Universität Hamburg

KlimaCampus

Land use science in the 21st century

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MACSUR mid-term Conference, Sassari 1- 4th April 2014

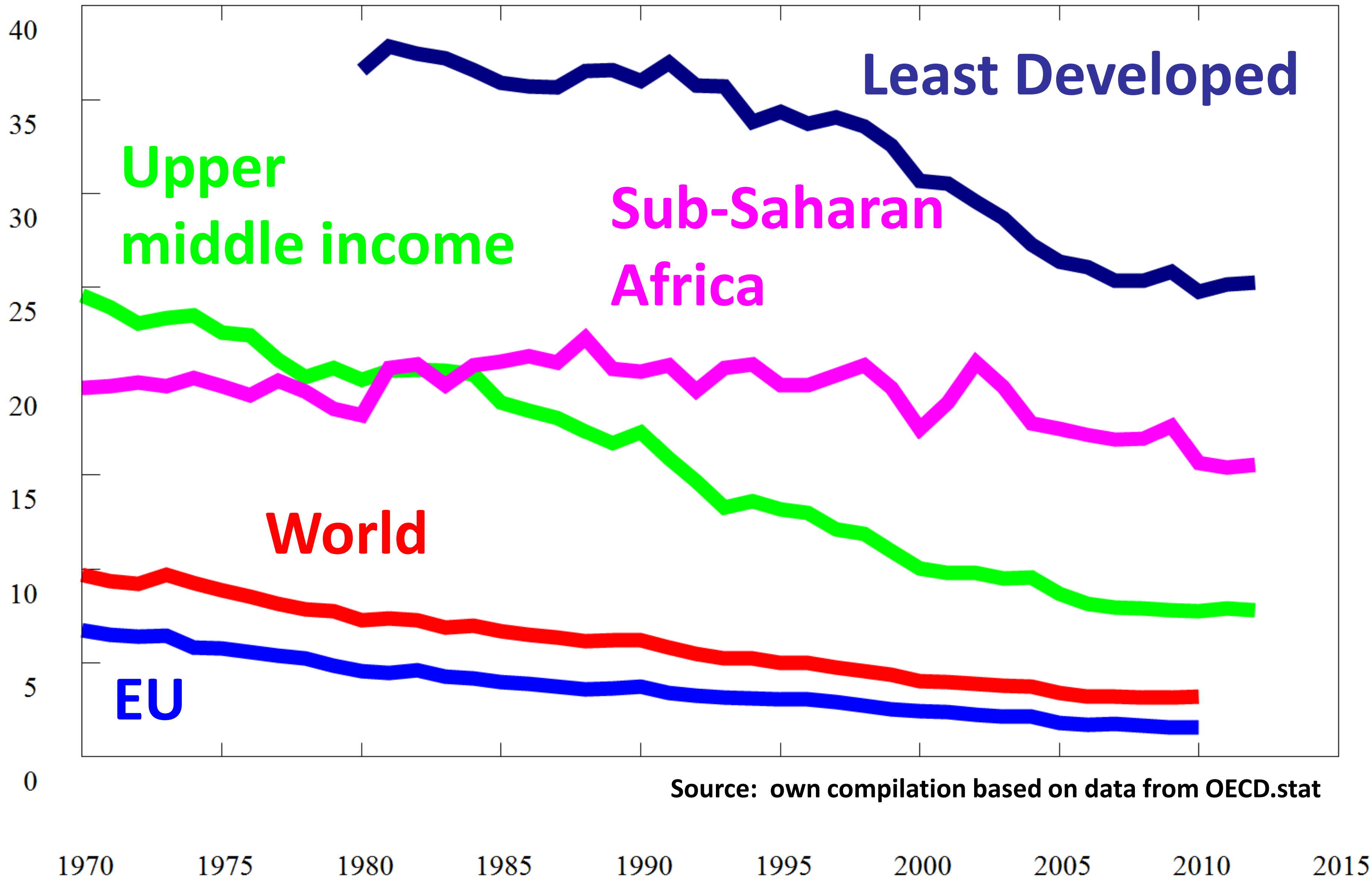
Do we still need land use science in the 21st century?

No!

After development, agriculture is not important anymore!

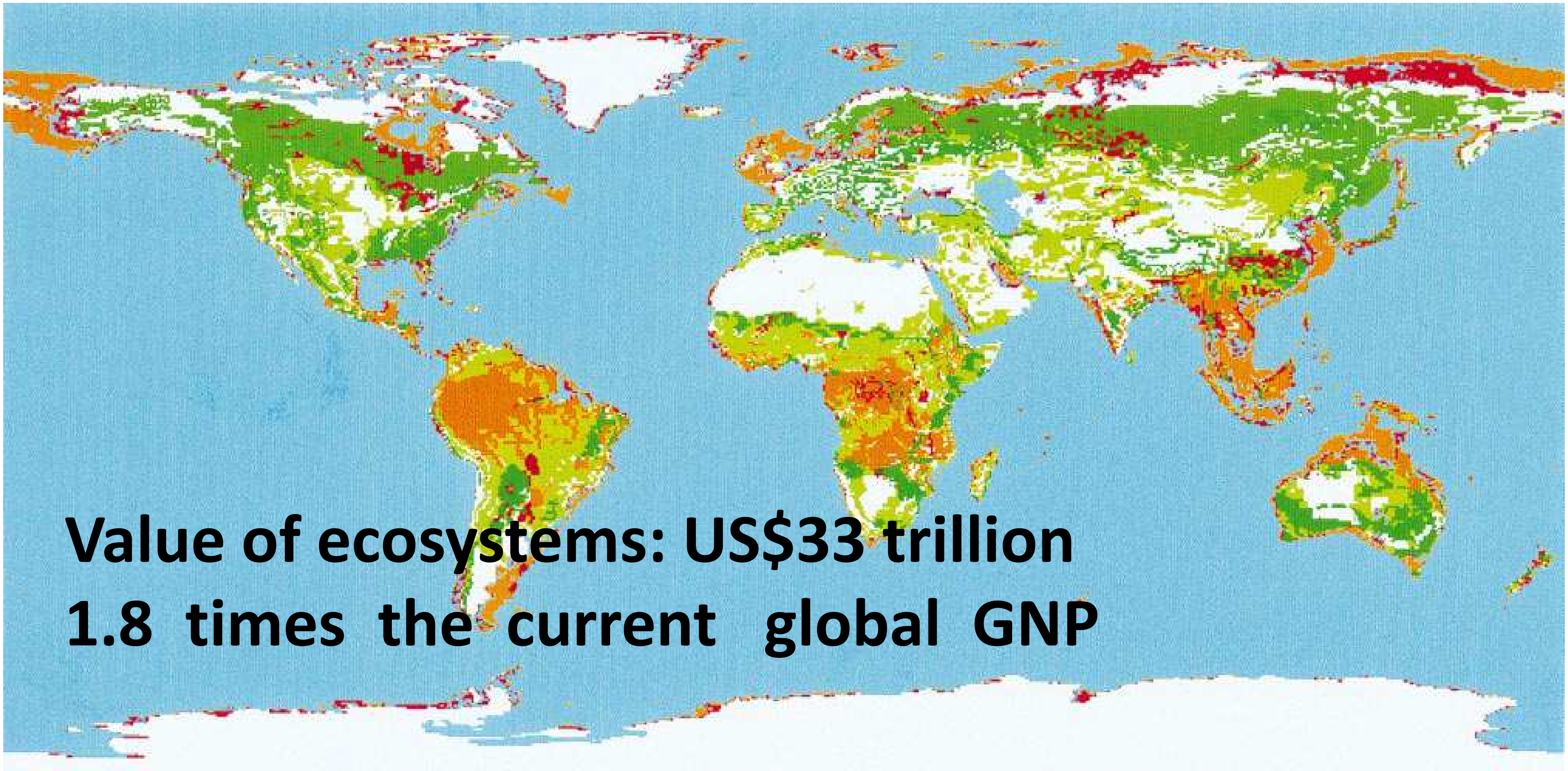
Source: Several Professors of Economics

Agricultural Income (GDP Share)



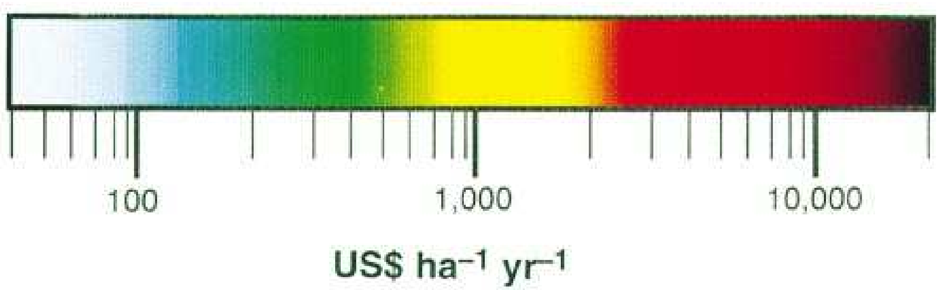
Source: own compilation based on data from OECD.stat

What about GDP of agricultural non-market impacts?

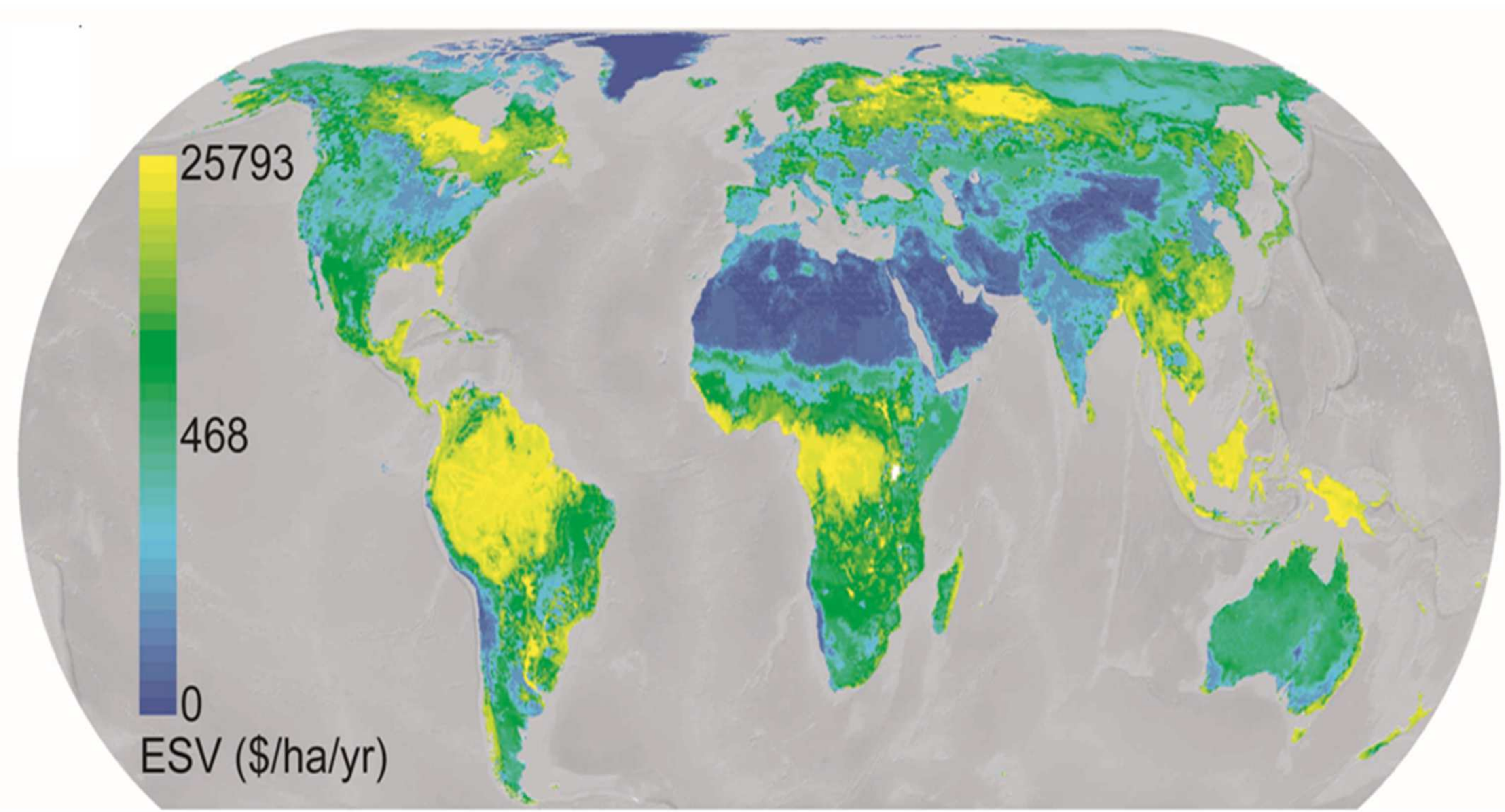


Value of ecosystems: US$33 trillion
1.8 times the current global GNP

Costanza et al. The value of the world’s ecosystem services and natural capital, Nature, 1997



Potential ecosystem service values



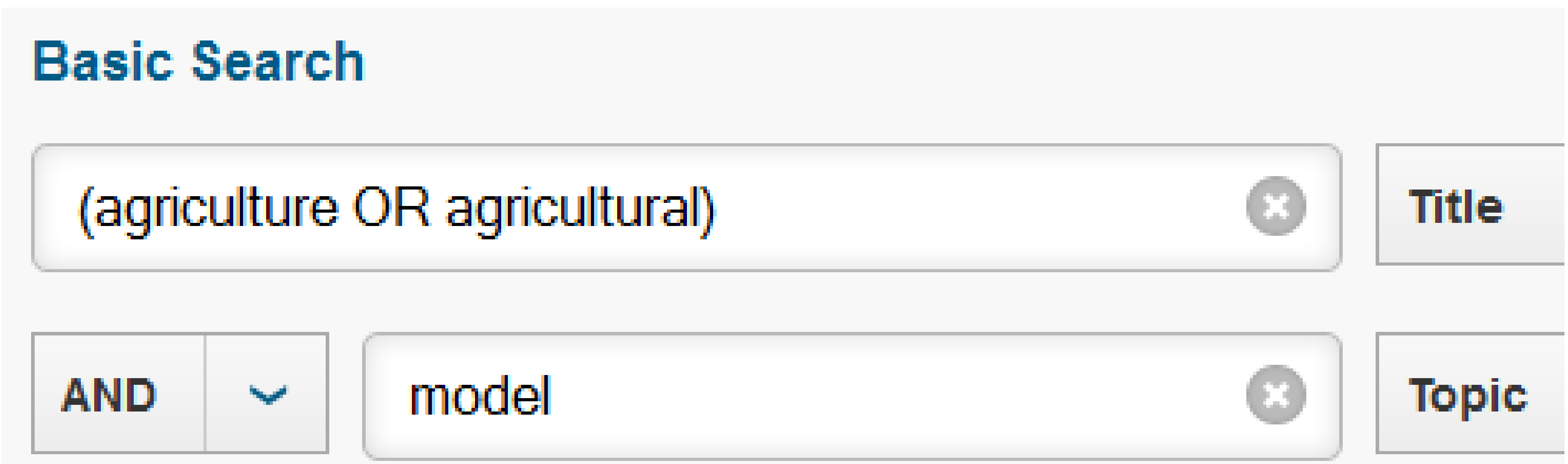
Turner W R et al. BioScience 2012

- Yes, agricultural GDP is declining.
- "GDP measures everything, in short, except that which makes life worthwhile" R. Kennedy (1968)
- Sustainable development calls for consideration and valuation of ecosystem services
- Besides, higher valued secondary GDP contributors are multipliers of primary sector values

Agricultural assessments are still important but include much more than food production

What is the research focus of high-impact agricultural models?

WEB OF SCIENCE



1991-2000 **(citations)**

- **Habitat management** to conserve **natural enemies** of arthropod **pests in agriculture**, ANNUAL REVIEW OF ENTOMOLOGY (2000), **759**
- Soil macroaggregate turnover and microaggregate formation: a mechanism for **C sequestration** under **no-tillage agriculture**, SOIL BIOLOGY & BIOCHEMISTRY, (2000), **620**
- Source approach for estimating **soil and vegetation energy fluxes** in observations of directional radiometric surface-temperature, AGRICULTURAL AND FOREST METEOROLOGY (1995), **491**
- Soil carbon fractions based on their degree of oxidation, and the development of a **carbon management index** for **agricultural systems**, AUSTRALIAN JOURNAL OF AGRICULTURAL RESEARCH, (1995), **487**
- Changes in the **abundance of farmland birds** in relation to the timing of **agricultural intensification** in England and Wales, JOURNAL OF APPLIED ECOLOGY, (2000), **423**

2001-2010 **(citations)**

- **Agricultural intensification** and the collapse of Europe's **farmland bird populations**, PROCEEDINGS OF THE ROYAL SOCIETY B-BIOLOGICAL SCIENCES, (2001), **661**
- Global dimming: a review of the evidence for a widespread and significant **reduction in global radiation** with discussion of its probable causes and possible **agricultural consequences**, AGRICULTURAL AND FOREST METEOROLOGY, (2001), **436**
- Single- and multi-component **adsorption of cadmium and zinc using activated carbon** derived from bagasse - an agricultural waste, WATER RESEARCH, (2002), **392**
- Hyperspectral vegetation indices and novel algorithms for **predicting green LAI of crop canopies**: Modeling and validation in the context of **precision agriculture**, REMOTE SENSING OF ENVIRONMENT, (2004), **385**
- A synthesis of **carbon sequestration**, carbon emissions, and net carbon flux in agriculture: comparing **tillage practices** in the United States, (2002), **340**

The “optimal” land use assessment model

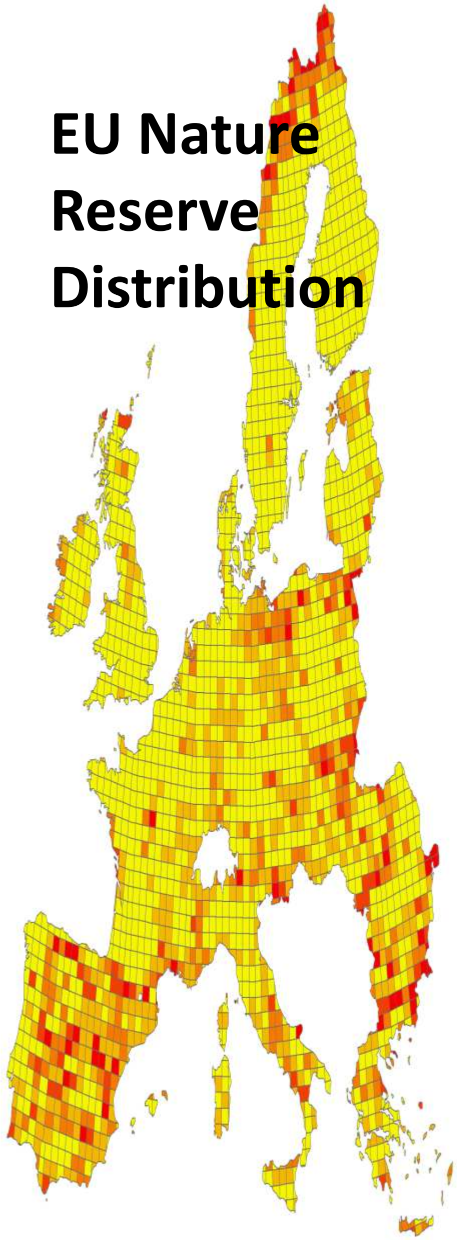
Insights from agro-environmental assessments

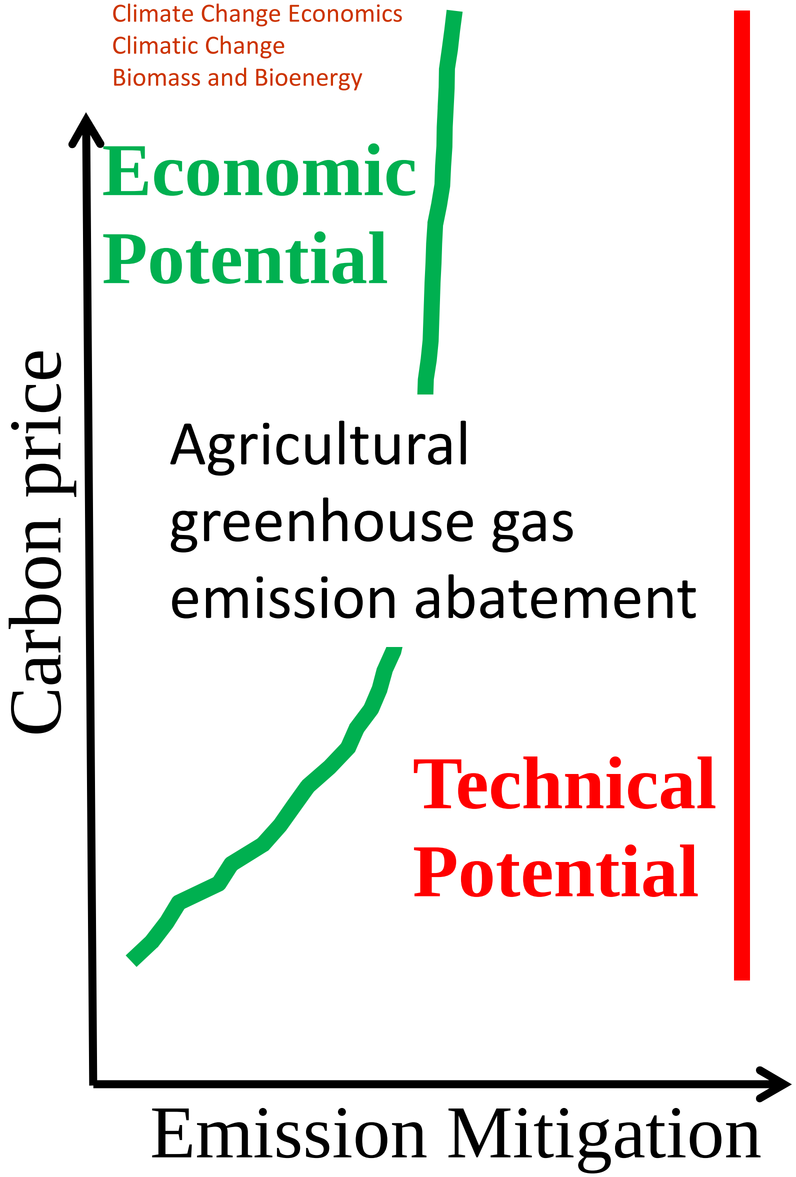
Biodiversity and Conservation
Ecological Modeling and Assessment
Environmental Science & Policy
Biological Conservation

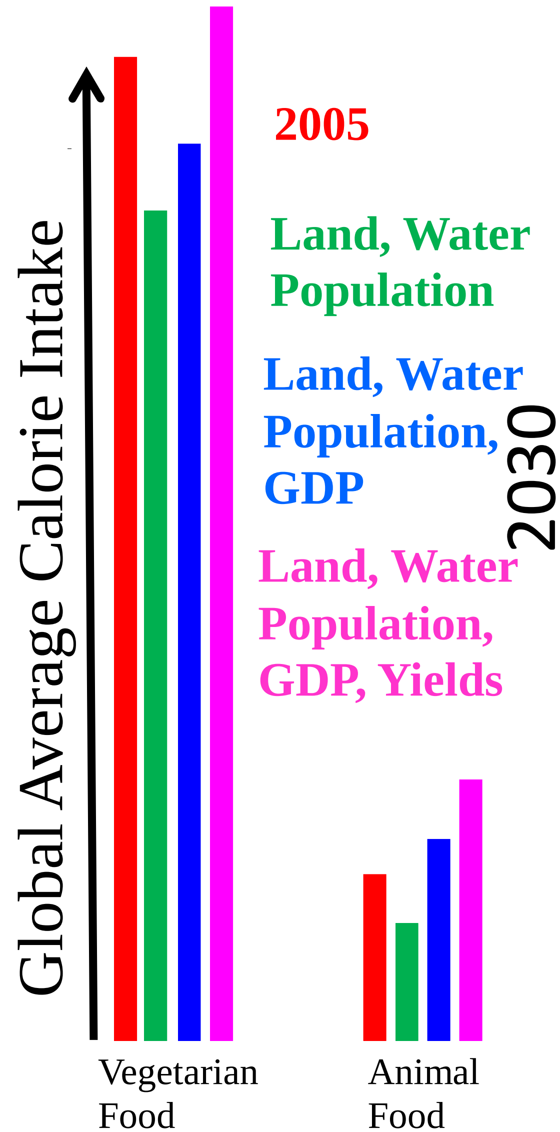
Agricultural Sector Analysis

Water Resources Research
Agricultural Systems
Energy Policy
Energy Efficiency

Science
Agricultural Systems
Agricultural Economics
Climate Change Economics
Climatic Change
Biomass and Bioenergy



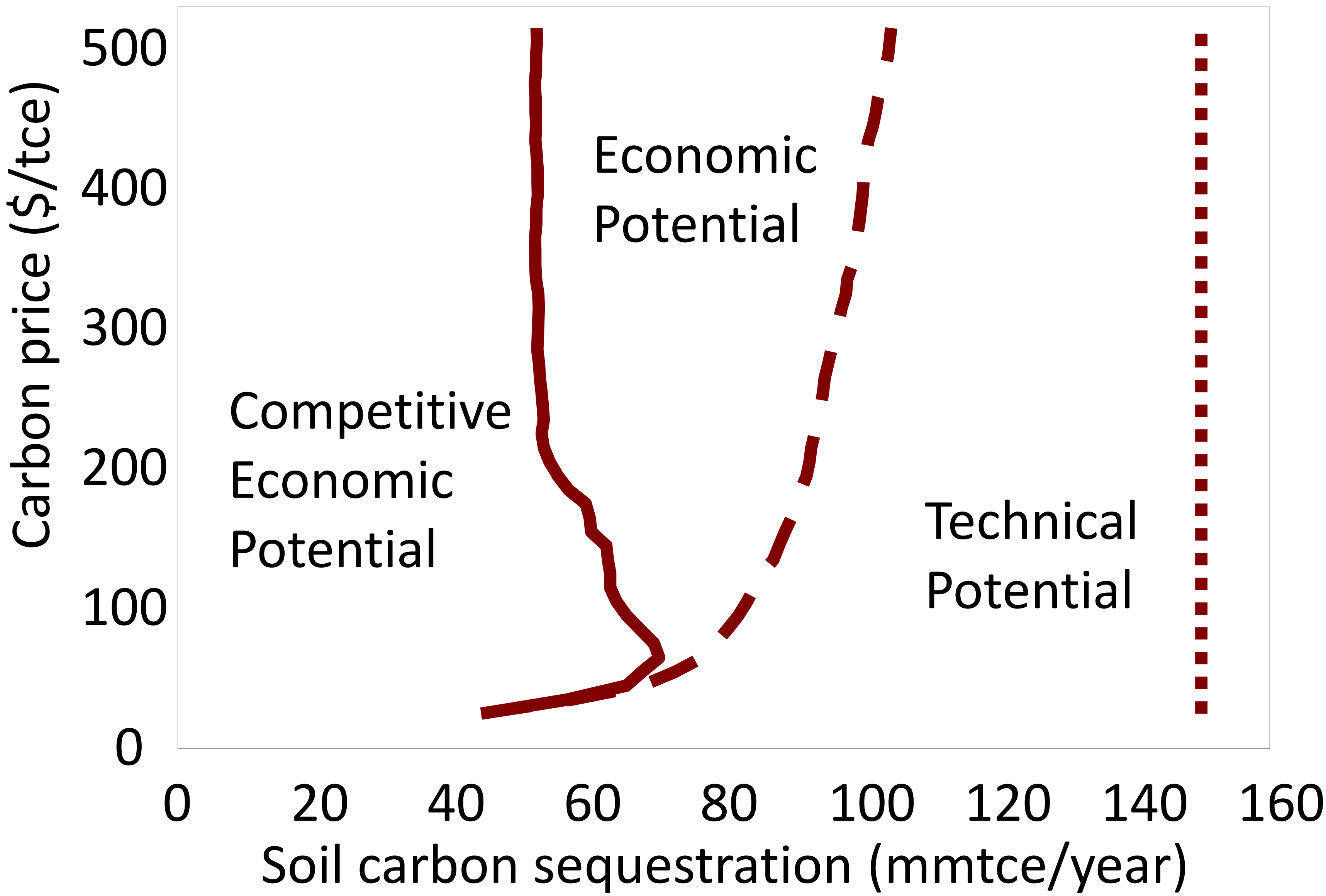




1) Model scope

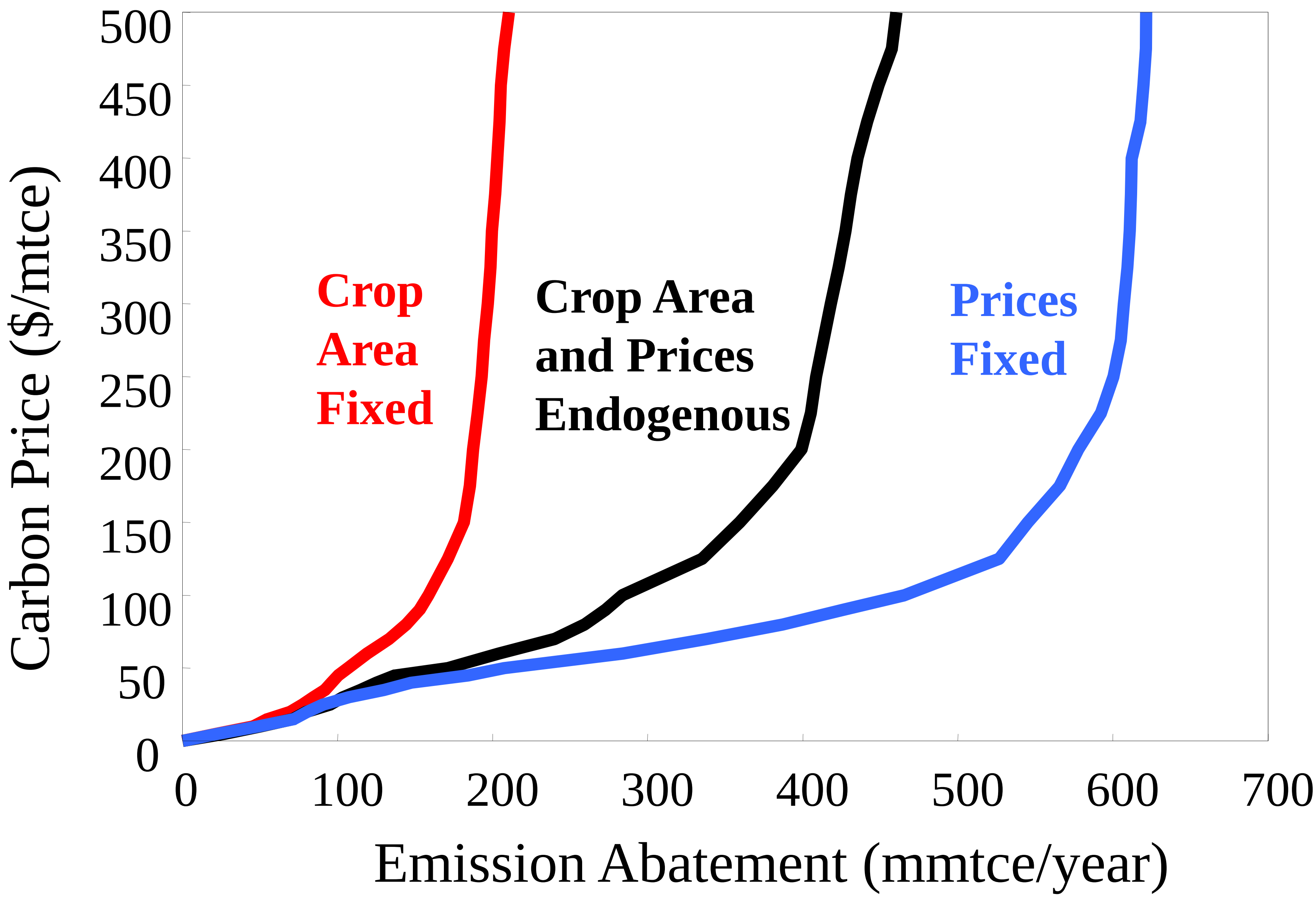
Regions	Sectors	Goods
Time Horizon	Technologies	Resources

US Carbon Benefits of Reduced Tillage



Schneider et al., Agr. Syst., 2007

US Agricultural GHG Emission Mitigation

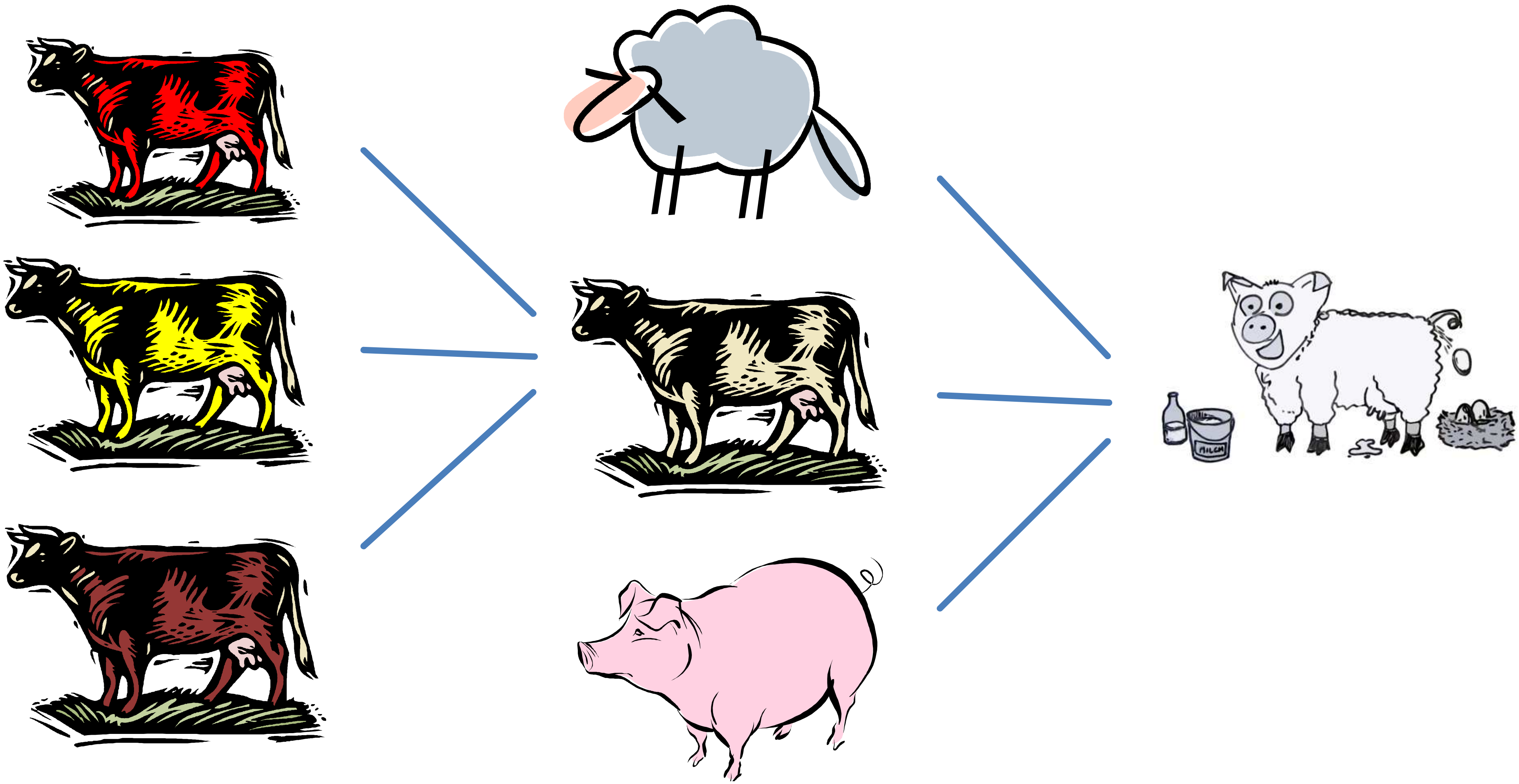


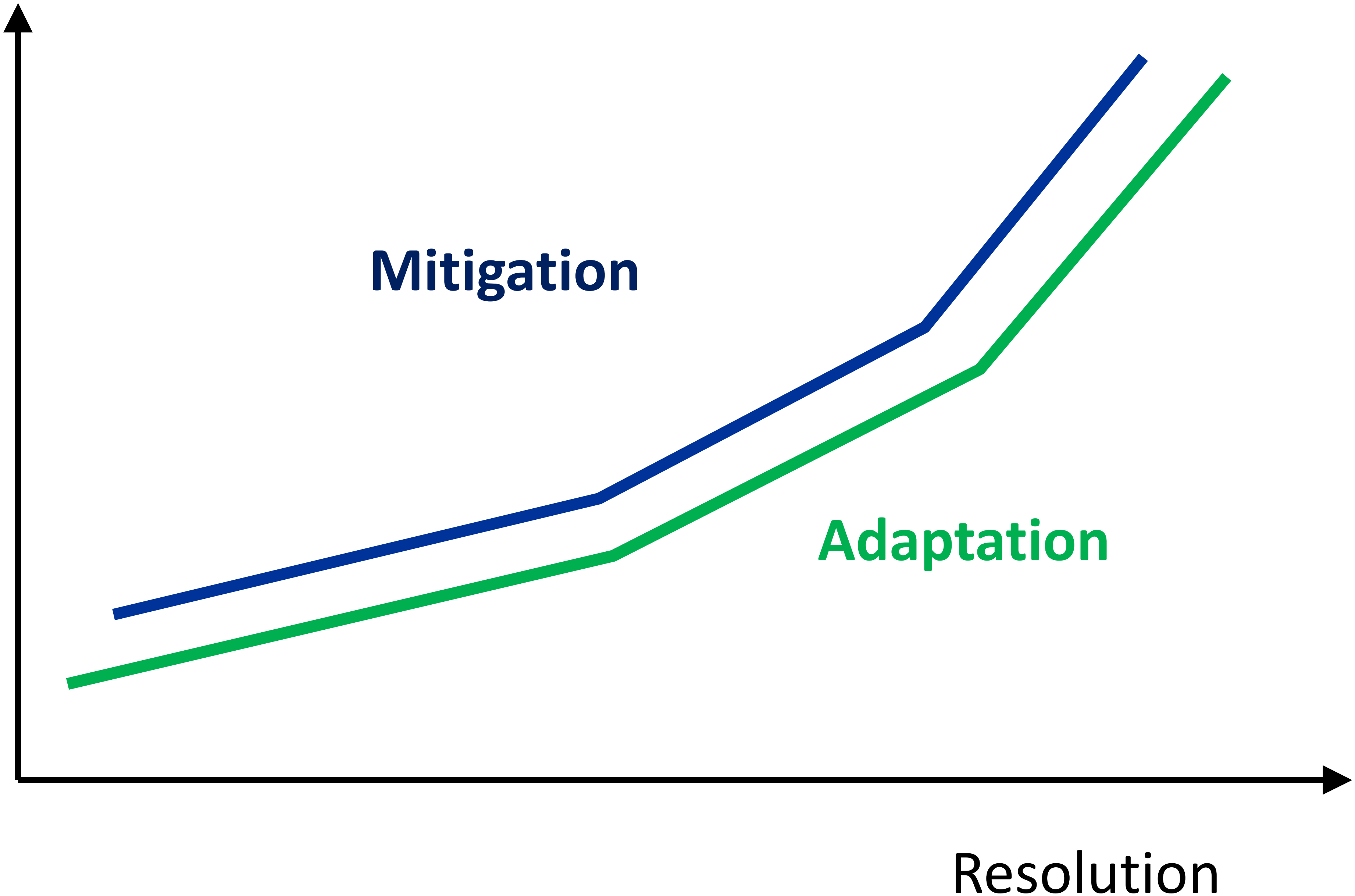
Schneider and McCarl, Agr. Econ., 2006

Insights

- Low scope assessments ignore synergies and tradeoffs
- Independent regional assessments tend to overestimate mitigation potentials

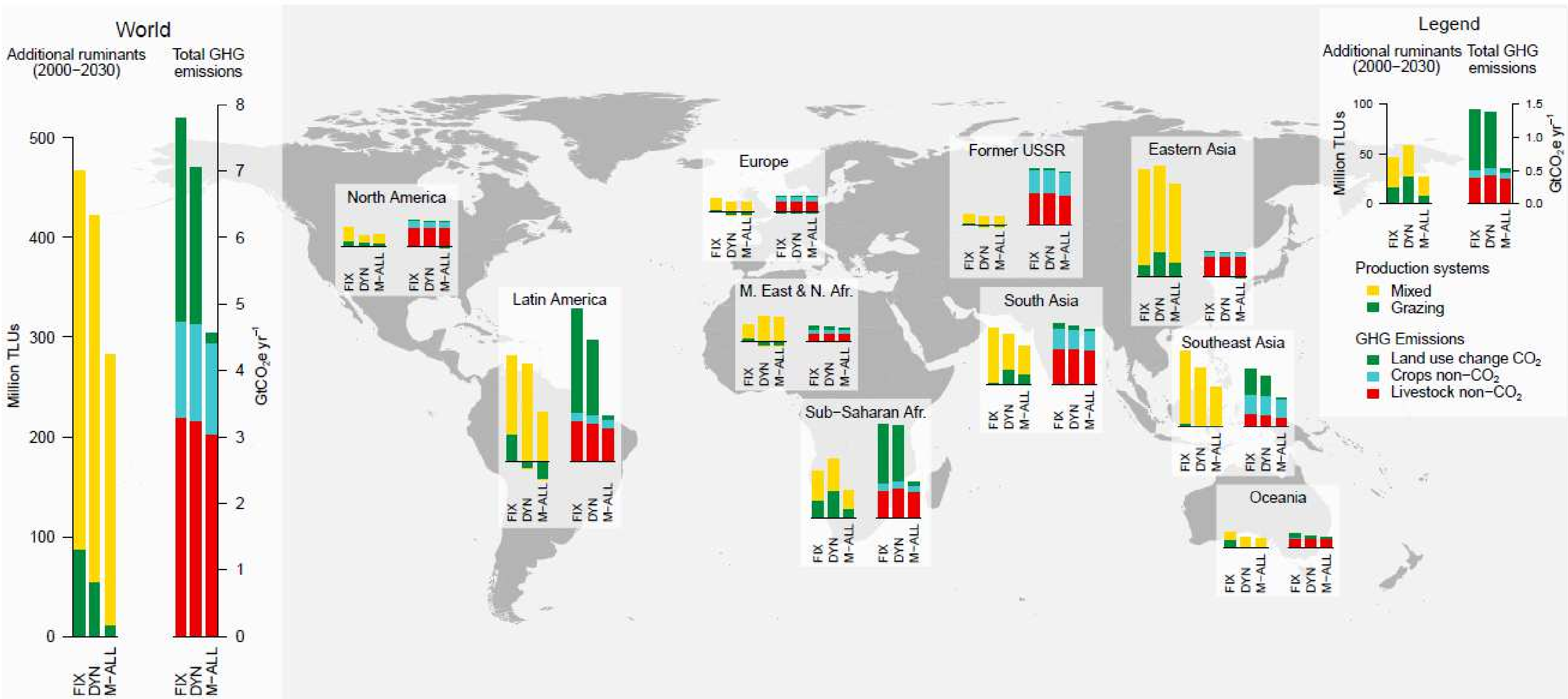
2) Model detail (resolution)





Mitigation
Adaptation
Resolution

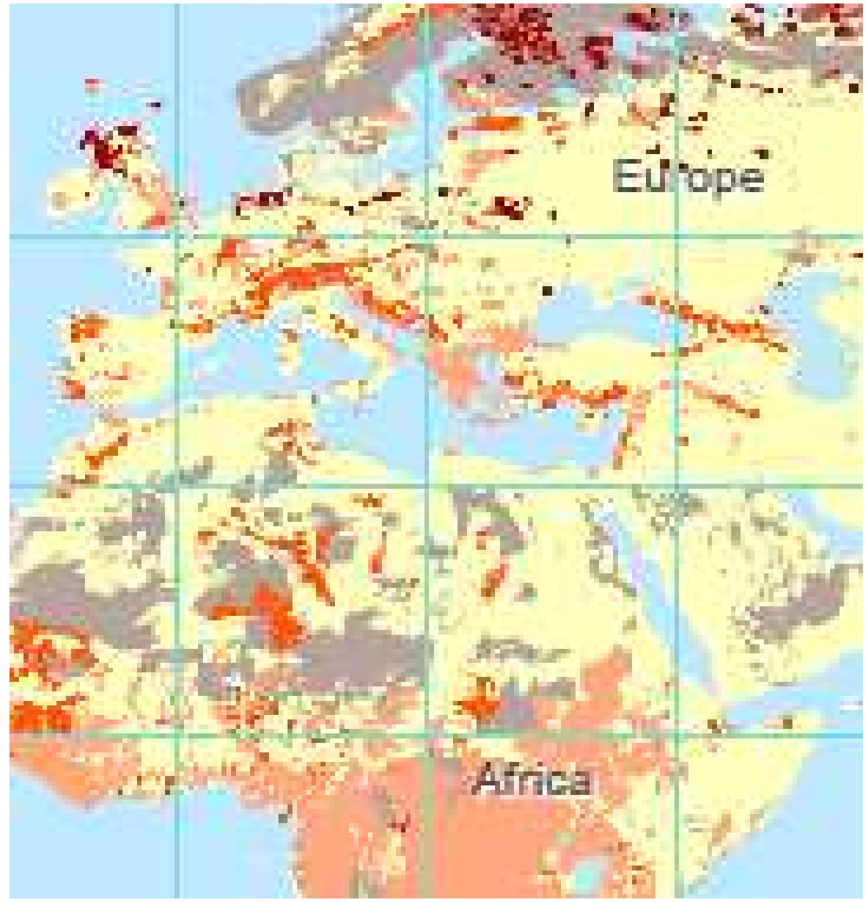
More flexibility → more mitigation



Climate change mitigation through livestock system transitions
Havlik et al., PNAS, 2013

Homogenous Response Units

5 altitude classes



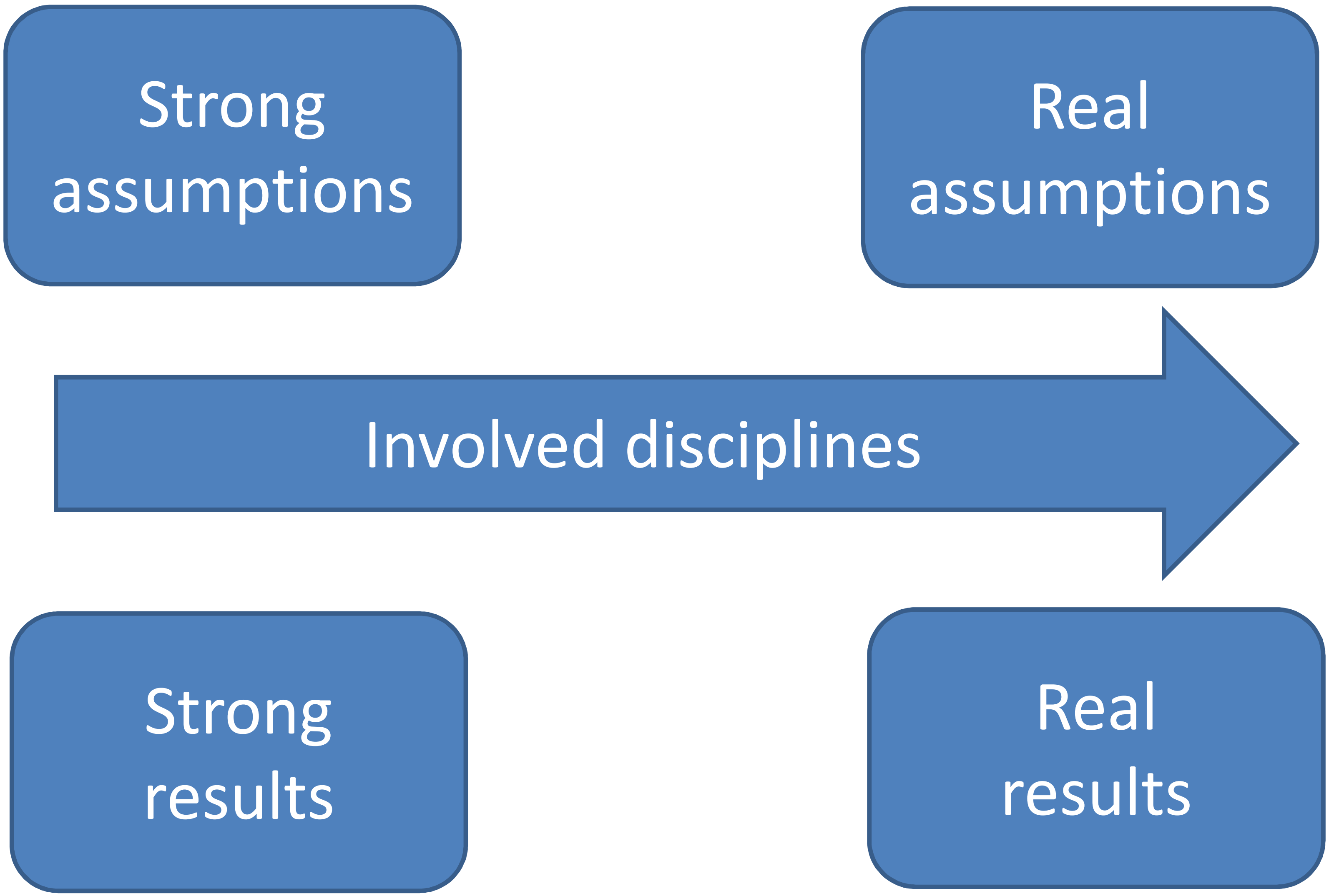
5 soil classes

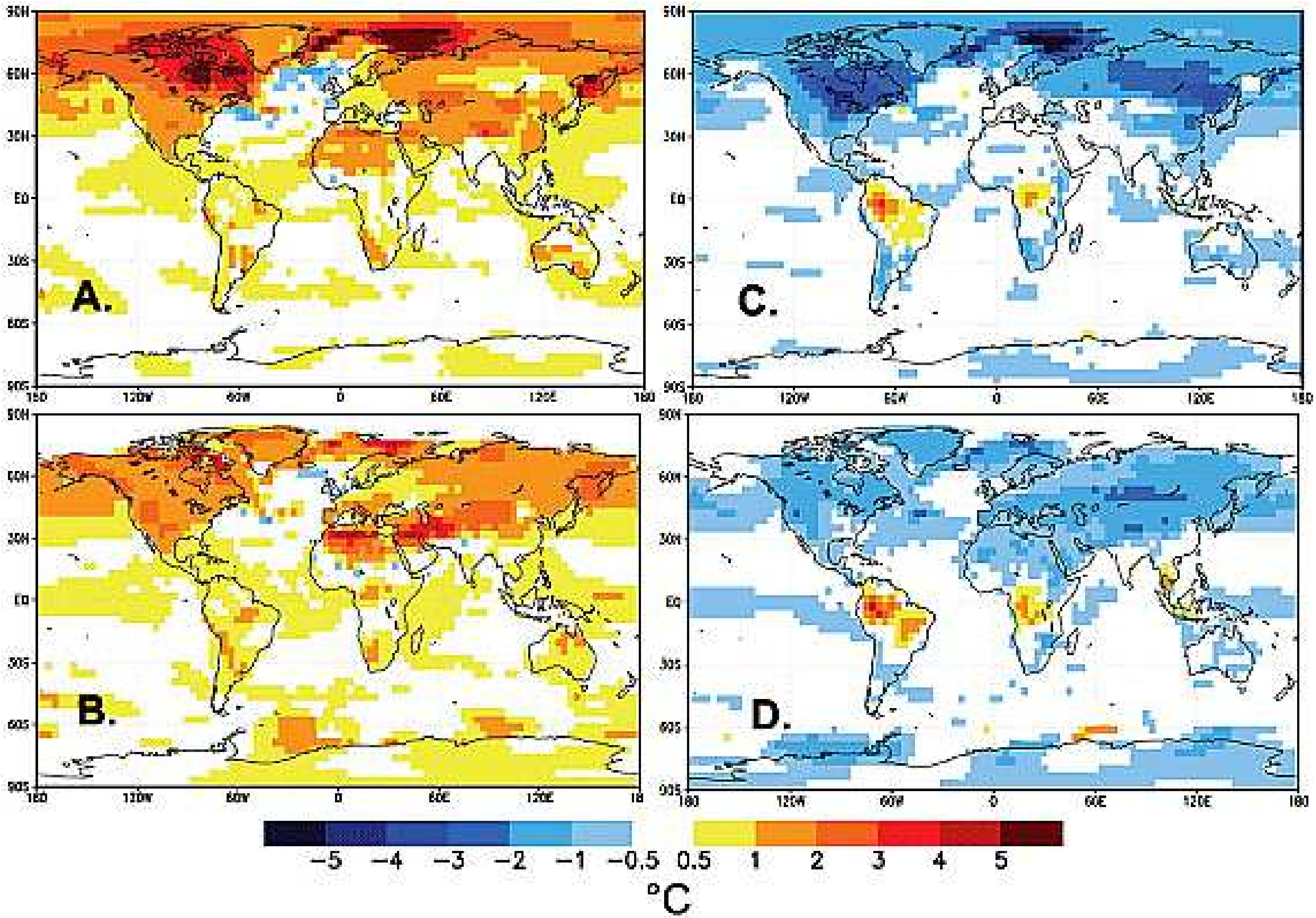
Maps compiled by R. Sos based on GEOBENE Project Data

Insights

- Low resolution tends to underestimate response (adaptation, mitigation, resilience)
- High resolution increases computational costs
- Heterogeneous resolution and/or implicit depiction of resolution may help

3) Interdisciplinarity

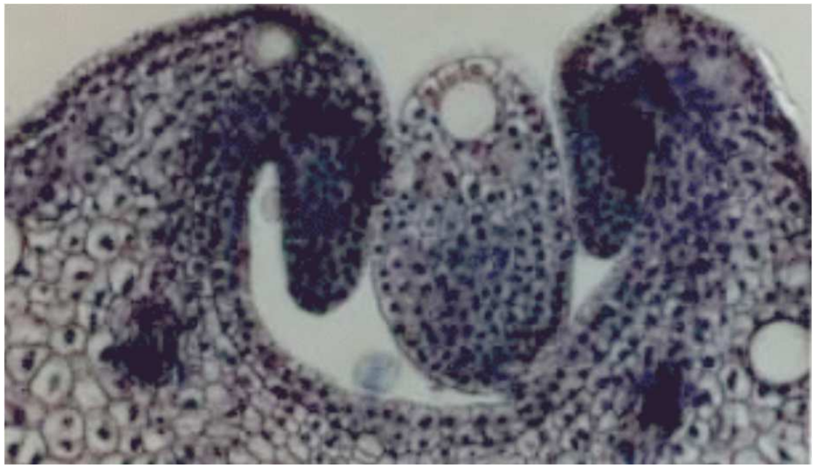




Global biogeophysical interactions between forest and climate
Brovkin et al., Geophysical Research Letters 36(7) 2009

Scales

- Genes
- Cells
- Individuals
- Communities
- Fields
- Farms
- Coun(r)ties, Biomes
- Global Markets



Source: Uwe A. Schneider, Diploma thesis

?

Source: The Royal Society, Gastner

Small scale analysts' tasks

- Transferability
- Aggregation
- Reduced form representation

Large scale analysts' tasks

- Heterogeneous resolution
- Disaggregation, Downscaling
- Implicit integration

4) Land use model development

- More complex models
- Method trade
- New datasets
- More model intercomparison
- Less Intuition
- More skeletons in closets

Crop models

EPIC

Effect of soil erosion on soil productivity.

CropSyst

Effect of climate, soils, and management on cropping systems productivity and the environment.

CERES

Prediction of the duration of growth, the average growth rates, and the amount of assimilate partitioned to the economic yield components of the plant.

Soil carbon dynamics
Phosphorus cycling
CO_2 effects, etc.

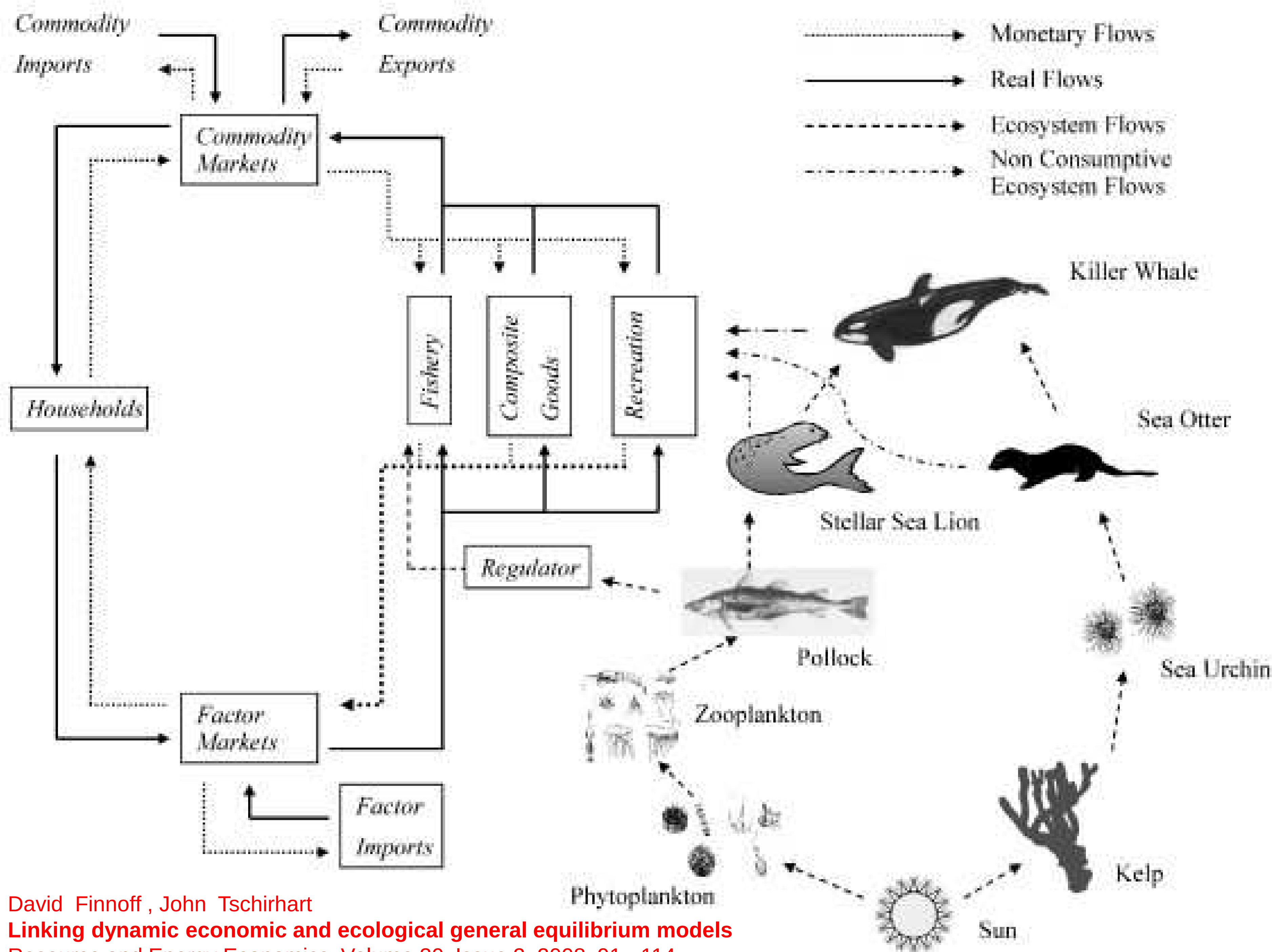
Models with similar features but different specifications and details

Source: L. Rasche

Method trade (e.g. Bioeconomics)

- General equilibrium models of ecosystems (e.g. work of J. Tschirhart)
- Vegetation models are solved as a Nash equilibrium
- Interactive ecological models (e.g. work of K.P. Freier, M. Hauhs)

See also: http://www-iam.nies.go.jp/aim/AIM_workshop/emf22/s5/Session5_07_Richard.pdf

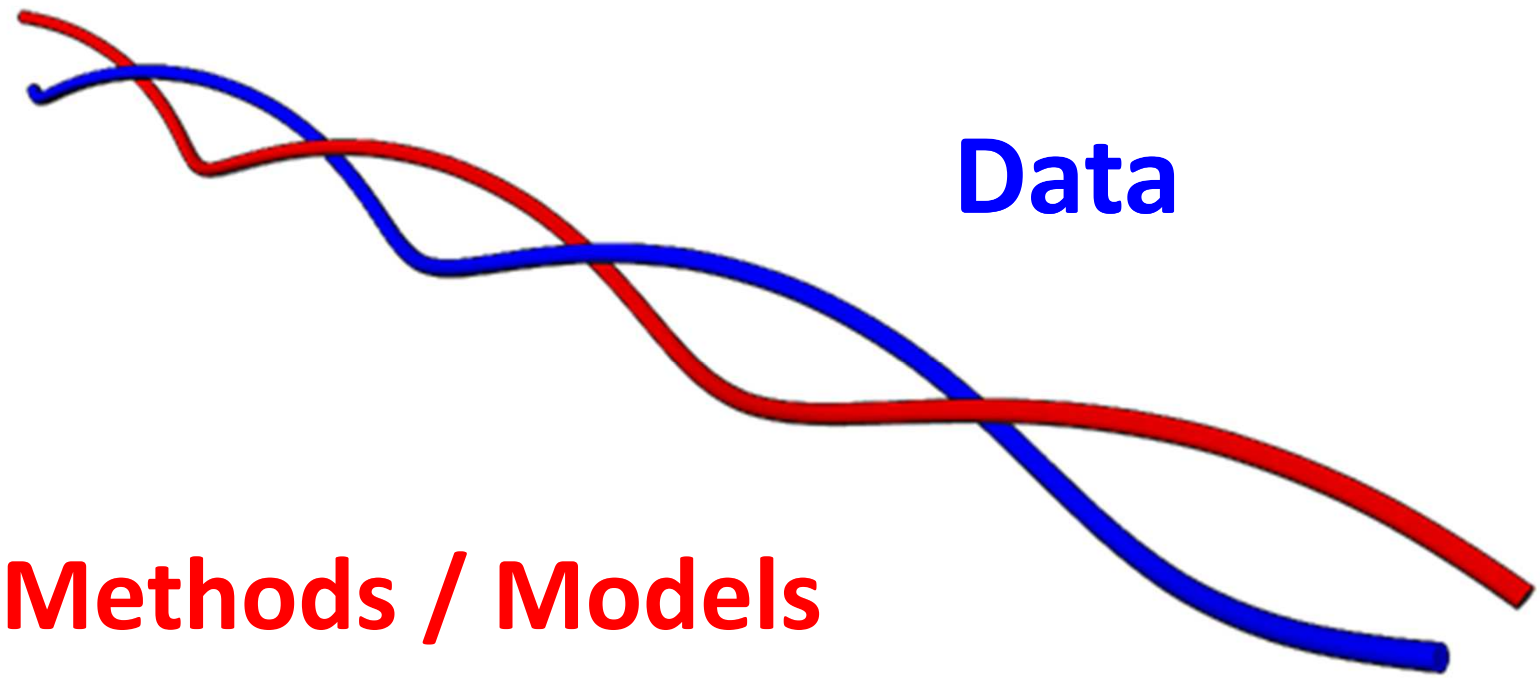


David Finnoff , John Tschirhart

Linking dynamic economic and ecological general equilibrium models

Resource and Energy Economics, Volume 30, Issue 2, 2008, 91 - 114

Scientific Evolution



The “optimal” land use assessment model

Summary


Source: Real Estate Advertisement


Thank you
Source: Real Estate Advertisement