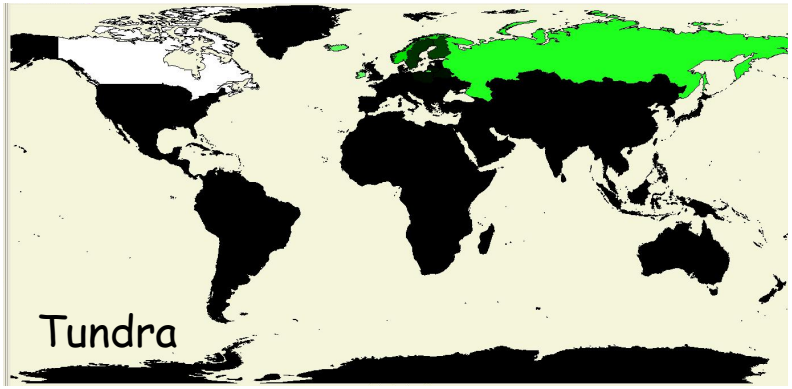
Source: DE GROOT et al. (2002)

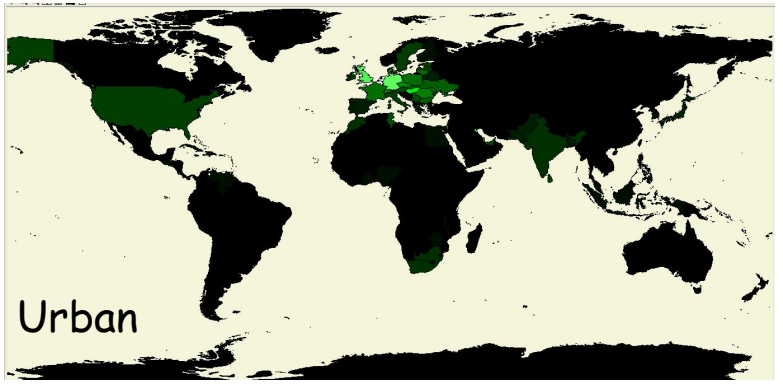
MIMES – exemplary results

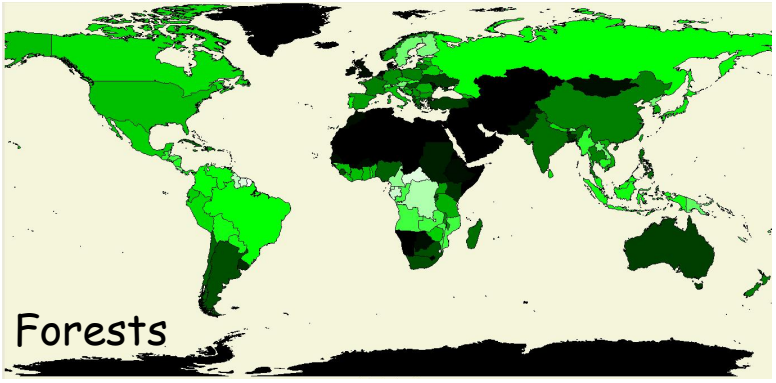
Ecosystems [% Area]

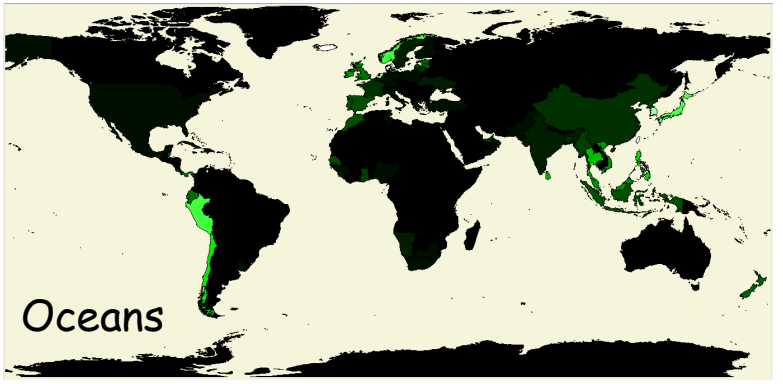






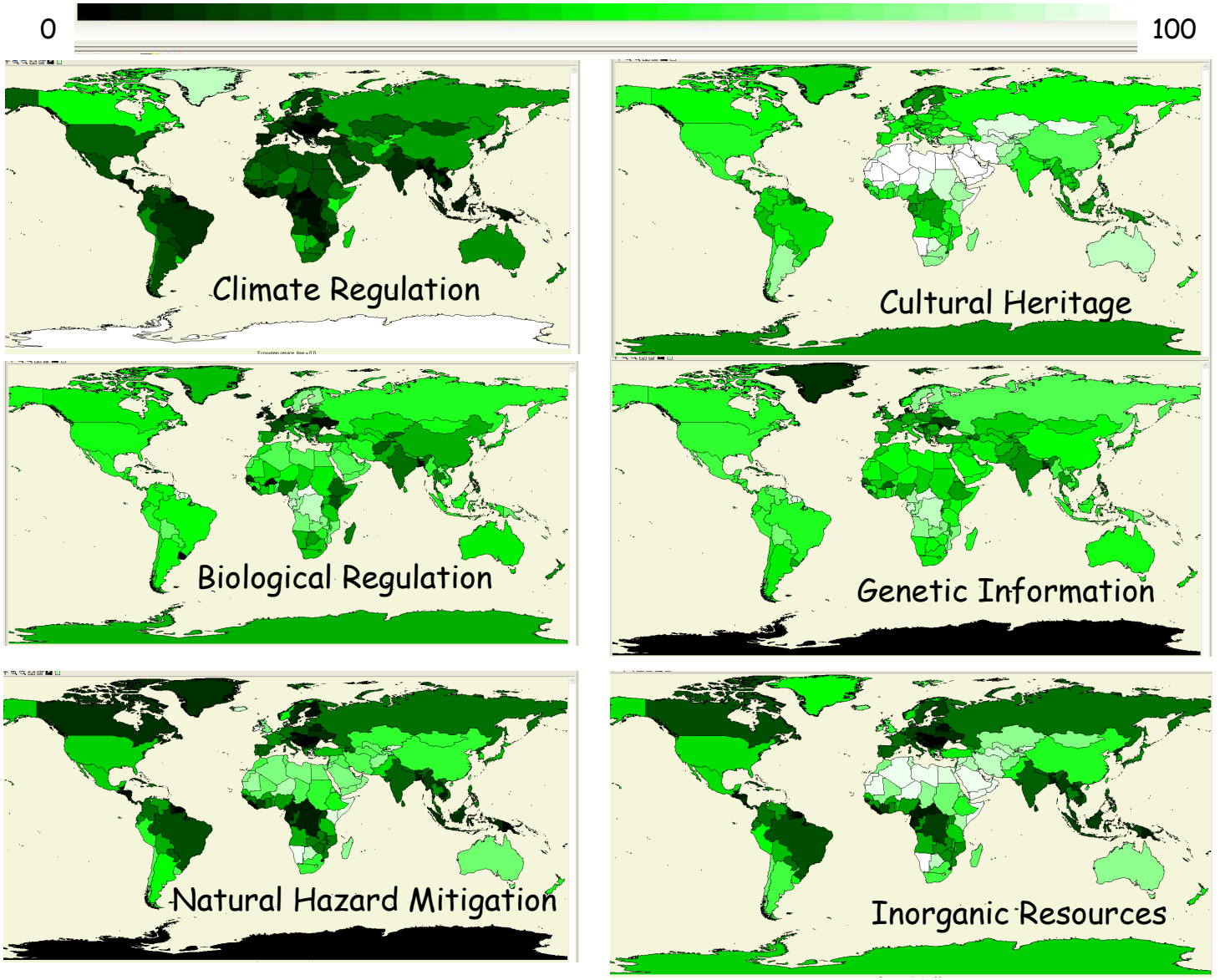




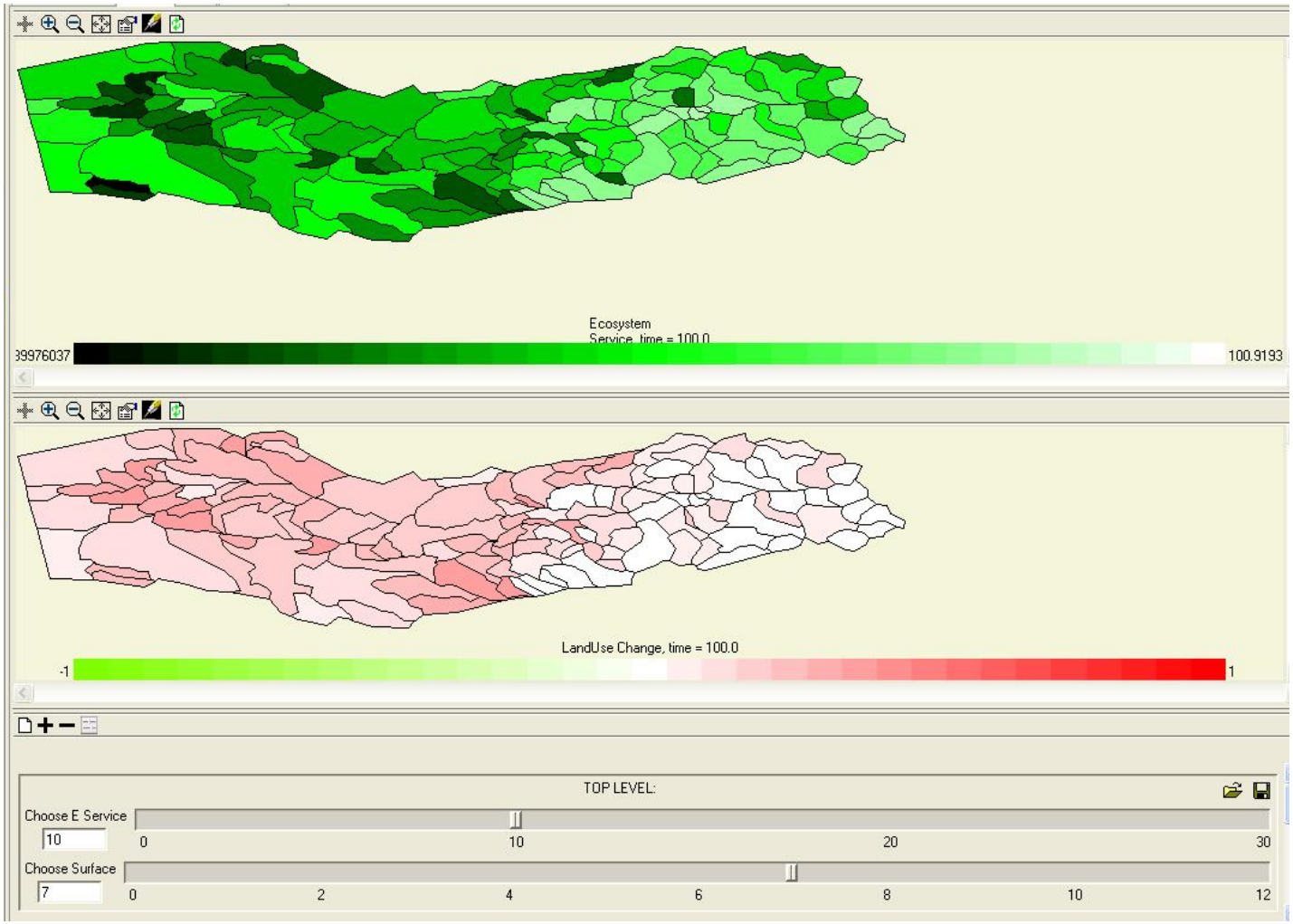


MIMES – exemplary results (2)

Ecosystem service index [-]



MIMES – exemplary results (3)



- spatial distribution of the waste treatment ecosystem service (#10)
- the land use change map in agricultural land use (#7)

→ sliders to choose the ES and land-uses

Herausforderungen der Modellierung

Datenverfügbarkeit

- Datenerhebung der EU verbessern
- Daten oft „räumlich entkoppelt"
- Integration von Expertenwissen systematisieren

Modellintegration

- logische Integration von Modellen
- modulare Modellierung

Einbeziehung von Stakeholdern

- partizipative Modellierung, Problemwissen ("tacit knowledge") einbeziehen
- Anforderungen der verschiedenen Endnutzer einbeziehen (Ergebnisse, GUI)

Aussagefähigkeit erhöhen

- Simulation der Entscheidungsfindung verbessern (ökonomische Rationalität)
- Lernprozesse modellierbar machen (Transaktionskosten)
- Aggregierung von Ergebnissen

Vielen Dank!