

# Ekosystémové služby a jejich využitelnost v ochraně přírody

David Vačkář

*Ústav výzkumu globální změny AV ČR, v.v.i.*

*Centrum pro otázky životního prostředí UK*



1. Mezinárodní rámec
2. Terminologie & klasifikace ES
3. Přístupy a datové zdroje k hodnocení ES
4. Scénáře ES
5. Využití ES v ochraně přírody

## ECOSYSTEM SERVICES

### Supporting

- NUTRIENT CYCLING
- SOIL FORMATION
- PRIMARY PRODUCTION
- ...

### Provisioning

- FOOD
- FRESH WATER
- WOOD AND FIBER
- FUEL
- ...

### Regulating

- CLIMATE REGULATION
- FLOOD REGULATION
- DISEASE REGULATION
- WATER PURIFICATION
- ...

### Cultural

- AESTHETIC
- SPIRITUAL
- EDUCATIONAL
- RECREATIONAL
- ...

LIFE ON EARTH - BIODIVERSITY

## CONSTITUENTS OF WELL-BEING

### Security

- PERSONAL SAFETY
- SECURE RESOURCE ACCESS
- SECURITY FROM DISASTERS

### Basic material for good life

- ADEQUATE LIVELIHOODS
- SUFFICIENT NUTRITIOUS FOOD
- SHELTER
- ACCESS TO GOODS

### Health

- STRENGTH
- FEELING WELL
- ACCESS TO CLEAN AIR AND WATER

### Good social relations

- SOCIAL COHESION
- MUTUAL RESPECT
- ABILITY TO HELP OTHERS

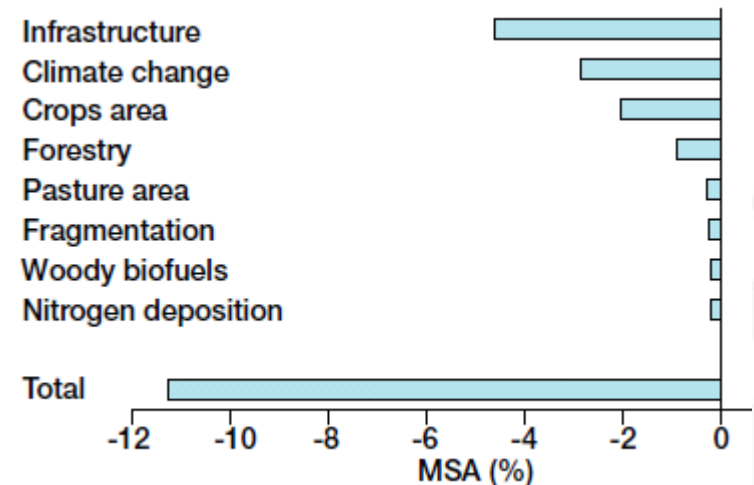
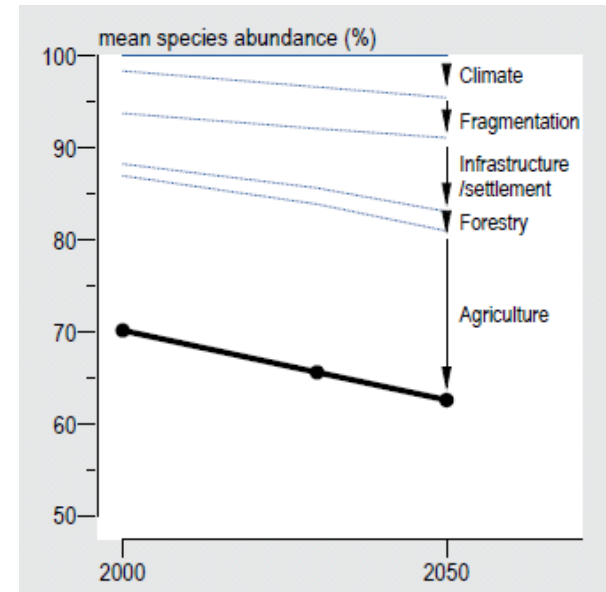
### Freedom of choice and action

OPPORTUNITY TO BE ABLE TO ACHIEVE WHAT AN INDIVIDUAL VALUES DOING AND BEING

# Náklady spojené se ztrátou přírody

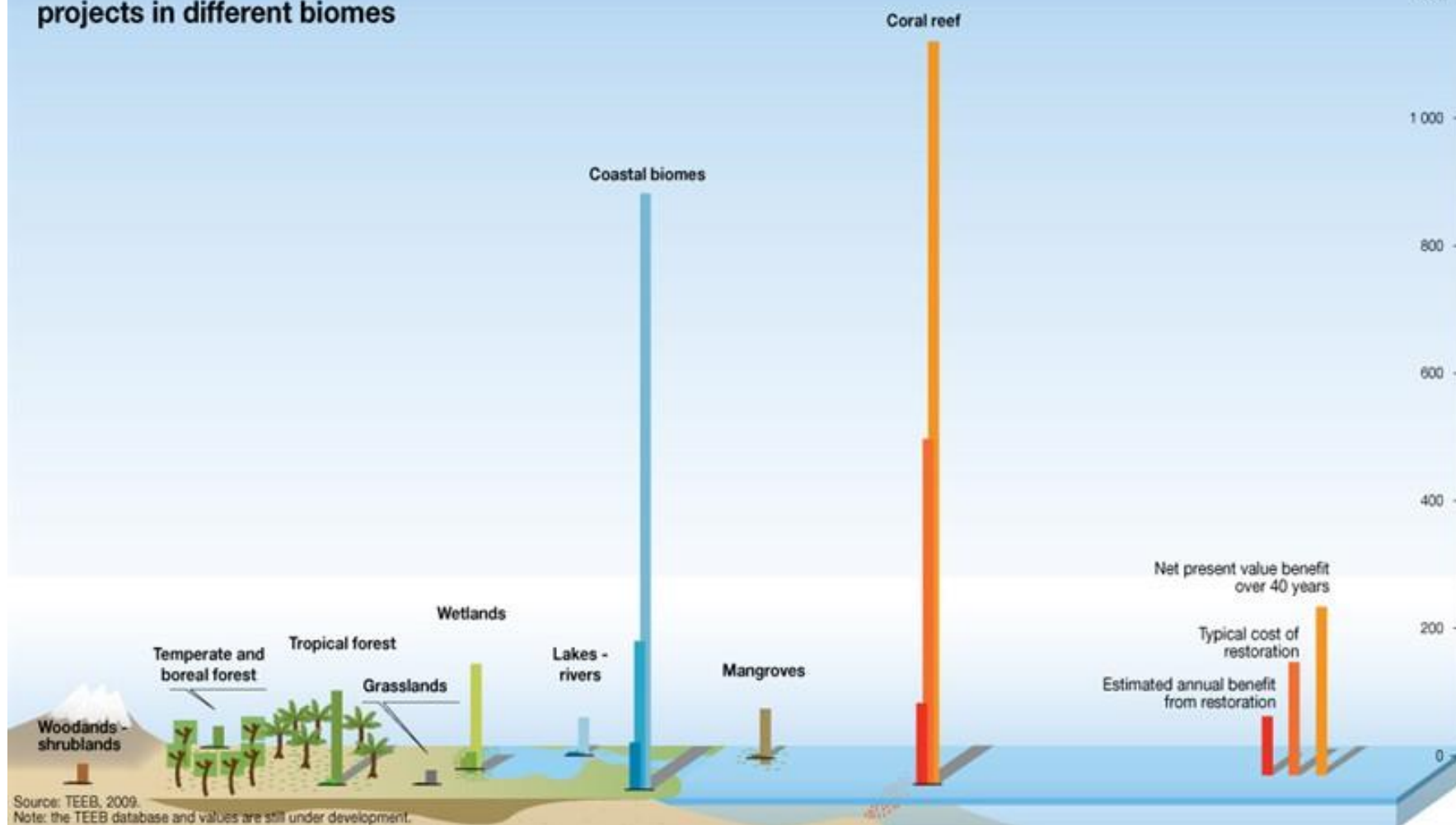
Ročně ztrácíme ekosystémové služby v hodnotě 50 miliard EUR. Celkem do roku 2050 by ztráty mohly dosáhnout až 7 % globálního HDP.

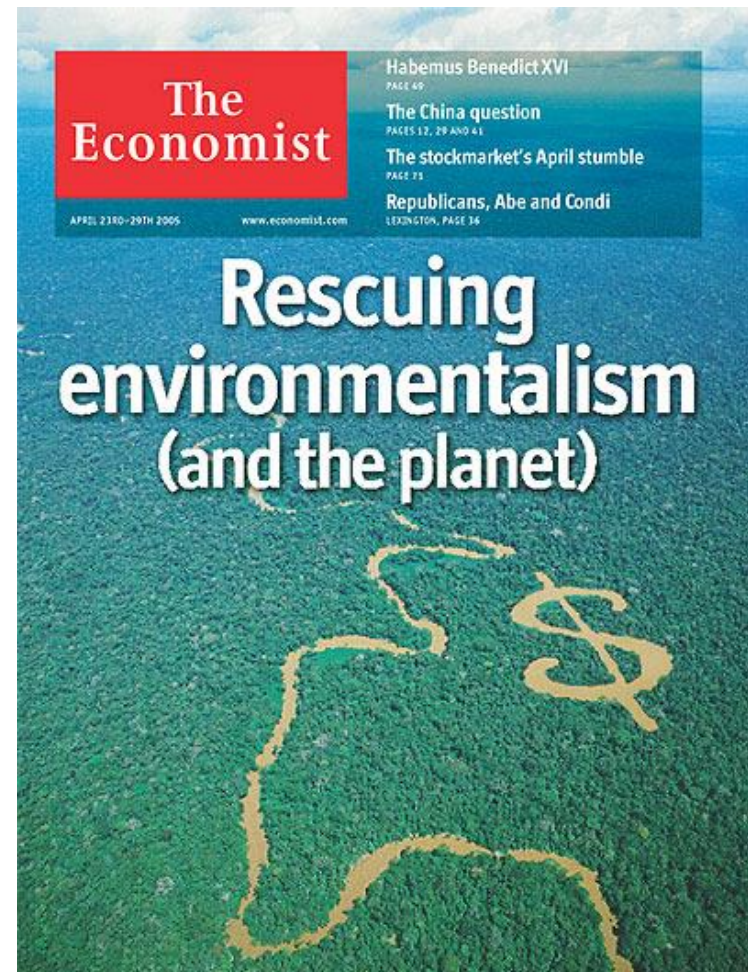
COPI – Cost of Policy Inaction  
Rethinking Global Biodiversity  
Strategies



## Estimated costs and benefits of restoration projects in different biomes

Thousands US dollars per hectare







# The value of the world's ecosystem services and natural capital

Robert Costanza<sup>\*,†</sup>, Ralph d'Arge<sup>‡</sup>, Rudolf de Groot<sup>§</sup>, Stephen Farber<sup>||</sup>, Monica Grasso<sup>†</sup>, Bruce Hannon<sup>¶</sup>, Karin Limburg<sup>‡\*</sup>, Shahid Naeem<sup>\*\*</sup>, Robert V. O'Neill<sup>††</sup>, Jose Paruelo<sup>‡‡</sup>, Robert G. Raskin<sup>§§</sup>, Paul Sutton<sup>|||</sup> & Marjan van den Belt<sup>††</sup>

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**The services of ecological systems and the natural capital stocks that produce them are critical to the functioning of the Earth's life-support system. They contribute to human welfare, both directly and indirectly, and therefore represent part of the total economic value of the planet. We have estimated the current economic value of 17 ecosystem services for 16 biomes, based on published studies and a few original calculations. For the entire biosphere, the value (most of which is outside the market) is estimated to be in the range of US\$16–54 trillion (10<sup>12</sup>) per year, with an average of US\$33 trillion per year. Because of the nature of the uncertainties, this must be considered a minimum estimate. Global gross national product total is around US\$18 trillion per year.**

Because ecosystem services are not fully 'captured' in commercial markets or adequately quantified in terms comparable with economic services and manufactured capital, they are often given too little weight in policy decisions. This neglect may ultimately compromise the sustainability of humans in the biosphere. The economies of the Earth would grind to a halt without the services of ecological life-support systems, so in one sense their total value to the economy is infinite. However, it can be instructive to estimate the 'incremental' or 'marginal' value of ecosystem services (the estimated rate of change of value compared with changes in ecosystem services from their current levels). There have been many studies in the past few decades aimed at estimating the value of a wide variety of ecosystem services. We have gathered together this large (but scattered) amount of information and present it here in a form useful for ecologists, economists, policy makers and the general public. From this synthesis, we have estimated values for ecosystem services per unit area by biome, and then multiplied by the total area of each biome and summed over all services and biomes.

Although we acknowledge that there are many conceptual and empirical problems inherent in producing such an estimate, we think this exercise is essential in order to: (1) make the range of potential values of the services of ecosystems more apparent; (2) establish at least a first approximation of the relative magnitude of global ecosystem services; (3) set up a framework for their further analysis; (4) point out those areas most in need of additional research; and (5) stimulate additional research and debate. Most of the problems and uncertainties we encountered indicate that our

estimate represents a minimum value, which would probably increase: (1) with additional effort in studying and valuing a broader range of ecosystem services; (2) with the incorporation of more realistic representations of ecosystem dynamics and interdependence; and (3) as ecosystem services become more stressed and 'scarce' in the future.

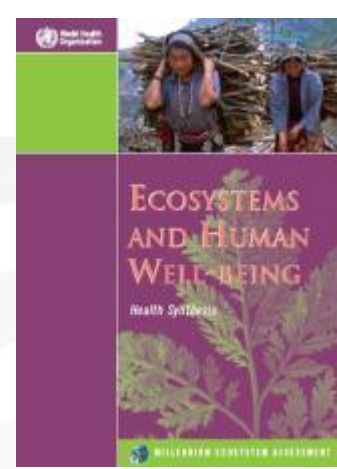
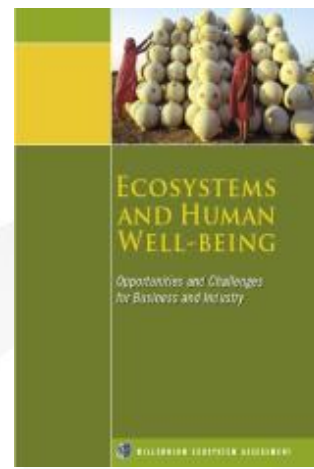
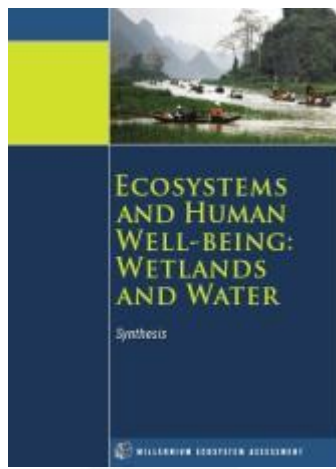
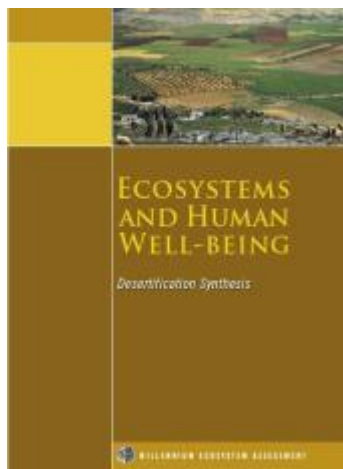
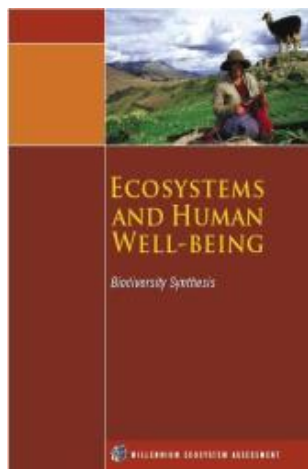
## Ecosystem functions and ecosystem services

Ecosystem functions refer variously to the habitat, biological or system properties or processes of ecosystems. Ecosystem goods (such as food) and services (such as waste assimilation) represent the benefits human populations derive, directly or indirectly, from ecosystem functions. For simplicity, we will refer to ecosystem goods and services together as ecosystem services. A large number of functions and services can be identified<sup>1–4</sup>. Reference 5 provides a recent, detailed compendium on describing, measuring and valuing ecosystem services. For the purposes of this analysis we grouped ecosystem services into 17 major categories. These groups are listed in Table 1. We included only renewable ecosystem services, excluding non-renewable fuels and minerals and the atmosphere. Note that ecosystem services and functions do not necessarily show a one-to-one correspondence. In some cases a single ecosystem service is the product of two or more ecosystem functions whereas in other cases a single ecosystem function contributes to two or more ecosystem services. It is also important to emphasize the interdependent nature of many ecosystem functions. For example, some of the net primary production in an ecosystem ends up as food, the consumption of which generates respiratory products necessary for primary production. Even though these functions and services are interdependent, in many cases they can be added because they represent 'joint products' of the ecosystem, which support human

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# Miléniové hodnocení ekosystémů

Miléniové hodnocení ekosystémů (Millennium Ecosystem Assessment, MA) zhodnotilo důsledky změn ekosystémů pro lidský blahobyt. Od roku 2001 do roku 2005 se na MA podílelo více než 1360 odborníků z celého světa. Jejich závěry poskytují state-of-the-art vědeckého posouzení stavu a trendů světových ekosystémů a služeb, které poskytují, jakož i vědecký základ pro opatření na jejich zachování a využití udržitelným způsobem.





## Making Nature's Values Visible

The Economics of Ecosystems and Biodiversity (TEEB) is a global initiative focused on drawing attention to the economic benefits of biodiversity including the growing cost of biodiversity loss and ecosystem degradation. TEEB presents an approach that can help decision-makers recognize, demonstrate and capture the values of ecosystem services & biodiversity.

## Country Projects



Since the launch of the TEEB reports various countries have initiated TEEB studies to demonstrate the value of their ecosystems and to encourage policy-making that recognizes and accounts for their ecosystem services and biodiversity.

[read more](#)

## Sector & Biome Studies



The sector and biome studies capture and assess the costs of biodiversity loss and ecosystem degradation, with the ultimate goal of integrating these findings into decision-making at all levels.

[read more](#)

## Latest Publications



### Natural Capital Accounting and Water Quality: Commitments, Benefits, Needs and Progress

December 2013 – The briefing note outlines existing guidance and

[| next >](#)
[read more](#)

## Country Case studies



## Discover more

### How to implement TEEB at the national level?

from TEEB Communications

## Upcoming Events

24.02.14 - 26.02.14

2nd World Oceans Summit

03.03.14 - 03.03.14

World Wildlife Day 2014

## Twitter Feed

### Tweets

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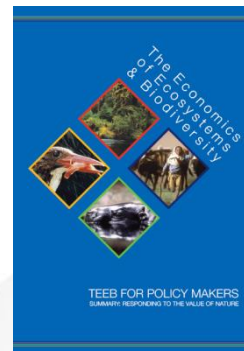
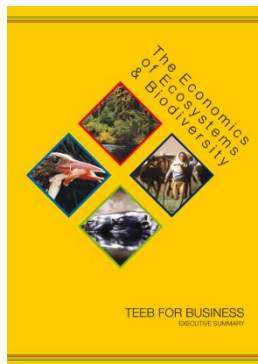
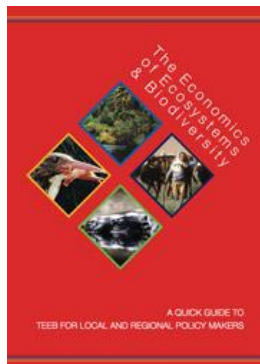
TEEB Initiative  
@TEEB4ME

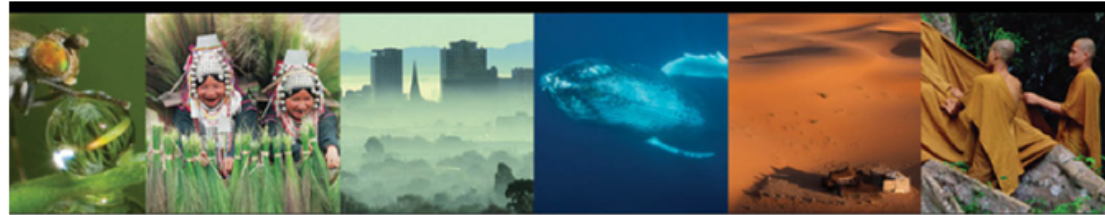
2h

Lesson learned: Motivate - enable- implement are key for successful forest landscape

# TEEB – Ekonomika ekosystémů a biodiverzity

- vyhodnotit náklady plynoucí ze ztráty biologické rozmanitosti a souvisejícího poklesu ekosystémových služeb na celém světě, a porovnat je s náklady na efektivní ochranu a udržitelné využívání.





# Intergovernmental Platform on Biodiversity & Ecosystem Services

[Home](#)[About IPBES](#)[Plenary Sessions](#)[Intersessional Process](#)[Policies and Procedures](#)[IPBES Events](#)[Stakeholders](#)[Resources](#)[Contact](#)

Select Language ▼

## In Focus

The Advance English version of the report and decisions adopted at IPBES-2 is now available [here](#).

Letter from IPBES chair requesting nominations of experts to contribute to IPBES work programme available [here](#).

## IPBES Membership

IPBES now counts 116 Members, with Cameroon recently joining. The full list of current IPBES Members is available [here](#).

All Member States are requested to submit the name and contact details of their National Focal Point (NFP) to the [IPBES Secretariat](#).

## Latest News

### Additional guidance for experts nominated and selected for the IPBES work programme

Created on Monday, 10 February 2014 14:48

Additional information to guide the nomination of experts for the IPBES work programme is provided [here](#) in relation to the expected workload of experts; and the selection, responsibilities, time commitment, duration of appointment and availability of support.

### Template available for nominations of experts for implementation of work programme

Created on Monday, 20 January 2014 12:52

The template for nominations of experts for implementation of work programme is available [here](#). Kindly complete one form per nomination and send by email to the IPBES Secretariat ( [secretariat@ipbes.net](mailto:secretariat@ipbes.net)) by 28 February 2014 at the very latest, accompanied by a short version of the Curriculum Vitae and a clear indication to which work programme deliverable the nomination is made. Further instructions for the nomination process are included in the [nomination template](#). Earlier nominations are encouraged and late nominations will not be able to be considered. Self-nominations cannot be accepted.

### Advance report and decisions from IPBES-2 now available, along with letter from IPBES Chair requesting nominations of experts for implementation of work programme

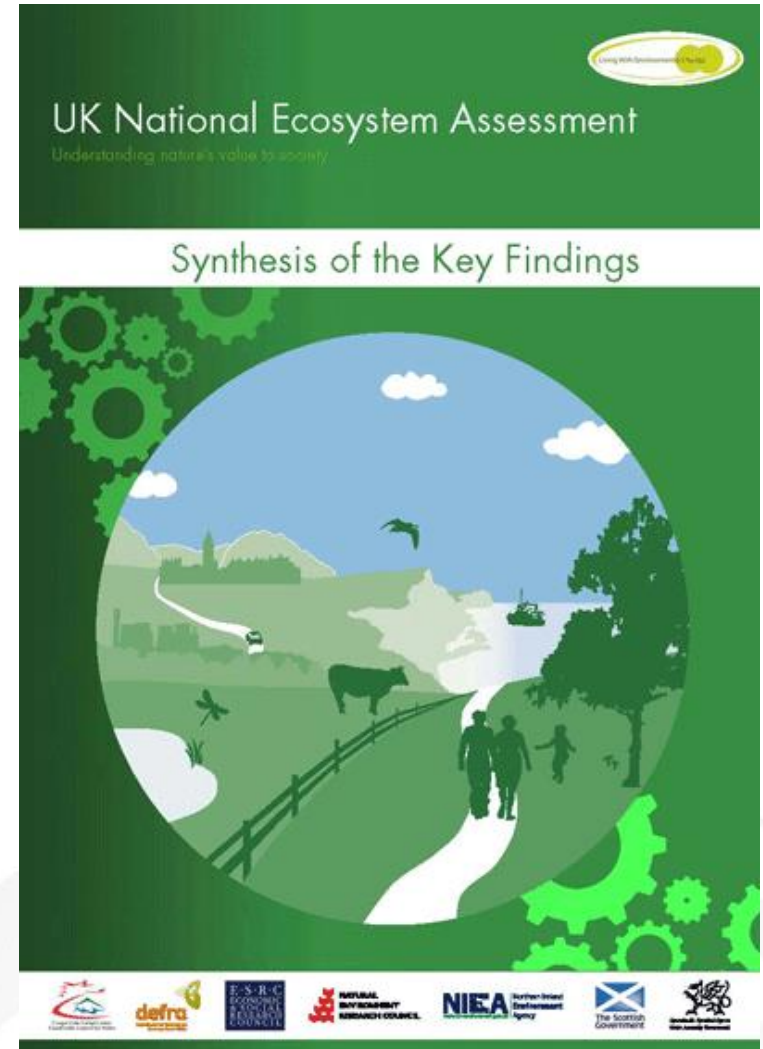
Created on Thursday, 09 January 2014 12:38

The Advance English [report and decisions](#) from IPBES-2, held in Antalya from 9-14 December 2013 are now available. Other UN languages of the report and decisions will be made available in due course. In addition, the Chair of IPBES, Professor Zakri has circulated a [letter](#) highlighting the achievements of IPBES-2, and calling for nominations of experts to contribute to the implementation of the Platform's work programme. A deadline of 28th February has been set for receipt of such nominations by the secretariat.

# Národní hodnocení ekosystémových služeb ve Velké Británii

Národní hodnocení ekosystémů (UK NEA) je první analýza životního prostředí Spojeného království, pokud jde o výhody, které poskytuje společnosti a pokračující hospodářské prosperitě. Jednalo se o komplexní proces zahrnující mnoho vládních, vědeckých, nevládních a soukromých organizací.

<http://uknea.unep-wcmc.org/>





# UK National Ecosystem Assessment



Home

About

NEW! Follow-on Phase

Ecosystem Assessment Concepts

News

Meetings &amp; Events

Getting Involved

Resources



*Understanding nature's value to society*

## News

### UK NEA Follow-on Phase: New report released, 16 July 2013

The value of potential marine protected areas in the UK to divers and sea anglers - Final Report. [Read more](#)

### Announcement of Opportunity for BESS workshops, 19 Feb 2013

The [BESS](#) (Biodiversity and Ecosystem Services Sustainability) programme is a 6-year, £13 million research programme addressing NERC strategic challenges and societal needs and the UK Government's strategic priorities with respect to biodiversity, ecosystems and their services. This funding call is

## What is the UK National Ecosystem Assessment?

The UK National Ecosystem Assessment (UK NEA) was the first analysis of the UK's natural environment in terms of the benefits it provides to society and continuing economic prosperity. Part of the Living With Environmental Change (LWEC) initiative, the UK NEA commenced in mid-2009 and reported in June 2011. It was an inclusive process involving many government, academic, NGO and private sector institutions.



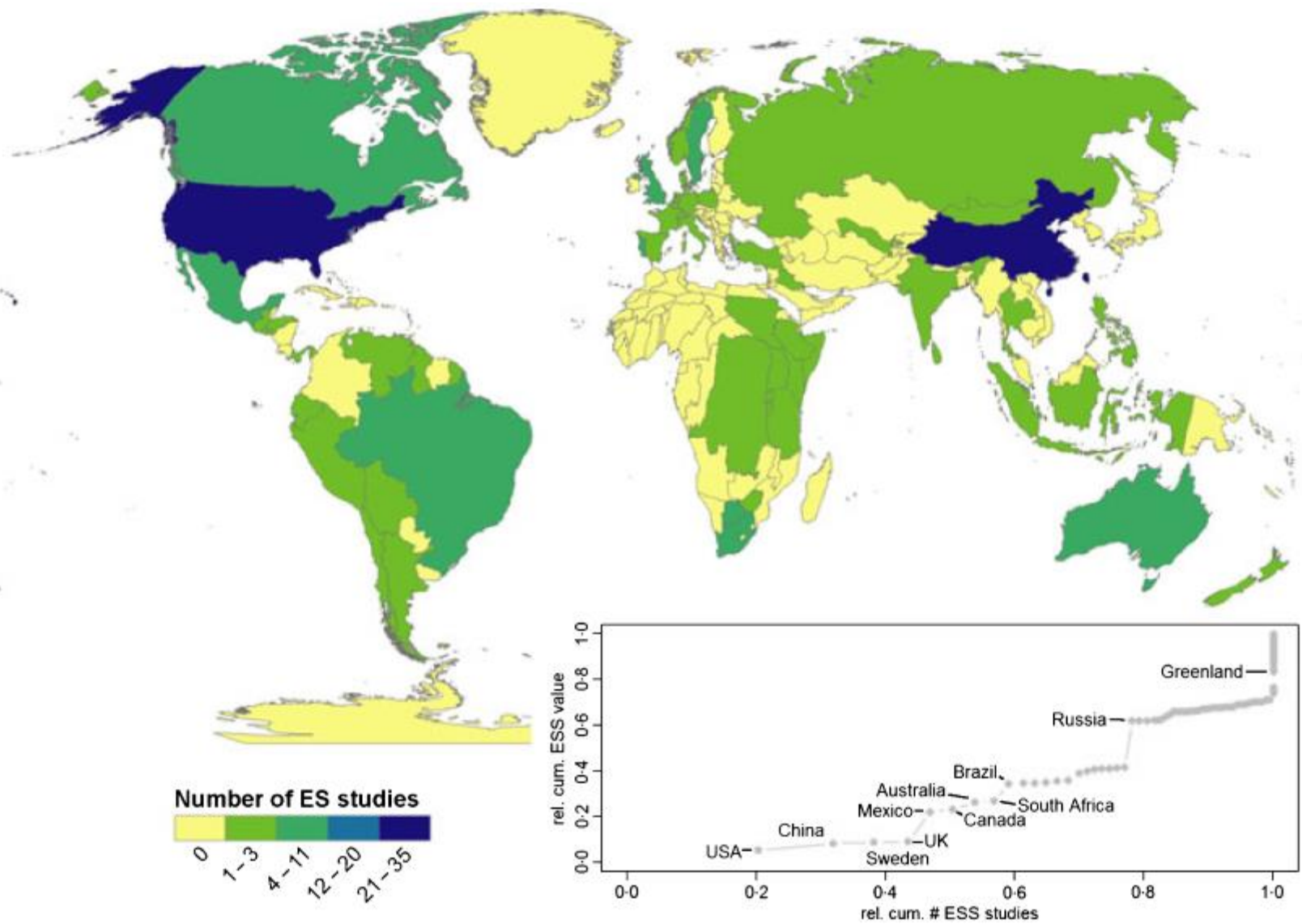
\*\*\*The **Synthesis of the Key Findings** for the UK NEA was launched on the 2 June 2011\*\*\*

UK National Ecosystem Assessment

Synthesis of the Key Findings







Seppelt, R., et al., *J Appl Ecol*, 2011

# Přehled stavu národních hodnocení ES

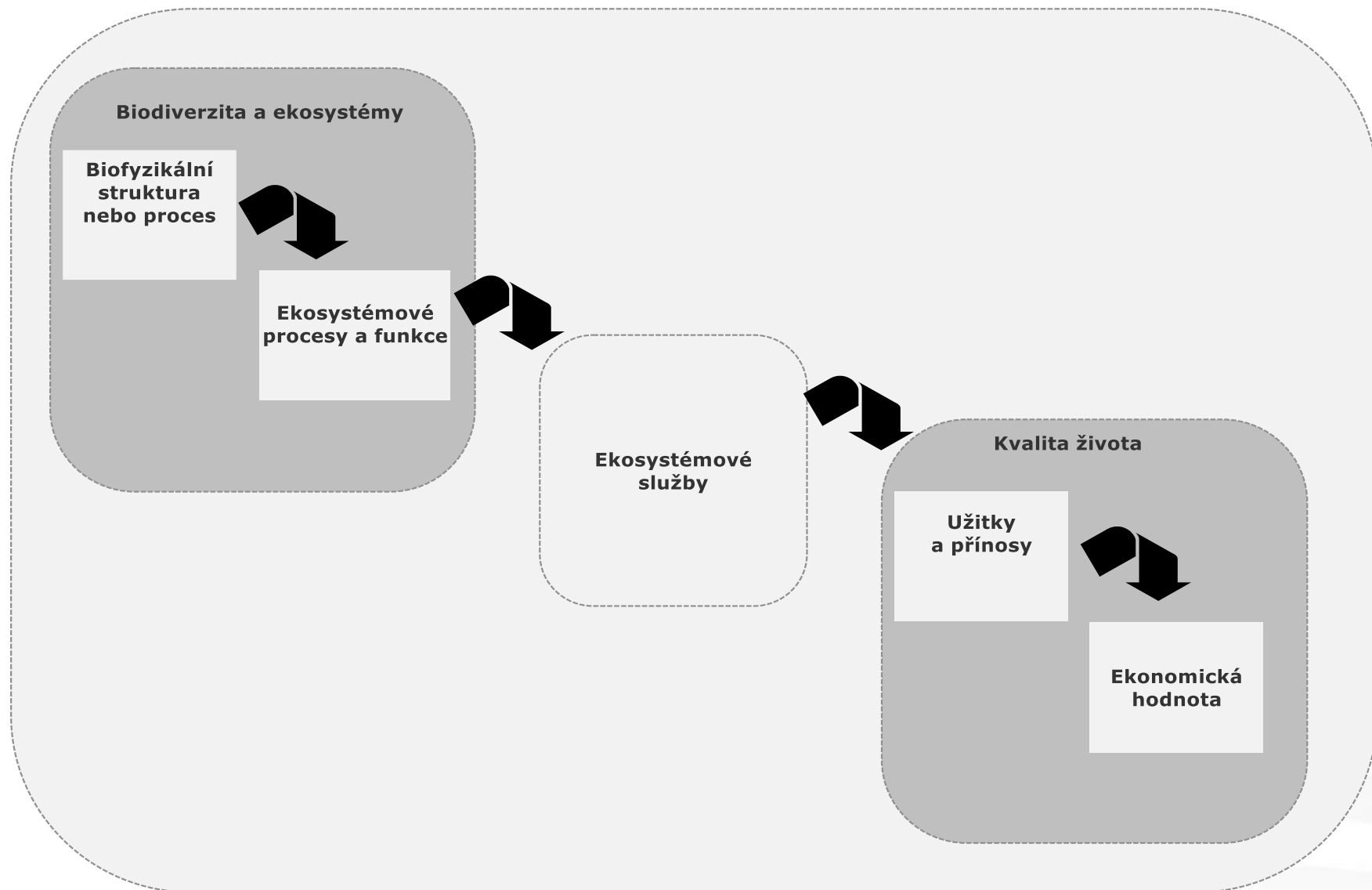
| Stát | Iniciace<br>hodnocení | Stav                           | Termín     | Metoda   | Hodnocené<br>ekosystémy | Hodnocené<br>služby |
|------|-----------------------|--------------------------------|------------|----------|-------------------------|---------------------|
| UK   | Vládní                | Dokončeno                      | 2009-2011  | MA       | Všechny                 | Z, R, K             |
| PT   | Vědecká               | Dokončeno                      | 2005       | MA       | Všechny                 | B, Z, R, K          |
| ES   | Vládní                | Probíhá                        | 2009-2014  | MA       | Všechny                 | Z, R, K             |
| N    | Vládní                | Dokončeno                      | 2011-2013  | TEEB     | Všechny                 | Z, R, K             |
| CH   | Vládní                | Dokončeno                      | 2011       | MA, ICES | Všechny                 | Z, R, K             |
| FR   | Vládní                | Probíhá                        | 2012-2016  | MA       | Všechny                 |                     |
| NL   | Vládní                | Probíhá                        | Od 1. 2011 | TEEB     | Všechny                 |                     |
| BE   | Vědecká               | Probíhá                        |            | TEEB     | Sladkovodní             |                     |
| CZ   | Vědecká               | Dokončeno pilotní<br>hodnocení | 2012-2013  |          | Všechny                 | Z, R, K             |
| D    |                       | Probíhá                        | 2012-2015  | TEEB     | Všechny                 |                     |
| SK   | Vládní                |                                | Od 1. 2014 |          | Všechny                 |                     |
| PL   | -                     | Neprobíhá                      | -          | -        | -                       | -                   |

B - biodiverzita, Z –zásobovací služby, R – regulační služby, K – kulturní služby

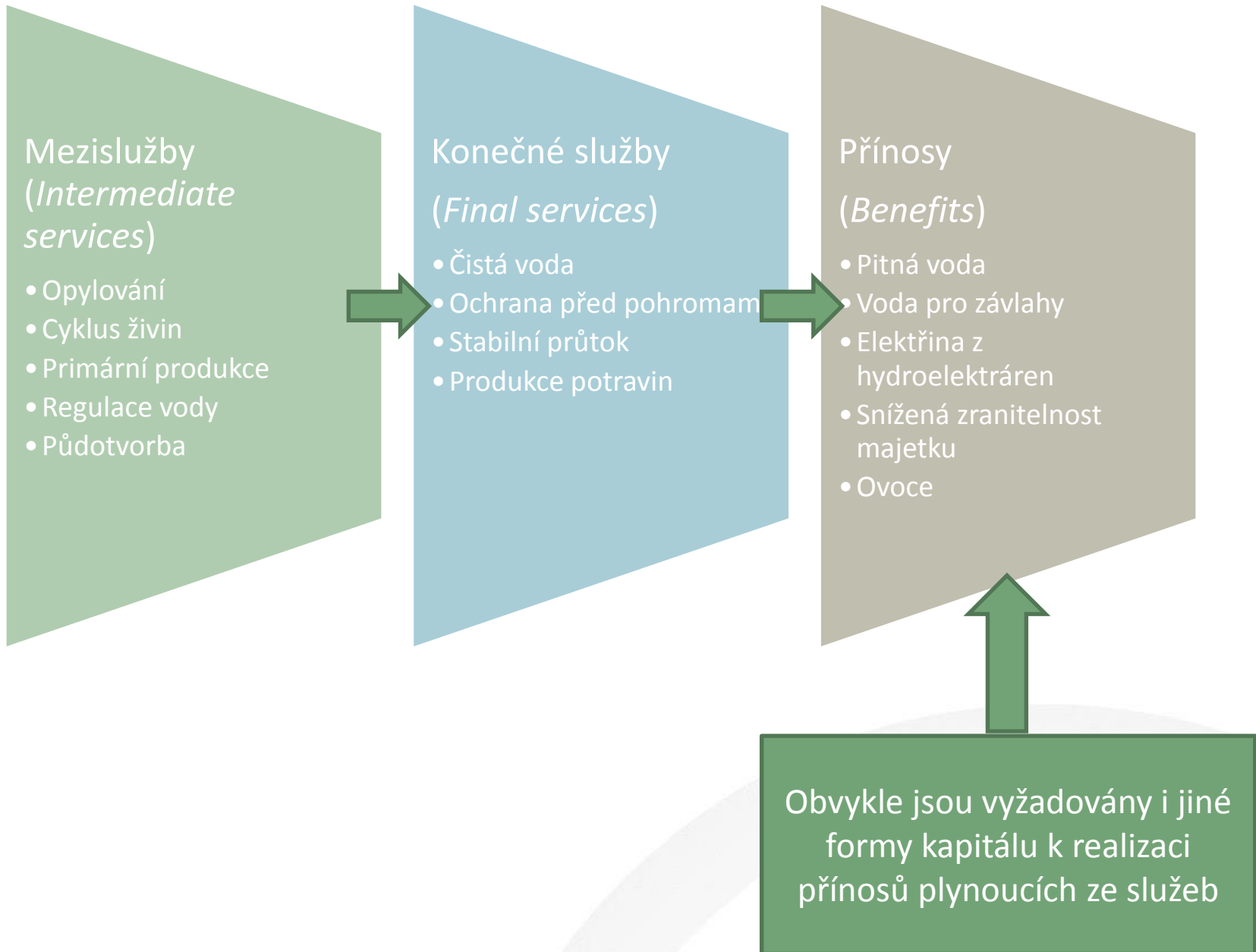
# Definice služeb ekosystémů

- ekosystémové služby jsou přínosy, které lidé získávají z ekosystémů (MA, 2005)
- ekosystémové služby jsou ekologické složky, které jsou přímo spotřebovávány nebo poskytující užitek a tím přispívající k lidskému blahobytu (Boyd a Banzhaf 2007)
- ekosystémové služby jsou aspekty ekosystémů využívané (aktivně či pasivně) k produkování lidského blahobytu (Fisher et al., 2009)
- ekosystémové služby představují příspěvek ekosystémů k přínosům užitým v ekonomické a jiné lidské činnosti (SEEA-EEA 2014)

# Kaskáda ekosystémových služeb







**GLOBALNÍ**  
**REGIONÁLNÍ**

**LOKÁLNÍ**



*strategie a intervence*

**KVALITA ŽIVOTA, BLAHOBYT A  
SNIŽOVÁNÍ CHUDOBY**

- materiální minimum pro spokojený život
- zdraví
- dobré sociální vztahy
- bezpečnost
- svoboda a možnost volby

**NEPŘÍMÉ HNACÍ SÍLY ZMĚNY**

- demografické
- ekonomické (globalizace, trh, obchod a politický rámec)
- sociálně politické (vláda, institucionální a legislativní rámec)
- věda a technologie
- kultura a náboženství (např. možnost volby co a kolik spotřebovat)

**PŘÍMÉ HNACÍ SÍLY ZMĚNY**

- změna lokálního využívání půdy a půdního pokryvu
- introdukce a mizení biologických druhů
- adaptace a využívání technologií
- vnější vstupy (např. používání umělých hnojiv, pesticidů, zavlažování)
- čerpání a spotřeba zdrojů
- klimatická změna
- neovlivnitelné přirozené fyzické a biologické hnací síly (sopečná činnost, evoluce)

**EKOSYSTÉMOVÉ SLUŽBY**

- poskytování statků (např. potrava, voda)
- regulační (např. regulace podnebí a nemocí)
- kulturní (např. spirituální a estetické)
- podpůrné (např. primární produkce, tvorba půdy)

*krátkodobé*

*dlouhodobé*

# Přístupy k hodnocení ekosystémových služeb

## 1) Sběr primárních dat, měření

Ukládání uhlíku v nadzemní biomase např. Strohbach&Haase (2009)

## 2) Využití indikátorů a expertní zhodnocení ekosystémových služeb

Produkční matice ekosystémových služeb (Burkhard et al. 2012)

## 3) Využití modelů a scénářů

InVEST, ARIES, MIMES

## 4) Přenos hodnot

Gómez-Baggethun&Barton (2013), Bastian et al. (2011), ...

## 5) Dotazníková šetření

Ochota platit Vecchiato&Tempesta (2013), Povědomí, postoje, poptávka po ES Casado-Arzuaga et al. (2013), Chiesura (2004), sociální hodnota ES

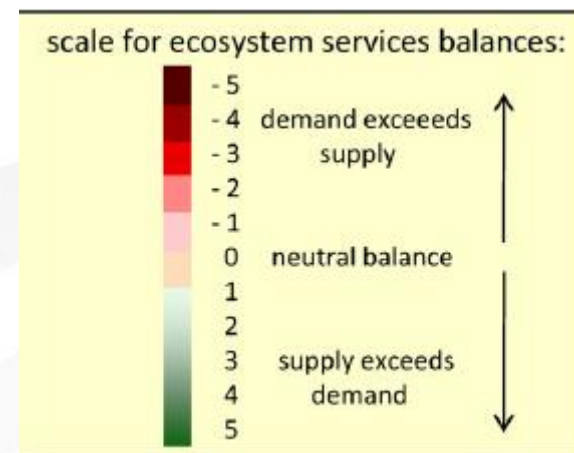
## 6) Kombinované metody

např. scénáře & modelování, šetření & přenos hodnot Vandermeulen et al. (2013)

| CORINE land cover type:         | Regulating services      |                           |                  |                      |                        |                    |                     |                    |             |  | Provisioning services |           |        |                   |             |            |        |           |        |                         | Cultural services |    |                               |                                 |  |  |  |  |  |  |
|---------------------------------|--------------------------|---------------------------|------------------|----------------------|------------------------|--------------------|---------------------|--------------------|-------------|--|-----------------------|-----------|--------|-------------------|-------------|------------|--------|-----------|--------|-------------------------|-------------------|----|-------------------------------|---------------------------------|--|--|--|--|--|--|
|                                 | Local climate regulation | Global climate regulation | Flood protection | Groundwater recharge | Air Quality Regulation | Erosion Regulation | Nutrient regulation | Water purification | Pollination |  | Crops                 | Livestock | Fodder | Capture Fisheries | Aquaculture | Wild Foods | Timber | Wood Fuel | Energy | Biochemicals / Medicine | Freshwater        |    | Recreation & Aesthetic Values | Intrinsic Value of Biodiversity |  |  |  |  |  |  |
| Continuous urban fabric         | -5                       | -3                        | -4               | -5                   | -5                     | -1                 | -1                  | -1                 | -3          |  | -5                    | -5        | -1     | -5                | -5          | -5         | -3     | -2        | -4     | -5                      | -5                |    | -4                            | -2                              |  |  |  |  |  |  |
| Discontinuous urban fabric      | -5                       | -3                        | -5               | -5                   | -5                     | -1                 | -2                  | -2                 | -4          |  | -3                    | -4        | -1     | -4                | -4          | -3         | -3     | -3        | -3     | -5                      | -5                |    | -4                            | -3                              |  |  |  |  |  |  |
| Industrial or commercial units  | -1                       | -5                        | -4               | -5                   | -5                     | -1                 | -3                  | -3                 | -4          |  | -5                    | -5        | -5     | -4                | -4          | -4         | -5     | -5        | -4     | -5                      | -5                |    | -1                            | -1                              |  |  |  |  |  |  |
| Road and rail networks          | -2                       | -4                        | -4               | -1                   | -4                     | -3                 |                     |                    | -1          |  |                       |           |        |                   |             |            | -2     |           | -4     |                         | -1                |    | -2                            |                                 |  |  |  |  |  |  |
| Port areas                      | -2                       | -3                        | -2               | -2                   | -2                     | -4                 |                     | -3                 | -1          |  | -2                    | -2        | -2     | -2                | -2          | -1         | -5     | -2        | -5     | -1                      | -3                |    | -1                            | -1                              |  |  |  |  |  |  |
| Airports                        | -2                       | -5                        | -1               | -1                   | -4                     | -1                 | -1                  | -2                 |             |  | -2                    | -2        | 1      | -1                | -1          | -1         | -1     |           | -5     | -1                      | -3                |    | -1                            |                                 |  |  |  |  |  |  |
| Mineral extraction sites        |                          |                           | -2               | -4                   |                        | -4                 |                     |                    |             |  |                       |           |        |                   |             |            | -2     |           | 2      |                         | -2                |    |                               |                                 |  |  |  |  |  |  |
| Dump sites                      | -2                       | -2                        |                  | -2                   | -3                     |                    |                     | -2                 |             |  |                       |           |        |                   |             |            |        |           | 0      |                         | -2                |    |                               |                                 |  |  |  |  |  |  |
| Construction sites              | -2                       |                           | -2               |                      | -1                     | -2                 | -2                  | -2                 |             |  |                       |           |        |                   |             |            | -4     |           | -4     |                         | -2                |    |                               |                                 |  |  |  |  |  |  |
| Green urban areas               | 0                        | 1                         |                  | 1                    | 0                      | 2                  | 1                   | 1                  | -1          |  | -1                    | -1        |        |                   |             | 1          |        | 1         | -1     |                         | -2                |    | -1                            | -1                              |  |  |  |  |  |  |
| Sport and leisure facilities    | -1                       | 1                         |                  | 0                    | -2                     | 1                  | 1                   | 0                  | 1           |  | -2                    | -2        | -1     | -2                | -2          | -2         | -1     | -1        | -3     | -3                      | -3                |    | 2                             |                                 |  |  |  |  |  |  |
| Non-irrigated arable land       | 0                        | -1                        | -1               | 1                    | -1                     | -2                 | -3                  |                    | -3          |  | 4                     | 5         | 5      |                   |             |            |        |           | 1      | 0                       |                   |    | 1                             |                                 |  |  |  |  |  |  |
| Permanently irrigated land      | 1                        | -1                        | -1               | -5                   | -1                     | -2                 | -3                  | -5                 | -3          |  | 4                     | 5         | 2      |                   |             |            |        |           | -1     | 0                       | -5                |    | 1                             |                                 |  |  |  |  |  |  |
| Ricefields                      | -1                       | -4                        | -5               | -3                   | -1                     | -5                 | -3                  | -5                 | -1          |  | 4                     |           | 2      |                   |             |            |        |           | -2     | -1                      | -5                |    | 1                             |                                 |  |  |  |  |  |  |
| Vineyards                       | -4                       | -1                        |                  | -2                   | -1                     | -5                 | -3                  | -4                 | -2          |  | 3                     |           |        |                   |             |            |        | -1        | 1      | -1                      | -2                | -4 | 5                             |                                 |  |  |  |  |  |  |
| Fruit trees and berries         | 0                        | 1                         | 2                | -1                   | 1                      | 1                  | -2                  | -1                 | 0           |  | 4                     |           |        |                   |             |            |        | 3         | 4      | -1                      | -2                | -3 | 5                             |                                 |  |  |  |  |  |  |
| Olive groves                    | -1                       | 0                         |                  | 0                    | 0                      | 1                  | -1                  | -1                 | -2          |  | 3                     |           |        |                   |             |            |        | 4         | 4      | 0                       | -2                | -1 | 5                             |                                 |  |  |  |  |  |  |
| Pastures                        | 0                        | -2                        | 0                | 1                    |                        | 4                  | -1                  | -2                 |             |  |                       | 4         | 2      |                   |             |            |        | -1        |        | 0                       | -1                | -2 | 3                             |                                 |  |  |  |  |  |  |
| Annual and permanent crops      | 1                        | 0                         | 0                | 0                    | 0                      | 0                  | -5                  | -2                 | -2          |  | 4                     | 5         | 5      |                   |             |            |        |           | -1     | 0                       | -1                |    | 1                             |                                 |  |  |  |  |  |  |
| Complex cultivation patterns    | 1                        | 0                         | 0                | 0                    | -1                     | -1                 | -5                  | -2                 | -3          |  | 3                     |           | 3      |                   |             |            |        |           | -1     | 1                       | -1                |    | 2                             |                                 |  |  |  |  |  |  |
| Agriculture& natural vegetation | 2                        | 0                         | 1                | 1                    | 0                      | 2                  | -3                  | -1                 | -2          |  | 2                     | 3         | 2      |                   |             | 3          | 3      | 3         | 0      | 0                       | -2                |    | 2                             | 3                               |  |  |  |  |  |  |
| Agro-forestry areas             | 1                        | 0                         | 1                | 0                    | 0                      | 2                  | -2                  | -1                 | 1           |  | 2                     | 3         | 2      |                   |             |            |        |           | 3      | 3                       | 1                 | -1 | 3                             |                                 |  |  |  |  |  |  |
| Broad-leaved forest             | 5                        | 4                         | 3                | 2                    | 5                      | 5                  | 5                   | 5                  | 5           |  |                       |           | 1      |                   |             |            |        | 4         | 4      | 4                       | 1                 | 5  | 5                             | 5                               |  |  |  |  |  |  |
| Coniferous forest               | 5                        | 4                         | 3                | 2                    | 5                      | 5                  | 5                   | 5                  | 5           |  |                       |           | 1      |                   |             |            |        | 4         | 4      | 4                       | 1                 | 5  | 5                             | 5                               |  |  |  |  |  |  |
| Mixed forest                    | 5                        | 4                         | 3                | 2                    | 5                      | 5                  | 5                   | 5                  | 5           |  |                       |           | 1      |                   |             |            |        | 4         | 4      | 4                       | 1                 | 5  | 5                             | 5                               |  |  |  |  |  |  |
| Natural grassland               | 2                        | 3                         | 1                | 1                    |                        | 5                  | 5                   | 5                  |             |  |                       | 3         |        |                   |             |            |        | 2         |        |                         |                   |    | 3                             | 3                               |  |  |  |  |  |  |
| Moors and heathland             | 4                        | 3                         | 2                | 2                    |                        | 3                  | 4                   | 2                  |             |  |                       | 2         |        |                   |             |            |        | 1         | 2      | 2                       |                   |    | 5                             | 5                               |  |  |  |  |  |  |
| Sclerophyllous vegetation       | 2                        | 1                         | 1                | 1                    |                        |                    |                     | 2                  |             |  |                       | 2         |        |                   |             |            |        | 1         | 2      |                         | 3                 |    | 2                             | 4                               |  |  |  |  |  |  |
| Transitional woodland shrub     | 1                        |                           |                  |                      |                        |                    |                     | 2                  |             |  |                       | 2         |        |                   |             |            |        | 1         | 2      | 1                       |                   |    | 2                             | 2                               |  |  |  |  |  |  |
| Beaches, dunes and sand plains  |                          |                           | 5                | 1                    |                        |                    |                     |                    |             |  |                       |           |        |                   |             |            |        |           | 1      |                         |                   |    | 4                             | 1                               |  |  |  |  |  |  |
| Bare rock                       |                          |                           | 1                | 1                    |                        |                    | 1                   |                    |             |  |                       |           |        |                   |             |            |        |           |        |                         |                   |    | 4                             |                                 |  |  |  |  |  |  |
| Sparsely vegetated areas        | 1                        |                           | 1                | 1                    |                        |                    |                     |                    |             |  |                       |           |        |                   |             |            |        |           |        |                         |                   |    |                               |                                 |  |  |  |  |  |  |
| Burnt areas                     | 1                        |                           |                  |                      |                        |                    |                     |                    |             |  |                       |           |        |                   |             |            |        |           |        |                         |                   |    |                               |                                 |  |  |  |  |  |  |
| Glaciers and perpetual snow     | 3                        | 3                         |                  | 4                    |                        |                    |                     |                    |             |  |                       |           |        |                   |             |            |        |           |        | 5                       |                   |    | 5                             |                                 |  |  |  |  |  |  |
| Inland marshes                  | 2                        | 2                         | 4                | 2                    |                        | 4                  |                     |                    |             |  | 2                     | 5         |        |                   |             |            |        |           |        |                         |                   |    |                               |                                 |  |  |  |  |  |  |
| Peatbogs                        | 4                        | 5                         | 3                | 3                    |                        | 3                  | 4                   | 2                  |             |  |                       |           |        |                   |             |            |        |           | 2      |                         |                   |    | 4                             | 4                               |  |  |  |  |  |  |
| Salt marshes                    | 1                        |                           | 5                |                      |                        | 2                  |                     |                    |             |  | 2                     |           |        |                   |             |            |        |           |        |                         |                   |    |                               | 3                               |  |  |  |  |  |  |

# Produkční matice ekosystémových služeb - expertní zhodnocení kapacity poskytovat ekosystémové služby

(Burkhard et al., 2012)



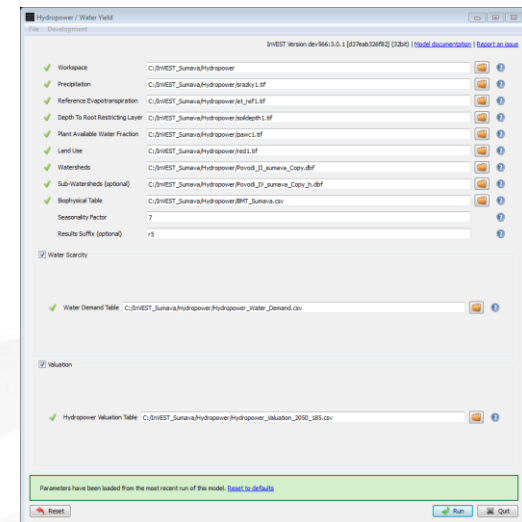
- Integrated Valuation of Environmental Services and Tradeoffs

<http://www.naturalcapitalproject.org/>

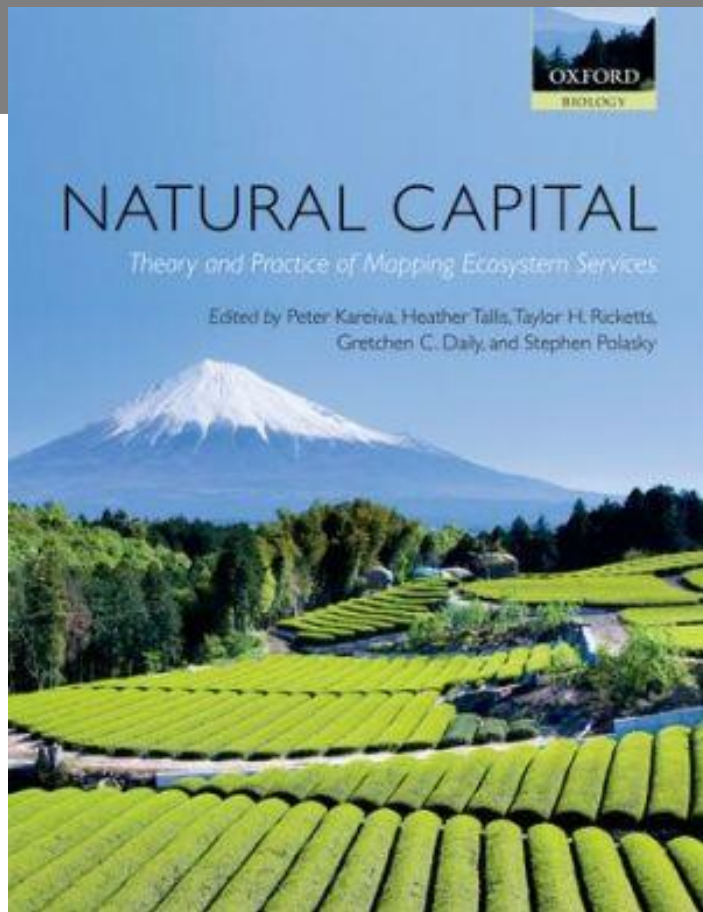
<http://www.naturalcapitalproject.org/InVEST.html>

- National Capital Project, Stanford University

- Ekologické produkční křivky
- Důraz na produkci ES







Kareiva et al., 2011

OPEN ACCESS Freely available online

PLOS one

## Projecting Global Land-Use Change and Its Effect on Ecosystem Service Provision and Biodiversity with Simple Models

Erik Nelson<sup>1\*</sup>, Heather Sander<sup>2\*</sup>, Peter Hawthorne<sup>3</sup>, Marc Conte<sup>1</sup>, Driss Ennaanay<sup>1</sup>, Stacie Wolny<sup>1</sup>, Steven Manson<sup>4</sup>, Stephen Polasky<sup>2,5</sup>

## Ecosystem services in decision making: time to deliver

Gretchen C Daily<sup>1\*</sup>, Stephen Polasky<sup>2</sup>, Joshua Goldstein<sup>1</sup>, Peter M Kareiva<sup>3</sup>, Harold A Mooney<sup>1</sup>, Liba Pejchar<sup>1</sup>, Taylor H Ricketts<sup>4</sup>, James Salzman<sup>5</sup>, and Robert Shallenberger<sup>6</sup>

## Modeling multiple ecosystem services, biodiversity conservation, commodity production, and tradeoffs at landscape scales

Erik Nelson<sup>1\*</sup>, Guillermo Mendoza<sup>1</sup>, James Regetz<sup>2</sup>, Stephen Polasky<sup>3</sup>, Heather Tallis<sup>1</sup>, D Richard Cameron<sup>4</sup>, Kai MA Chan<sup>5</sup>, Gretchen C Daily<sup>6</sup>, Joshua Goldstein<sup>7</sup>, Peter M Kareiva<sup>8</sup>, Eric Lonsdorf<sup>9</sup>, Robin Naidoo<sup>10</sup>, Taylor H Ricketts<sup>10</sup>, and M Rebecca Shaw<sup>4</sup>

## Integrating ecosystem-service tradeoffs into land-use decisions

Joshua H. Goldstein<sup>a,1</sup>, Giorgio Caldarone<sup>b</sup>, Thomas Kao Duarte<sup>b</sup>, Driss Ennaanay<sup>c,d</sup>, Neil Hannahs<sup>b</sup>, Guillermo Mendoza<sup>e</sup>, Stephen Polasky<sup>f,g</sup>, Stacie Wolny<sup>c,d</sup>, and Gretchen C. Daily<sup>c,d,1</sup>

<sup>a</sup>Department of Human Dimensions of Natural Resources, Colorado State University, Fort Collins, CO 80523; <sup>b</sup>Land Assets Division, Kamehameha Honolulu, HI 96813; <sup>c</sup>Department of Biology and <sup>d</sup>Woods Institute for the Environment, Stanford University, Stanford, CA 94305; <sup>e</sup>Institute Resources, US Army Corps of Engineers, Alexandria, VA 22315; and Departments of <sup>f</sup>Applied Economics and <sup>g</sup>Ecology, Evolution, and Behavior, Minnesota, St. Paul, MN 55108

Contributed by Gretchen C. Daily, February 17, 2012 (sent for review September 15, 2011)

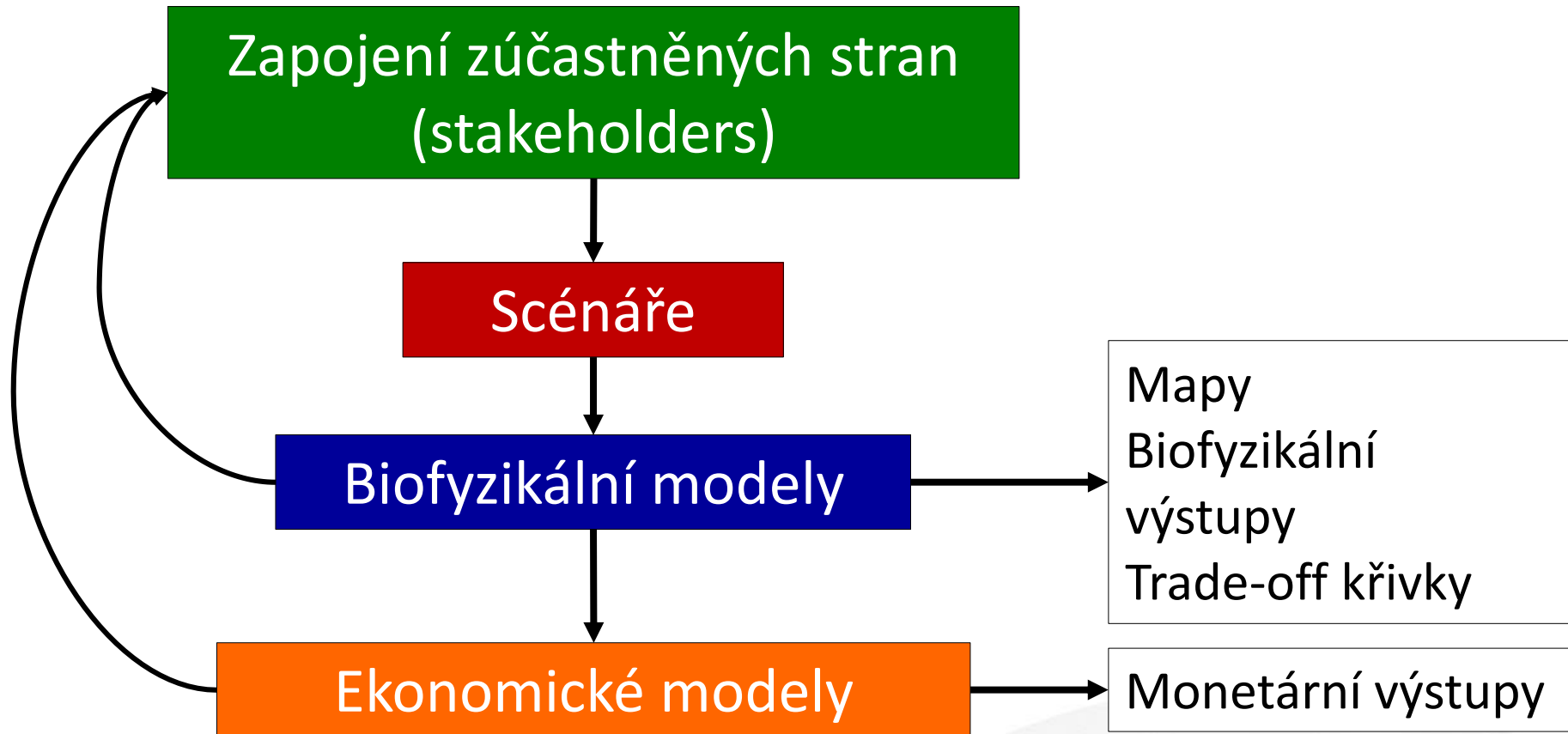
PNAS

# ES zahrnuté v modelech InVEST

- Suchozemské ekosystémy
  - Ukládání uhlíku
  - Čištění vody: zadržování živin
  - Zadržování sedimentů
  - Biodiverzita
  - Produkce elektřiny vodními elektrárnami
  - Produkce dřeva
  - Opylování
- Mořské ekosystémy



# Modelovací proces

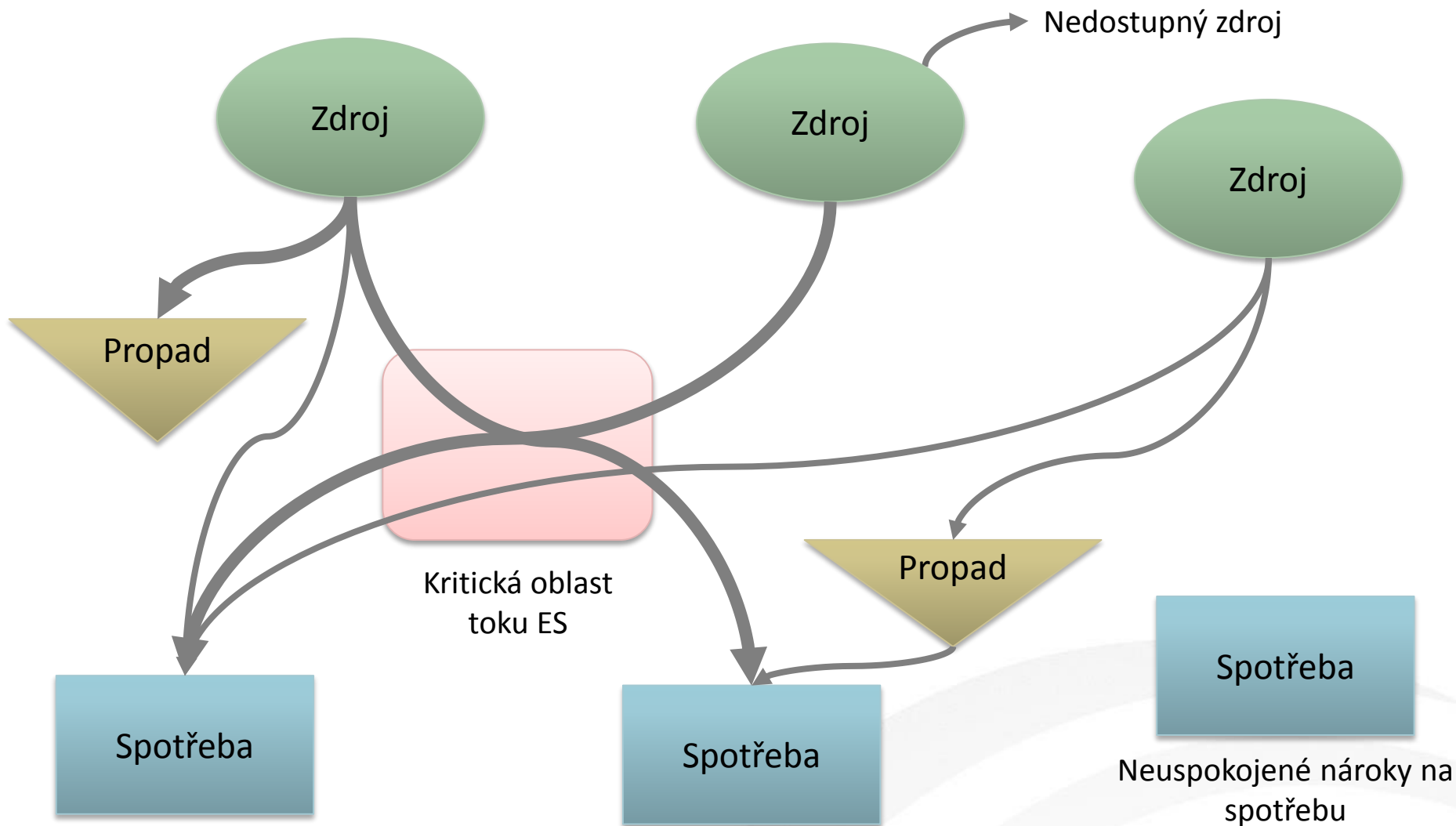




- ARtificial Intelligence for Ecosystem Services
- University of Vermont, Basque Centre for Climate Change (BC3)
- Důraz na spotřebu ES
- Dva typy rozhraní: modelovací x uživatelské

```
model Infiltration,  
  (uncertainty of im.ecology:Soil im.hydrology:InfiltratedWaterVolume)  
  as measure im.ecology:Soil im.hydrology:InfiltratedWaterVolume in mm  
  discretized by im:Level into  
    im:High if 5 to 10,  
    im:Low if 0 to 5  
  observing  
    (ElevationSeaLevel as classify (measure im.geography:Elevation in m) by im:Level into  
      im:Low if < 300,  
      im:Medium if 300 to 1000,  
      im:High if > 1000  
    ),  
    (Slope as classify (measure im.geography:Slope in degree_angle) by im:Level into  
      im:Low if < 5,  
      im:Medium if 5 to 14,  
      im:High if > 14  
    )  
  using bayesian(import="bn/testtraits.xdsl");
```

# Konceptualizace ES



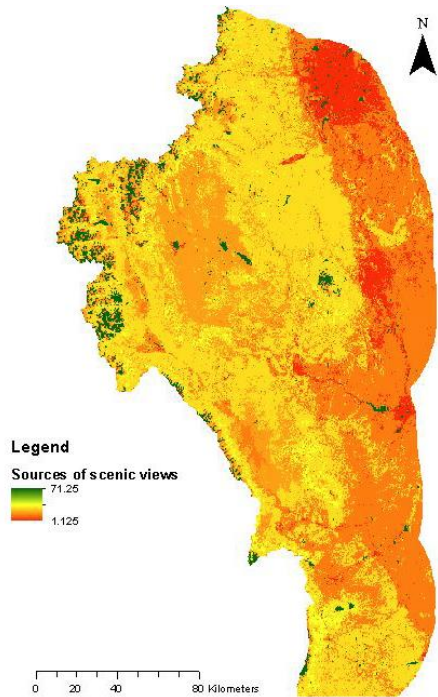


# ES hodnocené modelem ARIES

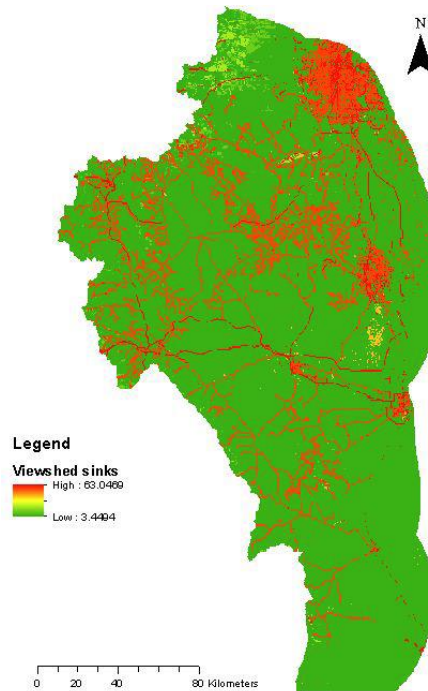
- Suchozemské ekosystémy
  - Ukládání uhlíku
  - Čištění vody: zadržování živin
  - Zadržování sedimentů
  - Opylování
  - Regulace povodní
  - Produkce ryb
  - Estetická hodnota krajiny
  - Rekreace



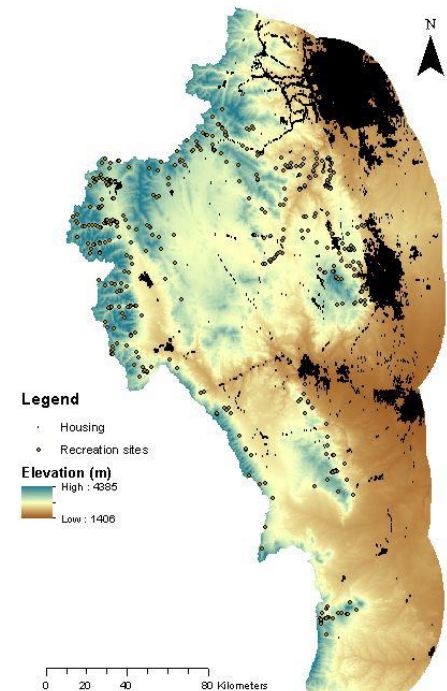
# Zdroje ES



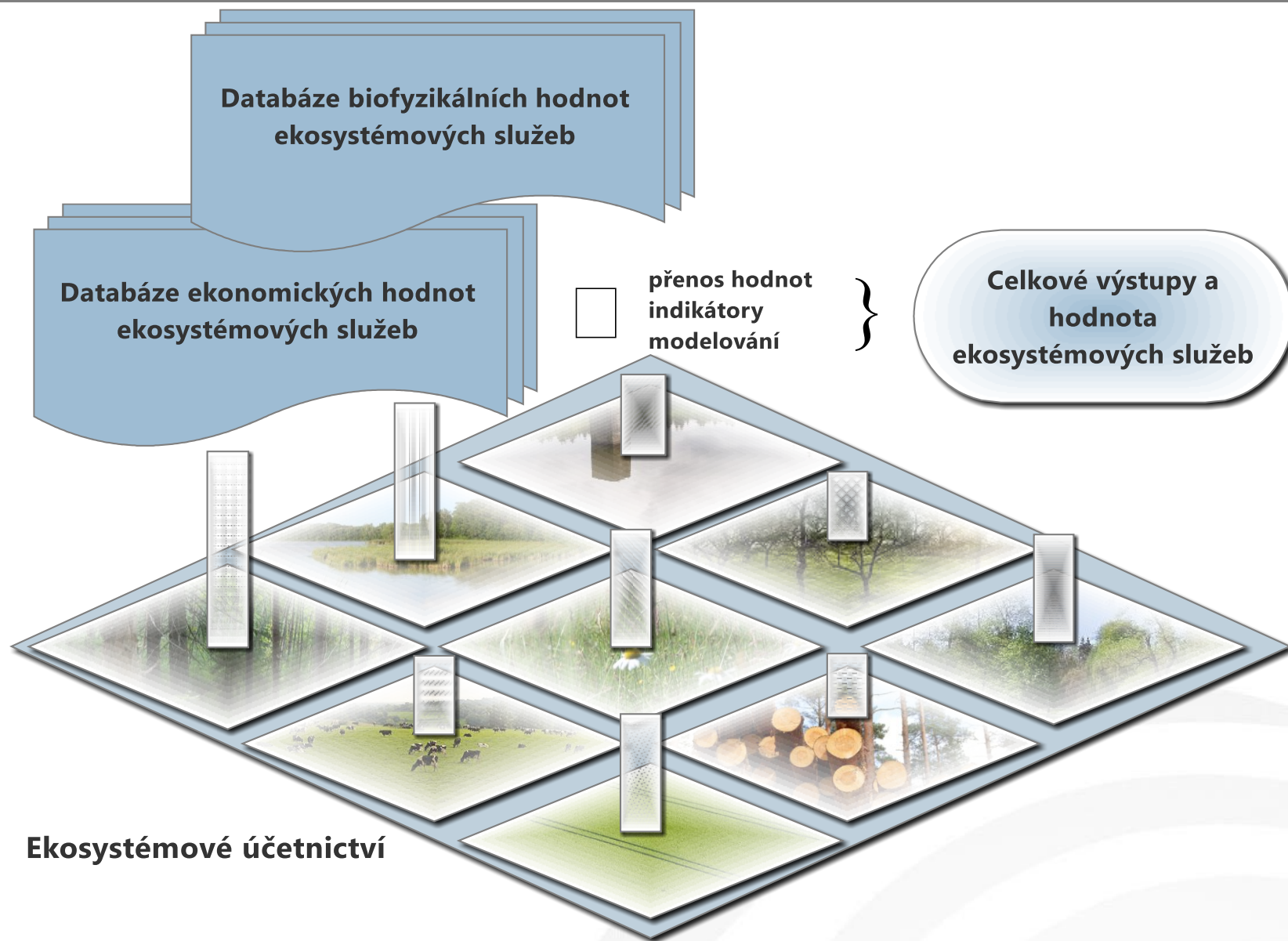
# Propady ES



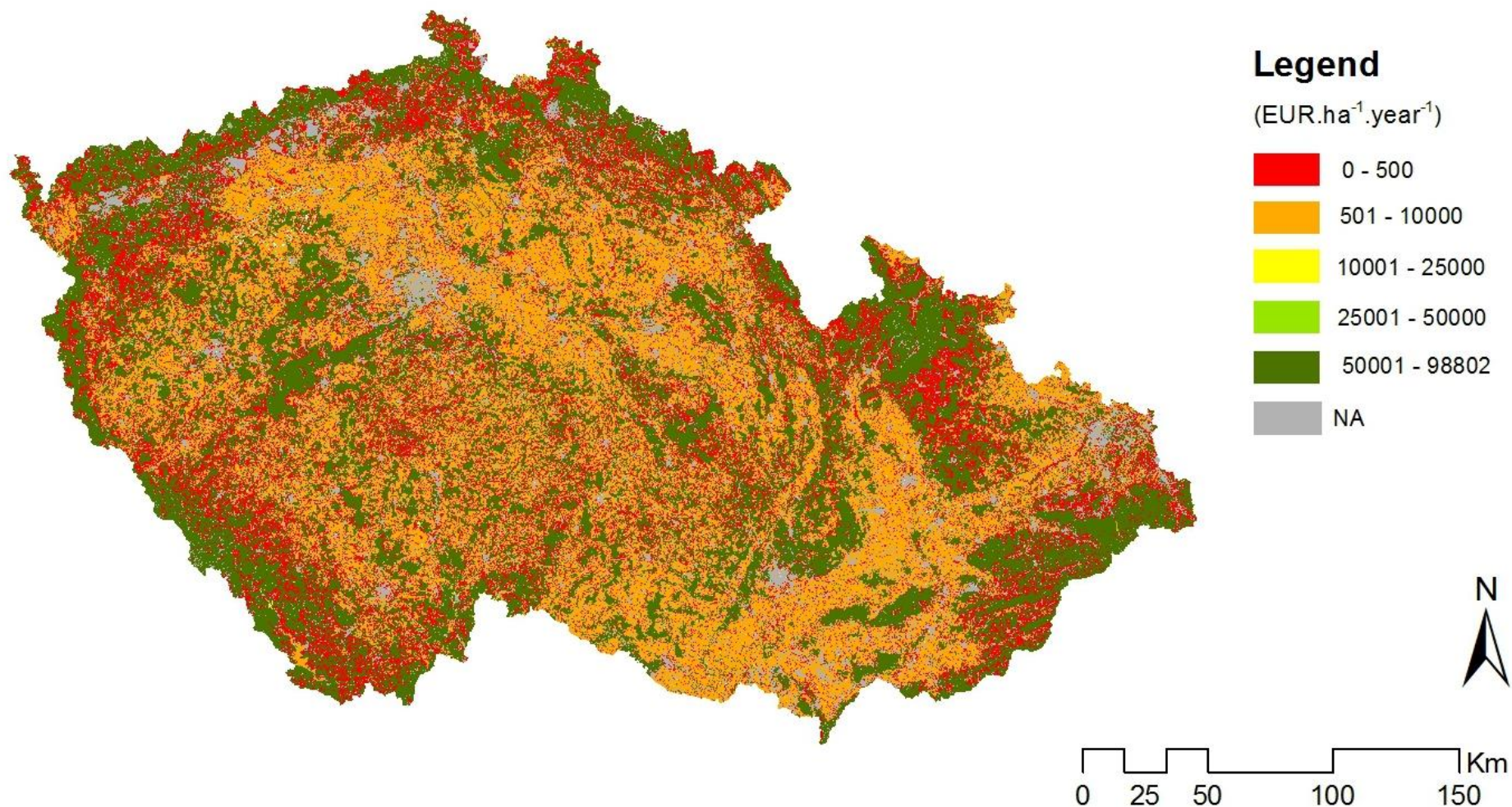
# Spotřeba ES



# Konsolidovaná vrstva ekosystémů ČR







Frélichová, J., Vačkář, D., Pártl, A., Loučková, B., Harmáčková, Z. V., Lorencová, E. (2014) *Integrated Assessment of Ecosystem Services in the Czech Republic. Ecosystem Services* 8: 110-117.

# Scénářový přístup

- reakce na nejistotu budoucího vývoje a predikcí
- scénáře "pravděpodobným, ale zjednodušeným způsobem popisují možný budoucí vývoj a základě koherentního souboru předpokladů týkajících se klíčových hnacích sil a vztahů"
- nejedná se o prognózy!
- storyline (narrative) = kvalitativní, popisná součást scénáře (příběh – nejdůležitější aspekty scénáře, hlavní směřování)
- přímé a nepřímé hnací síly





McKenzie et al., 2012

REVIEWS REVIEWS REVIEWS

## Why global scenarios need ecology

EM Bennett<sup>1</sup>, SR Carpenter<sup>1</sup>, GD Peterson<sup>1</sup>, GS Cumming<sup>2</sup>, M Zurek<sup>3</sup>, and P Pingali<sup>3</sup>

*Essay*

## Scenario Planning: a Tool for Conservation in an Uncertain World

GARRY D. PETERSON,<sup>\*‡</sup> GRAEME S. CUMMING,<sup>†</sup> AND STEPHEN R. CARPENTER<sup>\*</sup>

<sup>\*</sup>Center for Limnology, 680 N. Park Street, University of Wisconsin, Madison, WI 53706-1492, U.S.A.

<sup>†</sup>Wildlife Ecology and Conservation, Newins-Ziegler 303, Box 110430, University of Florida, Gainesville, FL 32611, U.S.A.

Advanced Review

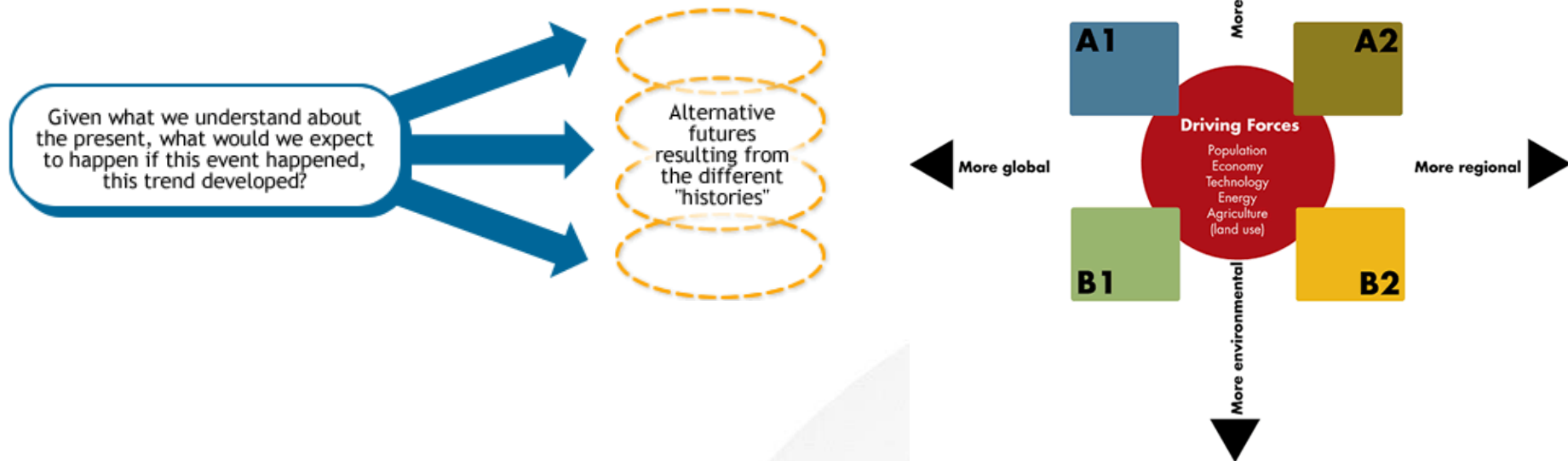
## Developing qualitative scenario storylines for environmental change assessment

Mark D. A. Rounsevell<sup>\*</sup> and Marc J. Metzger



# Typy scénářů

- Explorativní
  - pravděpodobné alternativy socioekonomického vývoje
  - porovnávání možných situací
  - série předpokladů  $\Rightarrow$  lišící se výsledky
  - př. IPCC SRES



# Typy scénářů

## ■ Normativní

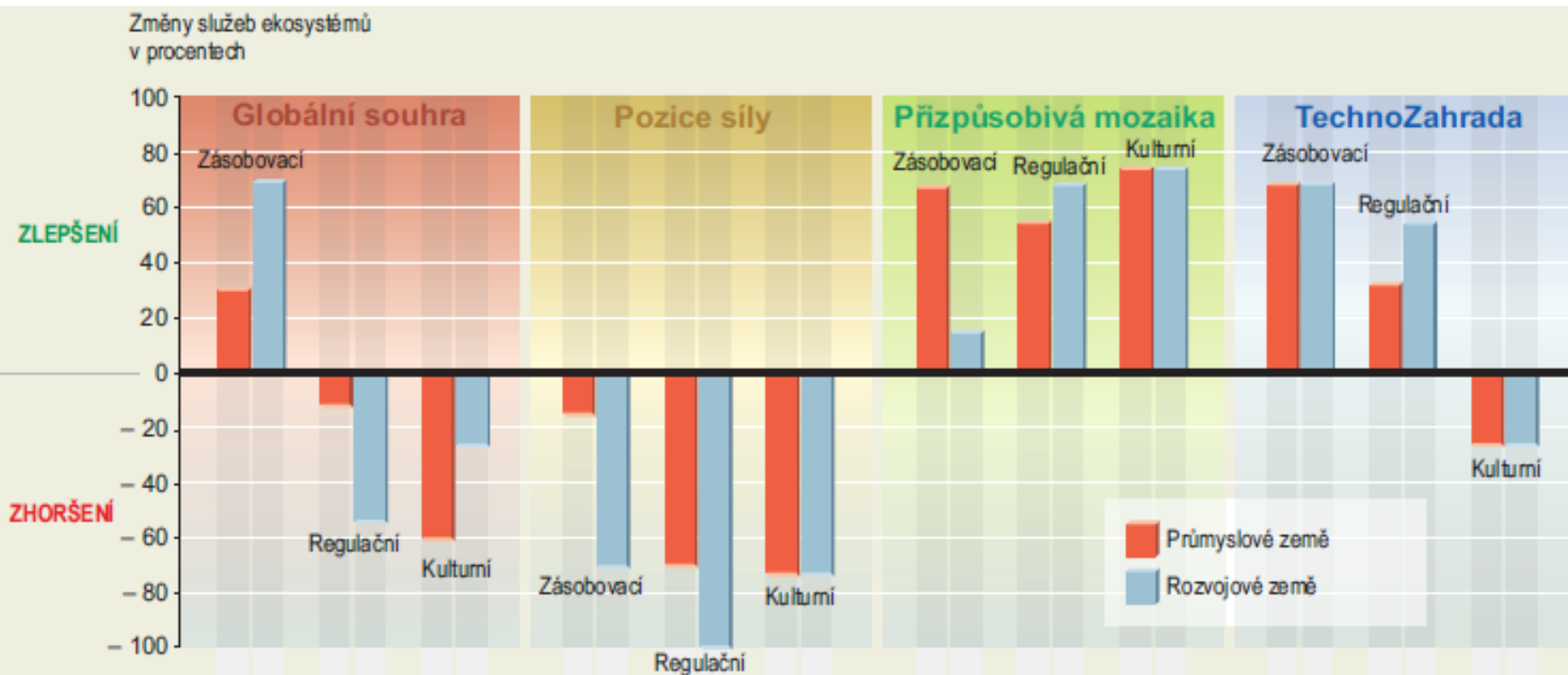
- popisují sérii událostí a příčinných souvislostí, které vedou ke změnám od současných podmínek k zamýšlené budoucnosti
- možné různé cesty ke stejnému cíli
- př. scénáře tvorby politik (CBD, Millenium Development Goals, EU)



# Scénářový přístup MA



# Poskytování ES podle scénářů MA



Počet služeb

|           |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|-----------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Zlepšení  | 3 | 4 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 4 | 3 | 5 | 6 | 4 | 4 | 4 | 4 | 4 | 6 | 1 | 1 |
| Beze změn | 2 | 2 | 8 | 2 | 3 | 2 | 3 | 0 | 3 | 0 | 2 | 0 | 2 | 1 | 4 | 3 | 0 | 0 | 2 | 2 | 4 | 2 | 2 | 2 |
| Zhoršení  | 1 | 0 | 1 | 6 | 2 | 2 | 2 | 5 | 6 | 9 | 3 | 4 | 0 | 2 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 2 | 2 |



Scénáře kombinující ochranu přírody,  
ekonomický rozvoj a začlenění  
adaptačních opatření na změnu  
klimatu

**Rozvoj**

**Ochrana  
přírody**

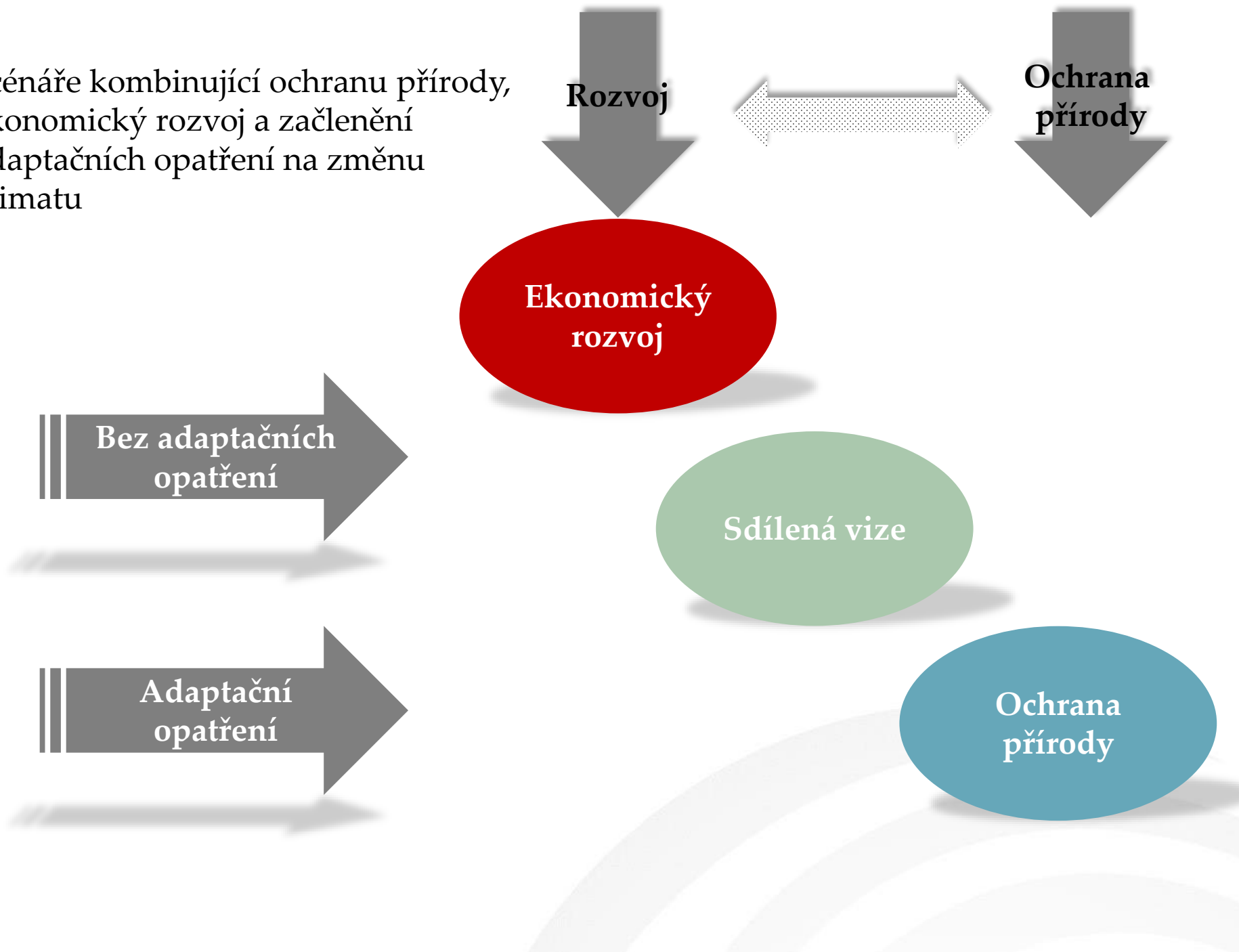
**Ekonomický  
rozvoj**

**Bez adaptačních  
opatření**

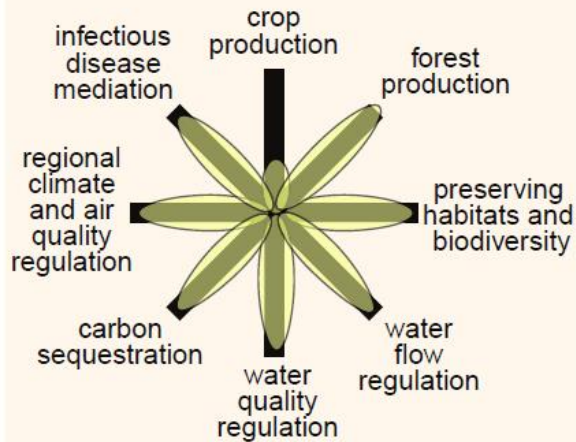
**Sdílená vize**

**Adaptační  
opatření**

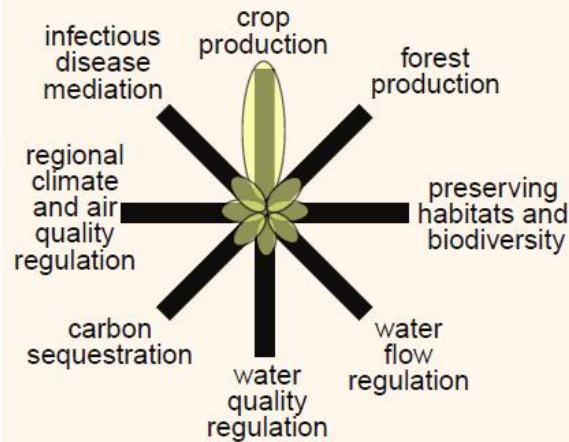
**Ochrana  
přírody**



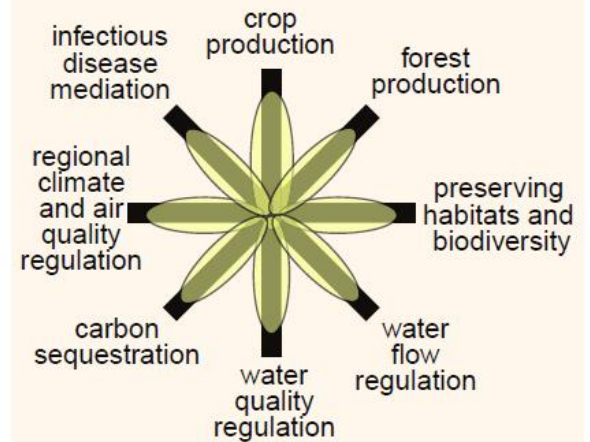
# Hodnocení rozporných nároků na ES



natural ecosystem



intensive cropland



cropland with restored ecosystem services

ES

## Třeboňsko: scénáře 2006 - 2050

Ekonomický  
rozvoj

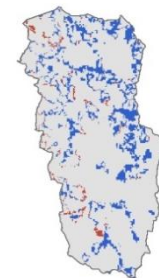
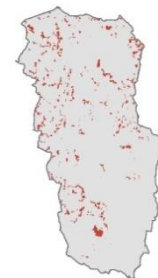
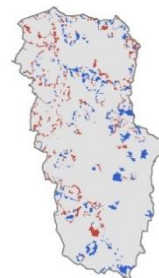
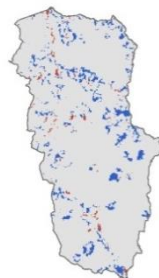
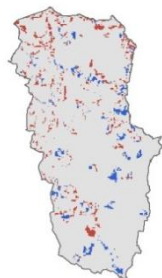
Exploatace  
krajiny

BaU

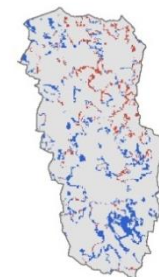
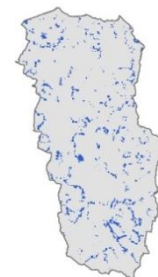
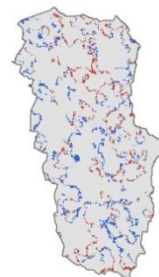
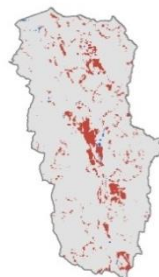
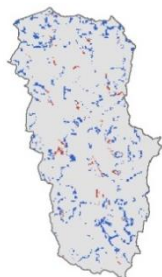
Ochrana  
přírody

Biopaliva

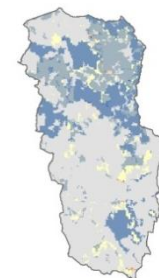
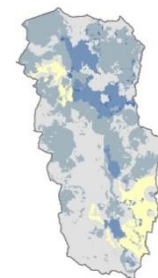
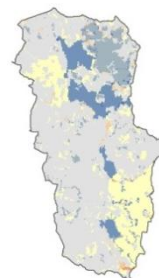
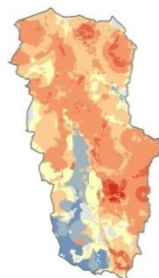
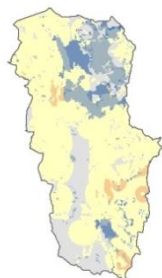
Produkce  
zemědělských  
plodin



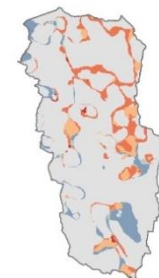
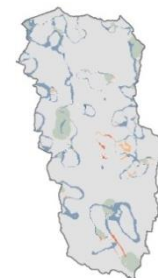
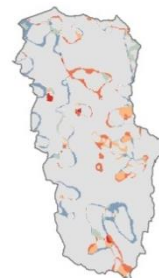
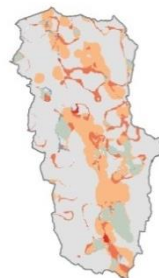
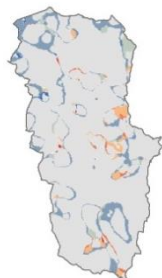
Produkce  
dřeva



Rekreační  
potenciál  
krajiny



Estetický  
potenciál  
krajiny



Růst



Pokles

ES

## Třeboňsko: scénáře 2006 - 2050

Ekonomický  
rozvoj

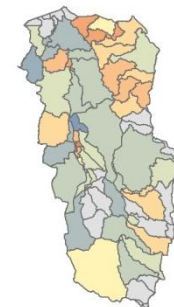
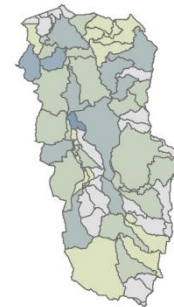
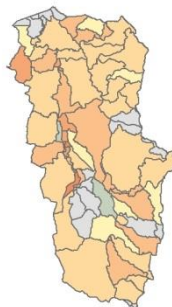
Exploatace  
krajiny

BaU

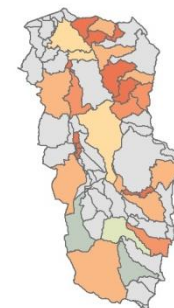
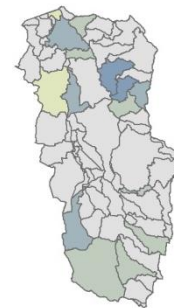
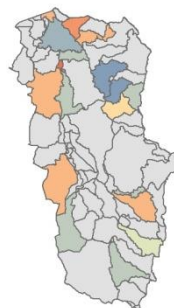
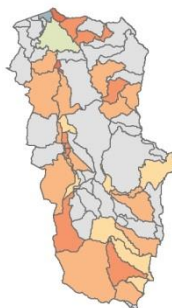
Ochrana  
přírody

Biopaliva

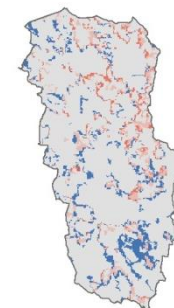
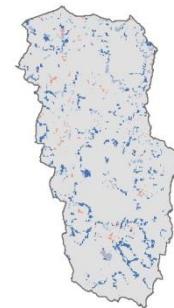
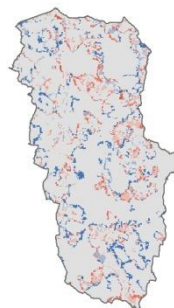
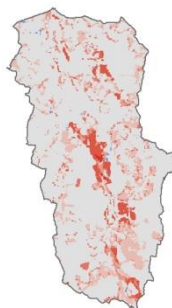
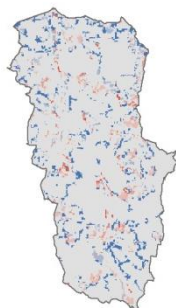
Kvalita  
vody:  
retence  
dusíku



Kvalita  
vody:  
retence  
sedimentů



Regulace  
klimatu



Růst

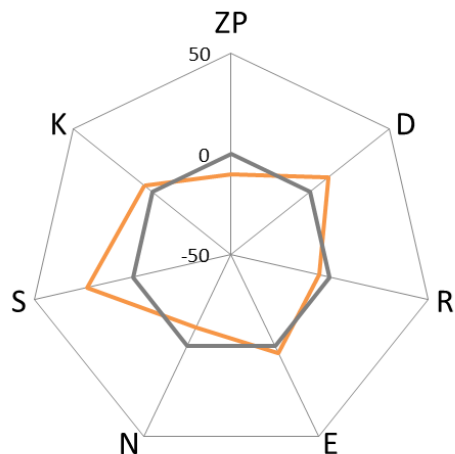


Pokles

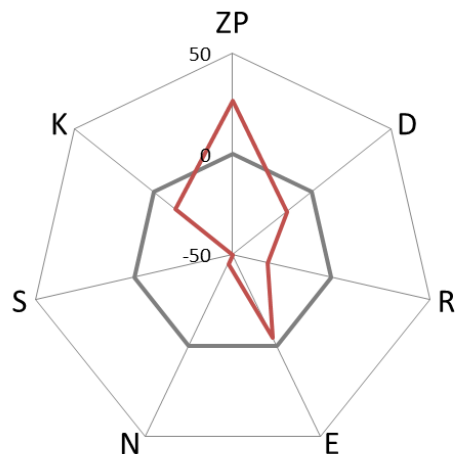


# Rozpory a synergie ES [% 2006-2050]

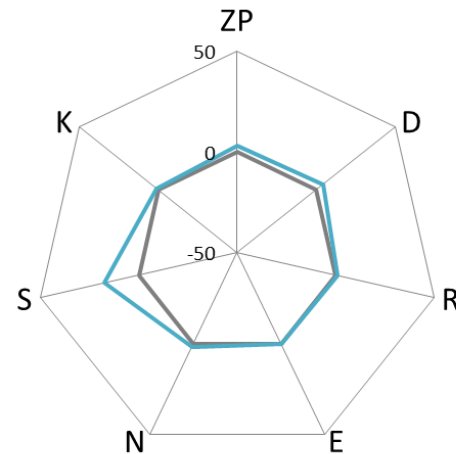
## **Ekonomický rozvoj**



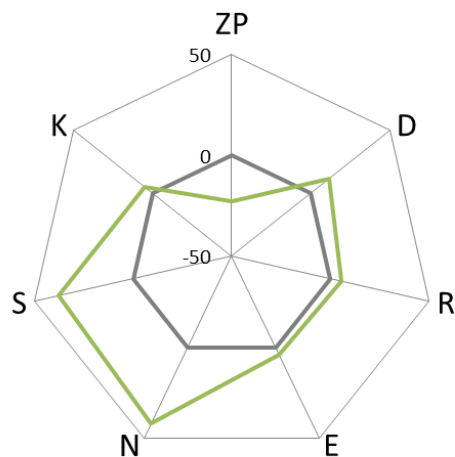
## **Exploatace krajiny**



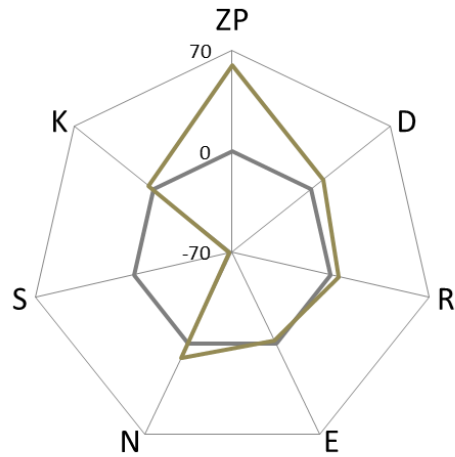
## **BaU**



## **Ochrana přírody**



## **Biopaliva**



## **Ekosystémové služby:**

Produkce zemědělských plodin (ZP)

Produkce dřeva (D)

Rekreační potenciál krajiny (R)

Estetický potenciál krajiny (E)

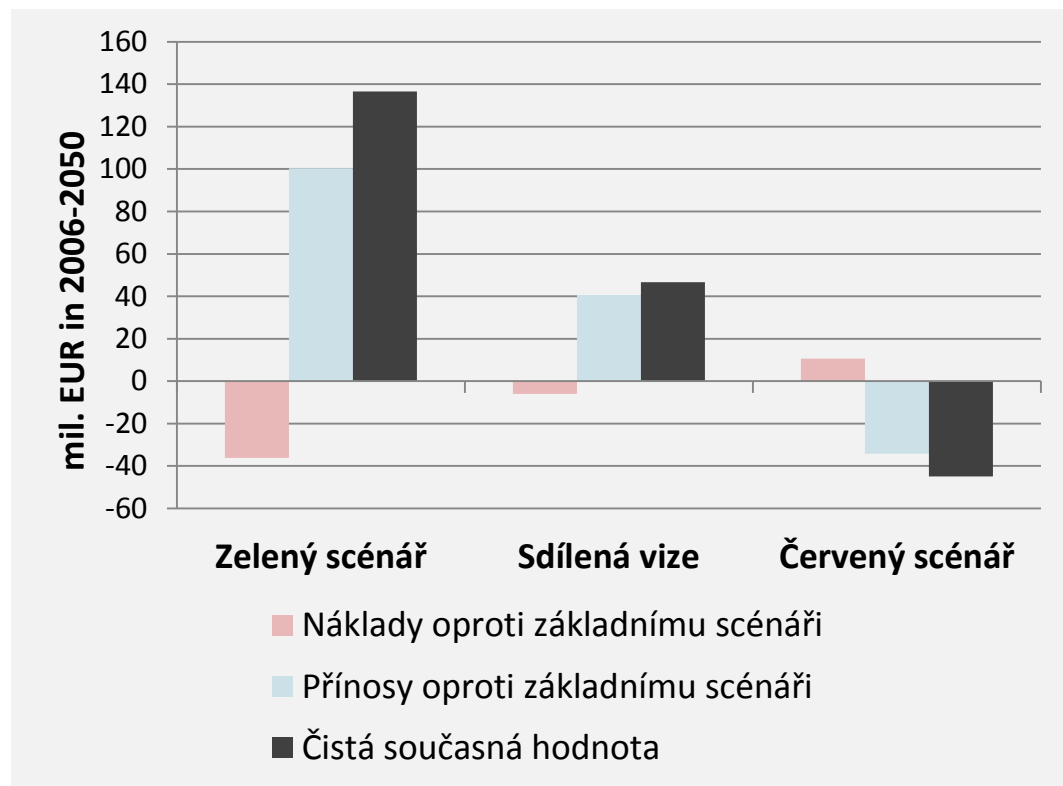
Kvalita vody: retence dusíku (N)

Kvalita vody: retence sedimentů (S)

Regulace klimatu (K)



# Analýza přínosů a nákladů (CBA)

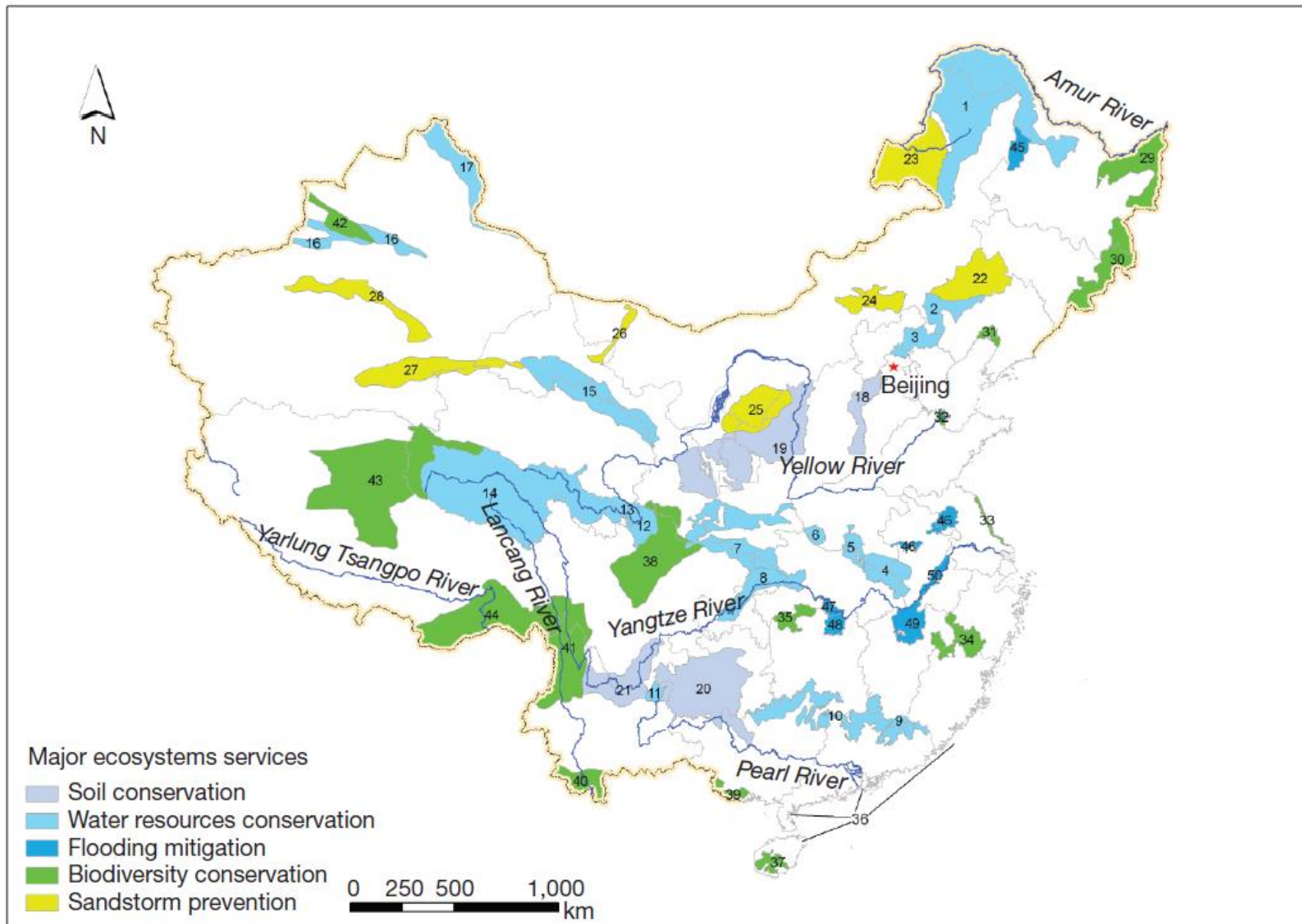


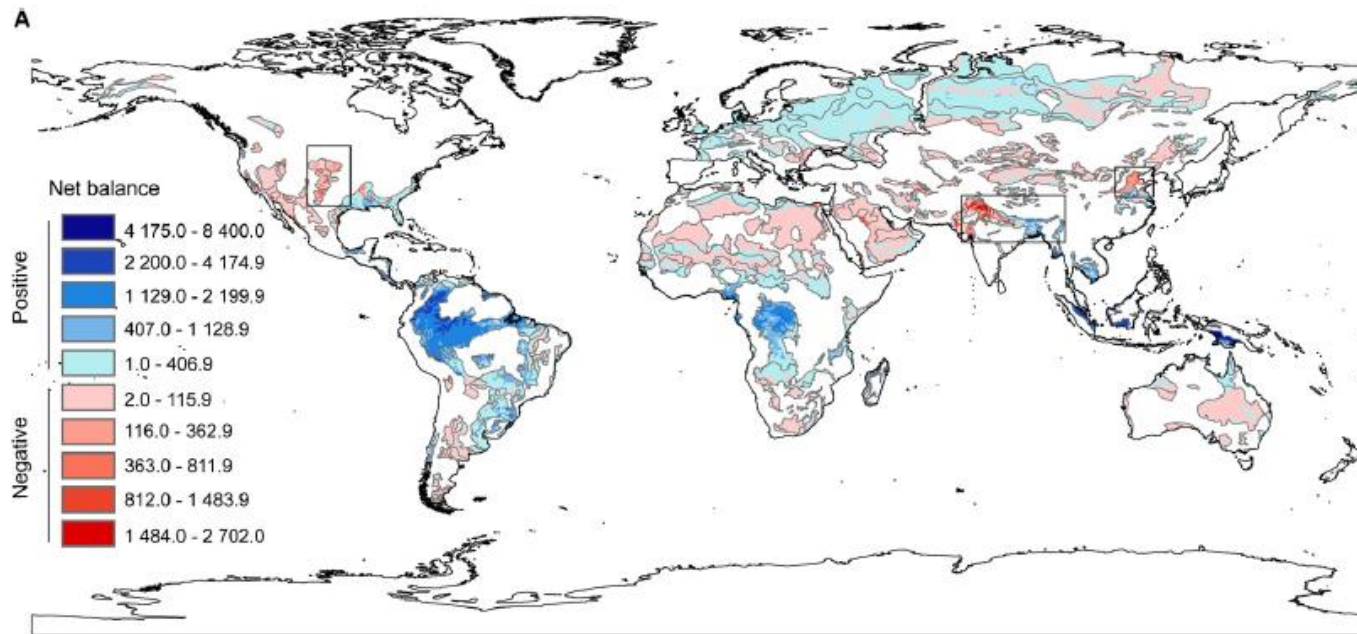
- Zelený scénář zahrnuje nejvyšší úroveň budoucích ekonomických přínosů
- Záporná čistá současná hodnota (NPV) Červeného scénáře

Výsledky zobrazeny pro klimatický scénář RCP 4.5, diskontní sazbu 1%, průměrné mezní náklady a jednotkové hodnoty ES

Harmáčková, Z., Lorencová, E., Vačkář, D. Ecosystem based adaptation and disaster risk reduction: scenario analysis of ecosystem services costs and benefits in a Central European national park. Springer, in press.

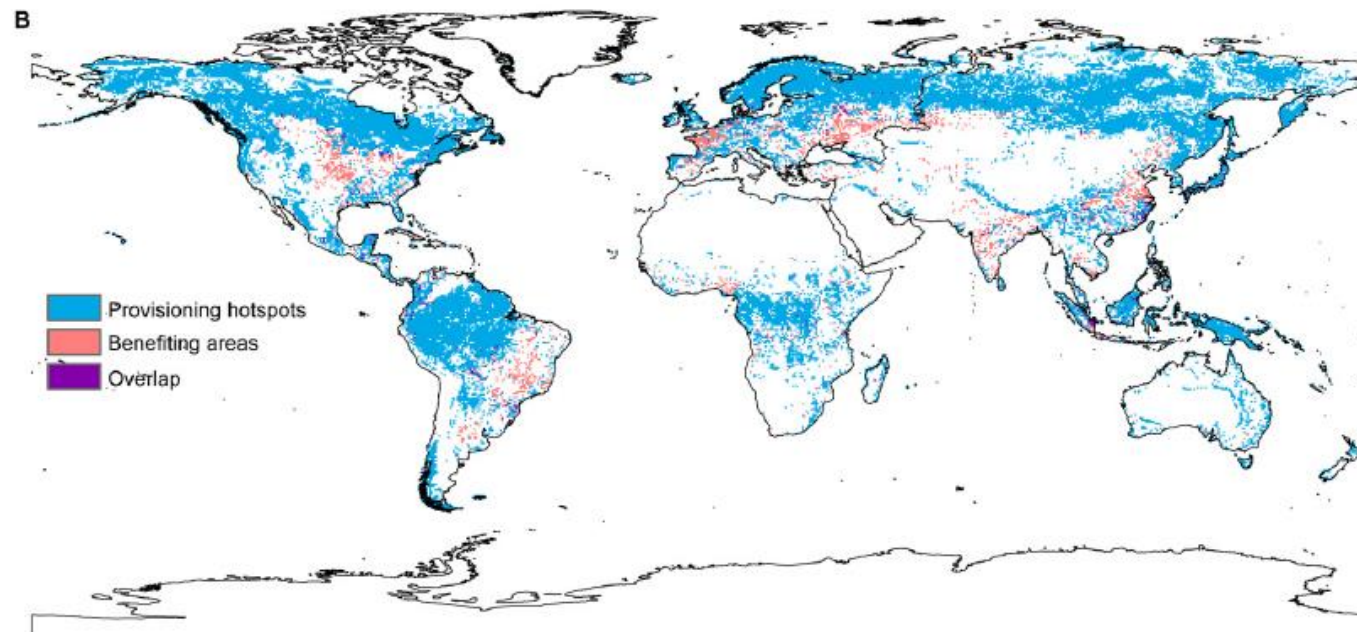
# Oblasti ochrany fungování ekosystémů v Číně (EFCA)





## Oblasti překryvu dodávky a užití ES

H.M. Serna-  
Chaveza et al.,  
2014, Ecol. Indicat.



# Shrnutí: proč ekosystémové služby

- Ekosystémové služby vyjadřují měřitelné přínosy lidské společnosti a kvalitě lidského života
- Ekosystémové služby zviditelňují hodnotu přírody a umožňují ji komunikovat v jednotném rámci
- Ekosystémové služby umožňují zhodnotit synergie a konflikty péče o životní prostředí, včetně možného budoucího vývoje
- Ekosystémové služby se začleňují do rozhodovacích procesů a mohou být využity jako podklad pro rozhodování na mnoha různých úrovních

# Děkuji za pozornost!

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david.vackar@czp.cuni.cz

<http://www.ecosystemservices.cz>

