Human activity, global change and its impacts on ecosystem services

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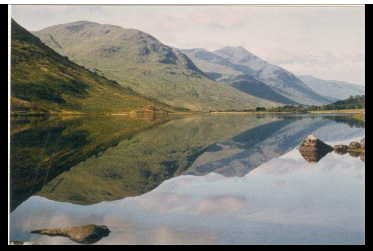
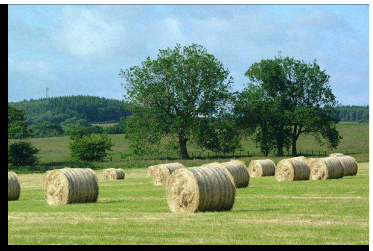
food production

slope stability

fire prevention


water storage


fibre production

biodiversity

pollination

Humans affect biodiversity and *vice versa*:

Ecosystem services form **vital links** between **humans** and their **environment.**

fodder production

carbon sequestration

flood protection

tourist attraction

recreation

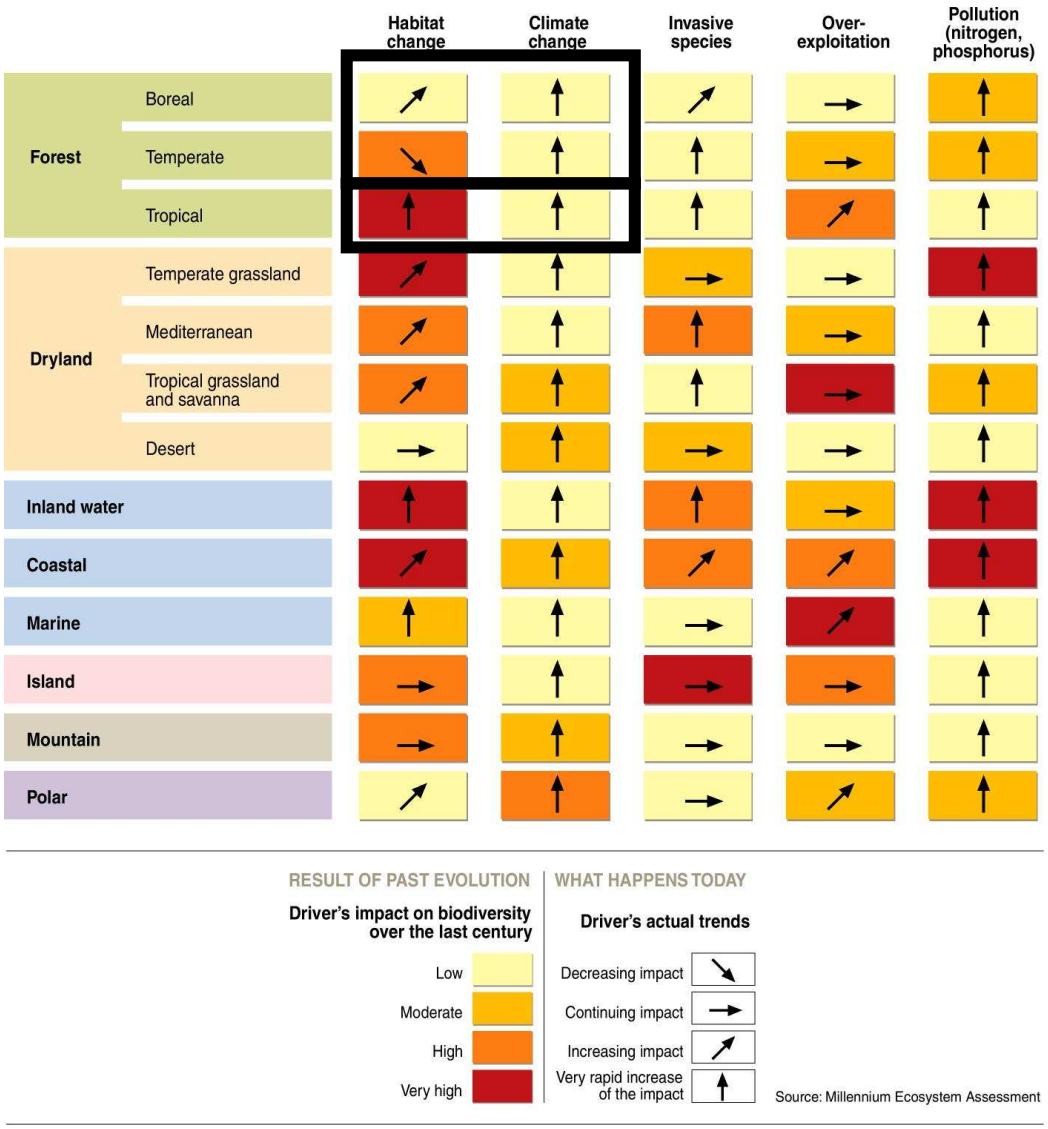
stabilising micro-climate

game reserve

shelter for livestock

beauty

Direct drivers of ecosystem services



Most direct drivers of degradation in ecosystem services are remaining constant or are growing in intensity in most ecosystems.

Millennium Ecosystem Assessment, 2005.

Impact Example 1: Europe

An ecosystem service assessment based on multiple, consistent, spatially explicit scenarios of **climate *and* land use change** (1990 - 2100, SRES A1FI, A2, B1, B2) and a range of ecosystem models.

www.pik-potsdam.de/**ATEAM**

Creating land use change scenarios: Three step approach

Land use categories
Urban, agriculture (subdivided into cropland, grassland, biomass energy), forest, protected areas.

1. **Quantify total area requirement** of each land use, as a function of changes in the relevant driver (e.g. demand for crops).

2. **Apply scenario specific allocation rules** to locate these land use quantities in geographic space across Europe.

3. **Post-process** to maintain **designated areas**.

Reginster and Rounsevell, 2006, Env Planning
Rounsevell et al. 2005, Agric. Ecosyst. Environ.

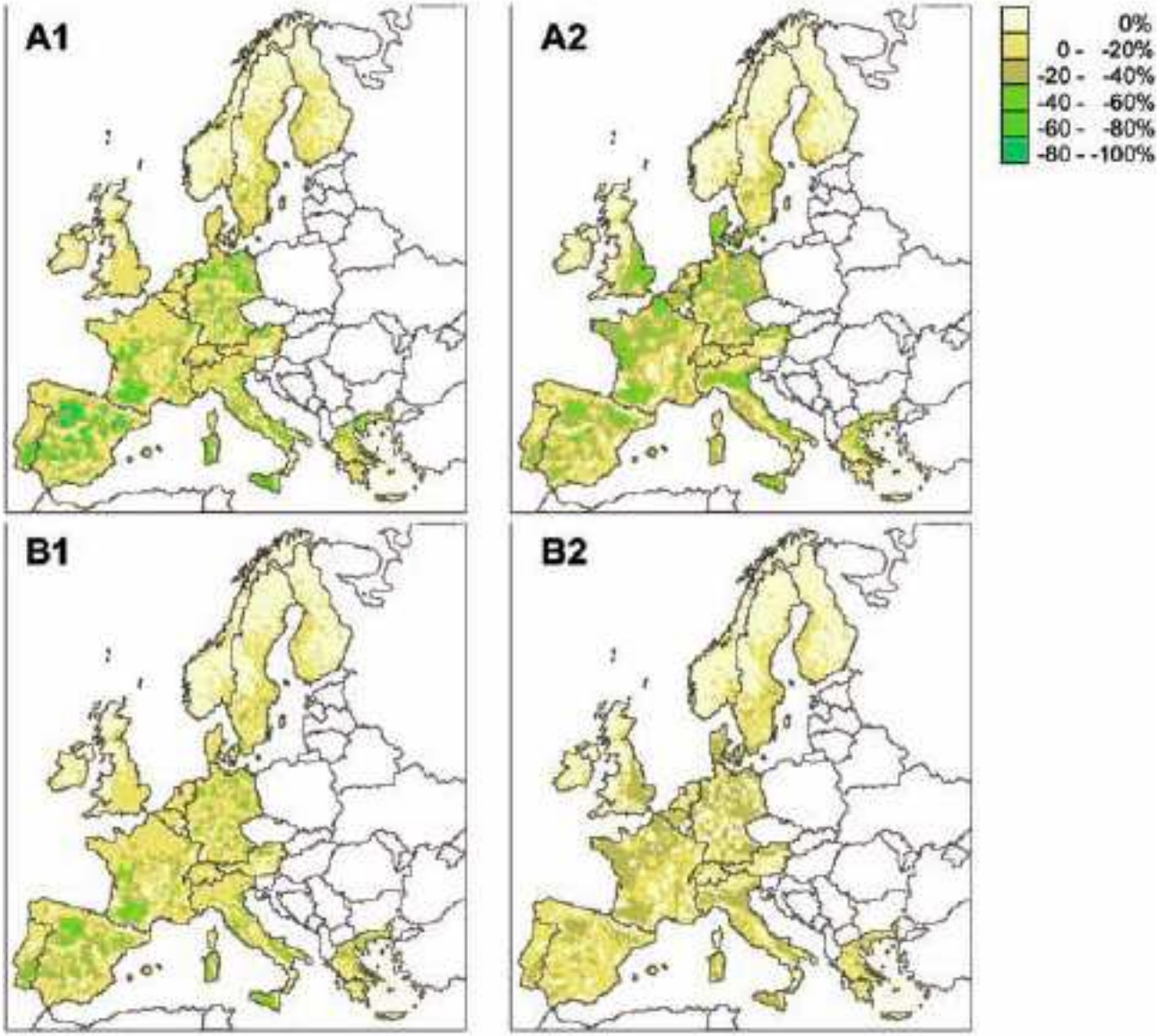
European agricultural land use drivers

Policy	Socio-Economics
Market intervention (subsidies, quotas)	*Demand*
Rural development (LFa)*	Population (consumption)
Environmental policy (NVZs, ESAs)**	Consumer preferences (meat, organic)
	Market liberalisation (WTO)***
	European Union enlargement
	Supply
	Resource competition (e.g. urban)
	Climate change (temperature, precipitation, CO_2)
	Technology and management

* Less Favoured Areas
** Nitrate Vulnerable Zones, Environmentally Sensitive Areas
*** World Trade Organisation

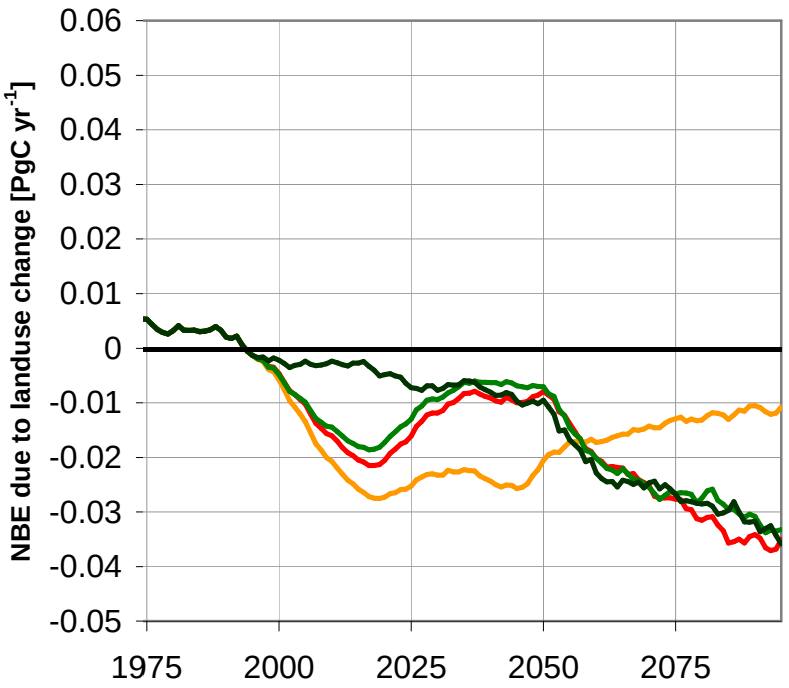
Reginster and Rounsevell, 2006, Env Planning
Rounsevell et al. 2005, Agric. Ecosyst. Environ.

Changes of cropland area
for food production by 2080



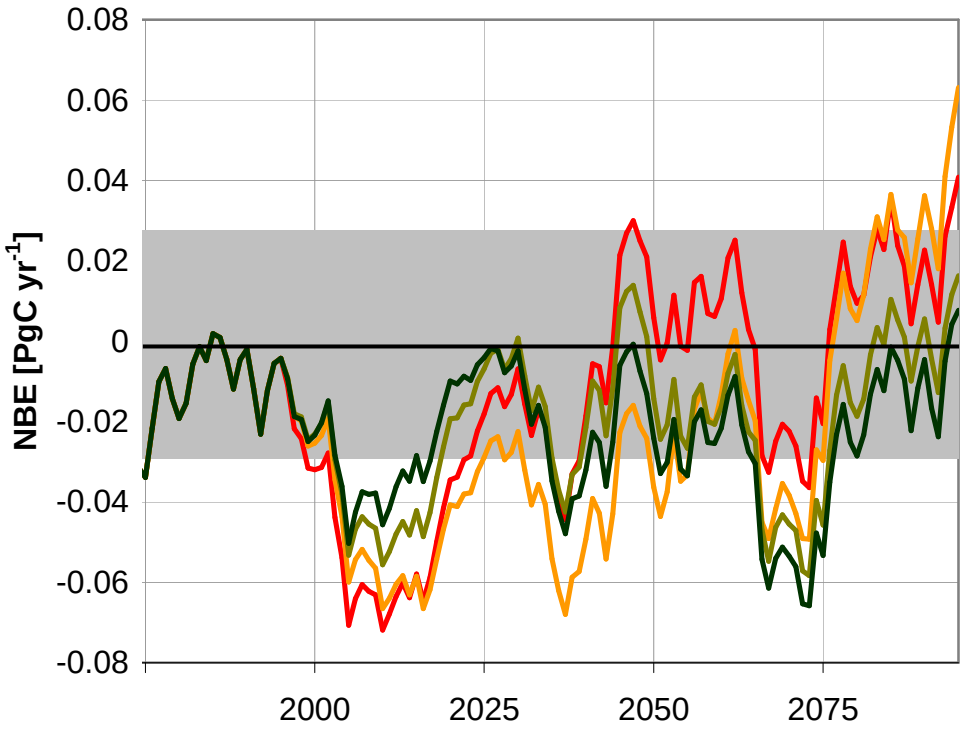
Schröter et al. 2005. *Science.*

European carbon storage



Land use change *only:*
positive effect, **sink increases**.

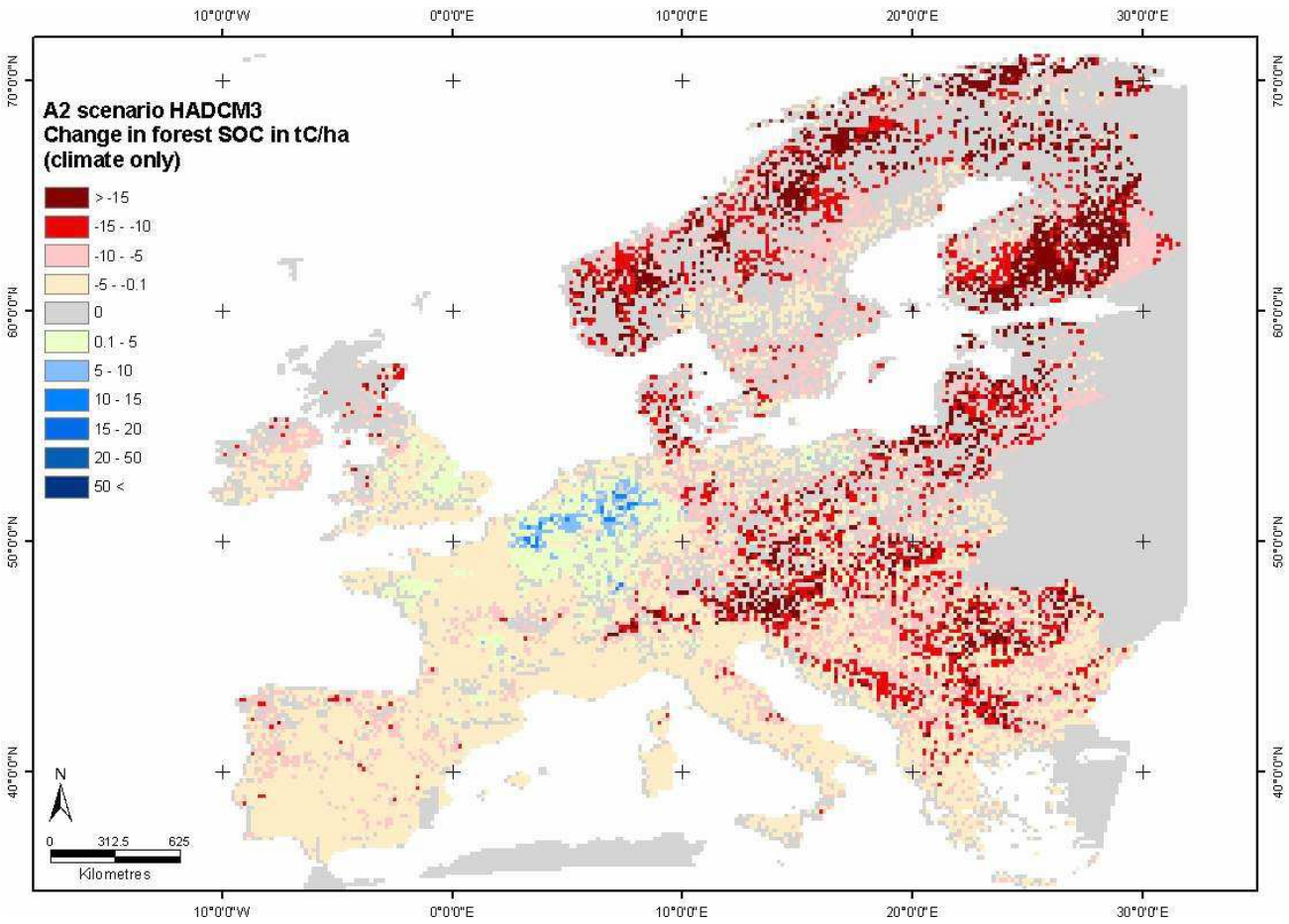
Land use *and* climate change together:
negative effect, **sink declines**.



pre-industrial natural variation
A1f
A2
B1
B2

Zaehle et al. 2004. *Geophys. Res. Abstr.*
Zaehle 2005. *PhD Thesis.*

Change in forest soil organic carbon
Driver: climate only.



Smith et al. 2005. Can. J. of Soil Sci.

Ecosystem services in Europe

Conclusions drawn from the sectors

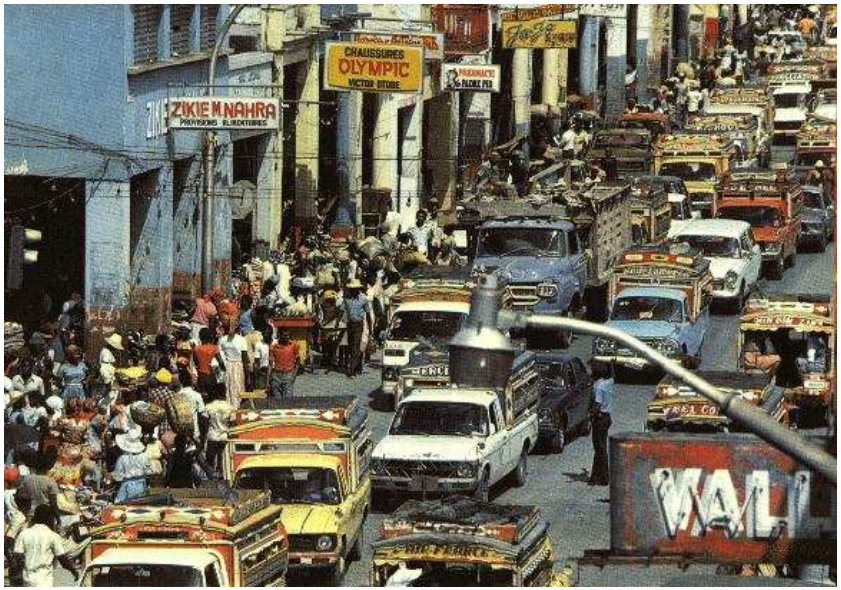
water, forestry, agriculture, tourism, nature conservation and energy:

Most of the problematic trends in Europe are climate related.

Land use change offers adaptation and mitigation opportunities.

Schröter et al. 2005. *Science.*

Impact example 2: Hispaniola



One Island, Two Stories

	Haiti	Dominican Republic
Economy	Poorest country outside Africa	Poor, but booming economy
Agriculture	Subsistence	Exports
Tourism	Few enclaves	Large industry
Population (Millions)	~10	~5
Population growth rate	High (3%)	Low (1.6%)
Forest area (%)	1	28
National Parks	4	74

Diamond, *Collapse*, 2005.
Schröter, CID Harvard Working Paper, 2005.

Degradation seen from space

From space: clear divide between Haiti and the Dominican Republic. Both have similar water resources.
Photo: NASA.

Farming Marginal Lands

Soil erosion leads to river silting, desertification, loss of hydropower option, hazards**.**

Hurricane Jeanne, 2004

- Jeanne brought **torrential rainfall** to Hispaniola
- In **Haiti** this resulted in **flooding and mudslides**
- **Similar exposure**, **different vulnerability**

	Haiti	Dominican Republic	Florida
Direct casualties	2 745	11	6
Injured	2 620	9	0
Lost homes	14 048	0	0
Resulting homeless	200 000	0	0
Total affected	315 594	14 009	40 000
Damage (US$)	21 Million	206 Million	7 Billion

EM-DAT, Emergency Disasters Data Base, Université Catholique de Louvain;
and National Hurricane Center, NOAA.

Conclusions

- Today's main **climate change adaptation strategy** for biodiversity should be **sustainable development of** other drivers, such as **habitat change and pollution**.
- **Industrial regions:** Trends in **direct drivers differ from developing regions:** ± stable population, little urbanisation, forest area ↑ , crop land ↓. This allows **land use changes** that **decrease negative impacts of climate change**, e.g.:
  - Water/energy/pollutant saving agricultural practices (e.g. organic farming)
  - biomass energy production (a sustainable amount)
  - a well-connected landscape to facilitate species migration
- **Developing regions:** immediate needs compromise vital ecosystem services, such as erosion regulation. Degradation has a direct and devastating effect on people. **Land use and climate change reinforce each other's negative impacts.**
  → Development and environmental conservation can create synergies.
- However, **conserving biodiversity does not necessarily conserve the ecosystem services valued by society** — We need to know which conservation measures sustain which ecosystem services, to feed this information into a **transdisciplinary policy process**.