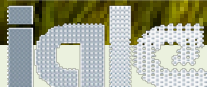


Benjamin Burkhard, Kiel University

Humans, nature and ecosystem services

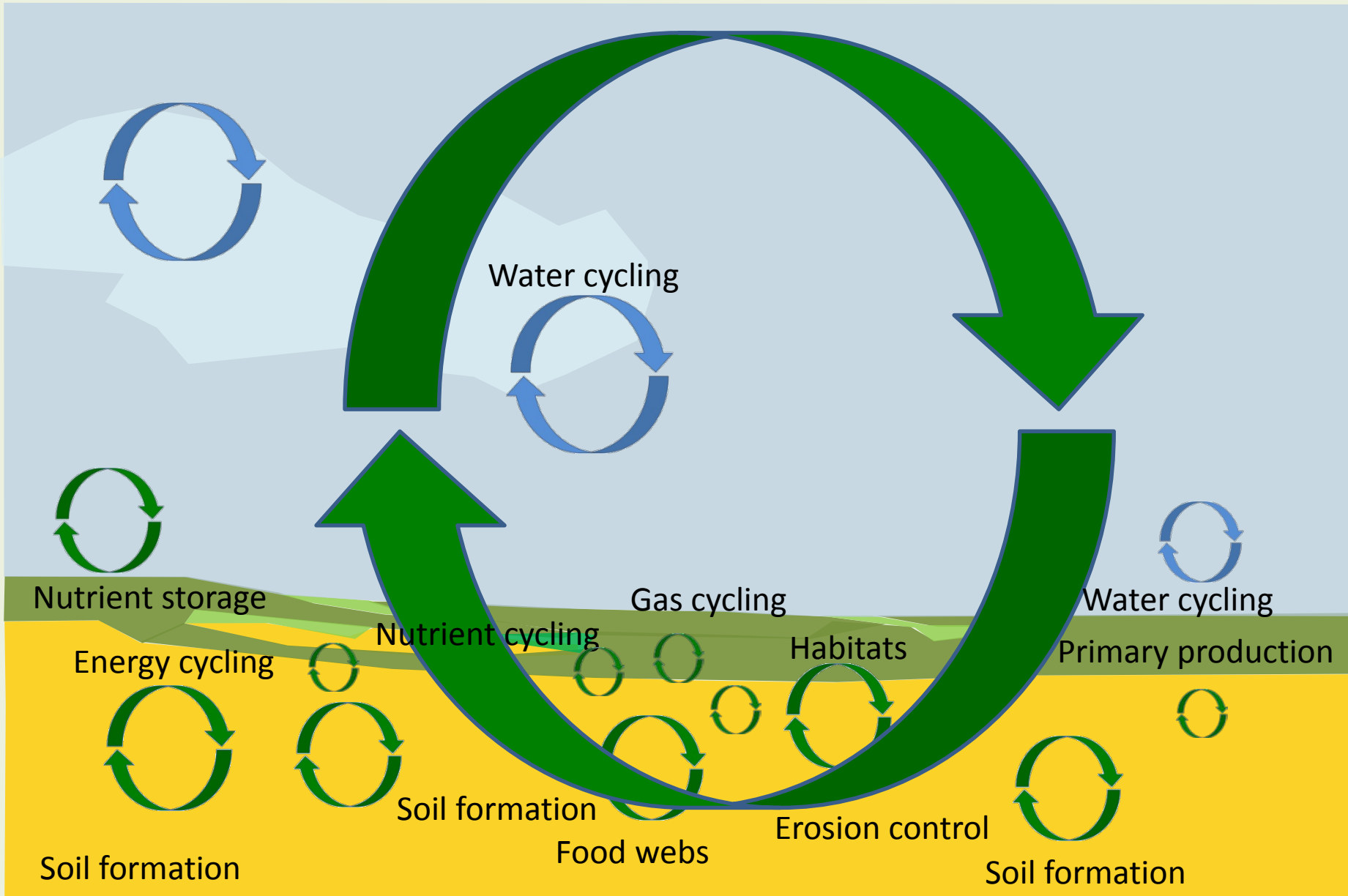
Closing the supply-demand gaps



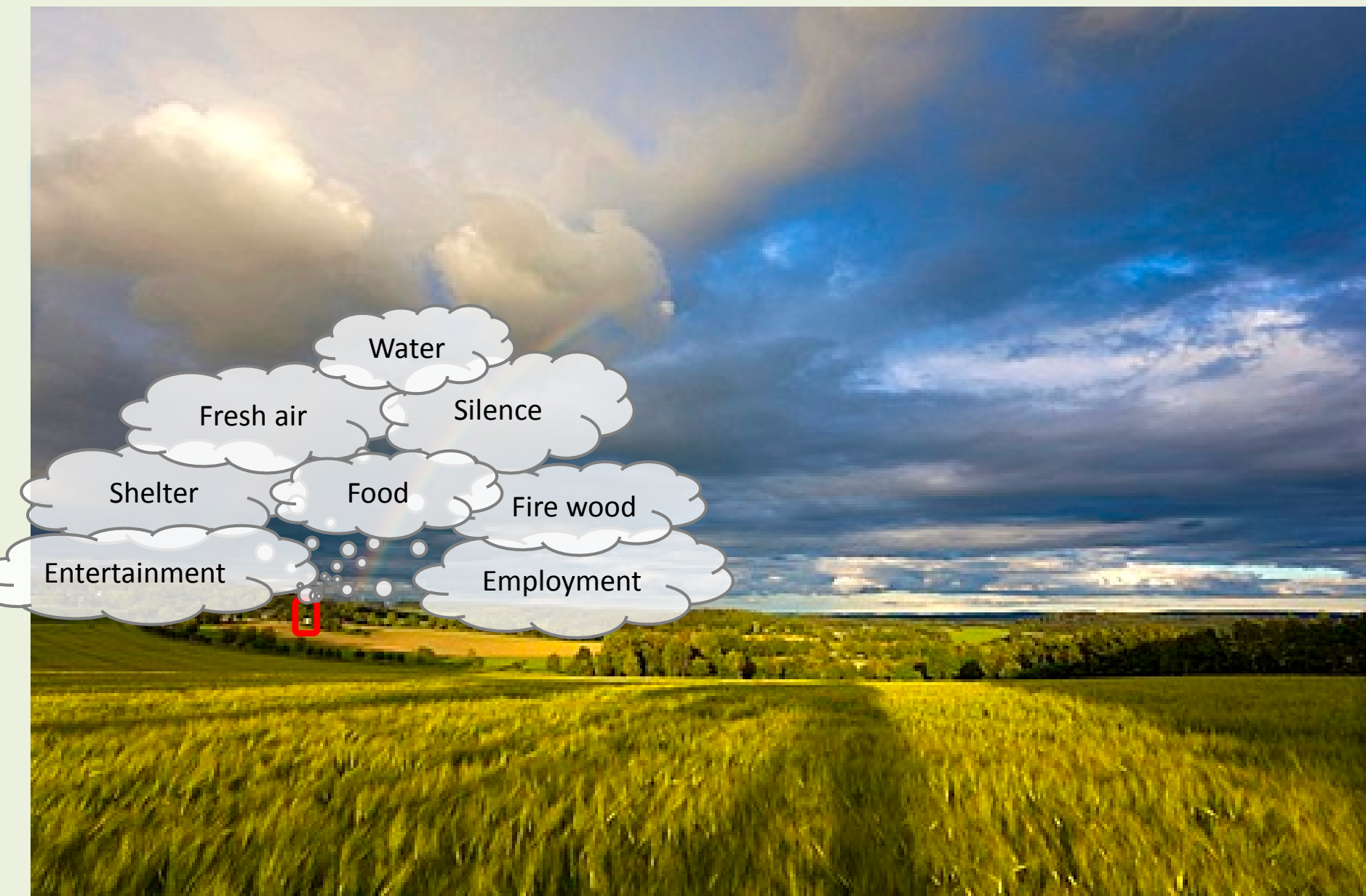
Multifunctional landscapes: Structures



Multifunctional landscapes: Processes and functions



Multifunctional landscapes: Ecosystem services



Multifunctional landscapes

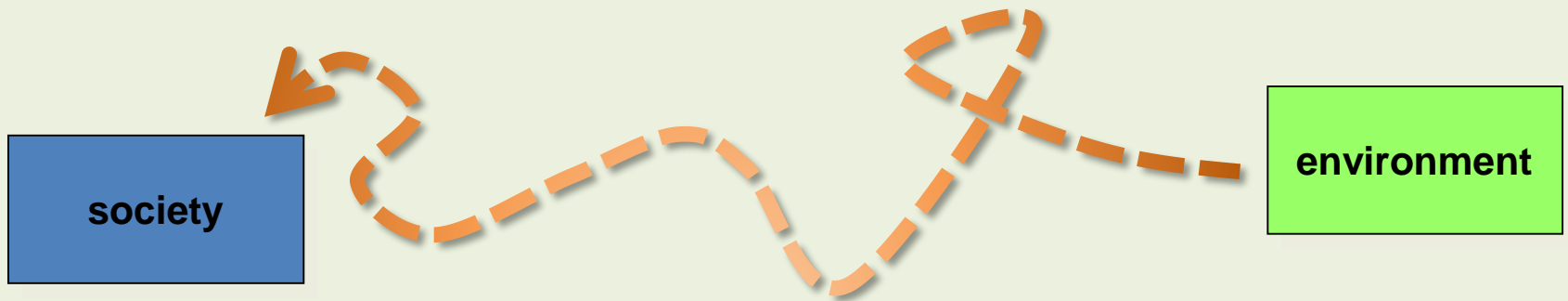
How are ecosystem services actually generated and how do they „flow“ from the environment to the society?

society

environment



And what are ecosystem services actually?



What are Ecosystem Goods and Services?

Definition of ecosystem services	Reference
“the benefits people obtain from ecosystems.”	MA, 2005
“the benefits human populations derive, directly or indirectly, from ecosystem functions.”	Costanza et al., 1997
“the conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfill human life.”	Daily, 1997
“the capacity of natural processes and components to provide goods and services that satisfy human needs, directly or indirectly.”	de Groot et al., 2002
“the set of ecosystem functions that is useful to humans.”	Kremen, 2005
“components of nature, directly enjoyed, consumed, or used to yield human well-being.”	Boyd & Banzhaf, 2007
“the aspects of ecosystems utilized (actively or passively) to produce human well-being.”	Fisher et al., 2009
“a range of goods and services generated by ecosystems that are important for human well-being.”	Nelson et al., 2009
“benefits that humans recognize as obtained from ecosystems that support, directly or indirectly, their survival and quality of life.”	Harrington et al., 2010
“a collective term for the goods and services produced by ecosystems that benefit humankind.”	Jenkins et al., 2010
“the contributions of ecosystem structure and function – in combination with other inputs – to human well-being”	Burkhard et al., 2012

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What are Ecosystem Goods and Services?

Regulating services:

e.g.

Nutrient regulation
Erosion regulation
Water regulation
Climate regulation



Provisioning services:

e.g.

Food
Energy
Water
Material for construction

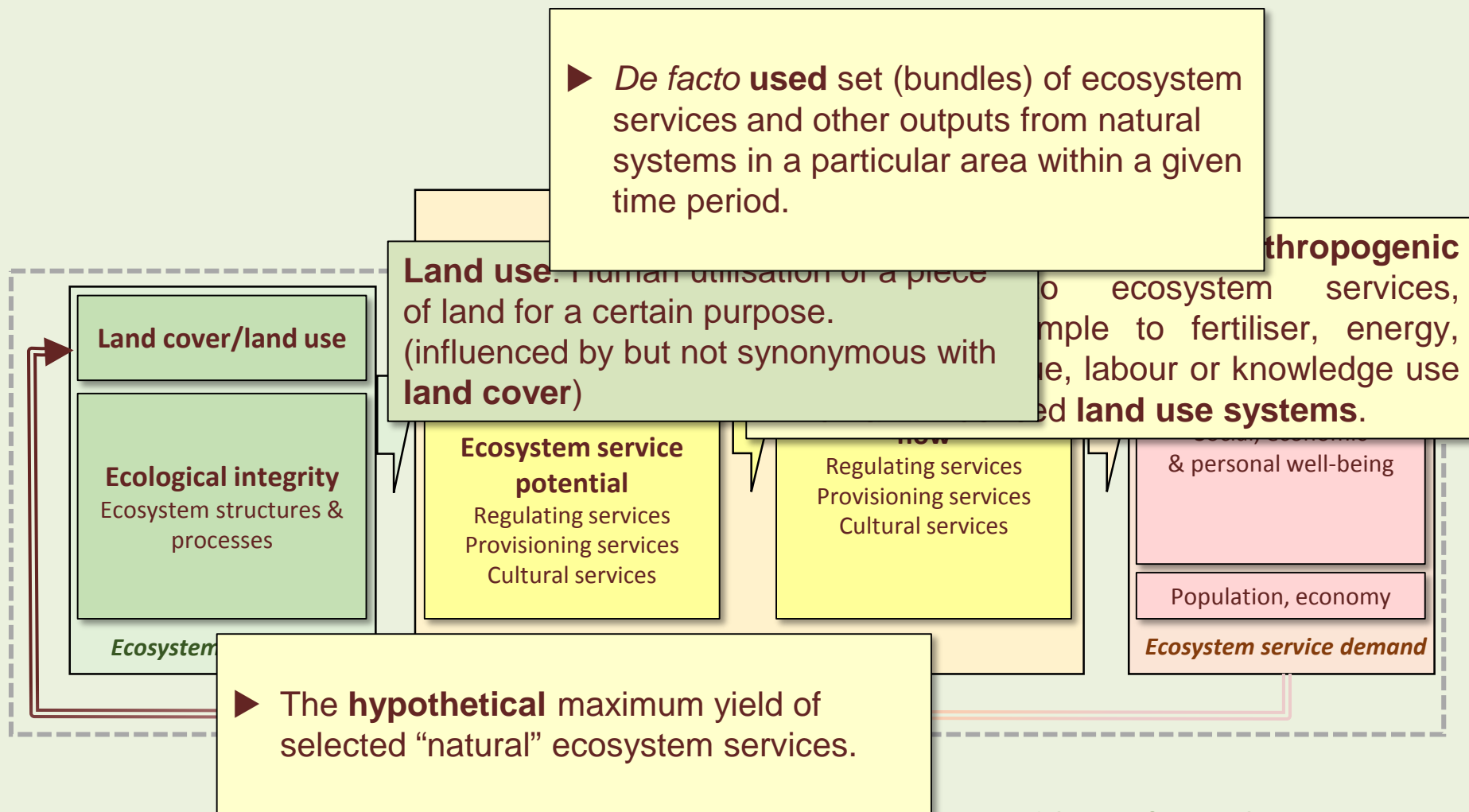


Cultural services:

e.g.

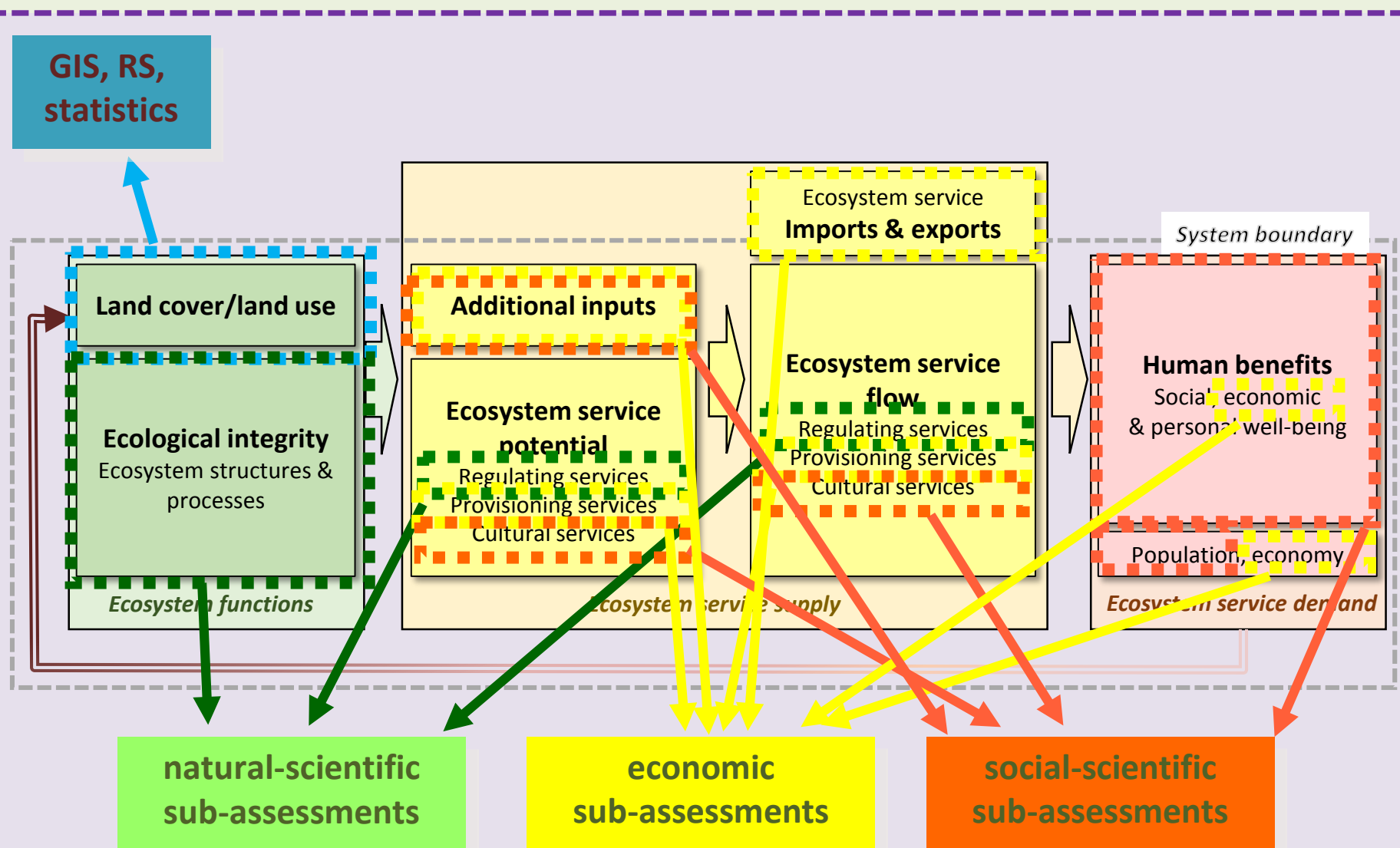
Landscape aesthetics
Recreation
Inspiration
Education





Conceptual model of ecosystem functions, services and benefits relations.

How to assess ecosystem services flows in landscapes?



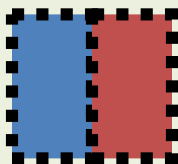
Integrative Transdisciplinary Ecosystem Services Assessment

To understand interactions between complex environmental systems and complex human societal systems new scientific approaches are needed:



Firm boundaries

- **Multidisciplinarity** - researchers in separate disciplines work *independently within* their own disciplinary perspective, to address a common problem.



Permeable boundaries

- **Interdisciplinarity** - researchers *work jointly*, but from each of their respective disciplinary perspectives, to address a common problem.

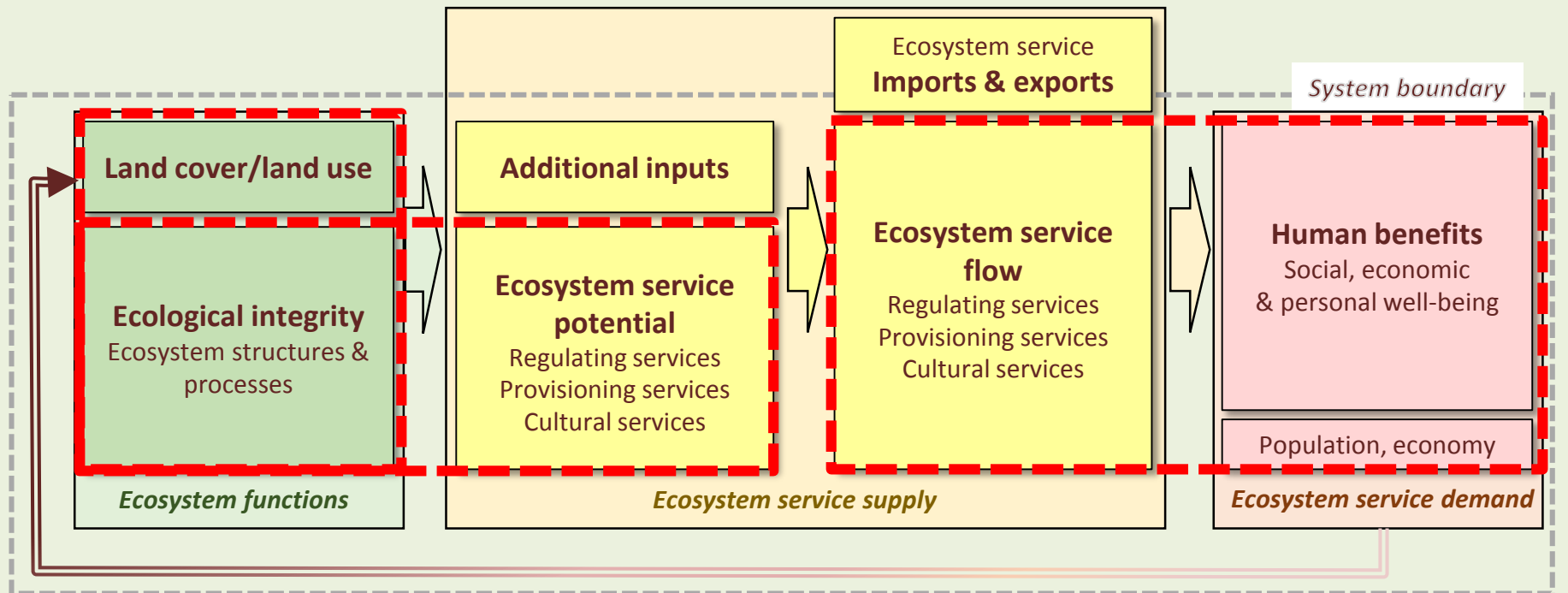


No or blurred boundaries

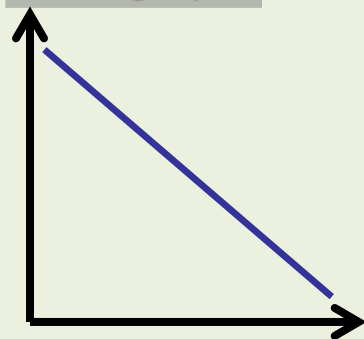
- **Transdisciplinarity** - researchers work jointly using a *shared conceptual framework* that draws together discipline-specific theories, concepts, and approaches, to address a common problem.

→ **Ecosystem services**

How do the different components affect each other?

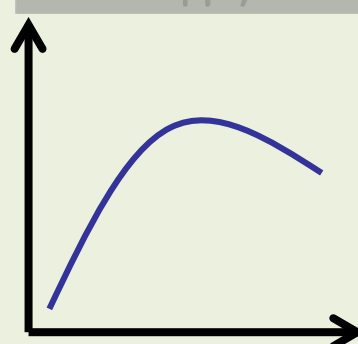


Ecological integrity



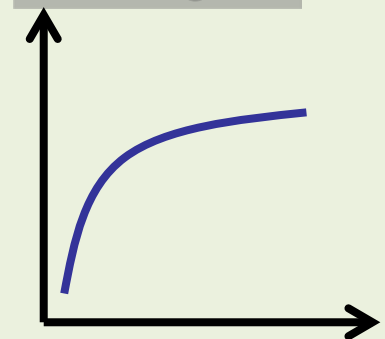
Land use intensity

Ecosystem service supply



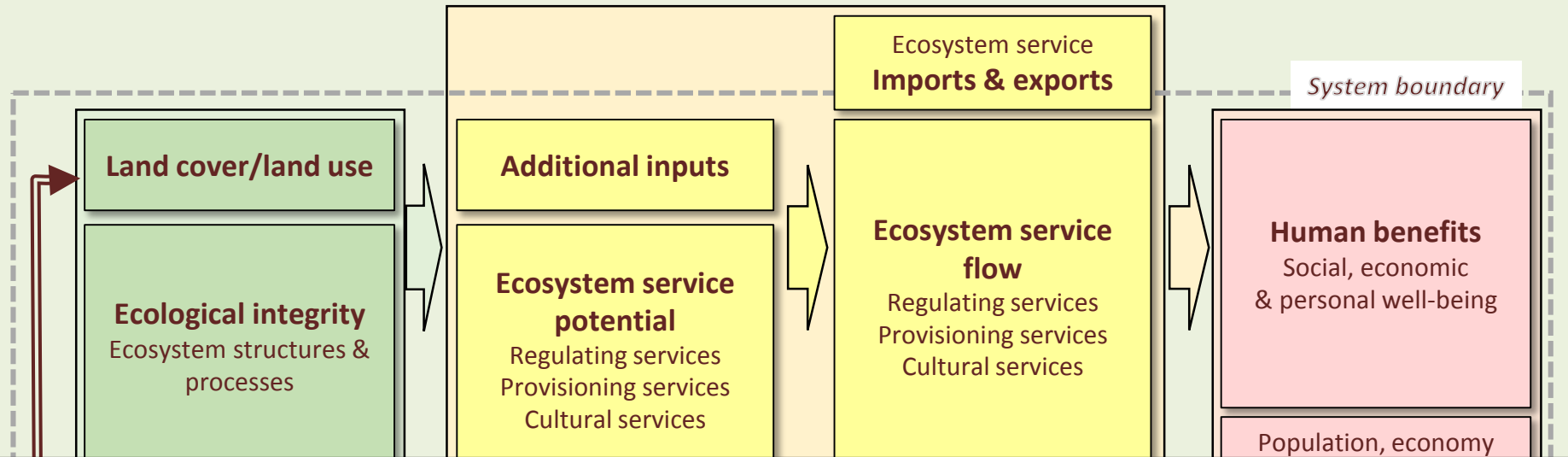
Ecological integrity

Human well-being

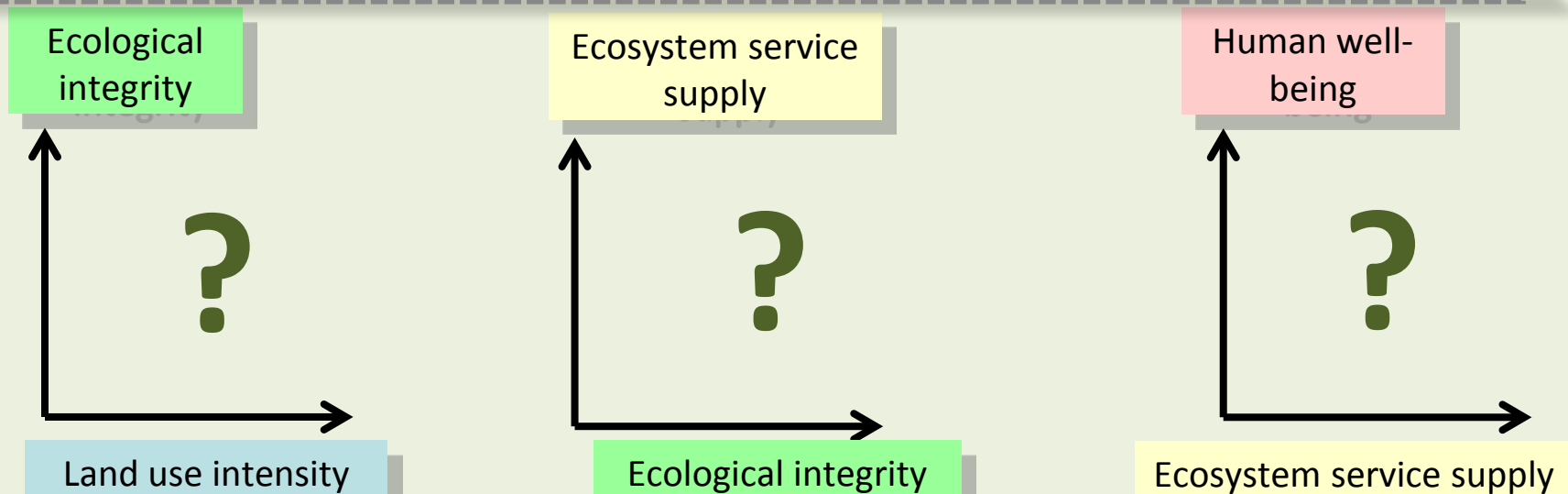


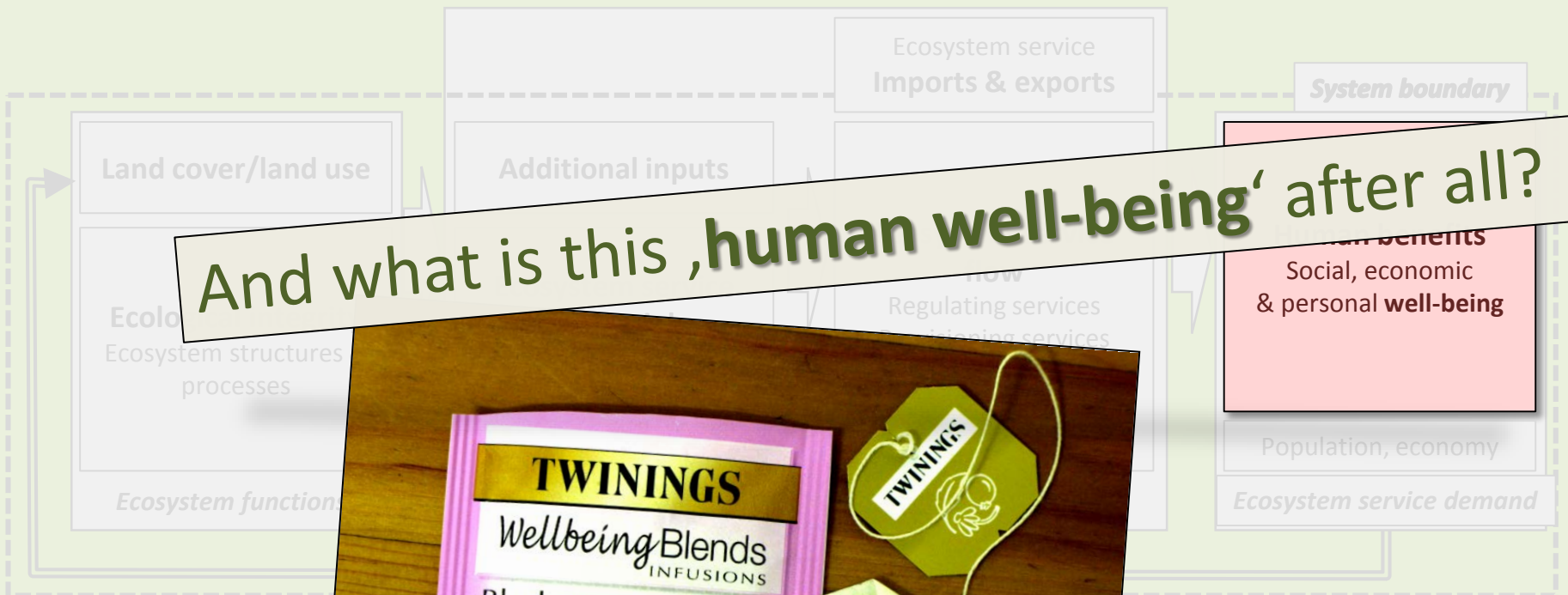
Ecosystem service supply

How do the different components affect each other?

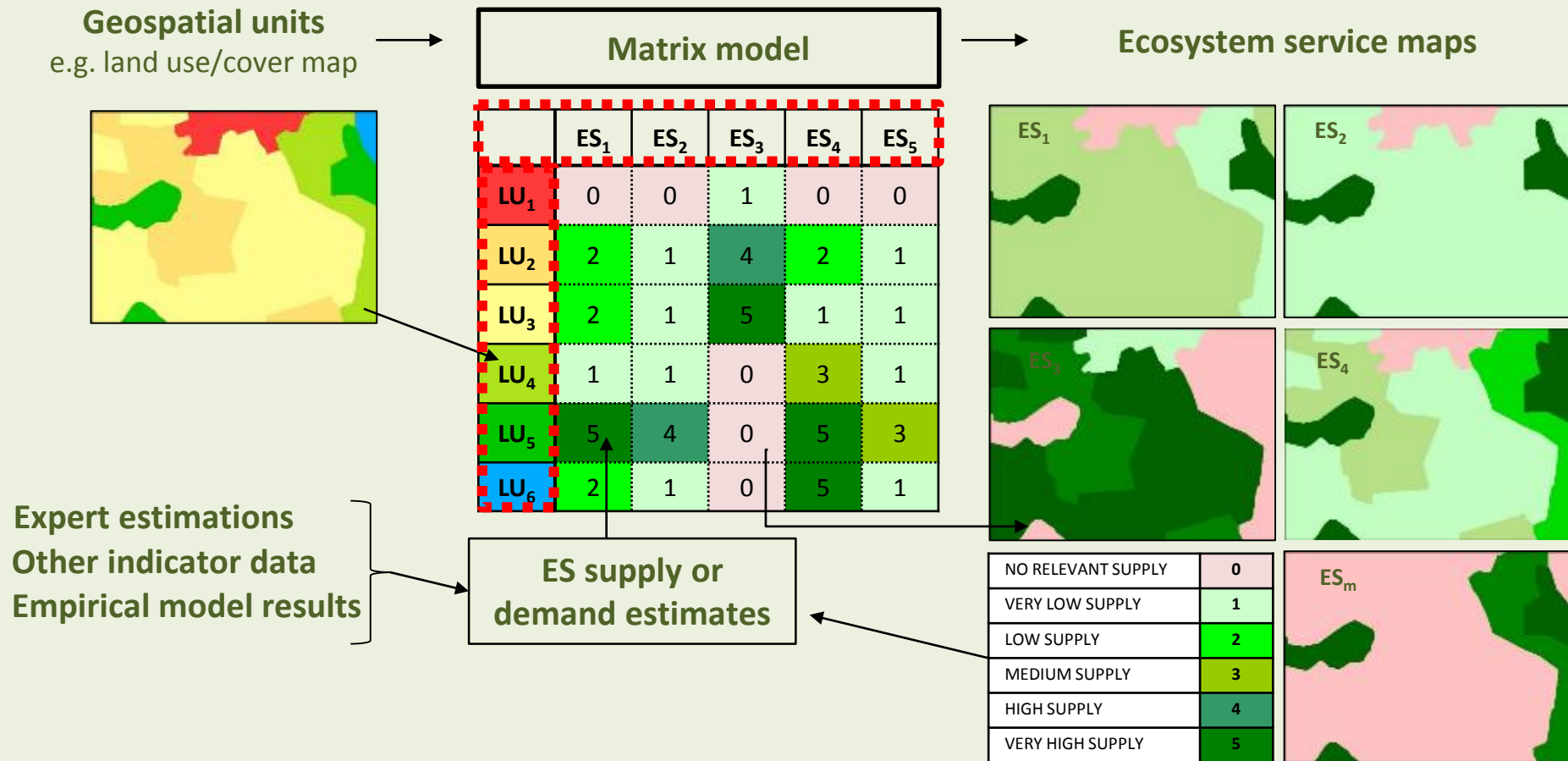


How will the curves look like in 'reality'?





Ecosystem service “matrix”



Ecosystem service “matrix”

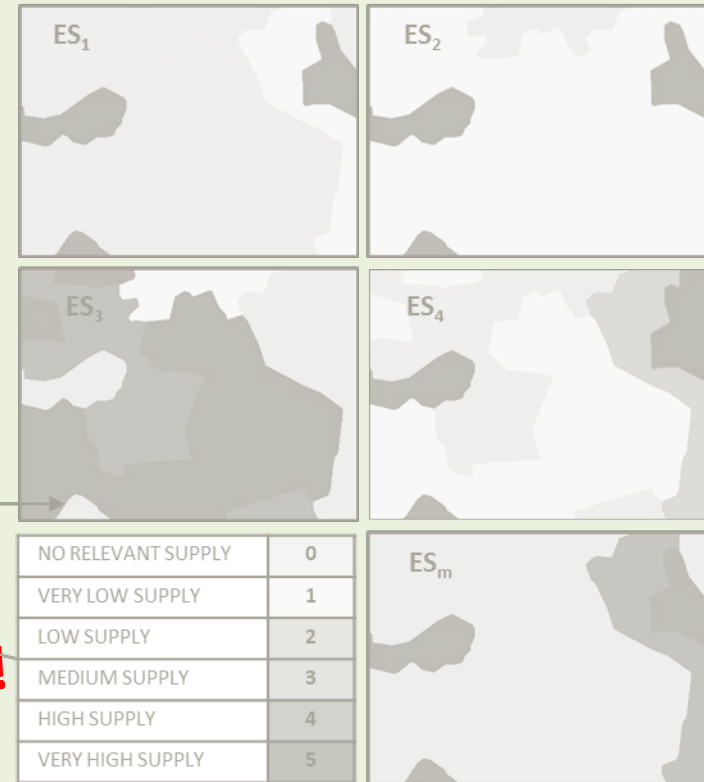
Geospatial units
e.g. land use/cover map



Matrix model

	ES ₁	ES ₂	ES ₃	ES ₄	ES ₅
LU ₁	0	0	1	0	0
LU ₂	2	1	4	2	1
LU ₃	2	1	5	1	1
LU ₄	1	1	0	3	1
LU ₅	5	4	0	5	3
LU ₆	2	1	0	5	1

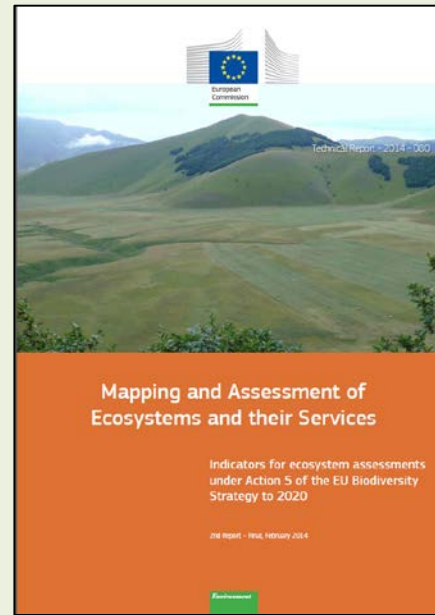
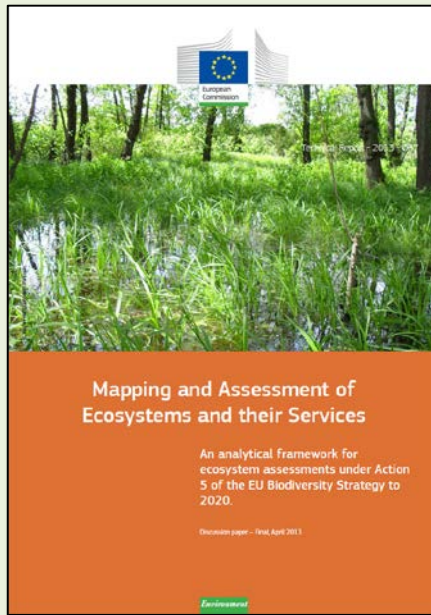
Ecosystem service maps



Expert estimations
Other indicator data
Empirical model results

ES supply or
demand estimates

Identification and quantification are crucial!



EU MAES Working group

Mapping and Assessment of Ecosystems and their Services

1st and 2nd report (2013, 2014)

http://ec.europa.eu/environment/nature/knowledge/ecosystem_assessment/pdf/MAESWorkingPaper2013.pdf
http://ec.europa.eu/environment/nature/knowledge/ecosystem_assessment/pdf/2ndMAESWorkingPaper.pdf

Expert estimations
 Other indicator data
 Empirical model results



Tiered approach for ES mapping

- ★ **Tier 1:** rather simple, e.g. land cover-based
- ★ **Tier 2:** more complex, e.g. statistics-based
- ★ **Tier 3:** complex, e.g. model-based



EU Horizon 2020 Project

ESMERALDA

Enhancing ecosystem service mapping
for policy and decision making

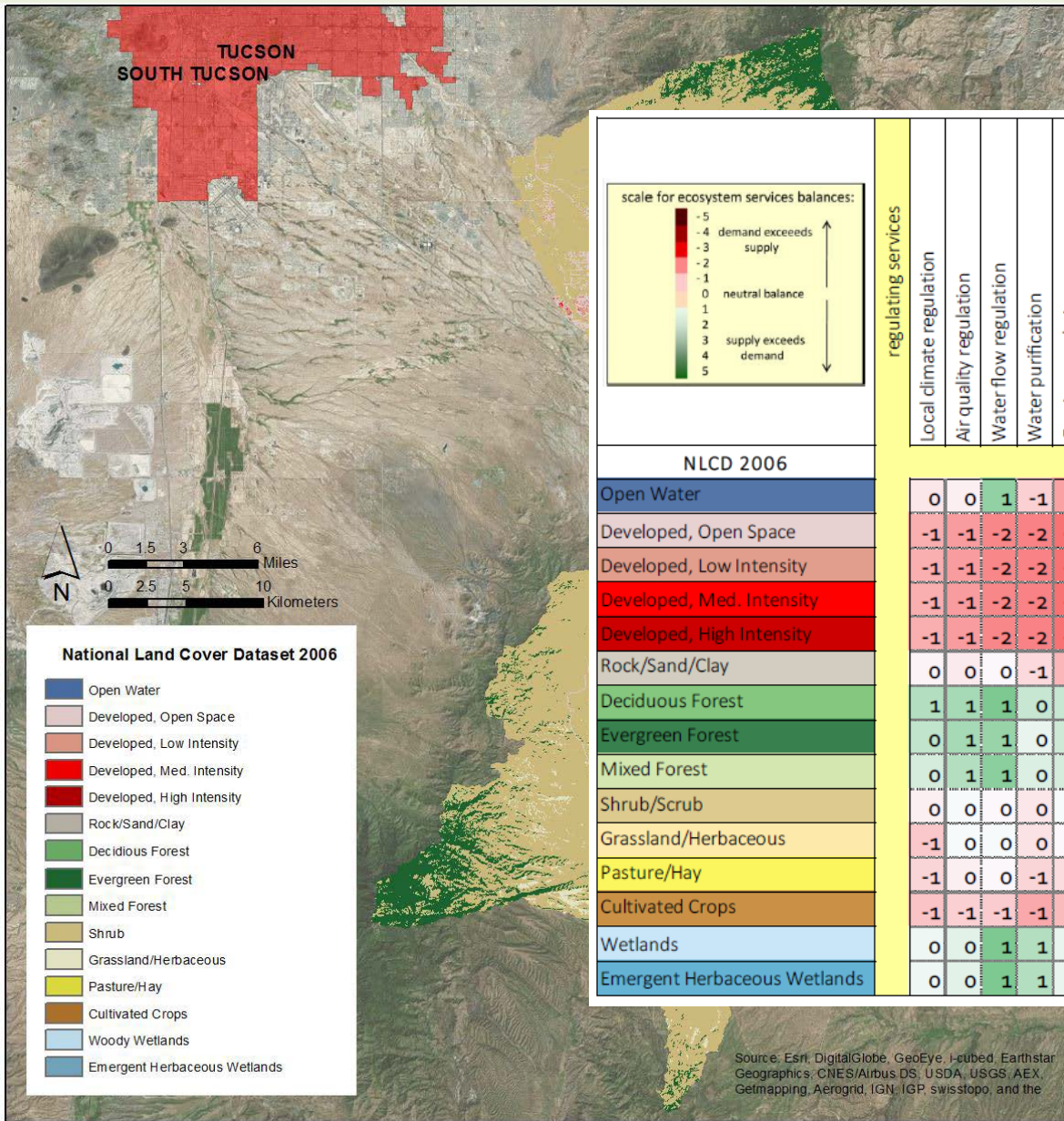
<http://esmeralda-project.eu/>

Expert estimations
Other indicator data
Empirical model results



Tiered approach for ES mapping

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scale for ecosystem services balances:

-5
-4 demand exceeds supply
-3
-2
-1
0 neutral balance
1
2
3 supply exceeds demand
4
5

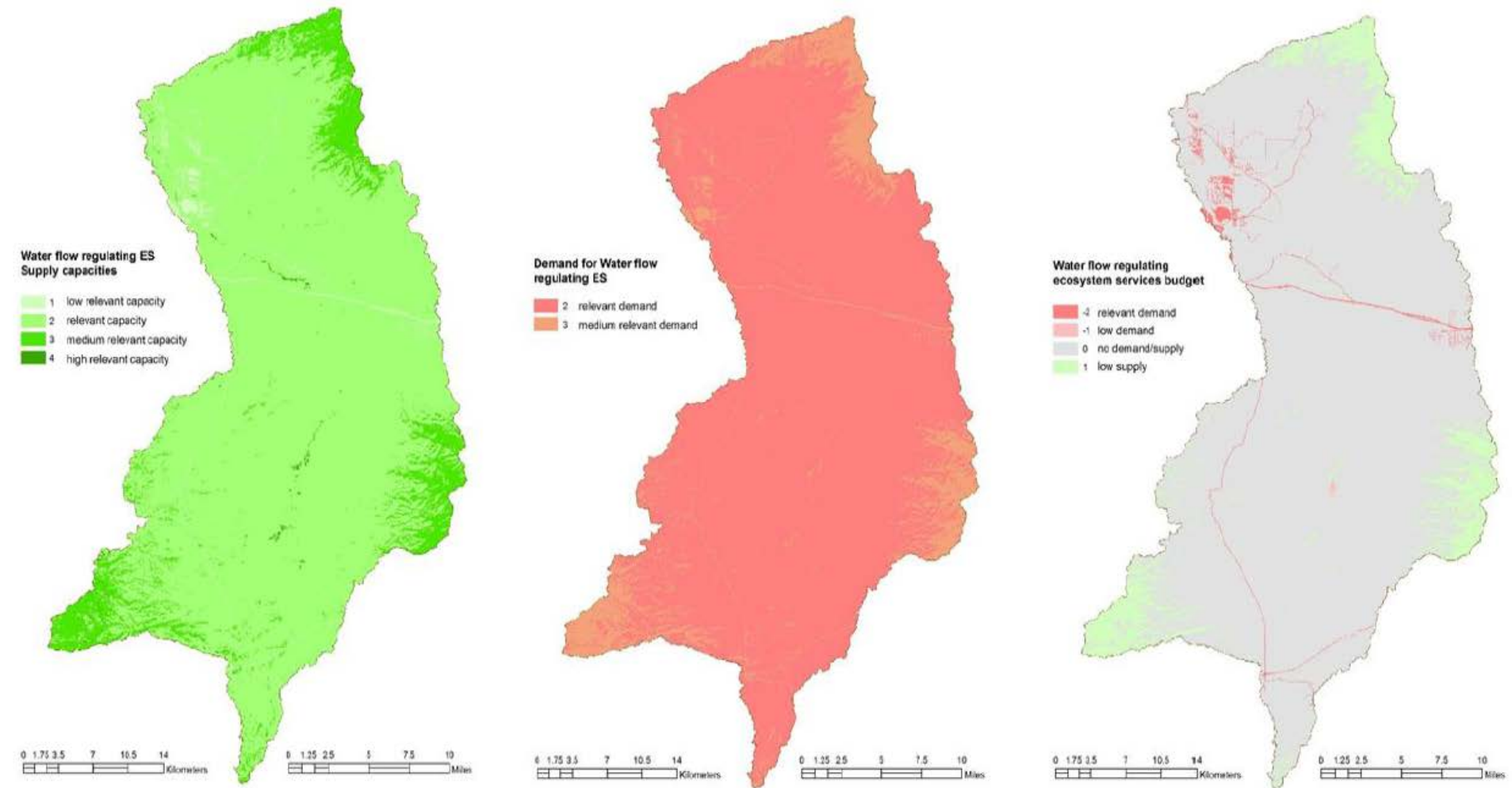
	regulating services								provisioning services				cultural services				
	Local climate regulation	Air quality regulation	Water flow regulation	Water purification	Erosion regulation	Natural hazard protection	Pollination	Regulation of waste	Crops	Freshwater	Mineral resources	Abiotic energy sources	Recreation and tourism	Landscape aesthetic, amenity and inspiration	Knowledge systems	Cultural heritage and cultural diversity	Natural heritage and natural diversity
NLCD 2006																	
Open Water	0	0	1	-1	-1	0	0	0	-1	0	0	0	1	1	1	0	1
Developed, Open Space	-1	-1	-2	-2	-2	-2	-2	-2	0	-2	-1	-1	0	0	0	0	0
Developed, Low Intensity	-1	-1	-2	-2	-2	-2	-2	-2	0	-2	-1	-1	0	0	0	0	0
Developed, Med. Intensity	-1	-1	-2	-2	-2	-2	-2	-2	0	-2	-1	-1	0	0	0	0	0
Developed, High Intensity	-1	-1	-2	-2	-2	-2	-2	-2	0	-2	-1	-1	0	0	0	0	0
Rock/Sand/Clay	0	0	0	-1	-1	0	-1	-1	0	0	1	1	1	0	1	0	1
Deciduous Forest	1	1	1	0	0	0	0	0	0	0	0	0	1	1	1	1	1
Evergreen Forest	0	1	1	0	0	0	0	0	0	0	0	0	1	1	0	1	1
Mixed Forest	0	1	1	0	0	0	0	1	0	0	0	0	1	1	1	1	1
Shrub/Scrub	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	1	0	1
Grassland/Herbaceous	-1	0	0	0	0	-1	0	0	0	-1	0	1	0	0	0	0	0
Pasture/Hay	-1	0	0	-1	0	-1	-1	-1	0	-1	0	1	0	0	1	1	0
Cultivated Crops	-1	-1	-1	-1	-1	-1	-1	-1	1	-2	0	0	0	0	1	0	0
Wetlands	0	0	1	1	0	1	0	1	0	1	0	1	1	1	0	1	1
Emergent Herbaceous Wetlands	0	0	1	1	0	1	0	1	0	1	0	1	1	1	0	1	1

n = 18

Source: Esri, DigitalGlobe, GeoEye, I-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the

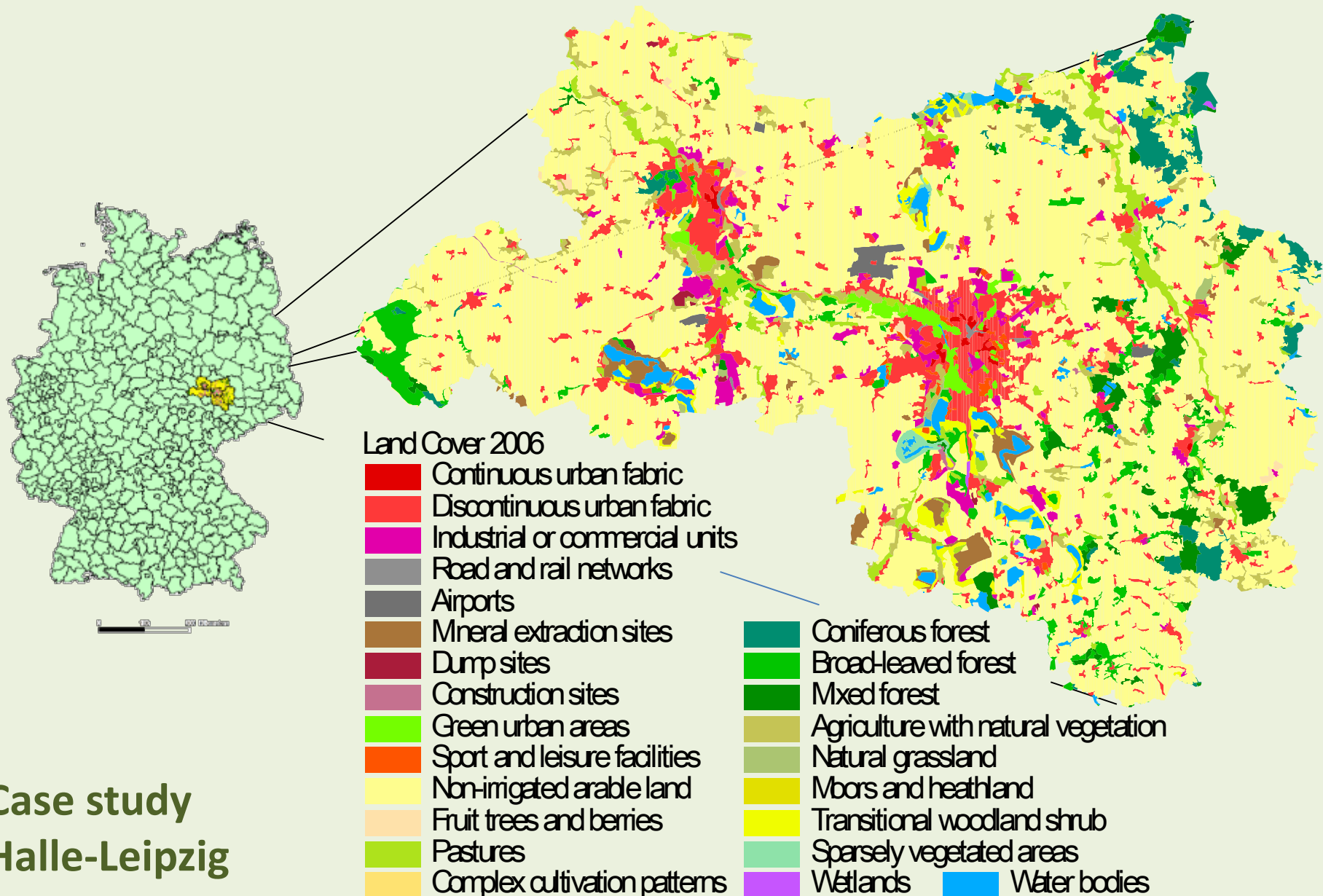
Yaneva & Nedkov (Stellenbosch 11/2015)

★ **Tier 1:** rather simple, e.g. land cover-based



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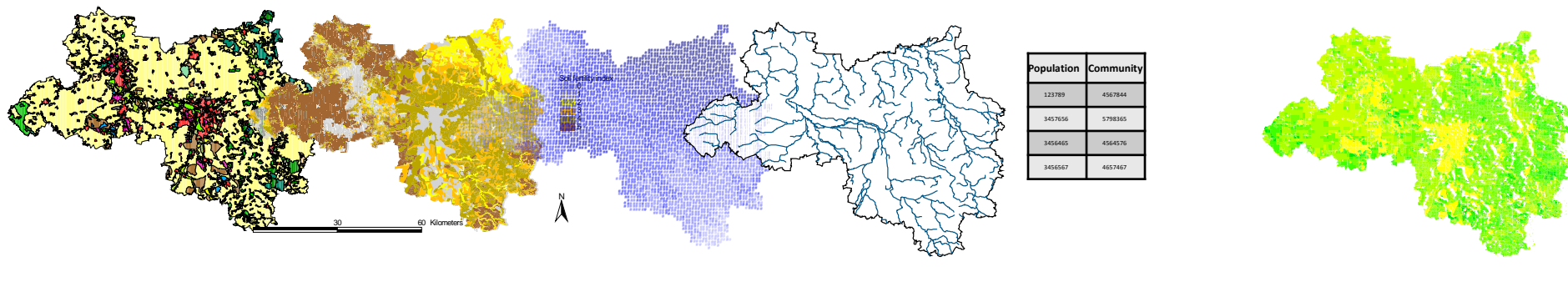


Case study Halle-Leipzig

Burkhard, Kroll, Nedkov & Müller in *Ecological Indicators* (2012)

★ **Tier 2:** more complex, e.g. statistics-based

Land cover data + soil data + climate data + hydrological data + statistics = Ecosystem service maps

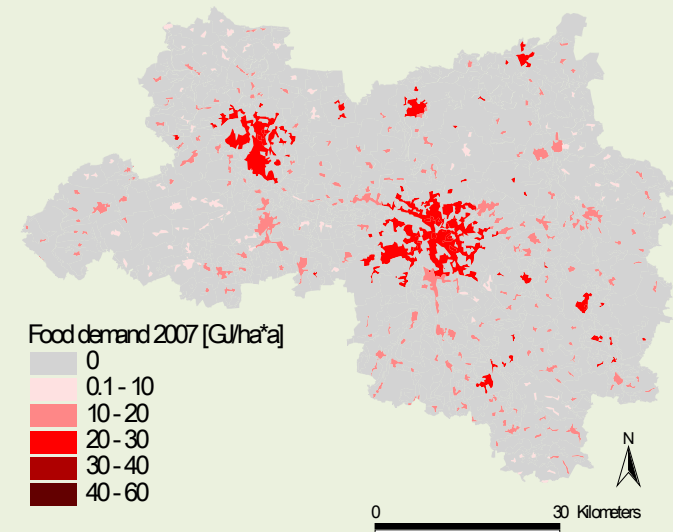
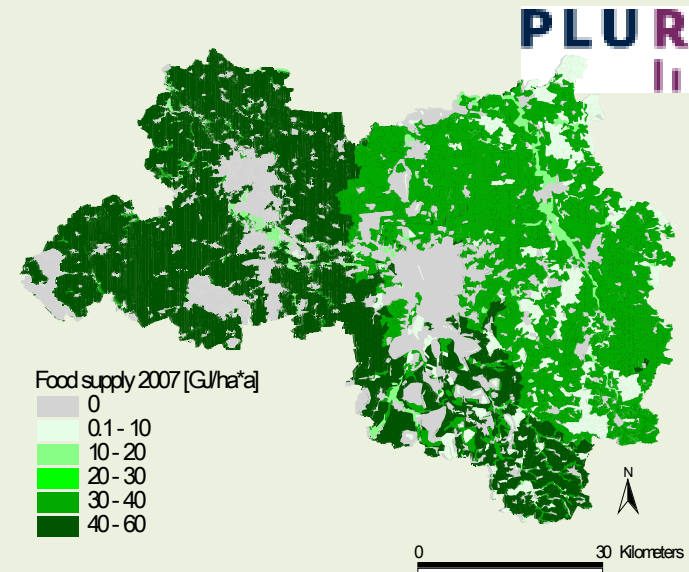
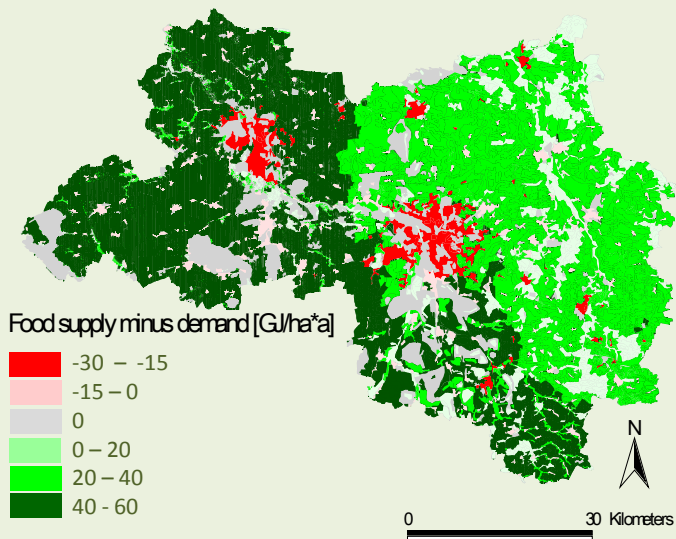


Case study
Halle-Leipzig

- Lump sites
- Broadleaved forest
- Construction sites
- Mixed forest
- Green urban areas
- Agriculture with natural vegetation
- Sport and leisure facilities
- Natural grassland
- Non-irrigated arable land
- Moors and heathland
- Fruit trees and berries
- Transitional woodland shrub
- Pastures
- Sparsely vegetated areas
- Complex cultivation patterns
- Wetlands
- Water bodies

Burkhard, Kroll, Nedkov & Müller in *Ecological Indicators* (2012)

★ **Tier 2:** more complex, e.g. statistics-based



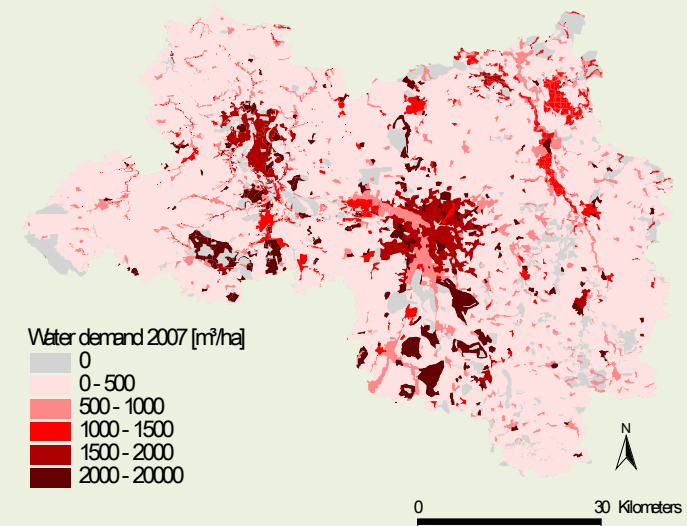
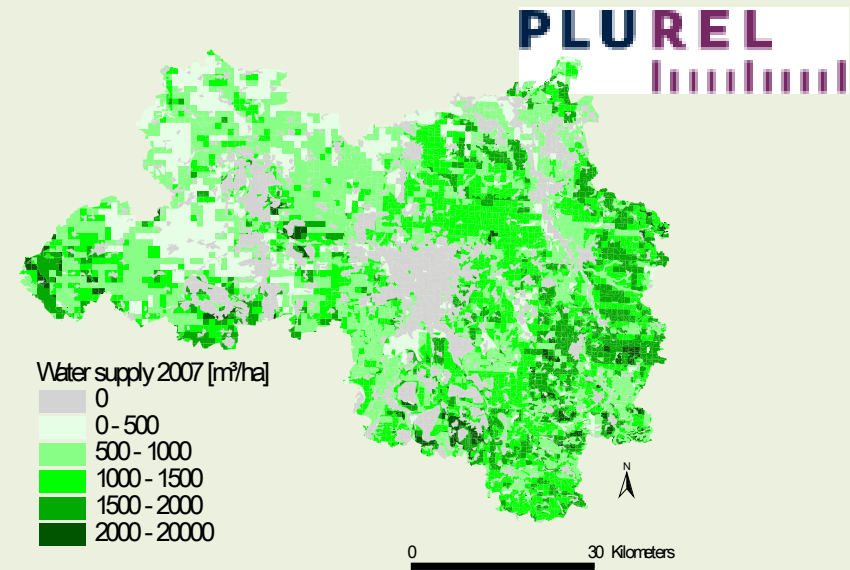
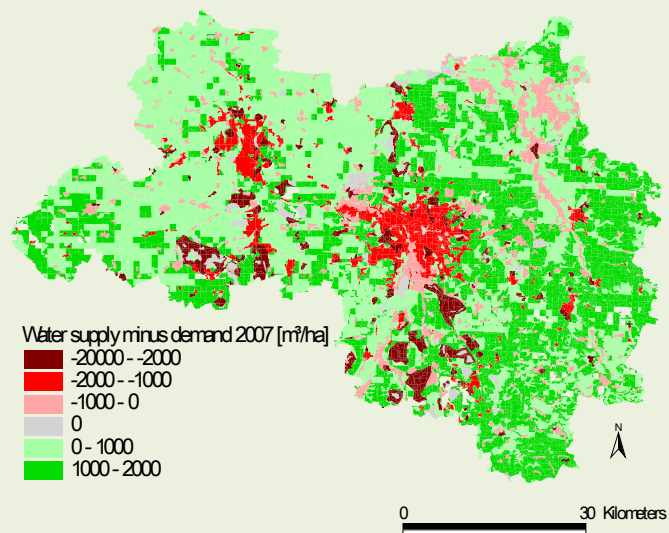
PLUREL
Institute

Case study Halle-Leipzig

Provisioning ES
“Food” supply and
demand 2007

Kroll et al. (2010); Kroll et al. (2012) - *Land Use Policy*

★ **Tier 2:** more complex, e.g. statistics-based

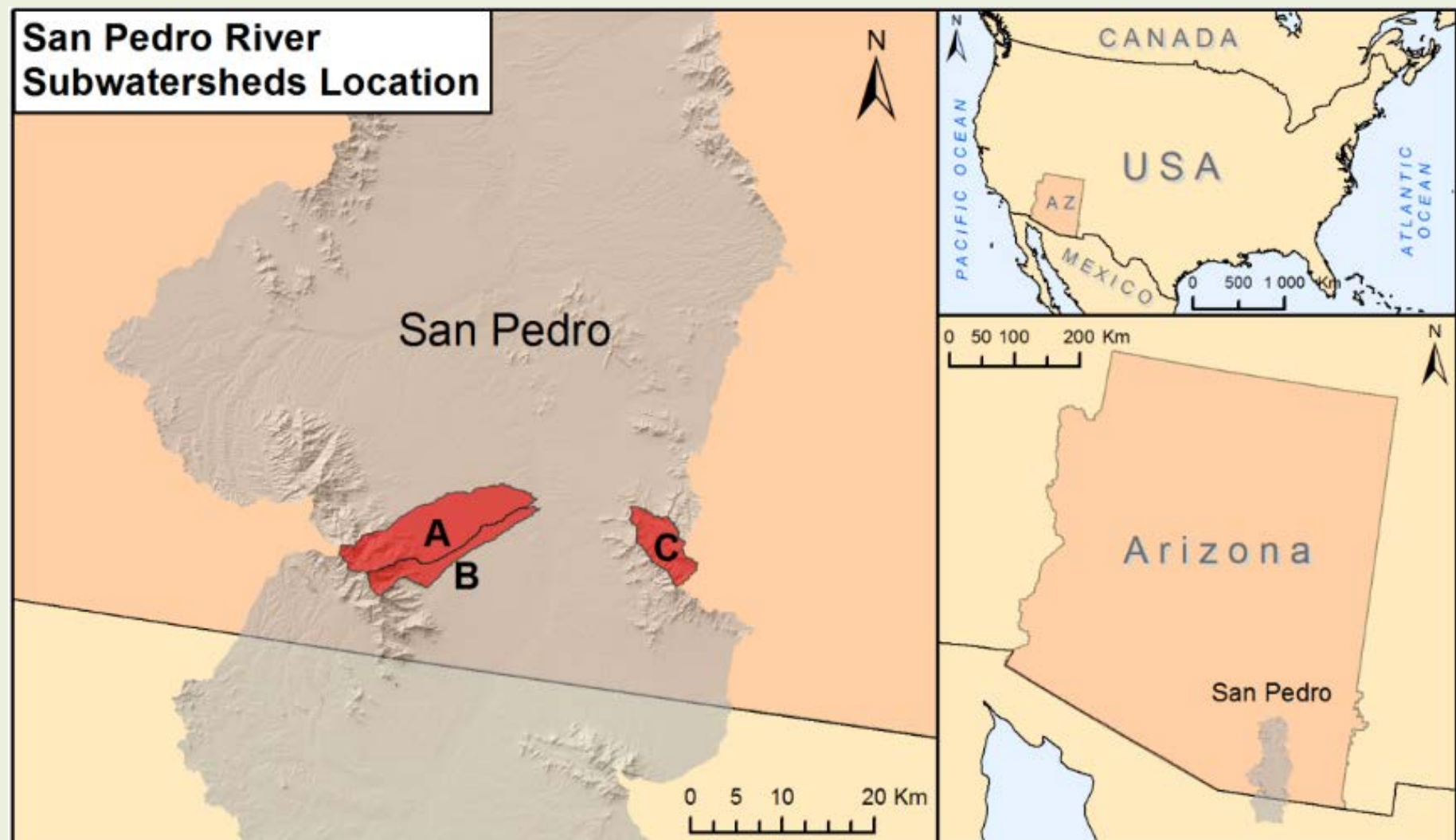


Case study Halle-Leipzig

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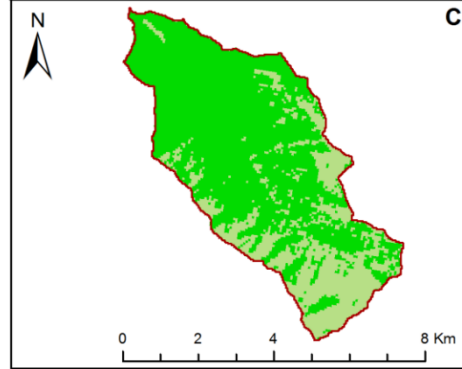
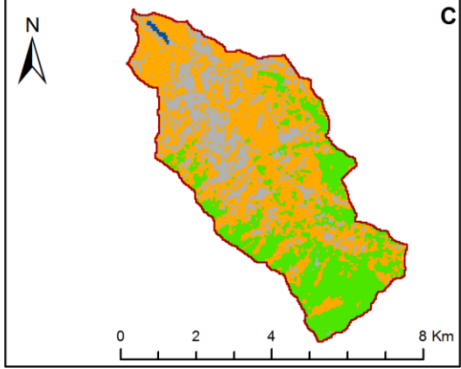
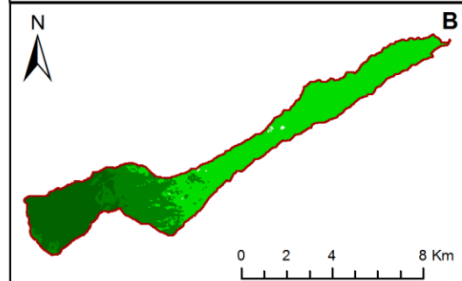
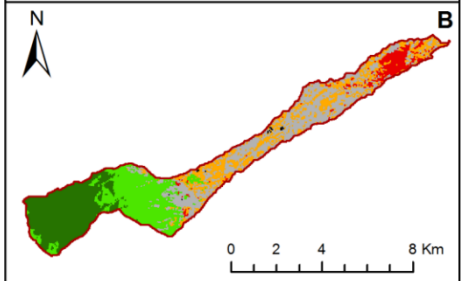
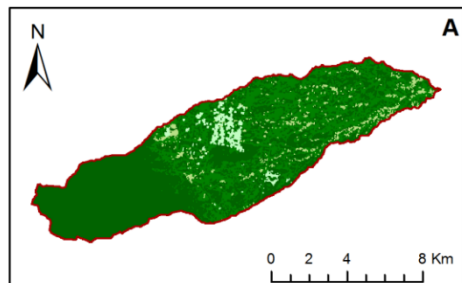
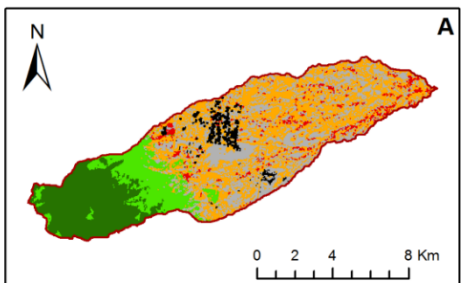
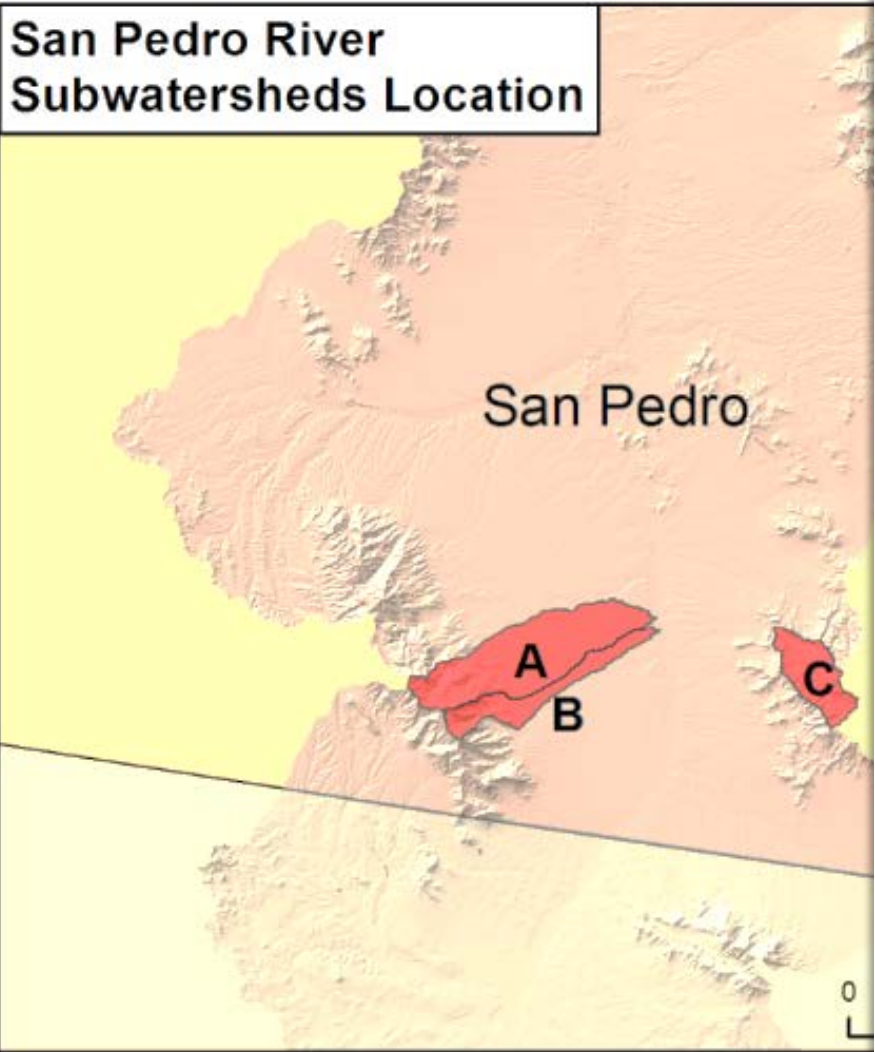
Case study San Pedro, Arizona

Boyanova et al. in *LNG&C* (2014)

★ **Tier 3:** complex, e.g. model-based

San Pedro River Subwatersheds- Arizona, USA

San Pedro River Subwatersheds Location



North America Landscape Characterization Classification System

- 1 - Forest
- 2 - Oak Woodland
- 3 - Mesquite Woodland
- 4 - Grassland
- 5 - Desert shrub
- 6 - Riparian
- 8 - Urban

Flood regulation ecosystem service supply

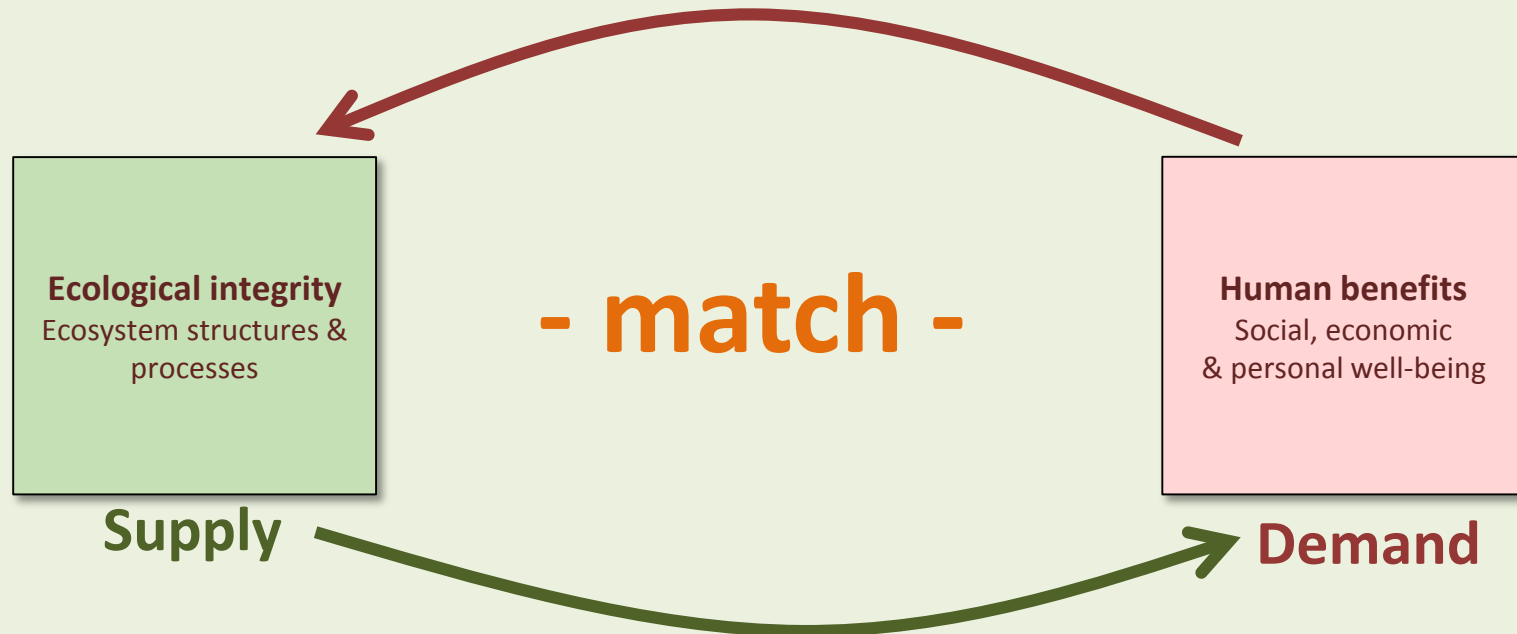
- 0 = no relevant supply
- 1 = low relevant supply
- 2 = relevant supply
- 3 = medium relevant supply
- 4 = high relevant supply
- 5 = very high relevant supply

Case study San Pedro, Arizona

Boyanova et al. in *LNG&C* (2014)

★ **Tier 3: complex, e.g. model-based**

Applications in Policy and decision making



Applications in Policy and decision making



The scientist ...

- thinks in complex pathways
- deals with hardly determinable dynamics
- complex human-environmental systems
- wants **absolute certainty!**



The politician/decision maker ...

- prefers reduced complexity
- wants aggregated information
- information that is relevant for specific problems
- support of his/her policy programme
- wants it **quick!**

Applications in Policy and decision making



"The global challenge to conserve biodiversity is not only a task of policy. Policy needs support - especially from science".

German Chancellor Dr. Angela Merkel, August 2010

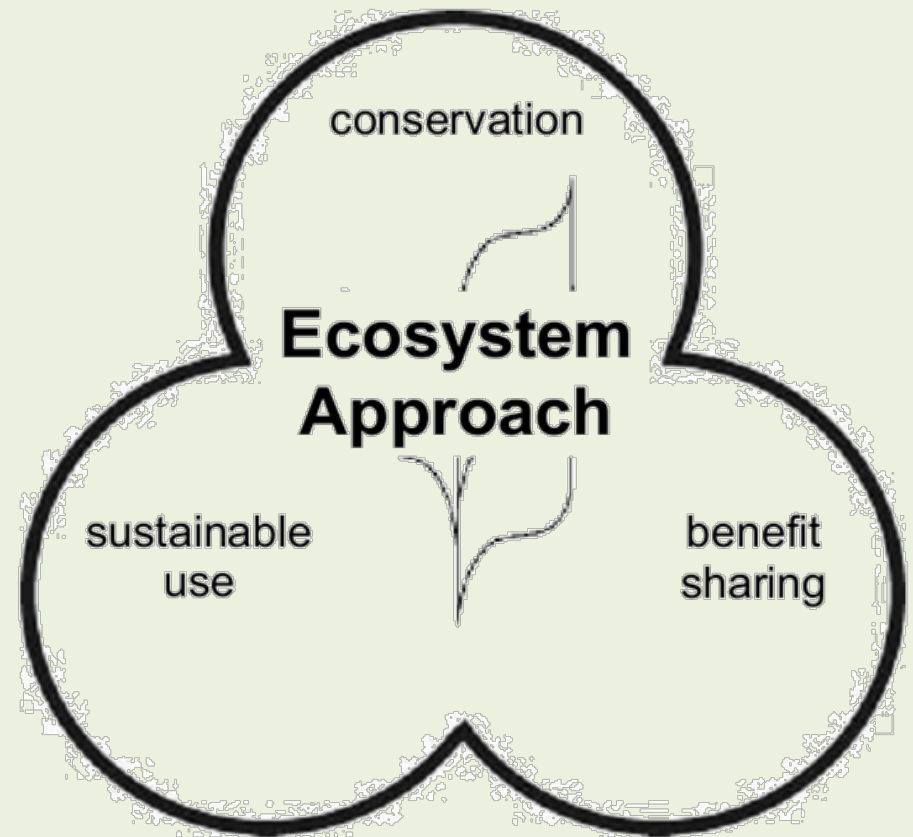
Applications in Policy and decision making



Convention on
Biological Diversity

UN CBD Ecosystem Approach

Strategy for the management of land, water and living resources that promotes **conservation** and **sustainable use** in an equitable way.

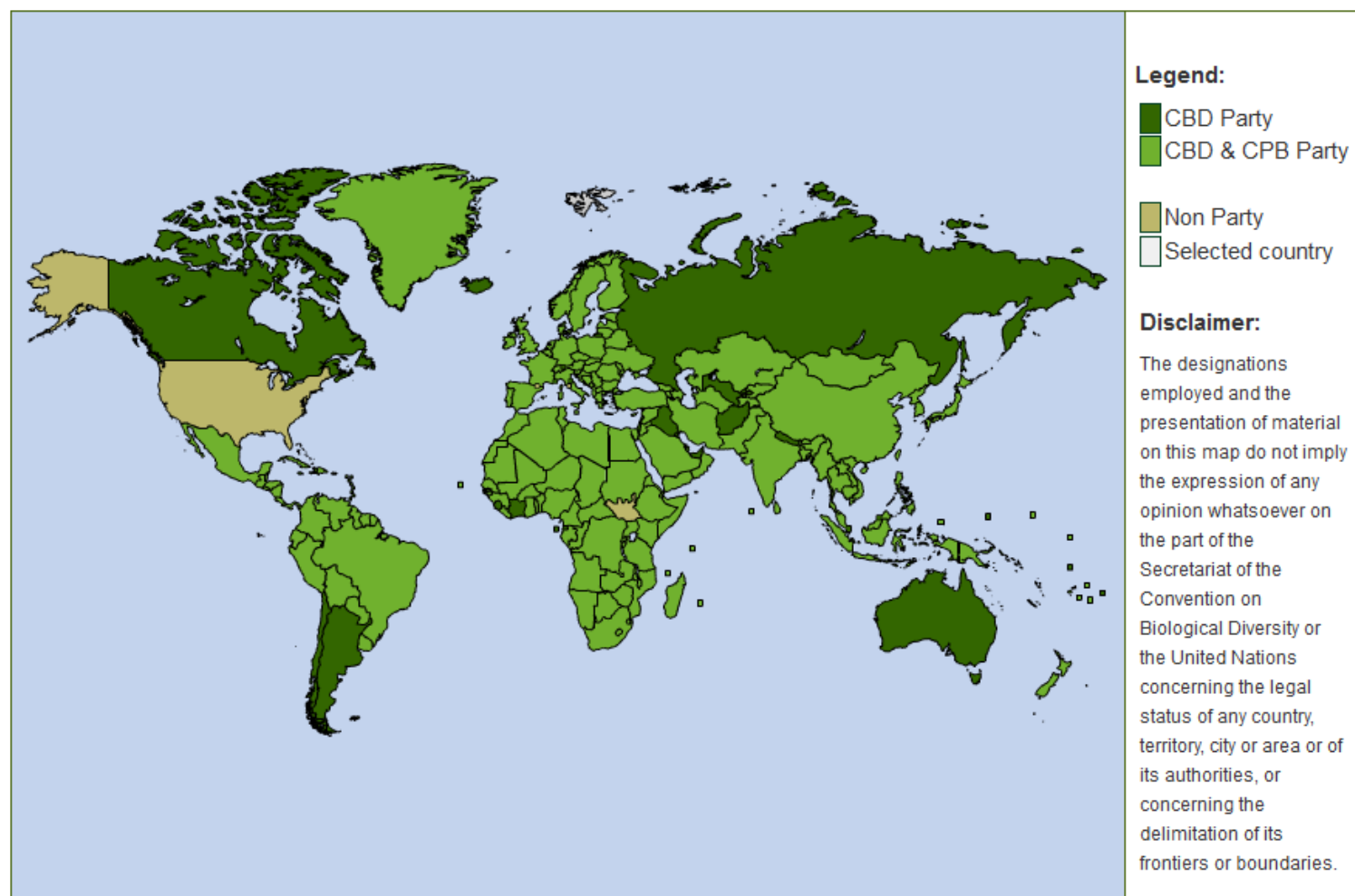


Applications in Policy and decision making



Convention on
Biological Diversity

UN CBD Ecosystem Approach



196 Parties

168 Signatures

Applications in Policy and decision making



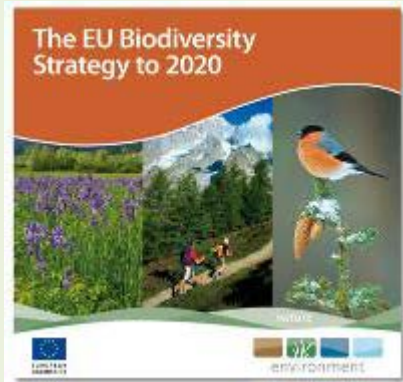
Convention on
Biological Diversity

UN CBD Ecosystem Approach

12 Malawi Principles

Principle 5: *“Conservation of ecosystem structure and functioning, in order to maintain **ecosystem services**, should be a priority target of the ecosystem approach.”*

Applications in Policy and decision making



EU Biodiversity Strategy 2020 (from 2011)

*The EU Biodiversity Strategy aims to halt the loss of **biodiversity** and **ecosystem services** in the EU and help stop global biodiversity loss by 2020. It reflects the commitments taken by the EU in 2010, within the **international Convention on Biological Diversity**.*

Applications in Policy and decision making



EUROPEAN COMMISSION

Brussels, 3.5.2011
COM(2011) 244 final

COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN
PARLIAMENT, THE COUNCIL, THE ECONOMIC AND SOCIAL COMMITTEE
AND THE COMMITTEE OF THE REGIONS

Our life insurance, our natural capital: an EU biodiversity strategy to 2020

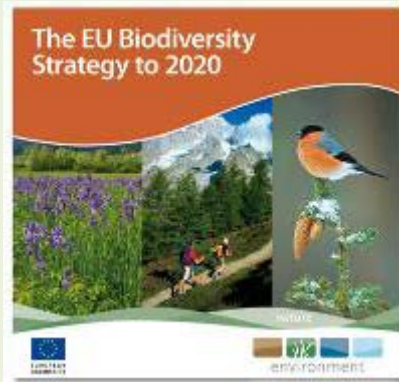
{SEC(2011) 540 final}
{SEC(2011) 541 final}



*“Biodiversity is also our natural capital, delivering **ecosystem services** that underpin our economy.*

*Its deterioration and loss jeopardises the provision of these **services**: we lose species and habitats and the wealth and employment we derive from nature, and endanger our own **wellbeing.**“*

Applications in Policy and decision making



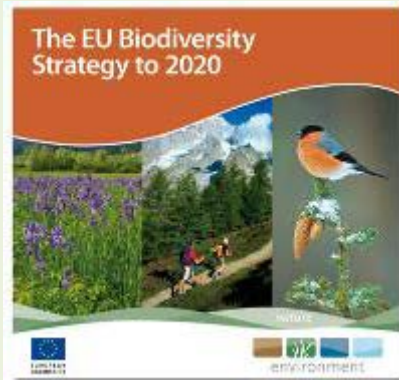
EU Biodiversity Strategy 2020

6 Key targets:

- 1. Protect species and habitats.**
- 2. Maintain and restore ecosystems.**
- 3. Achieve more sustainable agriculture and forestry.**
- 4. Make fishing more sustainable and seas healthier.**
- 5. Combat invasive alien species.**
- 6. Help stop the loss of global biodiversity.**

<http://ec.europa.eu/environment/nature/biodiversity/comm2006/2020.htm>

Applications in Policy and decision making



EU Biodiversity Strategy 2020

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6. Help stop the loss of global biodiversity.

By 2020, **ecosystems and their services** are maintained and enhanced by establishing green infrastructure and restoring at least 15 % of degraded ecosystems

<http://ec.europa.eu/environment/nature/biodiversity/comm2006/2020.htm>

Applications in Policy and decision making



EU Biodiversity Strategy 2020

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3. Achieve more sustainable agriculture and forestry.
4. Make fishing more sustainable and healthier.
5. Combat invasive alien species.
6. Help stop the loss of global biodiversity.

3 specific actions:

Action 5: Map and assess the state and economic value of **ecosystems and their services** in the entire EU territory; promote the recognition of their economic worth into accounting and reporting systems across Europe

Action 6: Restore ecosystems, maintain their services and promote the use of **green infrastructure**

Action 7: Assess the **impact of EU funds** on biodiversity and investigate the opportunity of a compensation or offsetting scheme to ensure that there is no net loss of biodiversity and ecosystem services

<http://ec.europa.eu/environment/nature/biodiversity/comm2006/2020.htm>

Applications in Policy and decision making



October 7, 2015

M-16-01

MEMORANDUM FOR EXECUTIVE DEPARTMENTS AND AGENCIES

FROM: Shaun Donovan, Director
Office of Management and Budget

Christina Goldfuss, Managing Director
Council on Environmental Quality

John Holdren, Director
Office of Science and Technology Policy

SUBJECT: Incorporating Ecosystem Services into Federal Decision Making

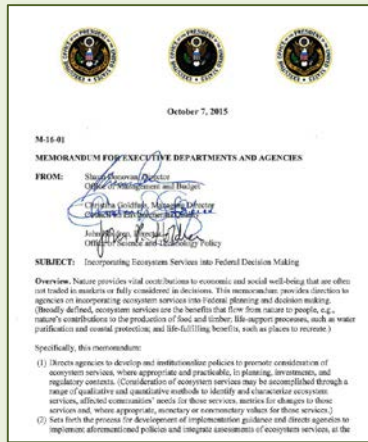
Overview. Nature provides vital contributions to economic and social well-being that are often not traded in markets or fully considered in decisions. This memorandum provides direction to agencies on incorporating ecosystem services into Federal planning and decision making. (Broadly defined, ecosystem services are the benefits that flow from nature to people, e.g., nature's contributions to the production of food and timber; life-support processes, such as water purification and coastal protection; and life-fulfilling benefits, such as places to recreate.)

Specifically, this memorandum:

- (1) Directs agencies to develop and institutionalize policies to promote consideration of ecosystem services, where appropriate and practicable, in planning, investments, and regulatory contexts. (Consideration of ecosystem services may be accomplished through a range of qualitative and quantitative methods to identify and characterize ecosystem services, affected communities' needs for those services, metrics for changes to those services and, where appropriate, monetary or nonmonetary values for those services.)
- (2) Sets forth the process for development of implementation guidance and directs agencies to implement aforementioned policies and integrate assessments of ecosystem services, at the

Memorandum US government:
**Incorporating Natural
 Infrastructure and Ecosystem
 Services in Federal Decision-
 Making**
 October 7, 2015

Applications in Policy and decision making



Memorandum US government:
Incorporating Natural Infrastructure and Ecosystem Services in Federal Decision-Making
 October 7, 2015

- Federal agencies shall **incorporate value of green infrastructure and ecosystem services** into federal planning and decision making
- Agencies shall develop and institutionalize **policies that promote consideration of ecosystem services** in planning, investment, and regulatory contexts
- A more detailed **guidance on integrating ecosystem-service assessments** into relevant programs and projects shall be created
- Ecosystem and community resilience, **sustainable use of natural resources**, and the recreational value of the Nation's unique landscapes **shall be maintained**

<https://www.whitehouse.gov/blog/2015/10/07/incorporating-natural-infrastructure-and-ecosystem-services-federal-decision-making>

Applications in Policy and decision making



Intergovernmental Platform on Biodiversity & Ecosystem Services

Highlights

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In Focus

Ecosystems for water and food security

Ecosystems for water and food security

Report of the first session of the plenary meeting to determine modalities and institutional arrangements for an IPBES

The report for the first session of the plenary meeting to determine modalities and institutional arrangements for an Intergovernmental Platform on Biodiversity and Ecosystem Services - UNEP/IPBES.MI/1/8 available [here](#) (Advance version).

Follow IISD's coverage of the first session of a plenary meeting on IPBES

Follow the meeting live by clicking [here](#) and on [Twitter](#).

Opening of the first session of a plenary meeting on IPBES

UNEP Chief Addresses First Plenary Session of the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) on Monday 3rd October, followed by the Vice President of Kenya, M. Kalonzo Musyoka,

Please click [here](#) for the full speech of M. Achim Steiner in writing and here for the [video](#). The video of the address from M. Kalonzo Musyoka is available [here](#).

UN Partners

UNESCO United Nations Educational, Scientific and Cultural Organization

Latest News

Report of the first session of the plenary meeting to determine modalities and institutional arrangements for an IPBES (Advance version).

News Alerts

- [Why protecting the world's wildlife is good for our wallets](#)
The Independent- 3 October 2011
- [How many species are there on earth and in the ocean?](#)
Nature Climate Change, 28 Aug. 2011
- [Boom and bust signals ecosystem collapse](#)
BBC News, 28 April 2011
- [UN expert panel for nature to kick off in 2011](#)
Euractiv, 4 Jan. 2011
- [UN authorizes new body to stem loss of ecosystems vital to life](#)
UN News Center-21 Dec. 2010
- [UN Green-Lights New Biodiversity Science Policy Platform](#)
ENS-21 Dec.2010
- [UN gives final approval to biodiversity science panel](#)
BBC News-21 Dec. 2010

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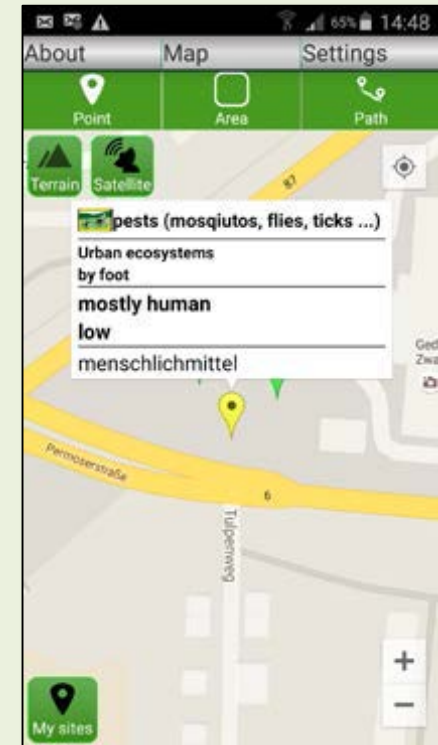
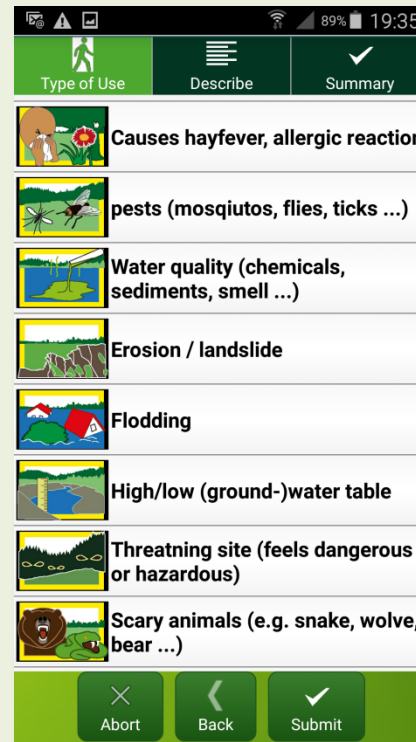
[Report of an international science workshop on assessments for IPBES held in Tokyo available](#)

[Registration open for October plenary meeting on IPBES](#)

<http://ipbes.net/>

Citizen science application

What did nature do for you today?



Use MapNat – The Smartphone App to map your personal use of ecosystem services!

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Open knowledge/data sharing



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Urban development and others

<http://oneecosystem.pensoft.net>

Conclusions

- Ecosystem services are a highly **transdisciplinary** concept.
- It is, like human-environmental systems, **highly complex**.
- Many **methods and data** are available and ready for use.
- Policy interest is increasing, but **applications** and success-stories are needed!

Thanks for your attention!

