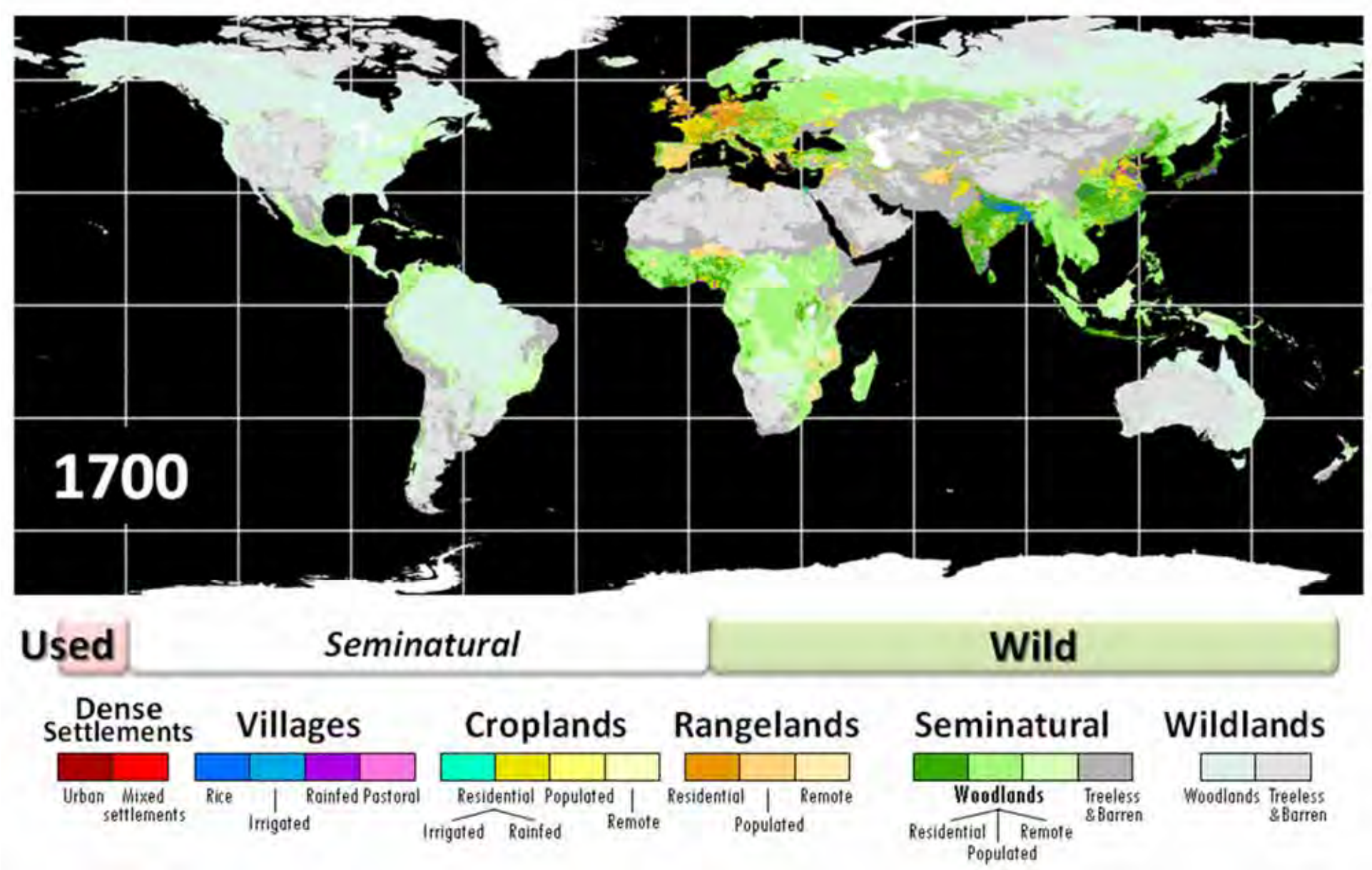
Land Change: global change in local places

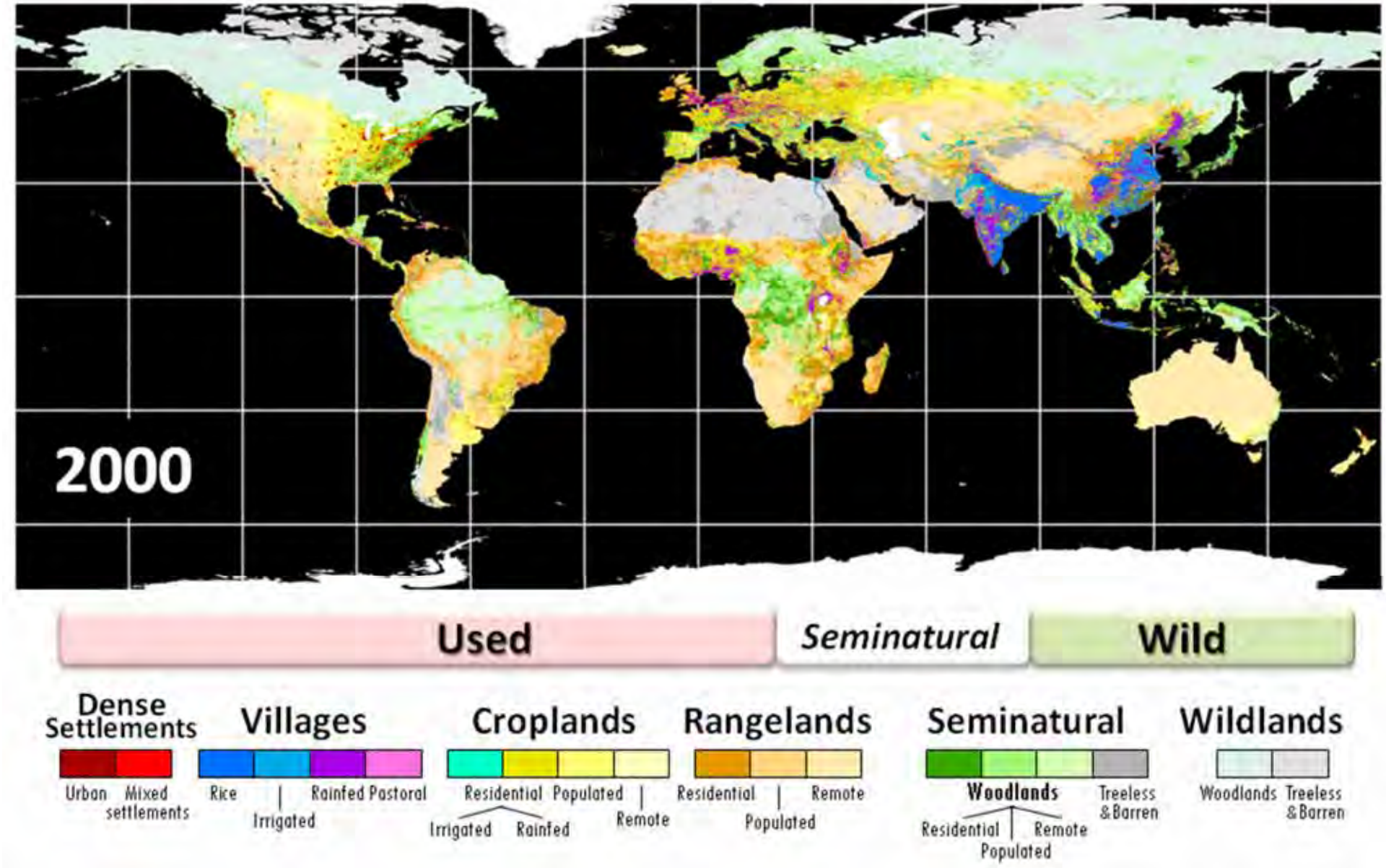
Peter Verburg

IVM Institute for Environmental Studies

Human influence on the environment (Ellis et al., 2010)



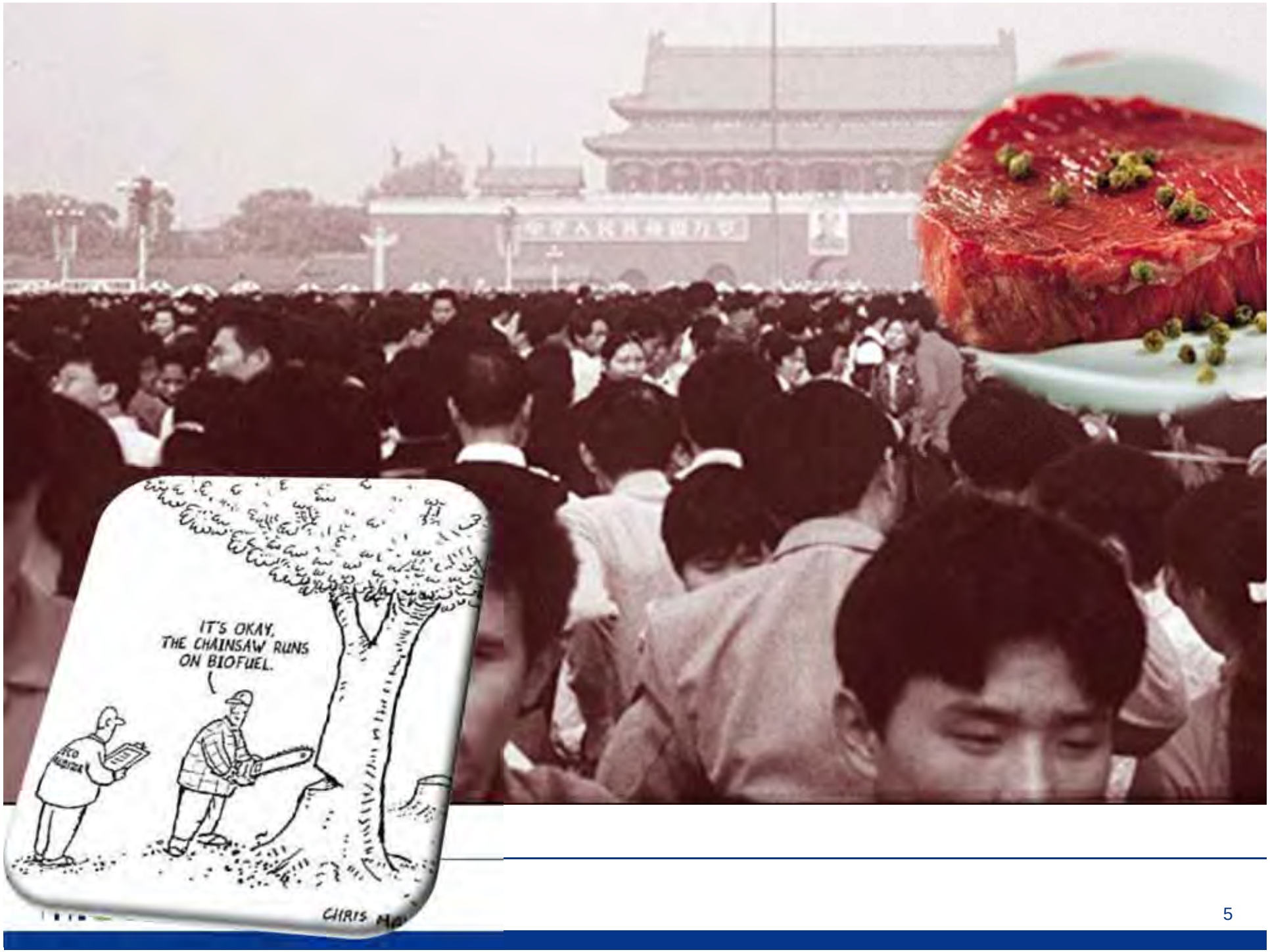
Human influence on the environment (Ellis et al., 2010)











IT'S OKAY, THE CHAINSAW RUNS ON BIOFUEL.

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Act now to stop land grabs

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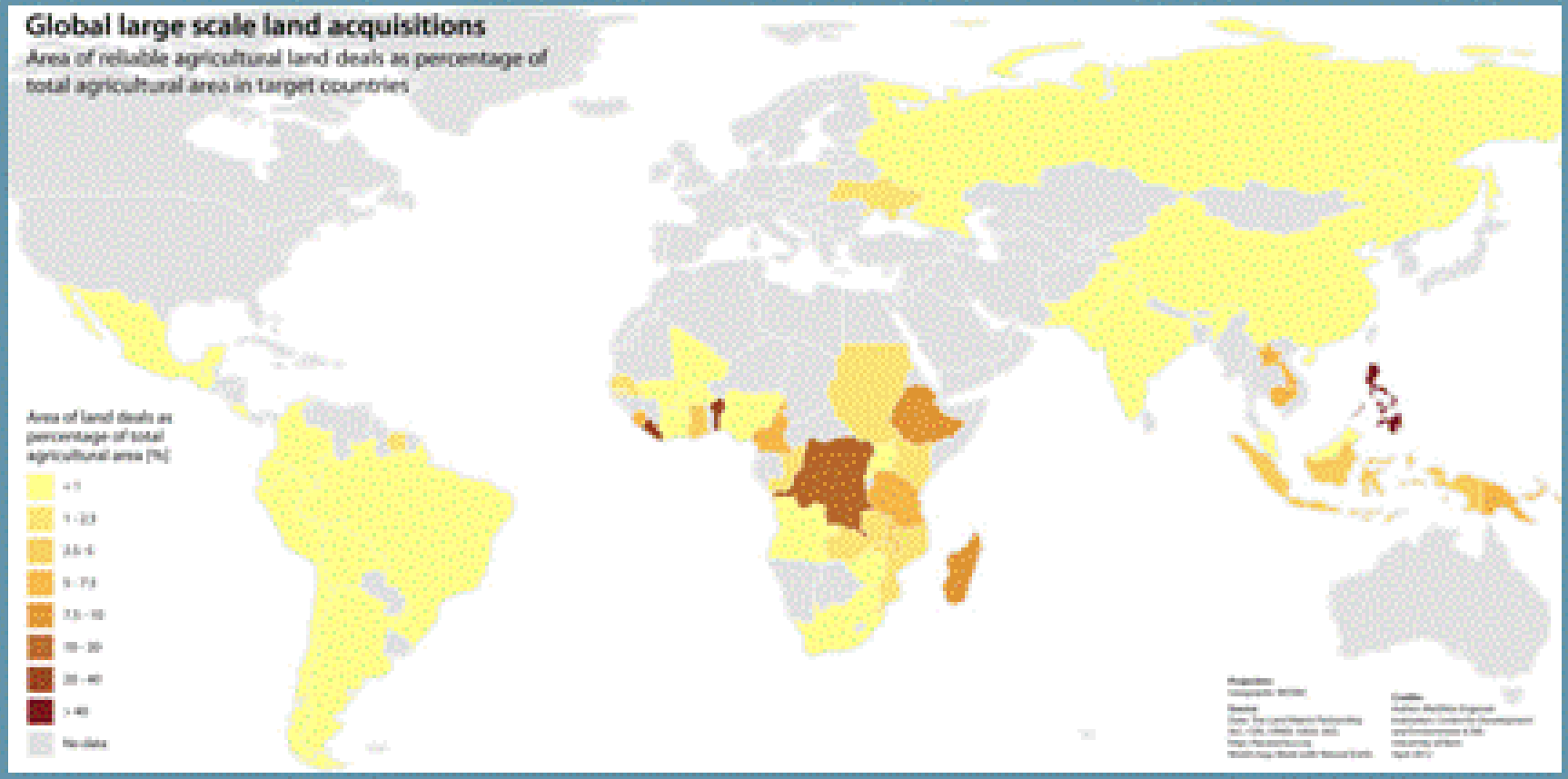
The land rush is real

In many countries a significant share of agricultural land is concerned



landportal.info/landmatrix

Land Matrix
landportal.info/landmatrix

Land abandonment

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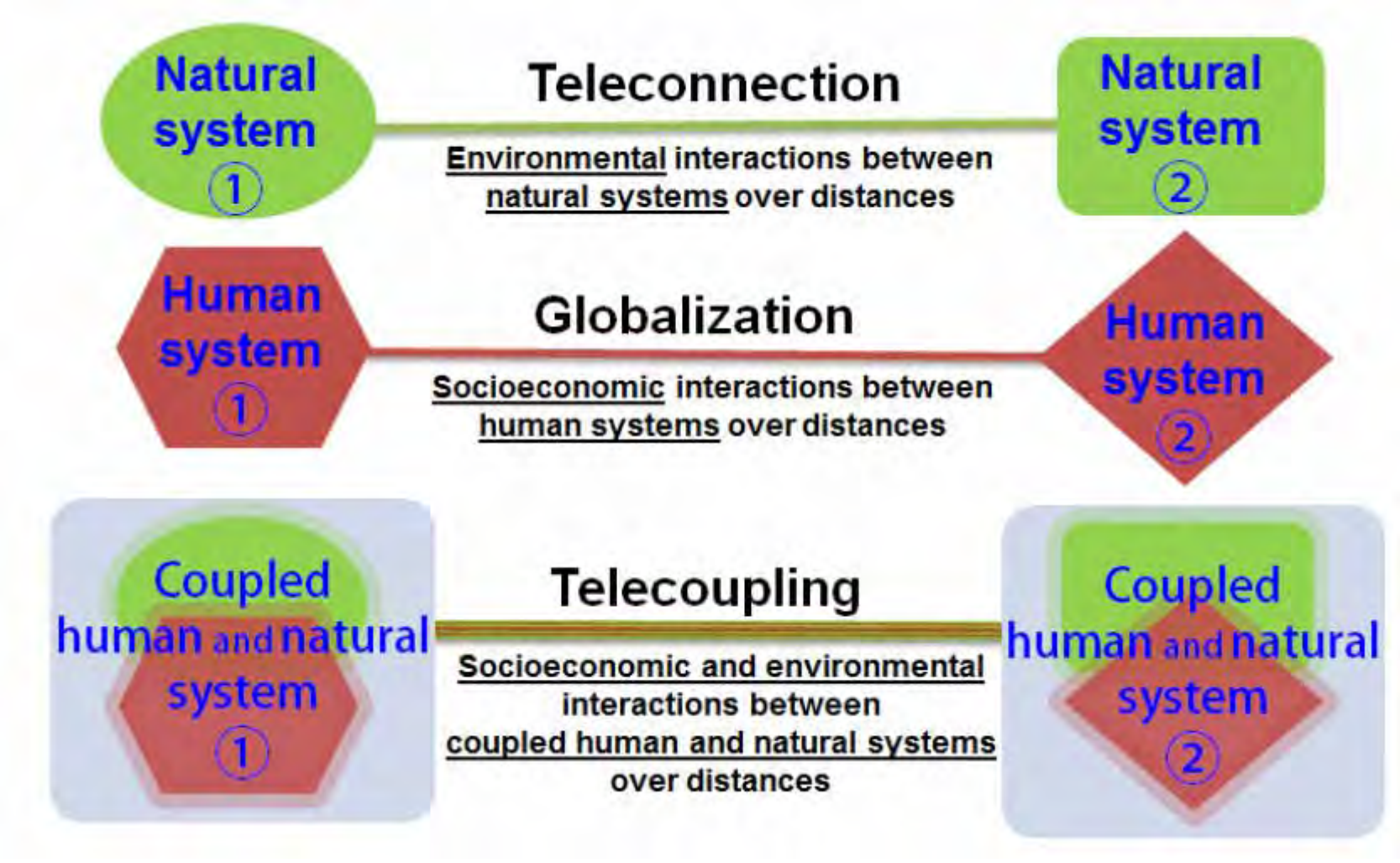
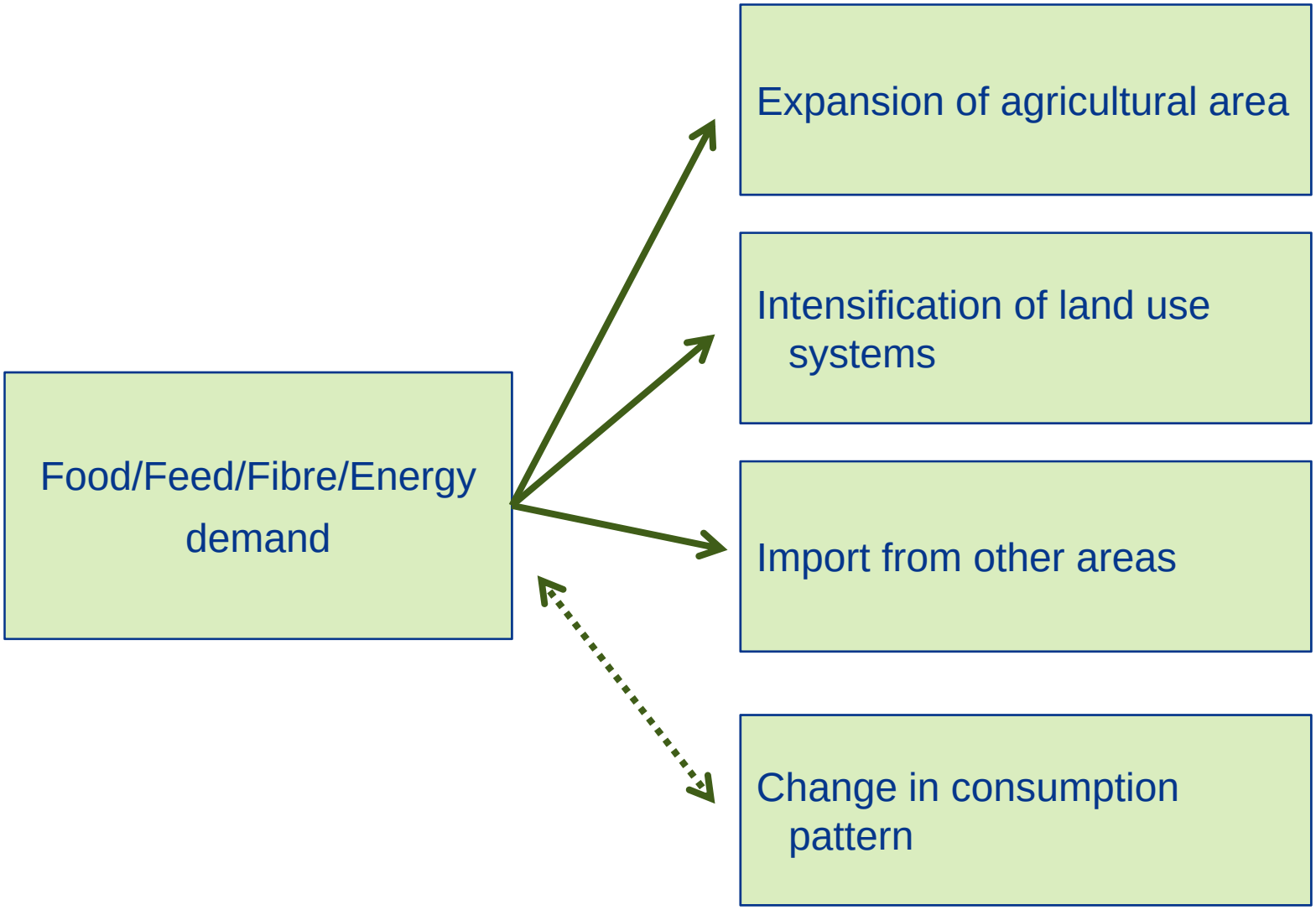
Local land change in a telecoupled world

Telecoupling

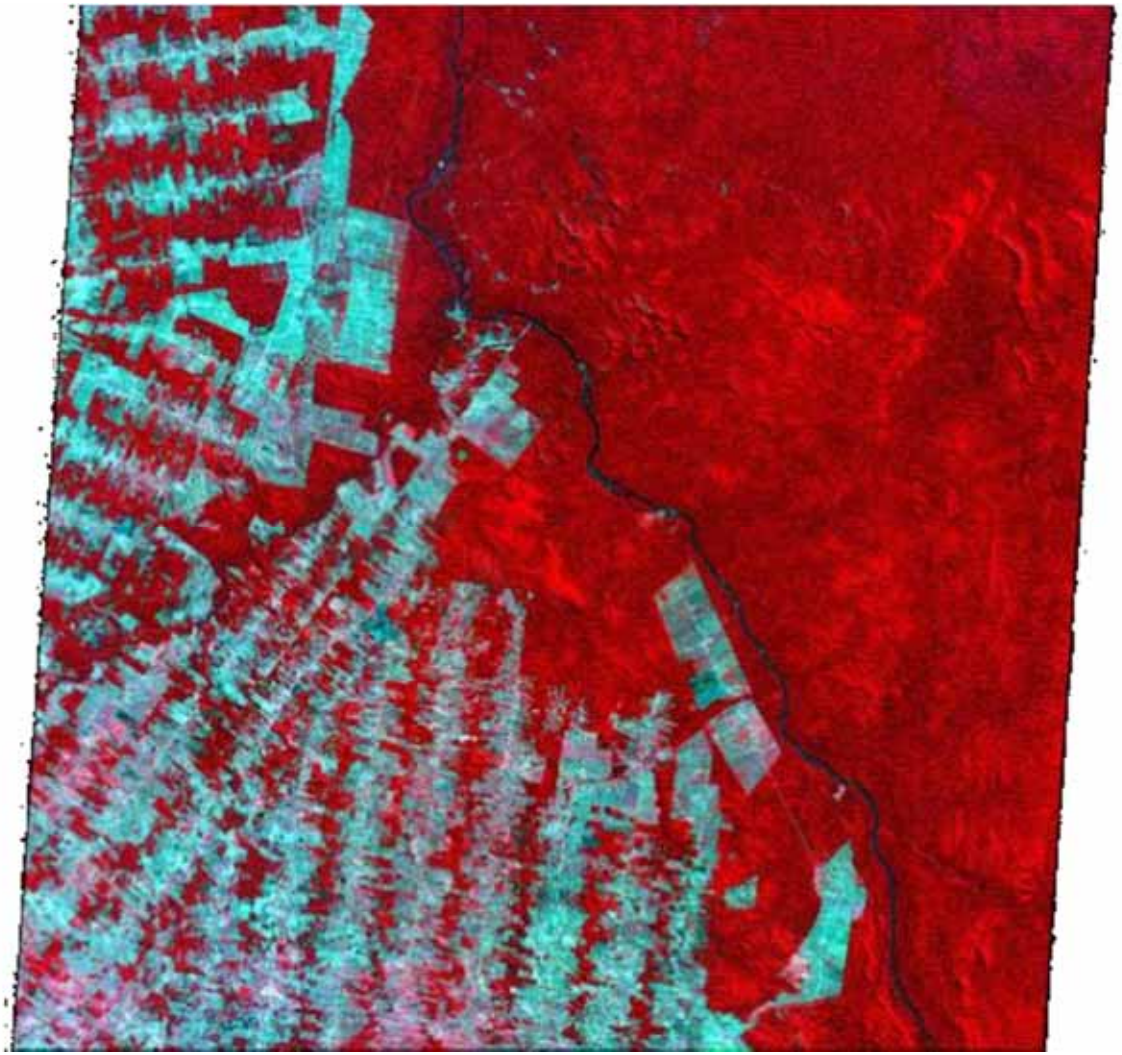


J. Liu, unpublished

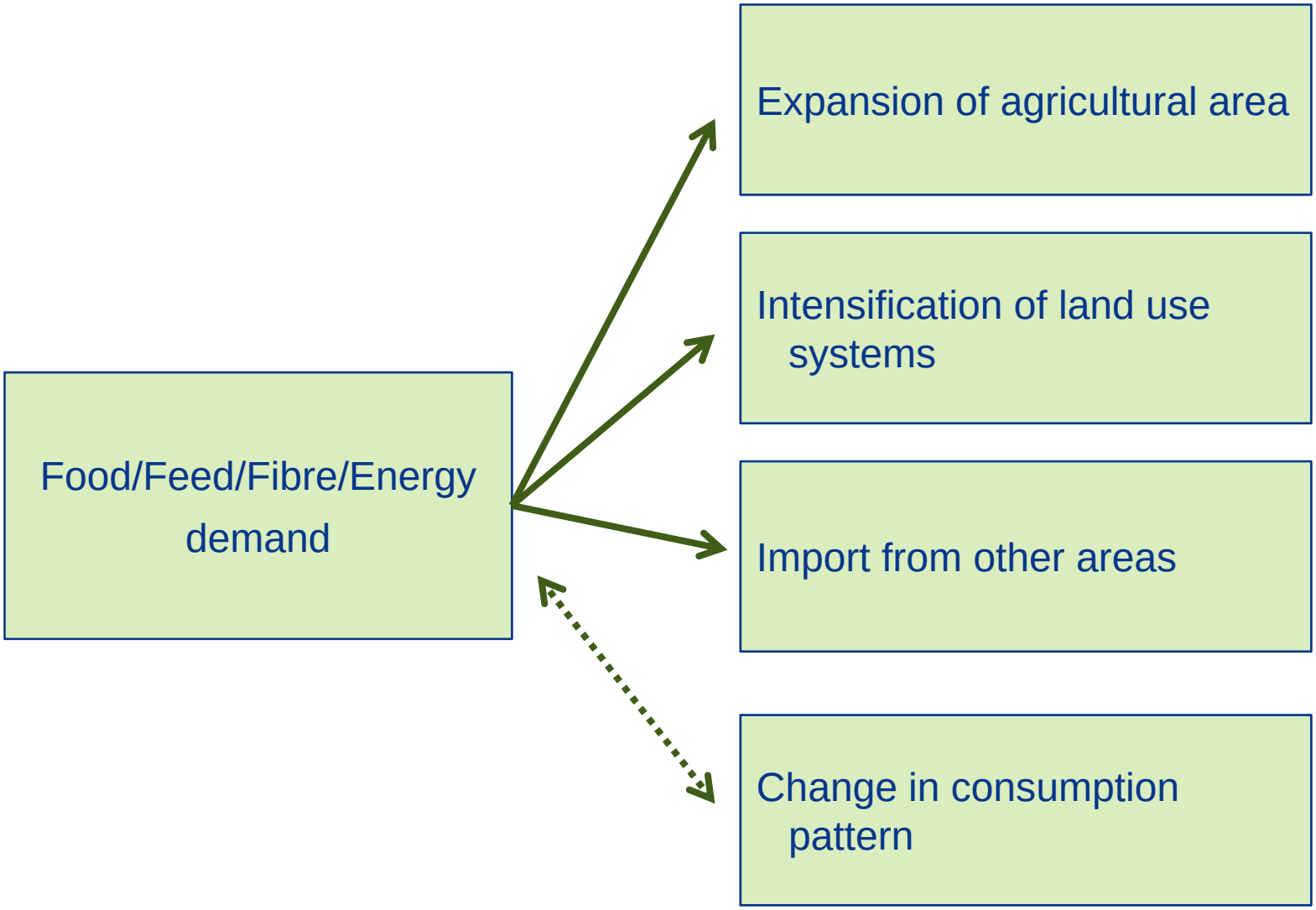
Agricultural production



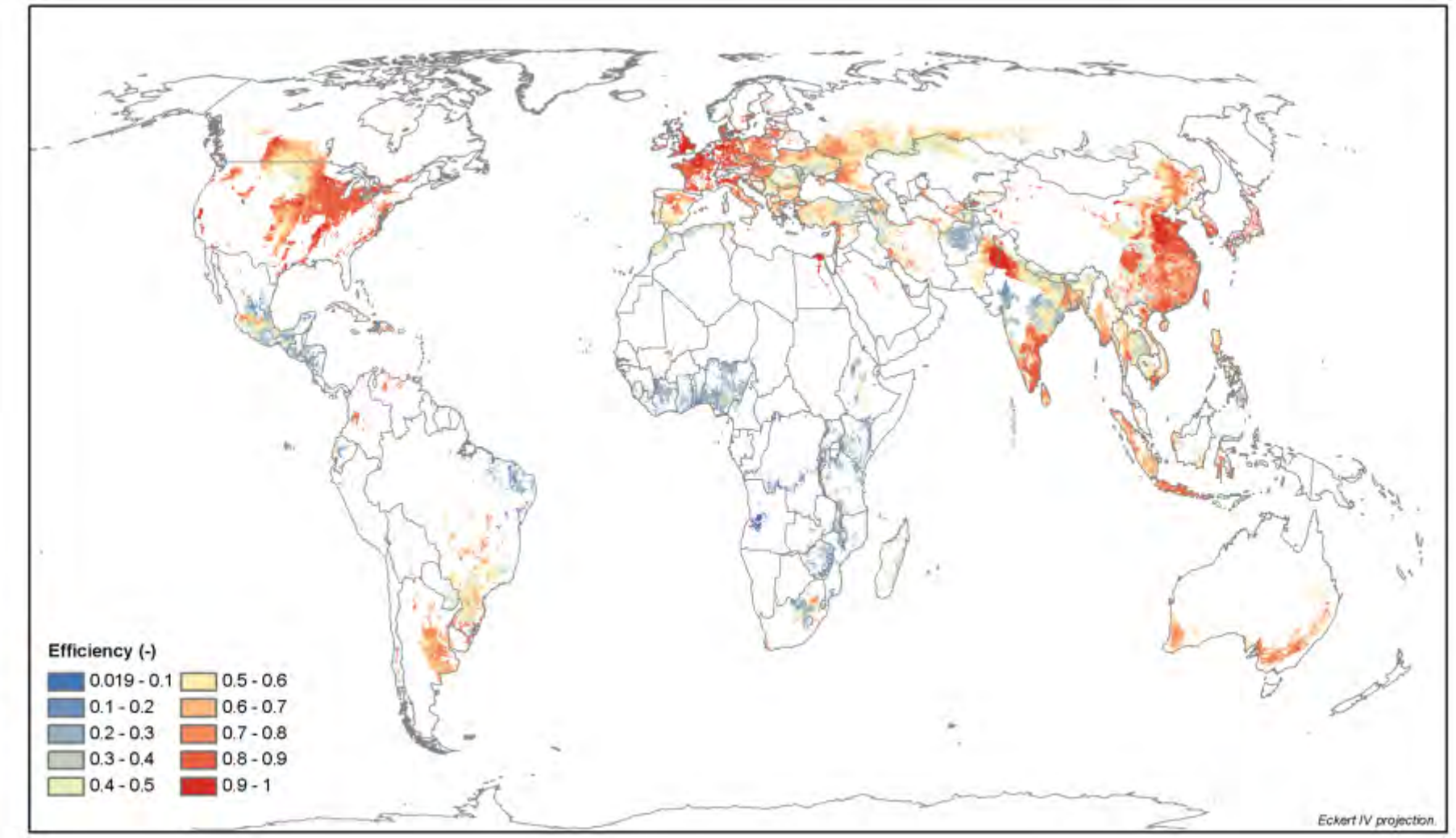
Expansion: land cover change



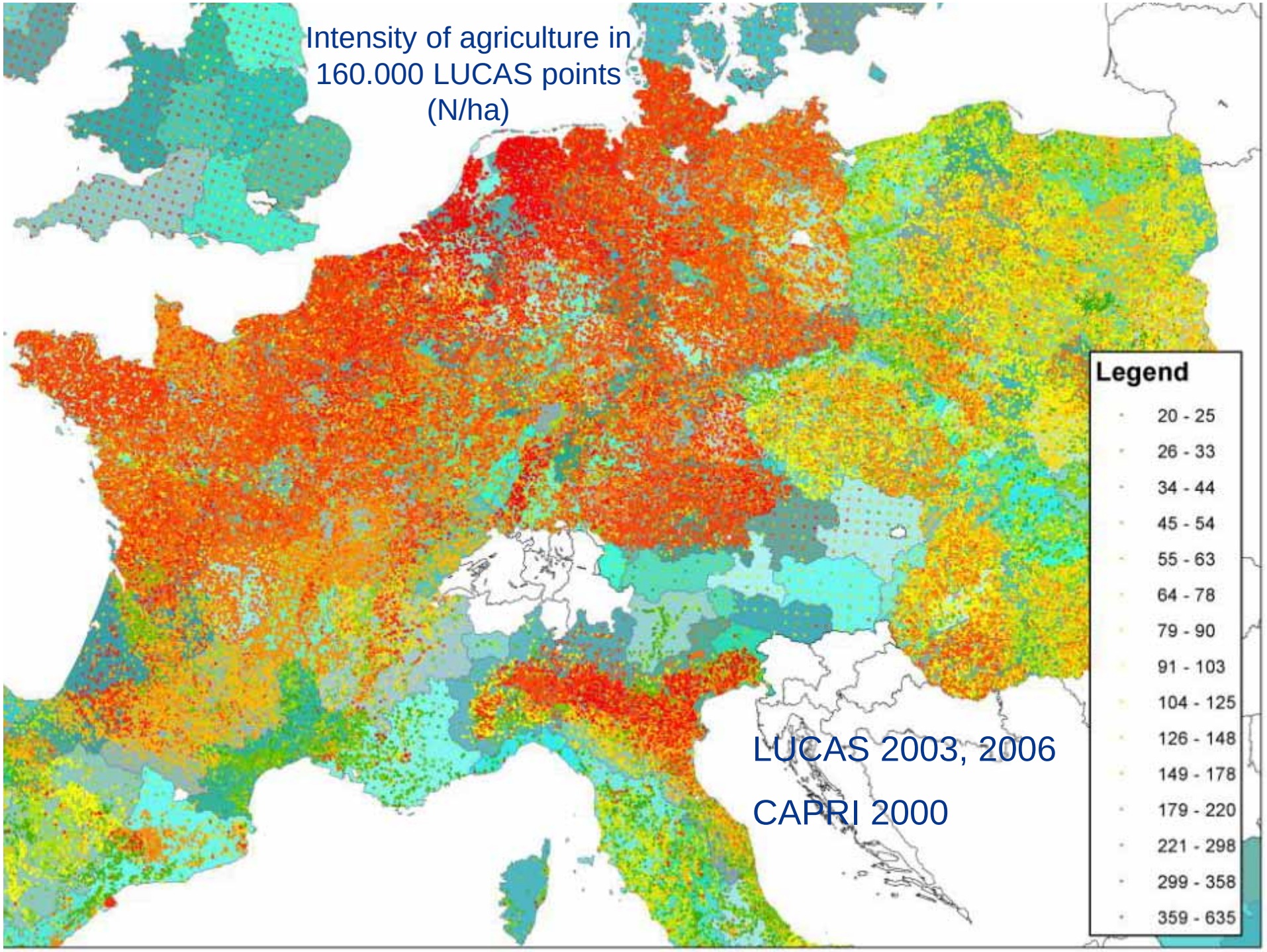
Food security

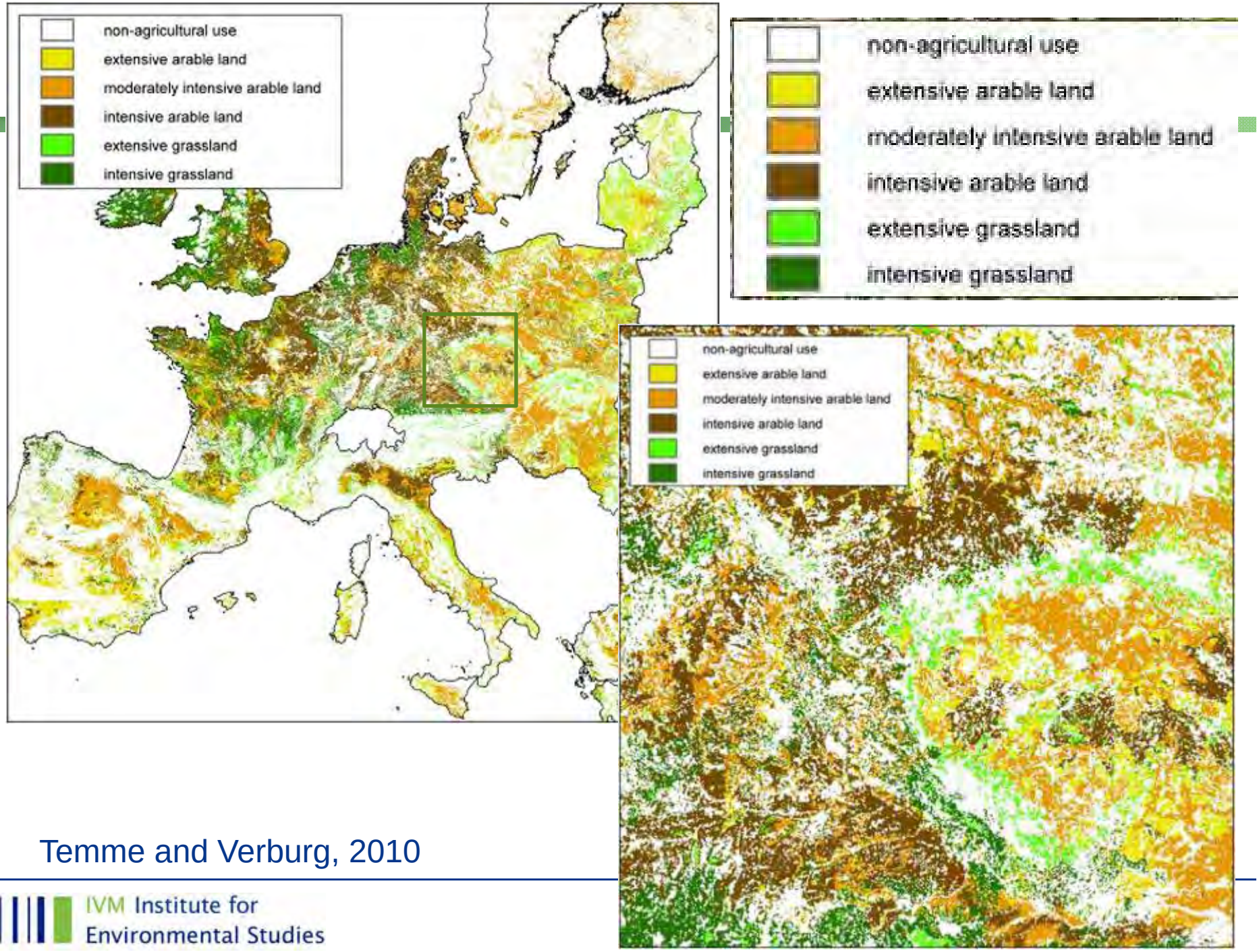


Agricultural intensity (cropland areas)

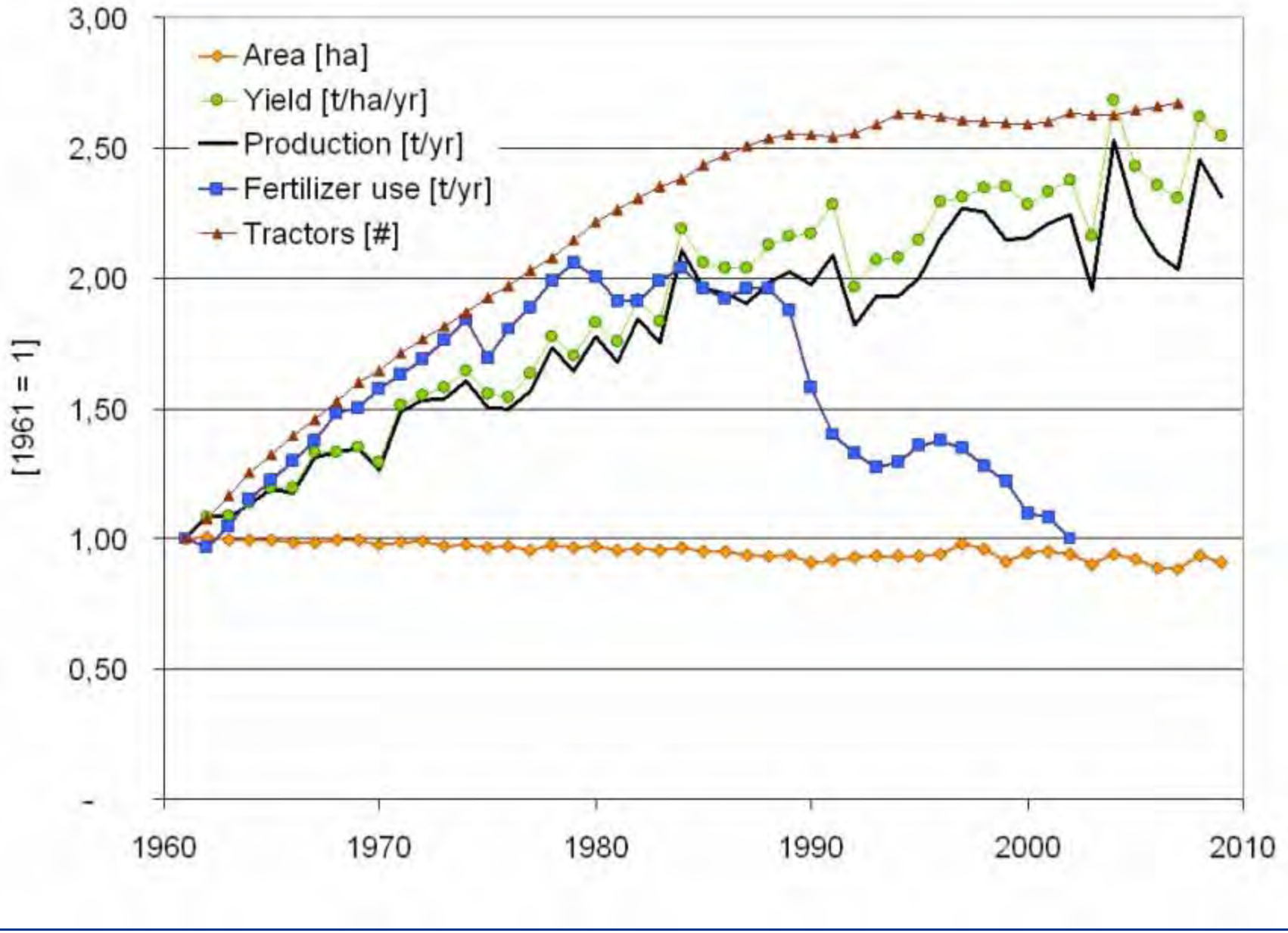


Based on *Neumann et al. (2010), Agricultural Systems 103, 316-326.*


Intensity of agriculture in
160.000 LUCAS points
(N/ha)
Legend
20 - 25
26 - 33
34 - 44
45 - 54
55 - 63
64 - 78
79 - 90
91 - 103
104 - 125
126 - 148
149 - 178
179 - 220
221 - 298
299 - 358
359 - 635
LUCAS 2003, 2006
CAPRI 2000

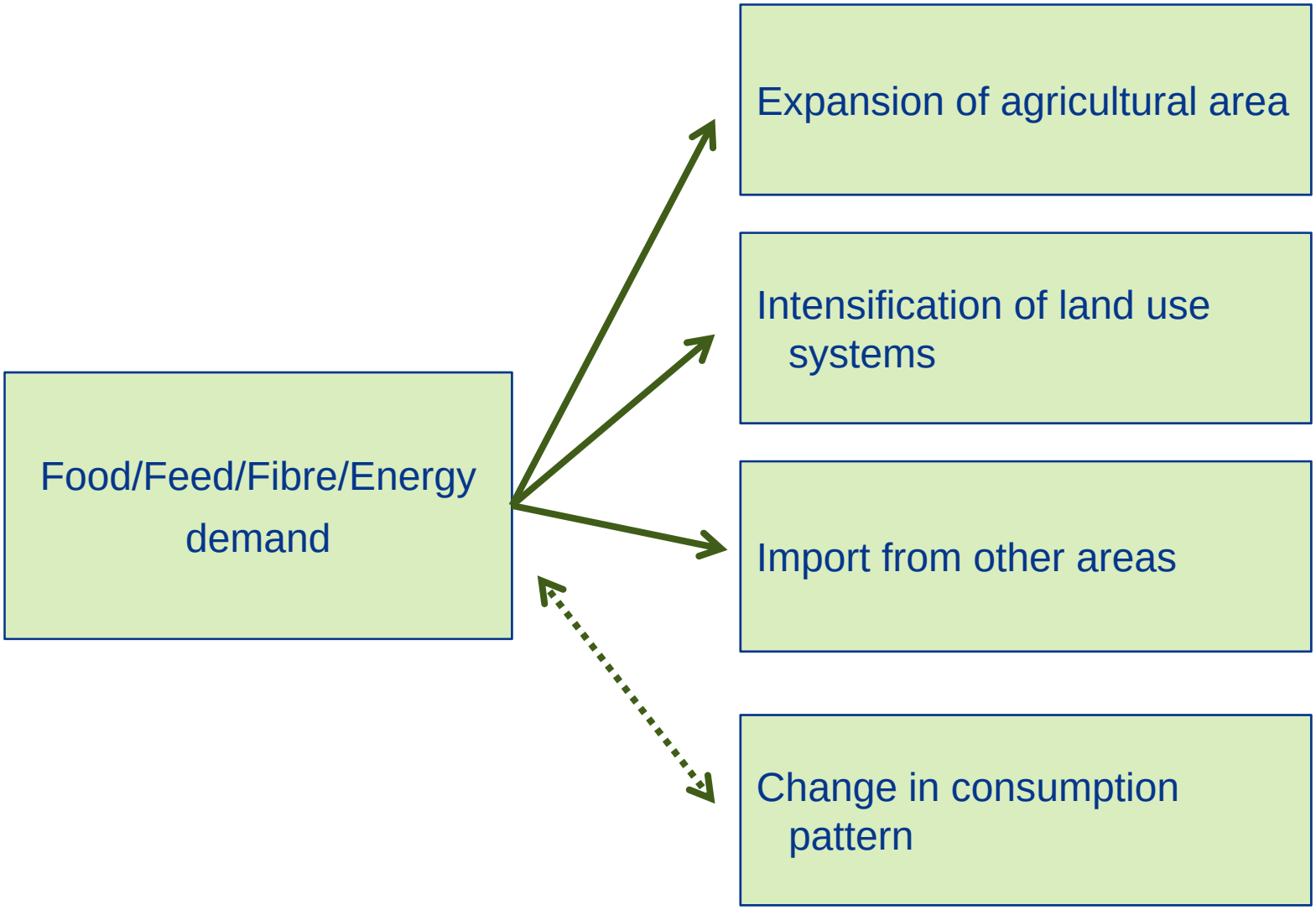


Temme and Verburg, 2010

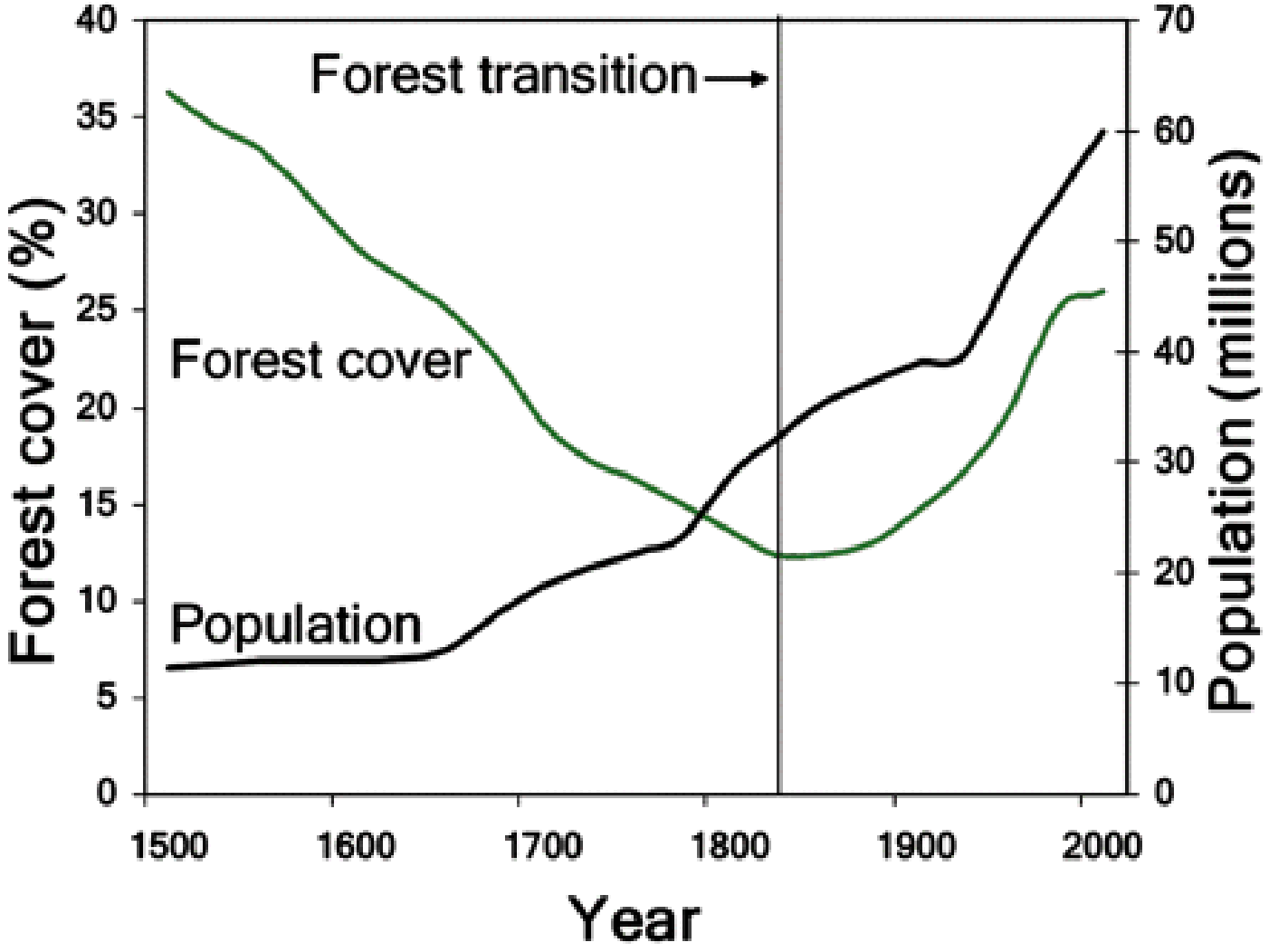


Rounsevell et al., 2012

Food security

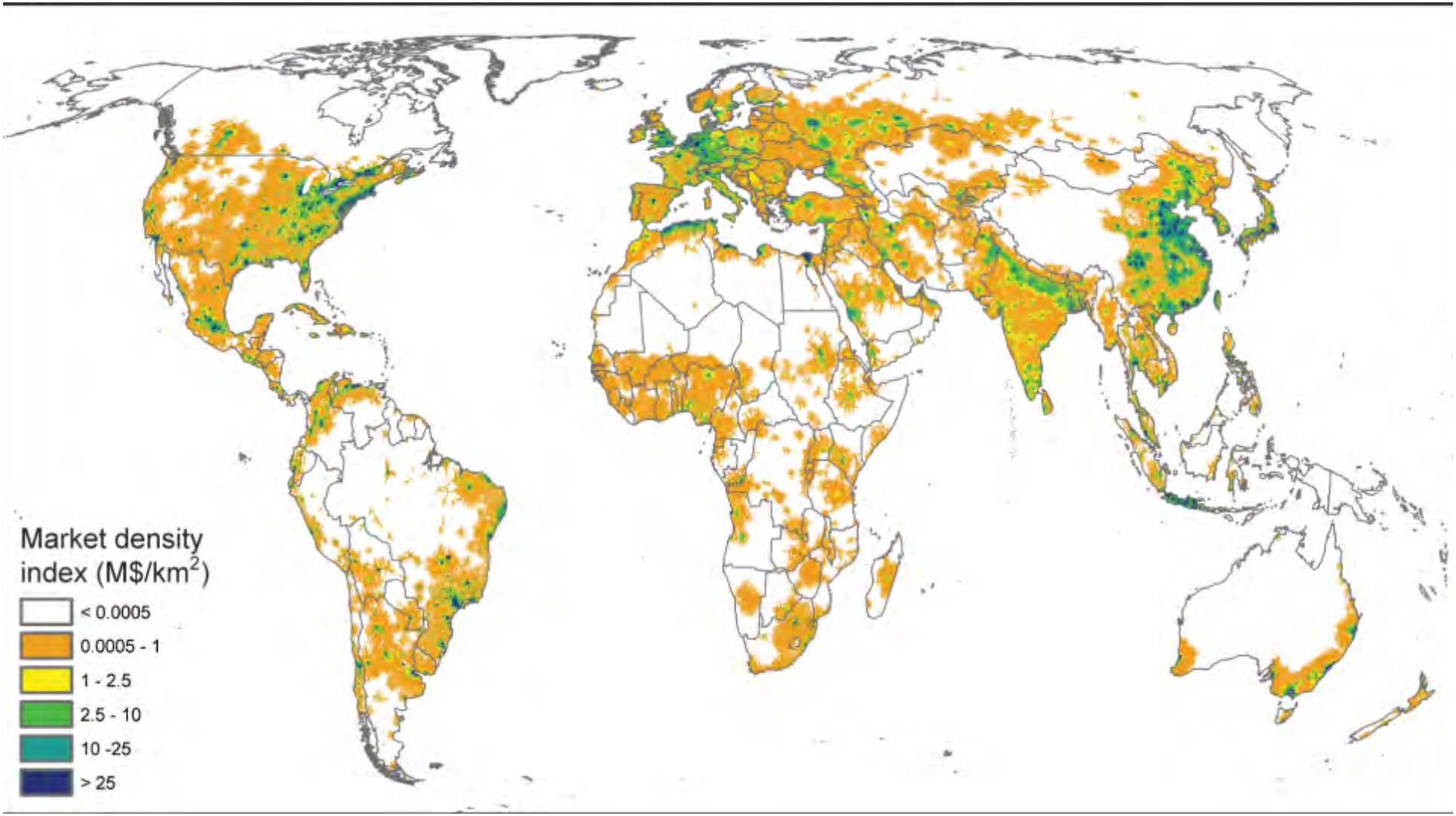


Forest transition: changing forest/population relations



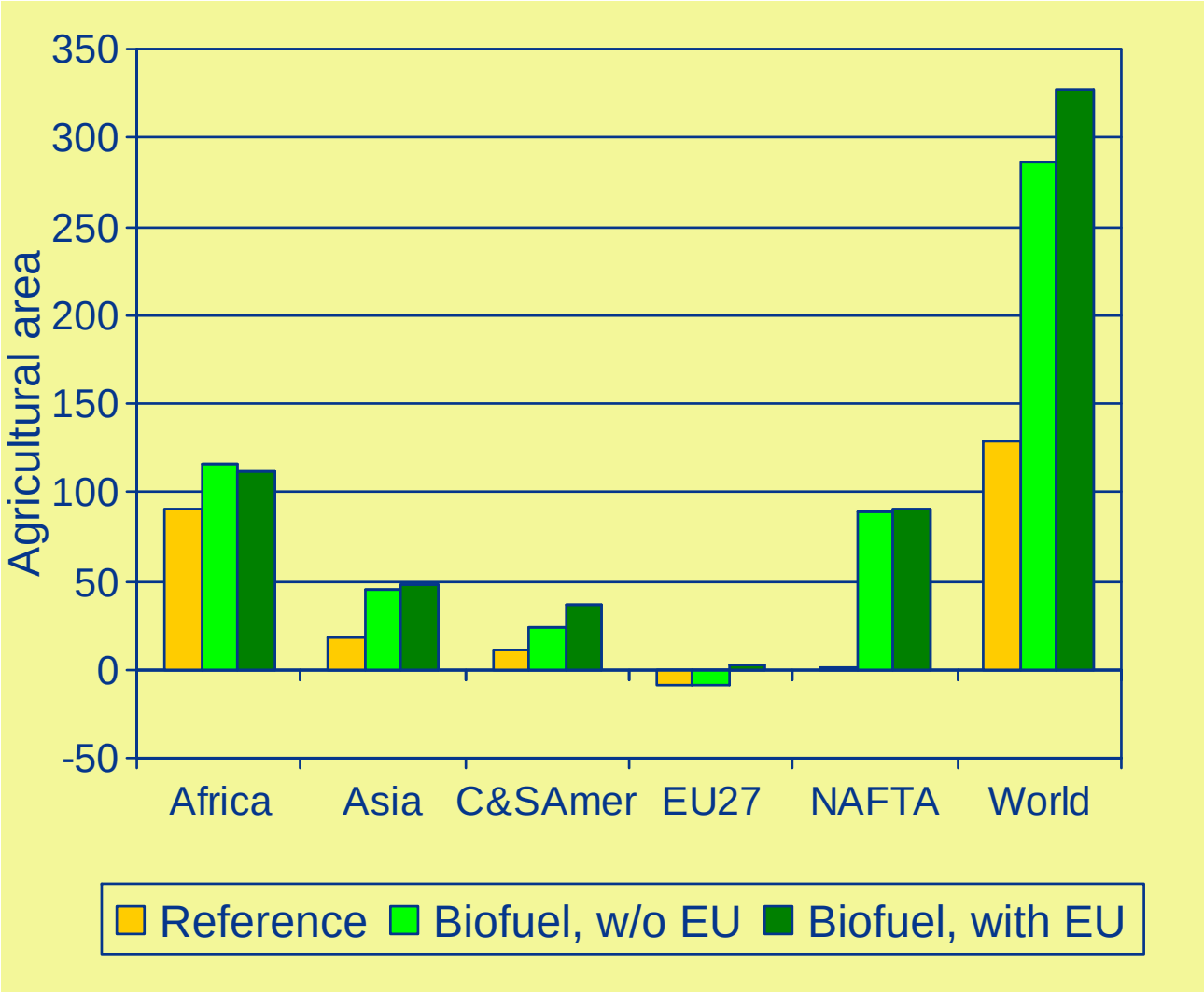
Kauppi et al., 2006

Market influence



Verburg et al., 2011

Spatial trade-offs: a scenario study 2000-2030



Verburg et al., 2008 Annals of Regional Science

Banse et al., 2010 Biomass and Bioenergy

Spatial trade-offs

Global scale

↓

Landscape scale

Increased competitiveness of agriculture

Marginal areas:
Abandonment

Prime agricultural areas:
Intensification/scale enlargement

Land sparing

vs.

Land sharing

Agricultural biodiversity

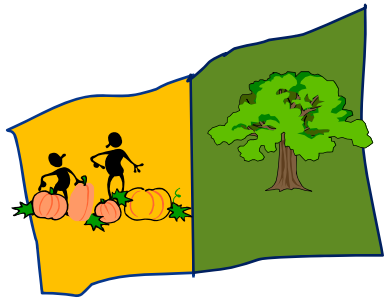
Wilderness

Intensification

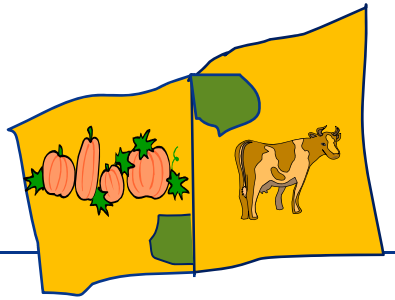
Abandonment

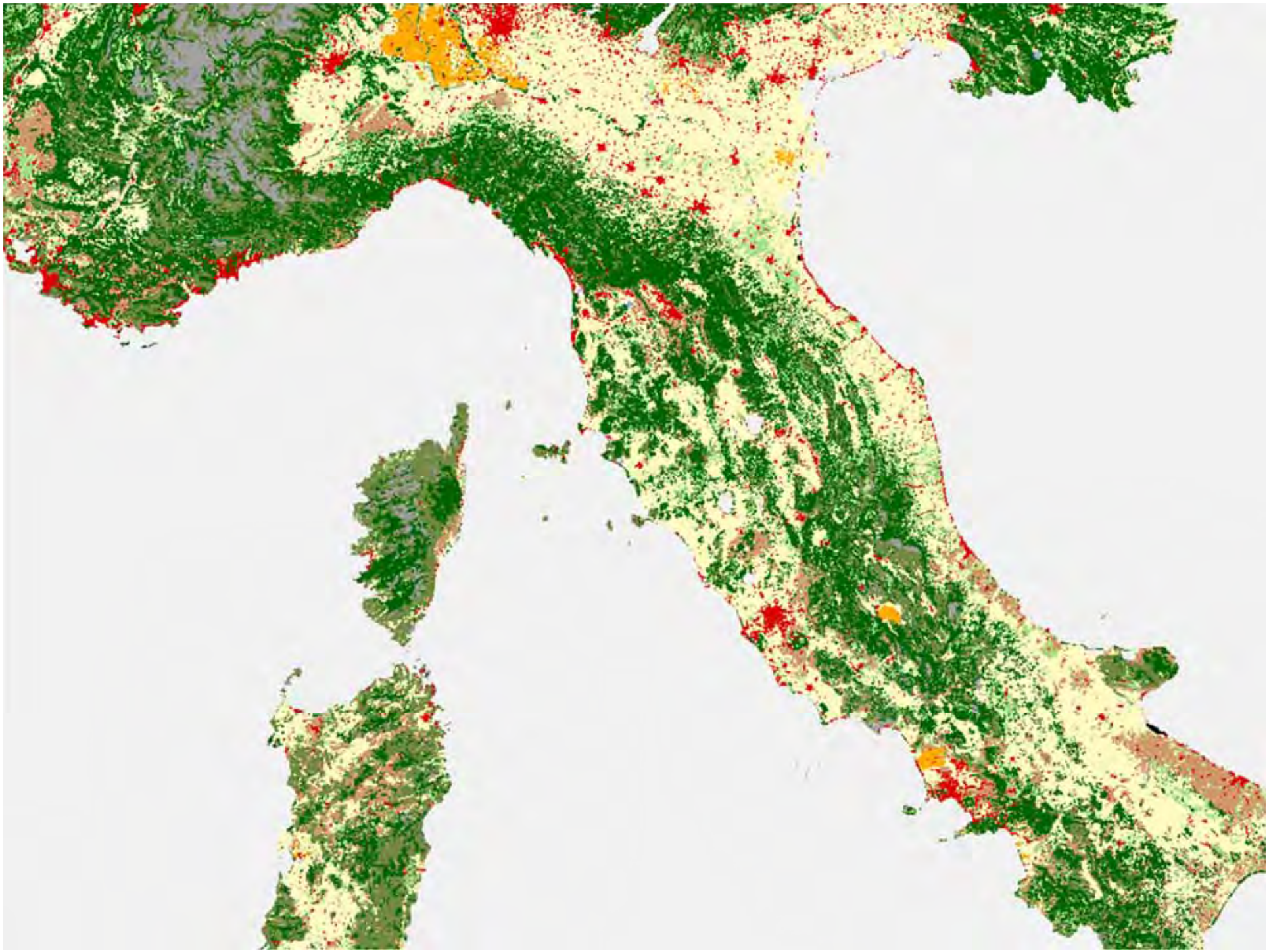
Land Sparing vs. Land Sharing

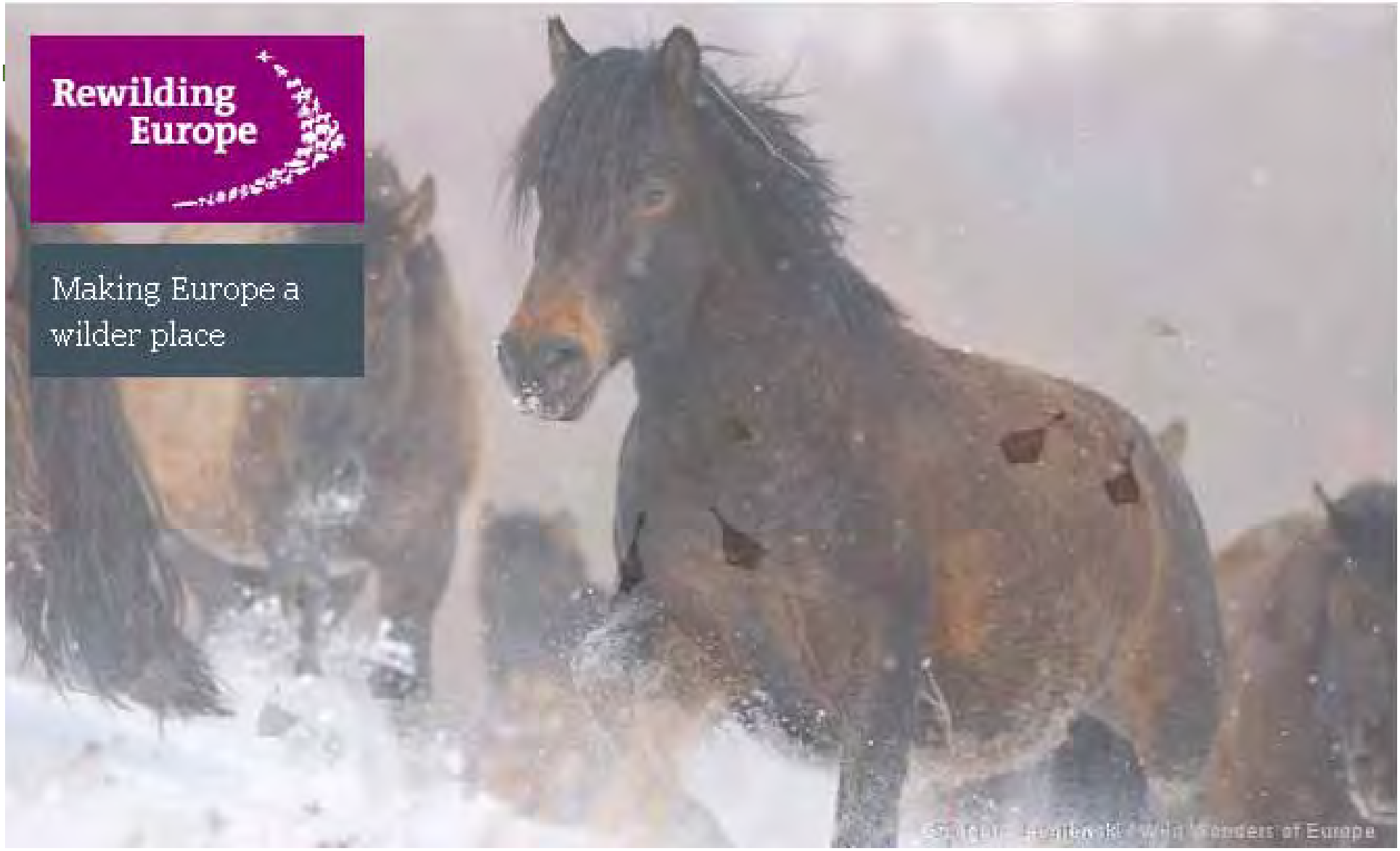
- Land sparing: human activities very intensive on ‘restricted’ area.
  - – High impact on ecosystem services in affected area
  - – Low impact on ecosystems in remaining area
  - ☹ Spatial/temporal spill-over / re-bound effects
  - ☹ Not all ecosystem services can be ‘transported’



- Land sharing: multi-functional land use
  - - Based on synergies in ecosystem service provision
  - - Extensive land uses, requiring large areas
  - ☹ Large land requirements, no ‘wilderness’



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Making Europe a wilder place


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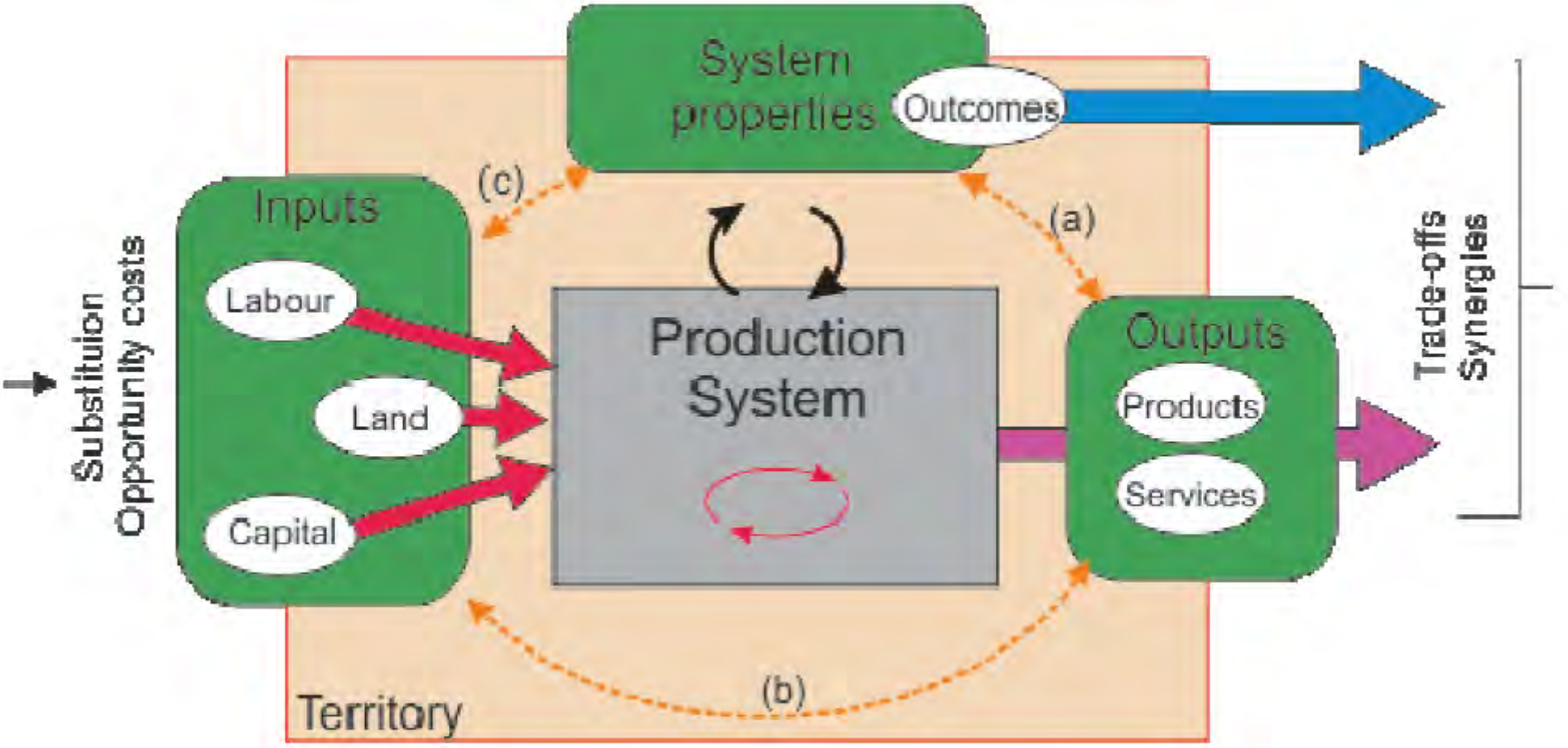
EFNCP
HOME
HNV FARMING POLICY
HNV PANORAMAS
BIODIVERSITY
PROJECTS
ACTIVITY BY MEMBER STATES
HNV Farming & Biodiversity
Panorama
Csik Mountains, Romania
The name of the site is derived from a mountain basin of the Eastern Carpathians, called Csik Basin.
The basin got its name from the Weatherfish (Misgurnus fossilis) that was once very abundant in the floodplain marshes.
more
Location: MUNTII CIUCULUI

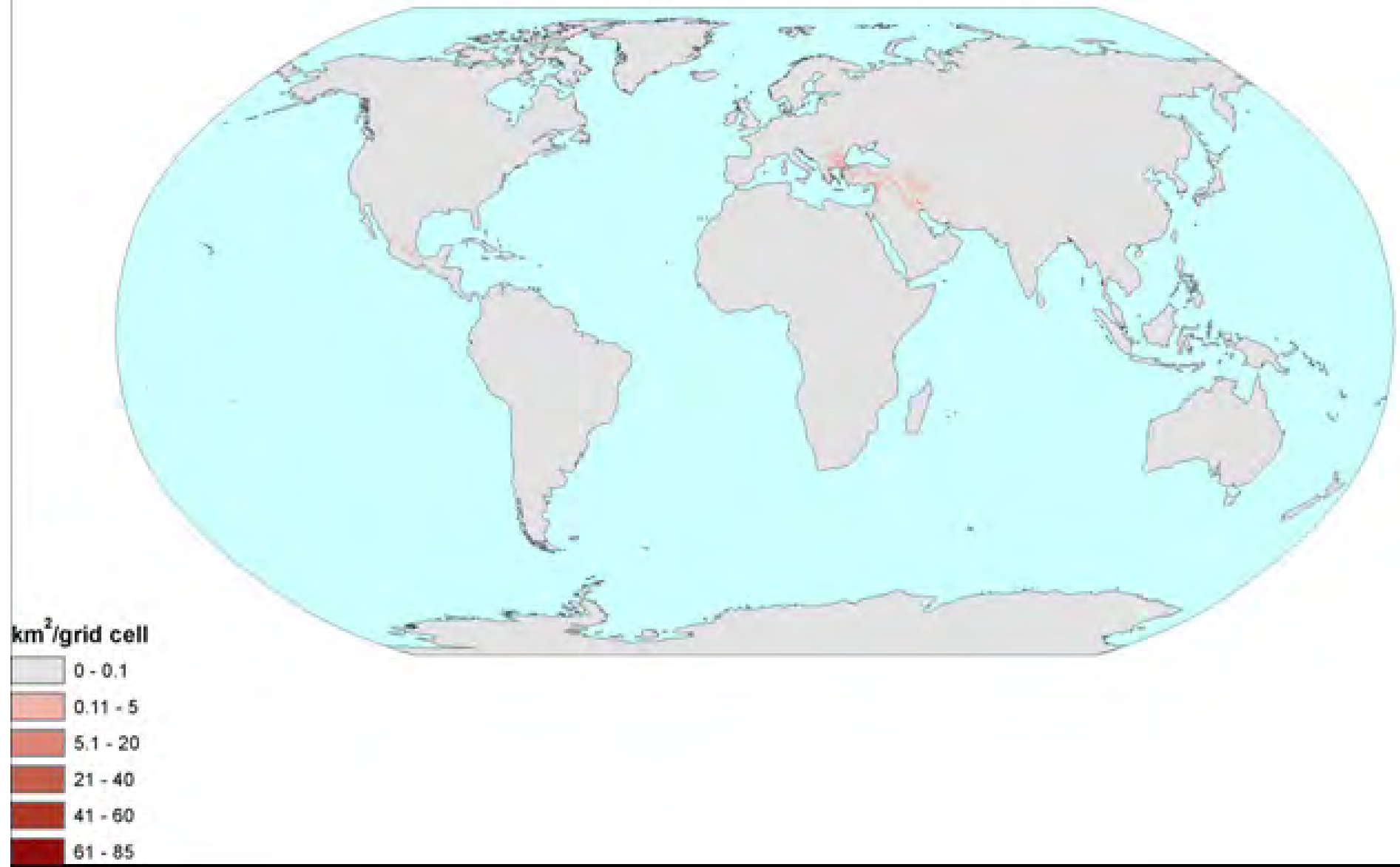
Land use intensity



Erb et al., subm.

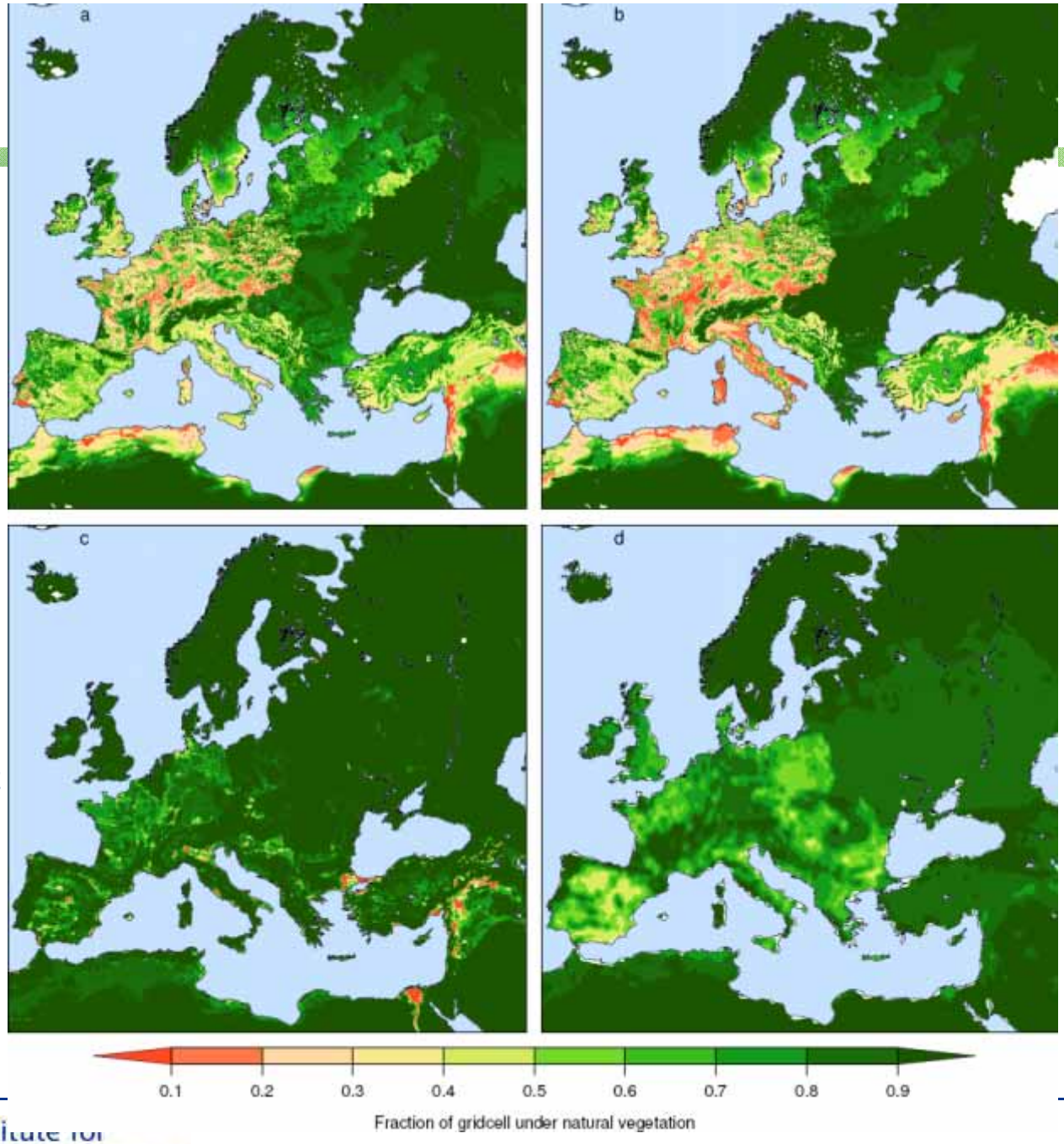
A historic perspective

Historical cropland estimate 6000 B.C.



AD 800

Kaplan et al, 2009
Standard scenario



Kaplan et al, 2009
Technology scenario

Klein Goldewijk et al. (2010)
HYDE 3.1

Pongratz et al. (2008)
Maximum scenario

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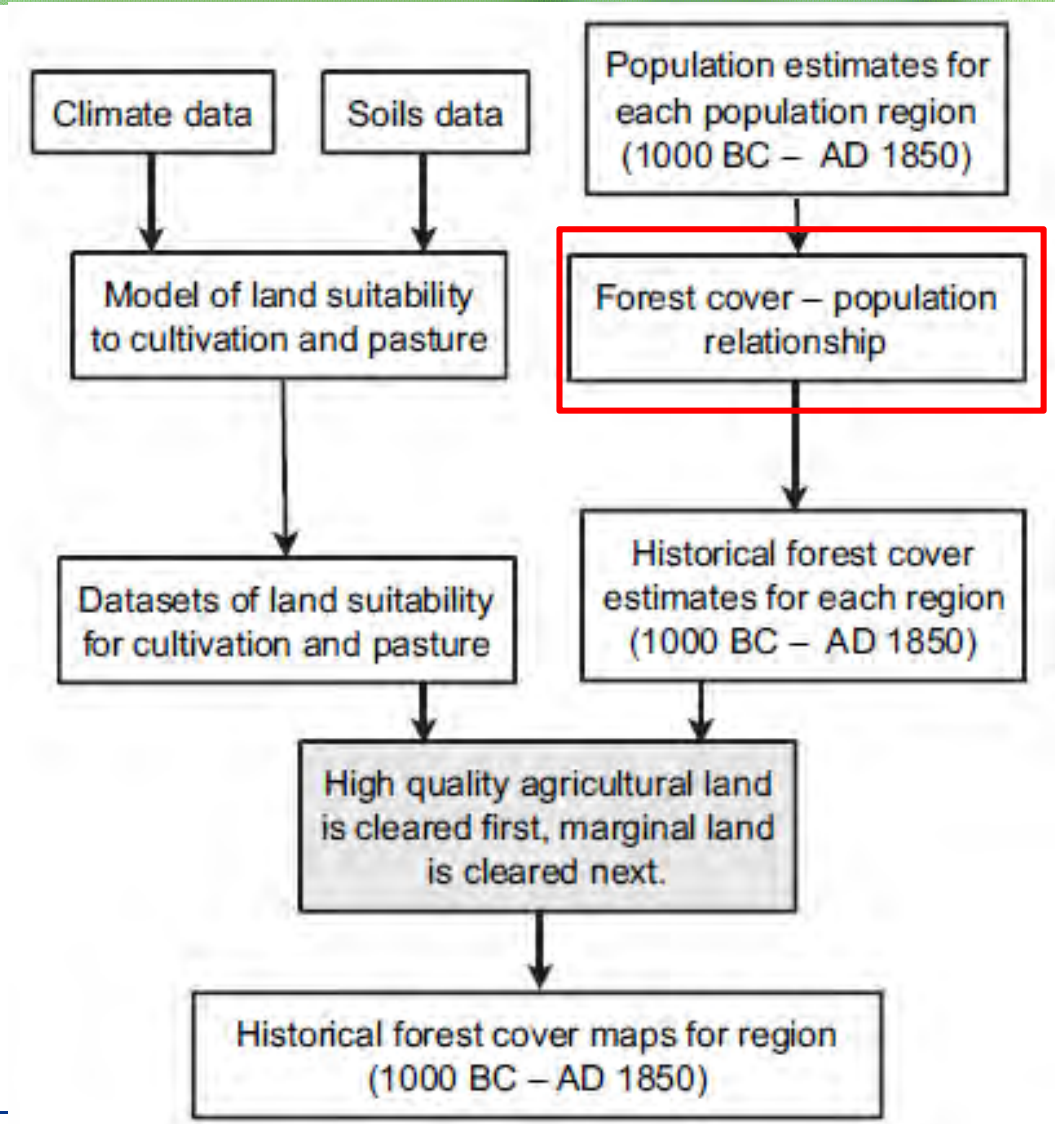
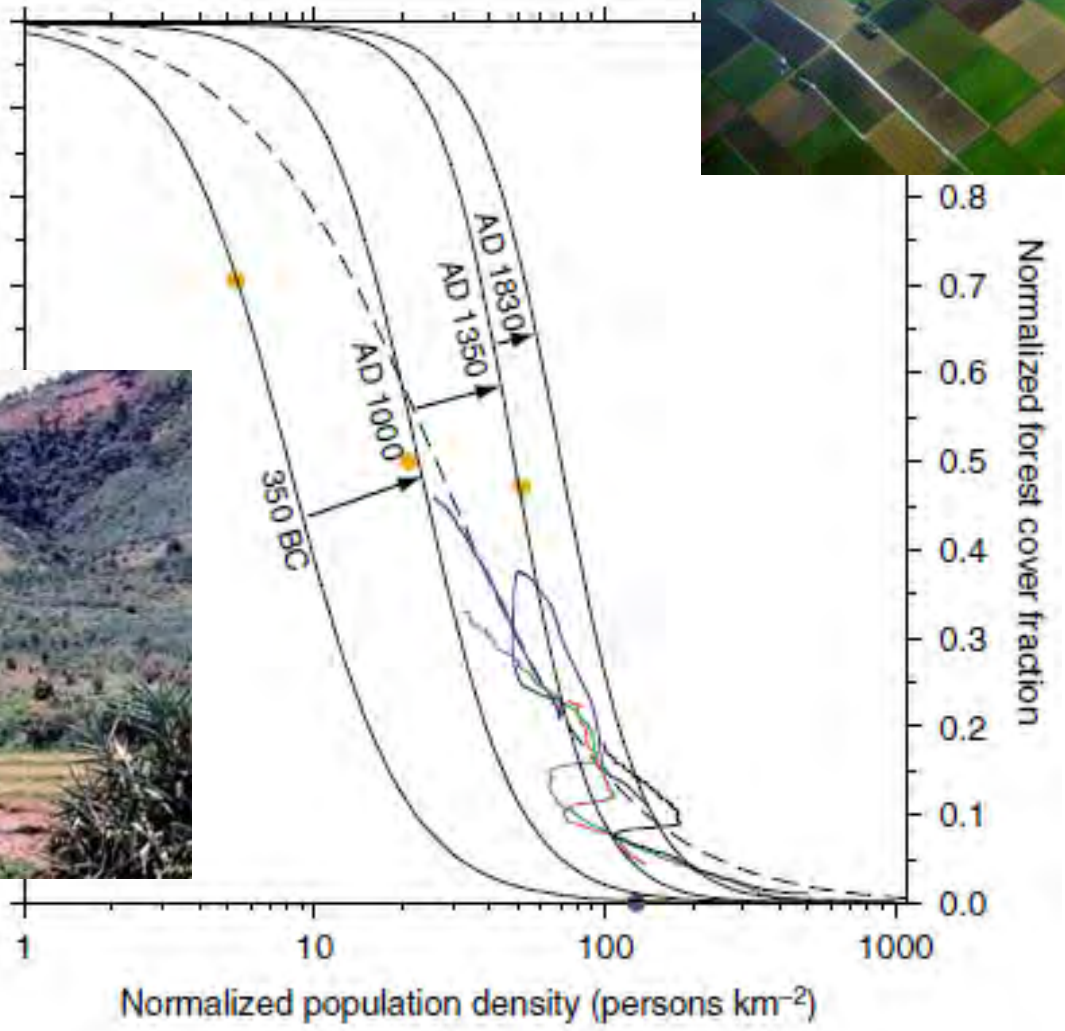
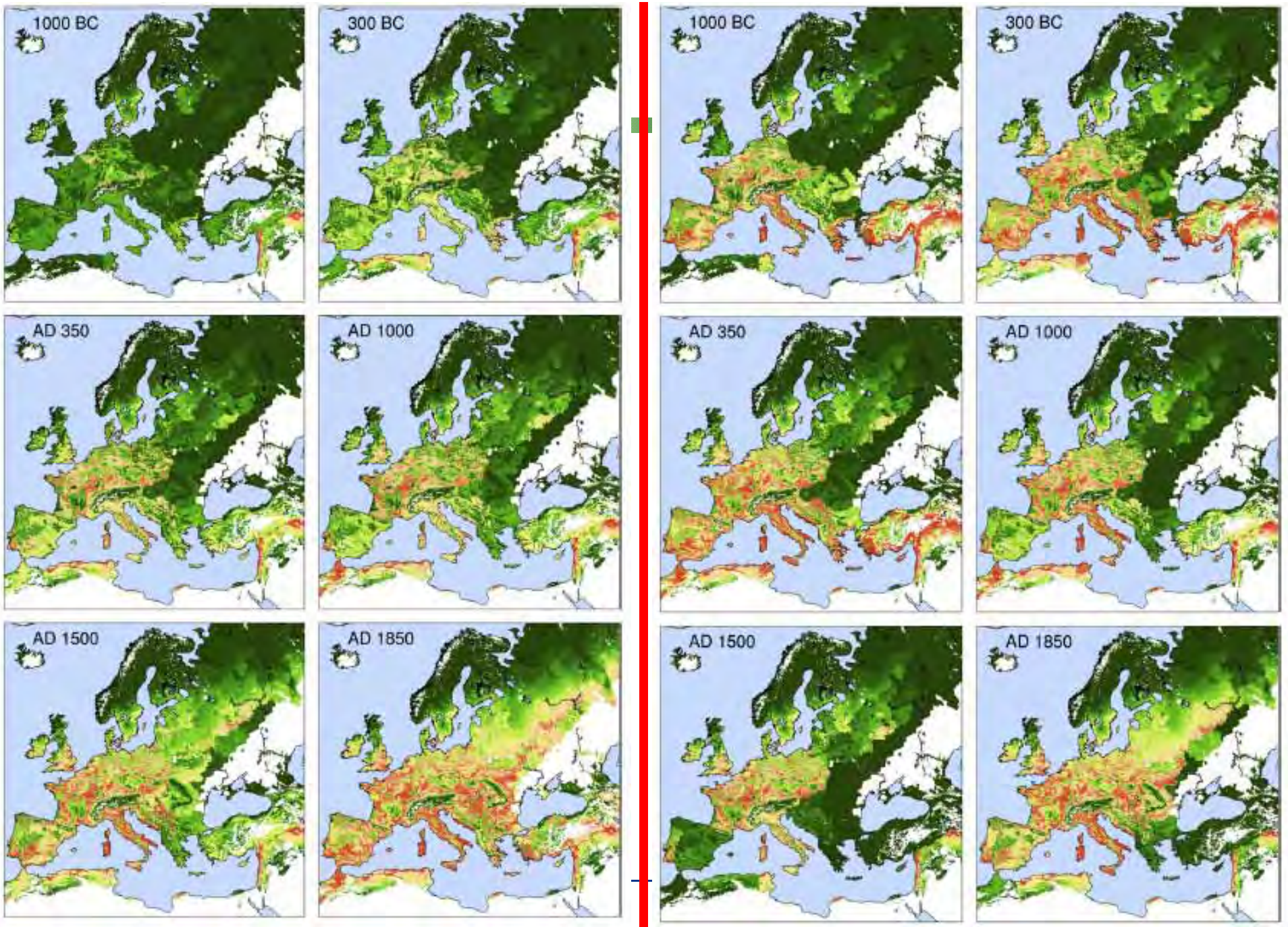


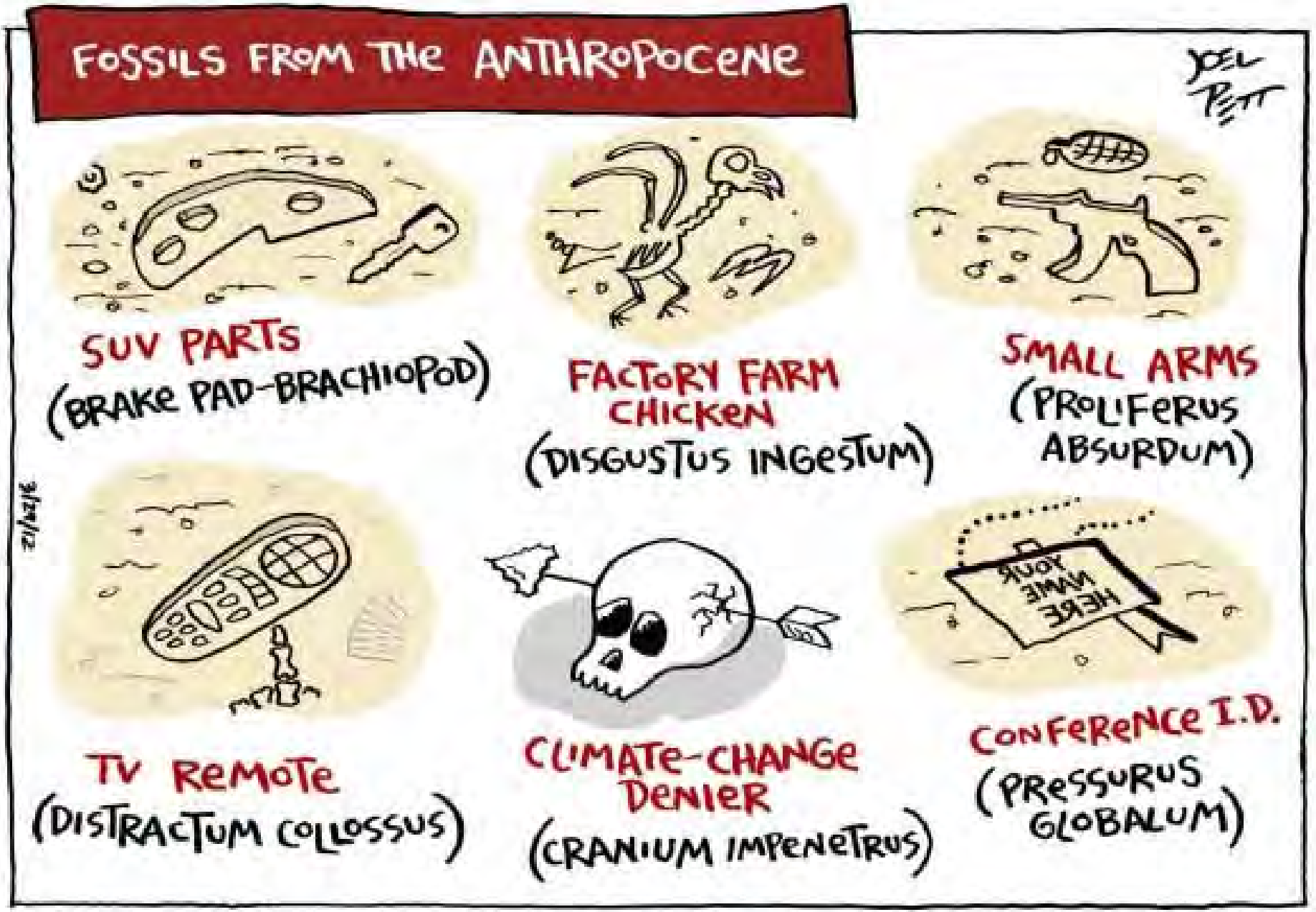
Kaplan et al., 2009

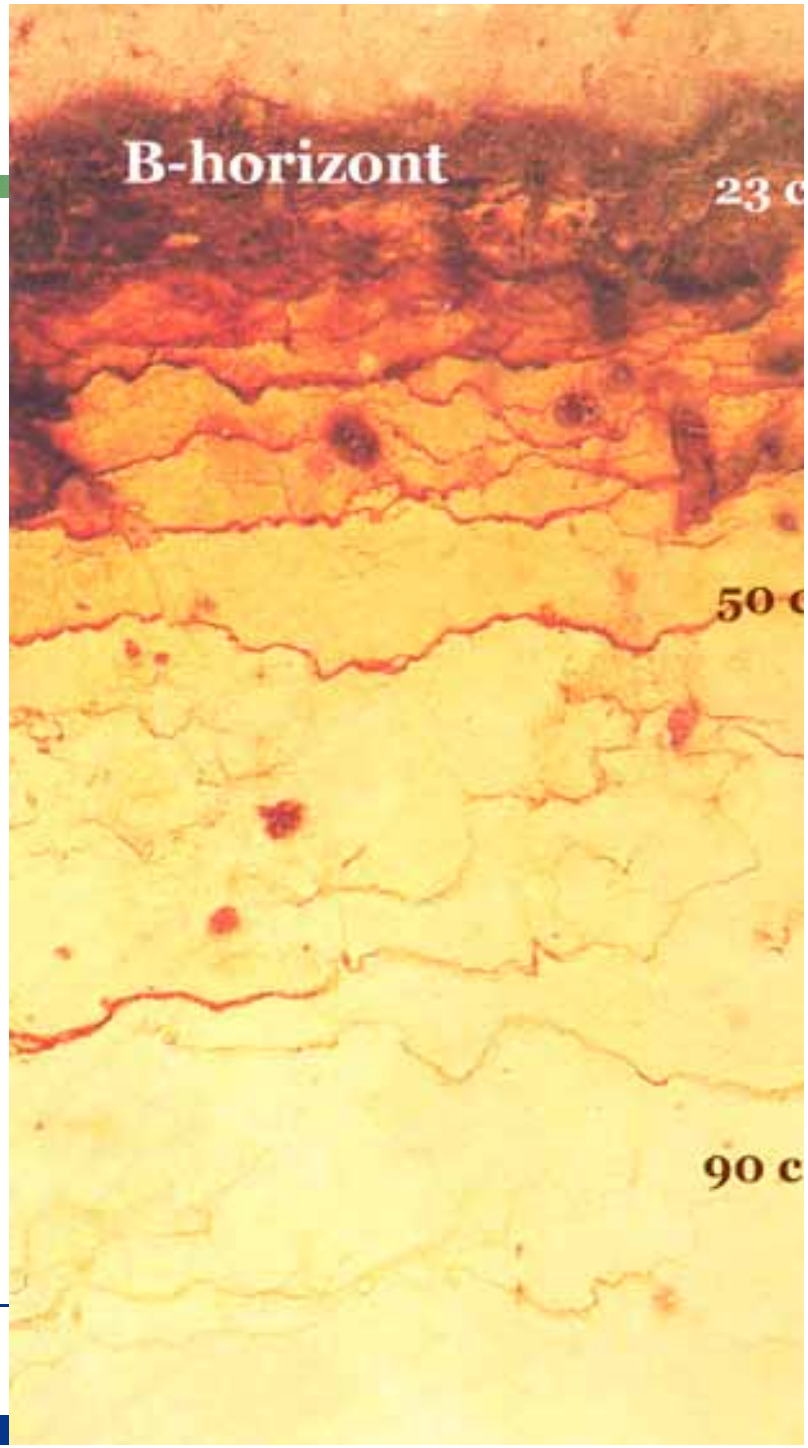

AD 1830
AD 1350
AD 1000
350 BC
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Normalized forest cover fraction
1
10
100
1000
Normalized population density (persons km⁻²)



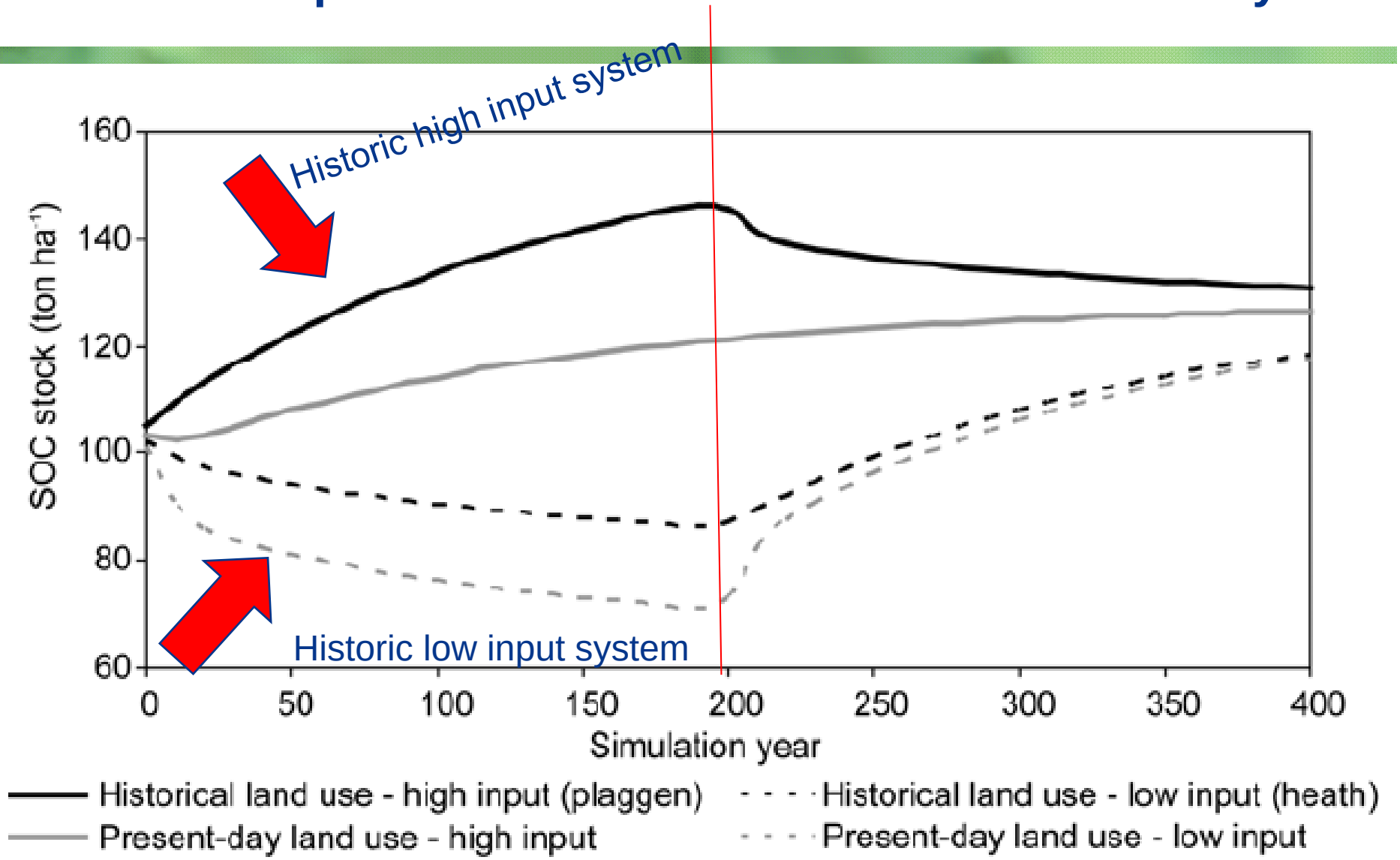
Environmental Studies

Kaplan et al., 2009


FOSSILS FROM THE ANTHROPOCENE
JOEL PETT
SUV PARTS
(BRAKE PAD-BRACHIOPOD)
FACTORY FARM CHICKEN
(DISGUSTUS INGESTUM)
SMALL ARMS
(PROLIFERUS ABSURDUM)
TV REMOTE
(DISTRACTUM COLLOSSUS)
CLIMATE-CHANGE DENIER
(CRANIUM IMPENETRUS)
CONFERENCE I.D.
(PRESSURUS GLOBALUM)


B-horizont
23 c
50 c
90 c

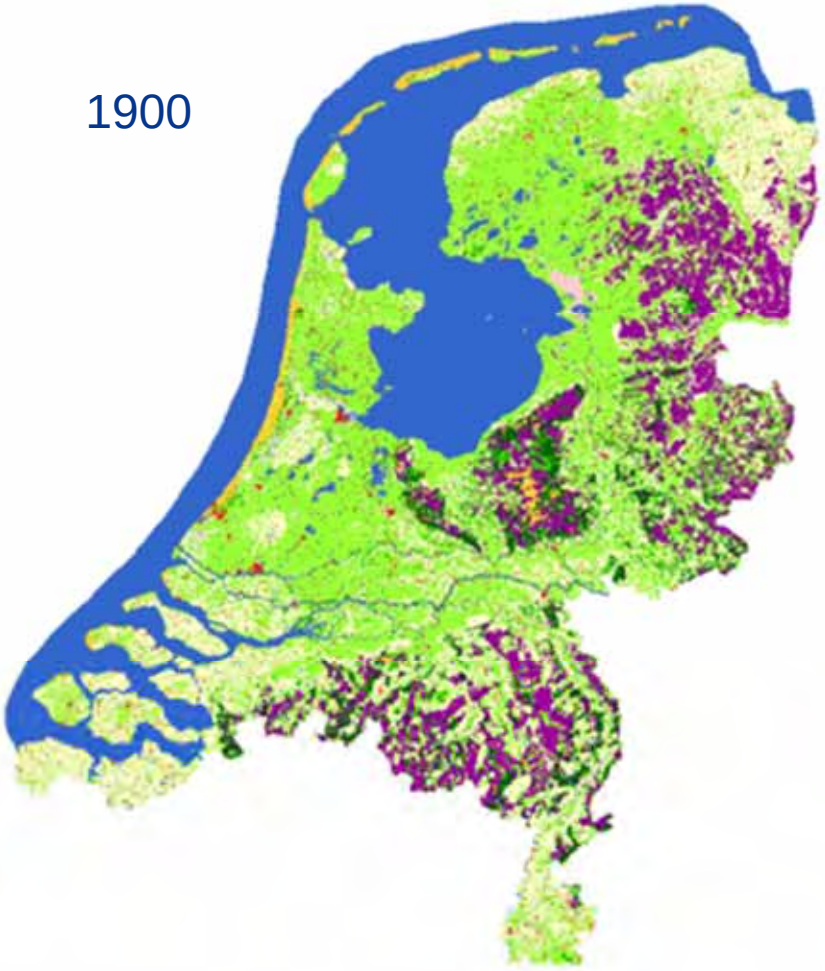
Simulation experiment SOC stocks and land use history



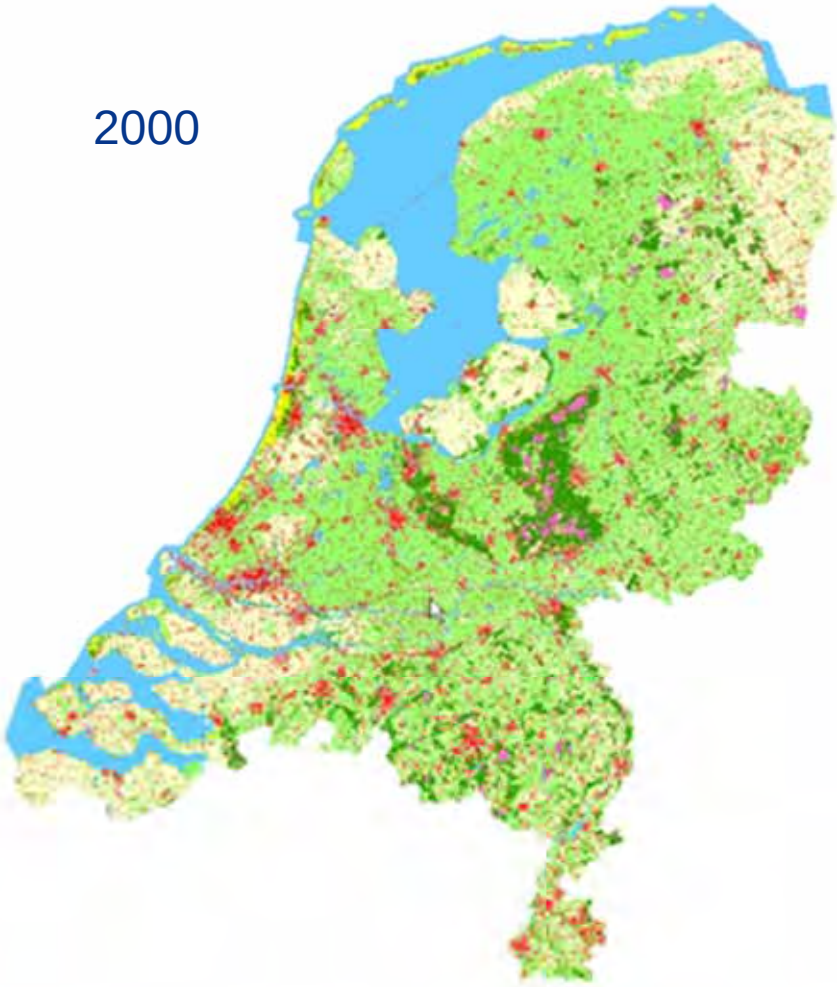
Schulp and Verburg., 2009 Agriculture, Ecosyst. Env.

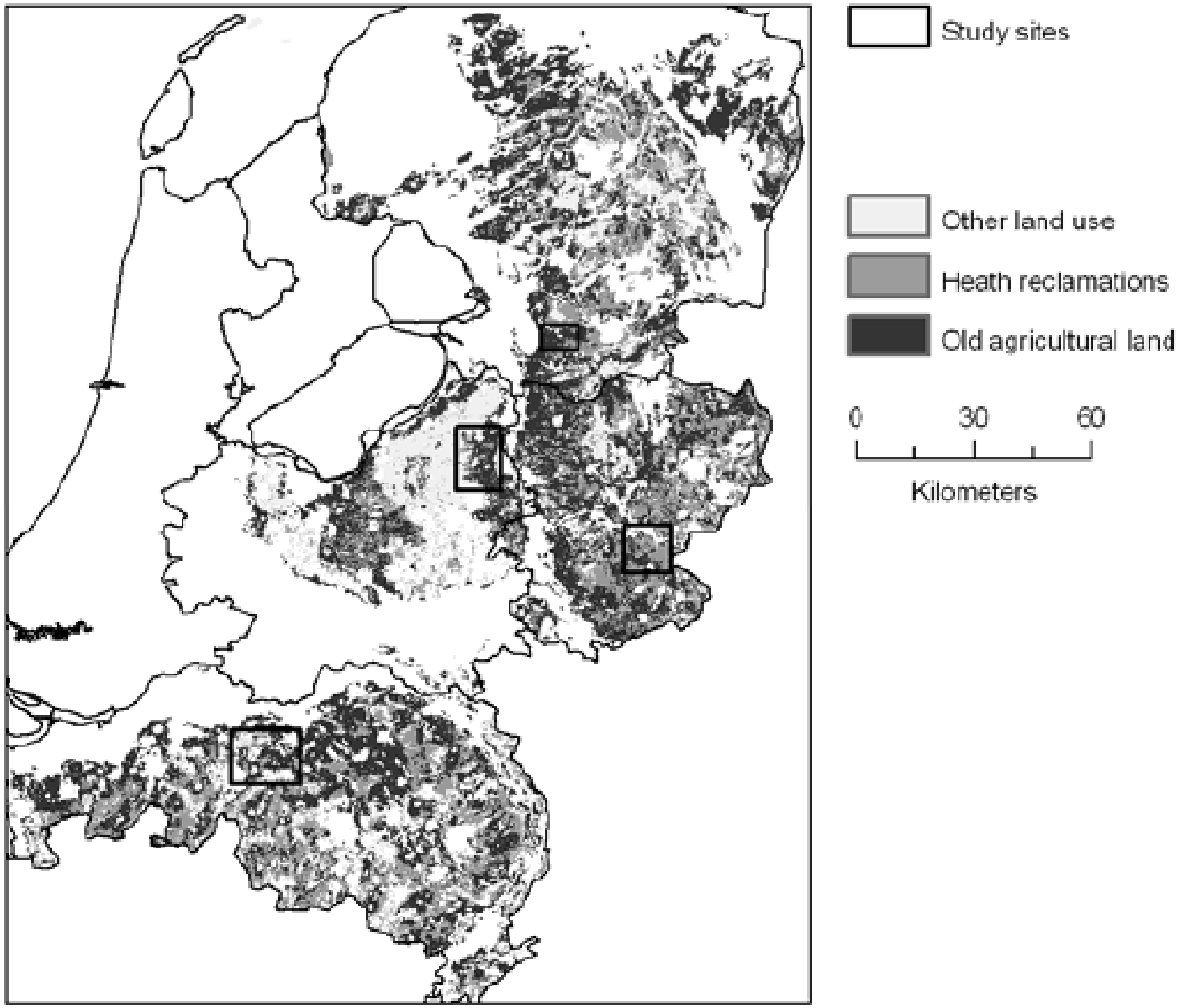
Luse change Netherlands 1900-2000

1900

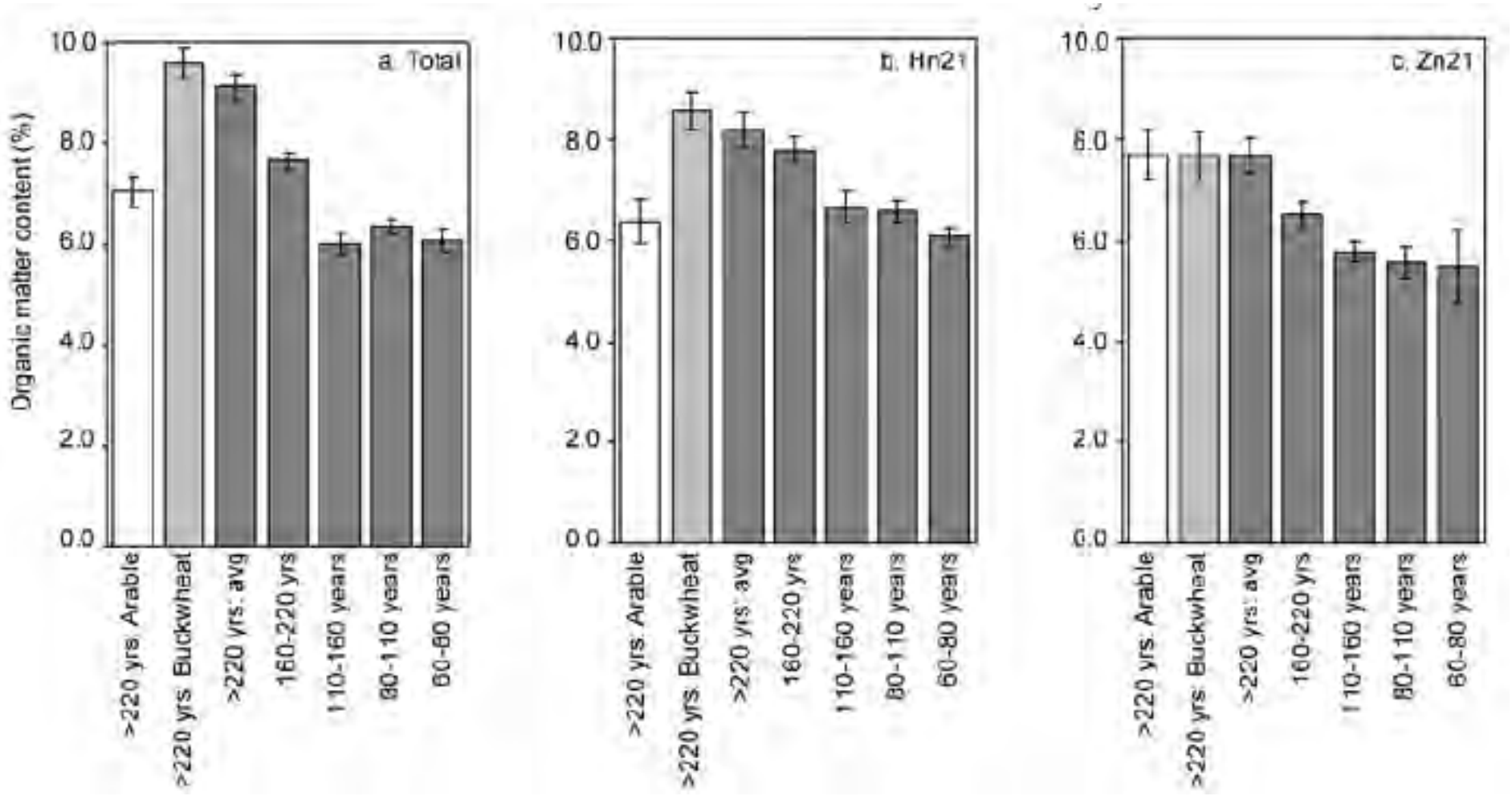


2000




Study sites
Other land use
Heath reclamations
Old agricultural land
0
30
60
Kilometers

Carbon stocks and ‘age’ of agricultural conversion



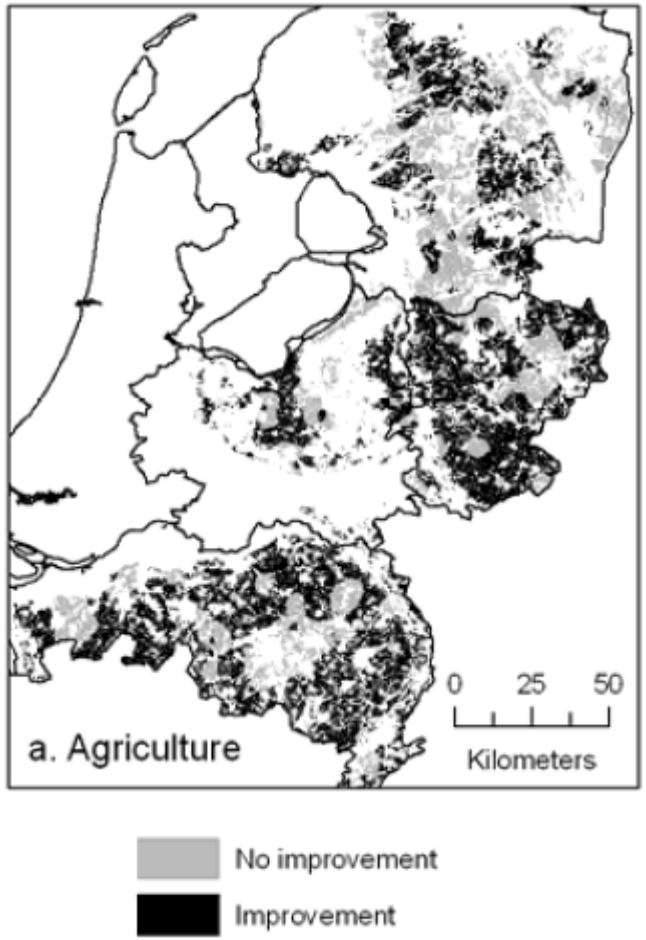
Schulp et al., 2009 Geoderma

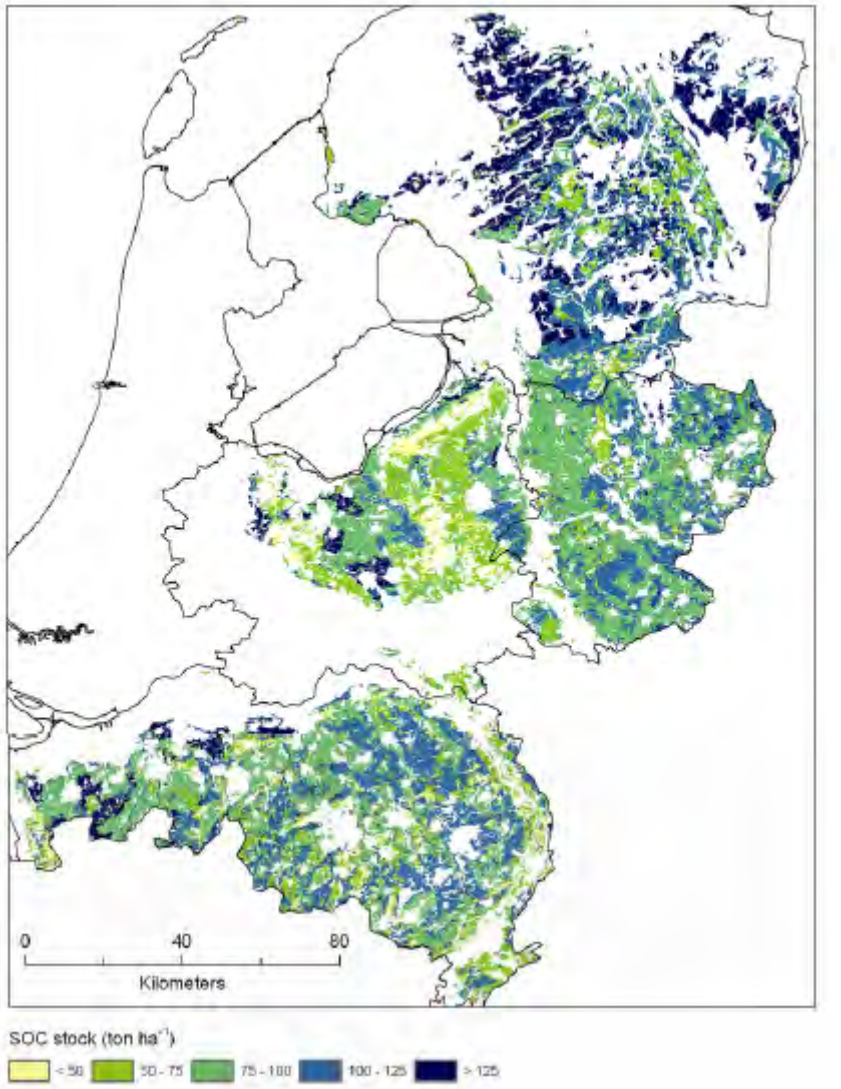
Explaining variables of soil carbon stocks

Independent variables	Site				
	Nieuwleusen	Achterhoek	Veluwe	Den Bosch	All sites
	Associations with SOC content – Determinants separately				
Site factors					
Loam content	23%	11%	6%	5%	0%
Median sand grain size	6%	1%	4%	6%	2%
Elevation	2%	8%	8%	4%	0%
Groundwater class	5%	3%	2%	3%	2%
Soil type	21%	6%	2%	12%	10%
Geomorphology	0%*	6%	3%	8%	4%
Land use history					
Reclamation type	14%	1%	2%	3%	17%
Land use 1900	15%	4%	3%	8%	2%
Reclamation age	12%	1%	1%	1%	1%
Present-day land use and management					
Land use 1999	0% *	1%	1%	3%	1%
Permanent grassland	0% *	0% *	1%	1% *	0%
OC_{eff} input by crops per zip code region	19%	4%	0%*	1%	2%
OC_{eff} input by livestock per zip code region	16%	0%*	1%	3%	2%
OC_{eff} input by crops per municipality					6%
OC_{eff} input by livestock per municipality					9%

Schulp and Verburg., 2009 Agriculture, Ecosyst. Env.

Improved soil carbon inventory accounting for land use history



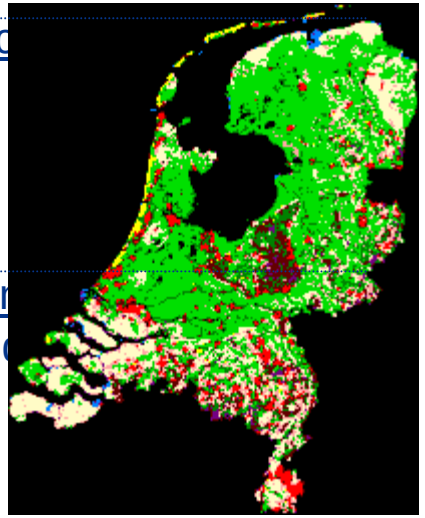


Schulp et al., 2013

Learning from history: validating land change models

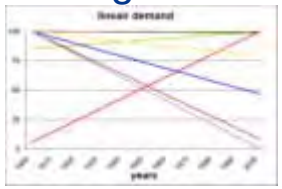
- Land use in 1900

Simulated land use for 200

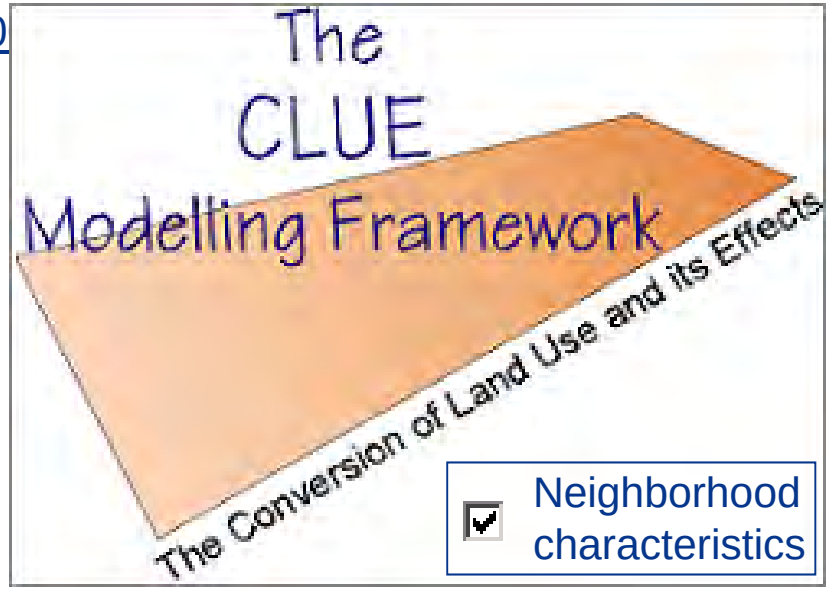


- Land use specific loc
- Results of statistical

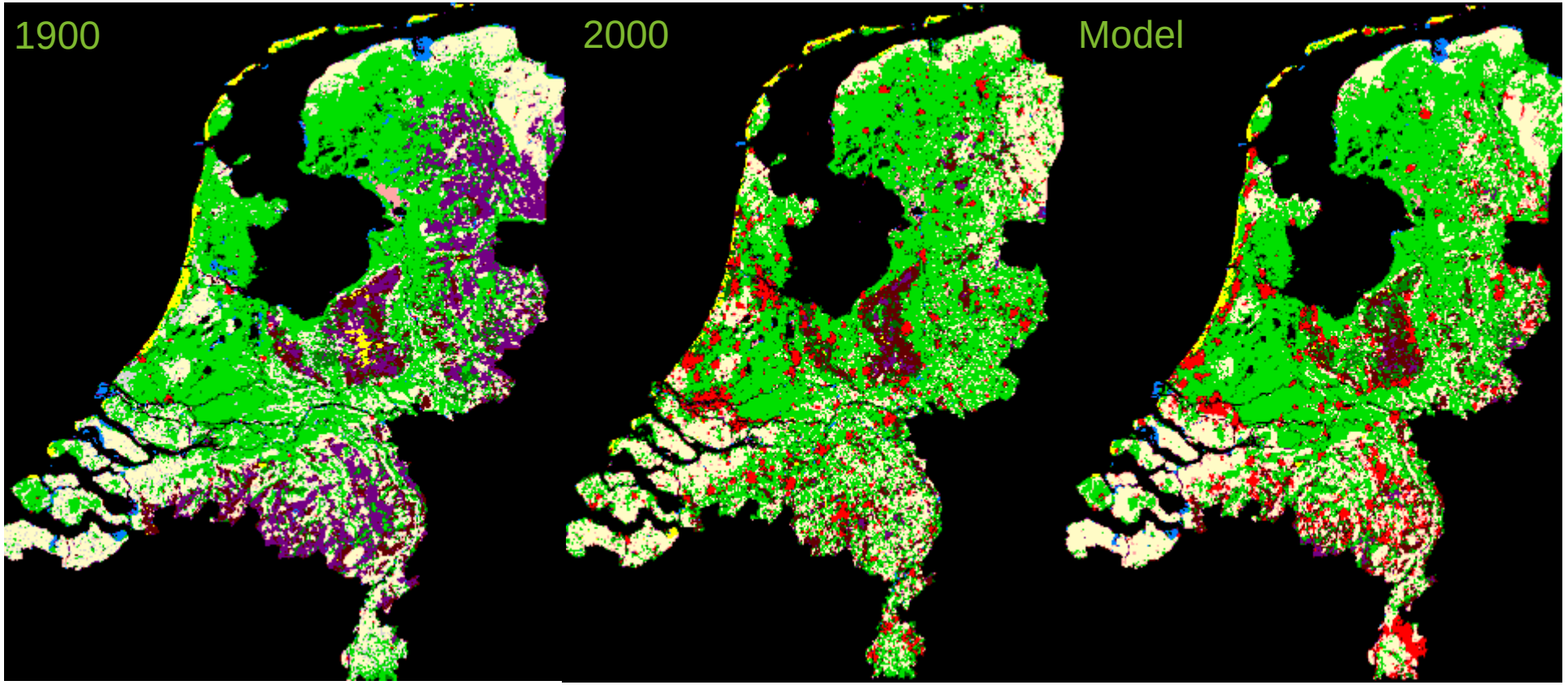
- Land use requiremer
- Change of land use



- Land use type specific conversion settings
  -How likely is a land use type to change
  -Which conversions are allowed



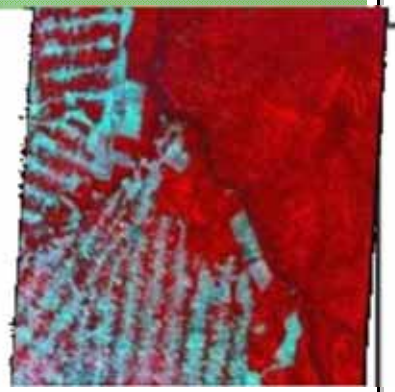
Model results



Lessons from historic land use analysis

- Large legacy effects
- Path dependence (e.g. cities)
- Large transitions have occurred due to changing human-environment interactions, fluctuations in land use
- Learn from areas with long-term sustainable production
- Telecoupling is not new (colonial period), but interactions are more intense and faster
- Demand for ‘services’ from the land is unprecedented
- Model predictions based on historic trends likely to be irrealistic

From land cover to land use to land function

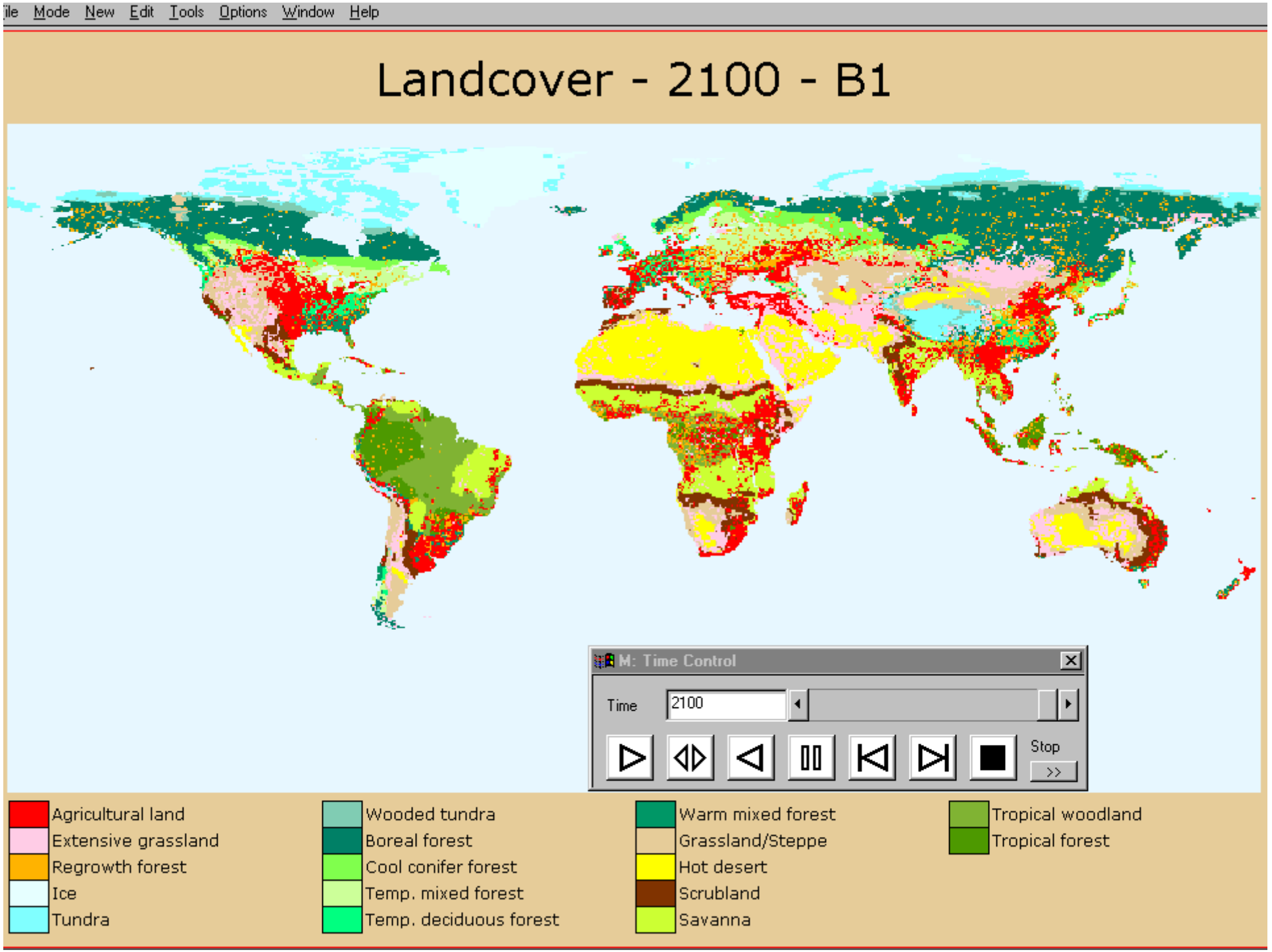


"Land cover can be a cause, constraint or consequence of land use"

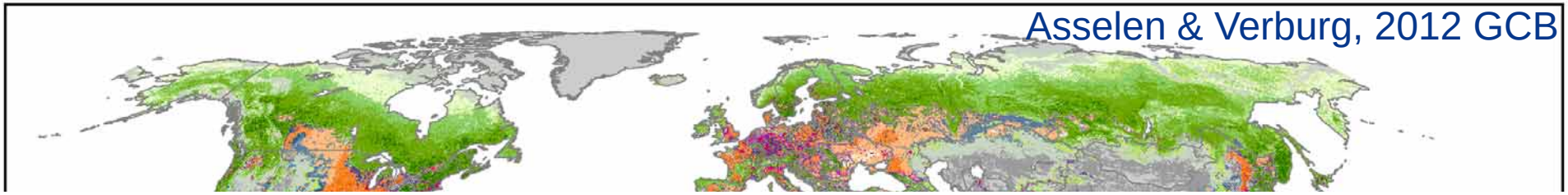
(Cihlar and Jansen, 2001)

Verburg et al., 2009 Journal of Environmental Management

Land functions:
the capacity of the land to provide goods and services


ile Mode New Edit Tools Options Window Help
Landcover - 2100 - B1
M: Time Control
Time
2100
Stop
>>
Agricultural land
Extensive grassland
Regrowth forest
Ice
Tundra
Wooded tundra
Boreal forest
Cool conifer forest
Temp. mixed forest
Temp. deciduous forest
Warm mixed forest
Grassland/Steppe
Hot desert
Scrubland
Savanna
Tropical woodland
Tropical forest

Asselen & Verburg, 2012 GCB



Cropland Systems

- Cropland; extensive with few livestock
- Cropland; extensive with bovines, goats & sheep
- Cropland; extensive with pigs & poultry
- Cropland; medium intensive with few livestock
- Cropland; medium intensive with bovines, goats & sheep
- Cropland; medium intensive with pigs & poultry
- Cropland; intensive with few livestock
- Cropland; intensive with bovines, goats & sheep
- Cropland; intensive with pigs & poultry

Mosaic cropland and grassland systems

- Mosaic cropland and grassland with bovines, goats & sheep
- Mosaic cropland and grassland with pigs & poultry
- Mosaic cropland (extensive) and grassland with few livestock
- Mosaic cropland (medium intensive) and grassland with few livestoc
- Mosaic cropland (intensive) and grassland with few livestock

Mosaic cropland and forest systems

- Mosaic cropland and forest with pigs & poultry
- Mosaic cropland (extensive) and forest with few livestock
- Mosaic cropland (medium intensive) and forest with few livestock
- Mosaic cropland (intensive) and forest with few livestock

Cropland Systems

- Cropland; extensive with few livestock
- Cropland; extensive with bovines, goats & sheep
- Cropland; extensive with pigs & poultry
- Cropland; medium intensive with few livestock
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- Cropland; medium intensive with pigs & poultry
- Cropland; intensive with few livestock
- Cropland; intensive with bovines, goats & sheep
- Cropland; intensive with pigs & poultry

Mosaic cropland and grassland systems

- Mosaic cropland and grassland with bovines, goats & sheep
- Mosaic cropland and grassland with pigs & poultry
- Mosaic cropland (extensive) and grassland with few livestock
- Mosaic cropland (medium intensive) and grassland with few livestock
- Mosaic cropland (intensive) and grassland with few livestock

Mosaic cropland and forest systems

- Mosaic cropland and forest with pigs & poultry
- Mosaic cropland (extensive) and forest with few livestock
- Mosaic cropland (medium intensive) and forest with few livestock
- Mosaic cropland (intensive) and forest with few livestock

Forest systems

- Dense forest
- Open forest with few livestock
- Open forest with pigs & poultry

Mosaic (semi-)natural systems

- Mosaic grassland and forest
- Mosaic grassland and bare

Grassland systems

- Natural grassland
- Grassland with few livestock
- Grassland with bovines, goats & sheep

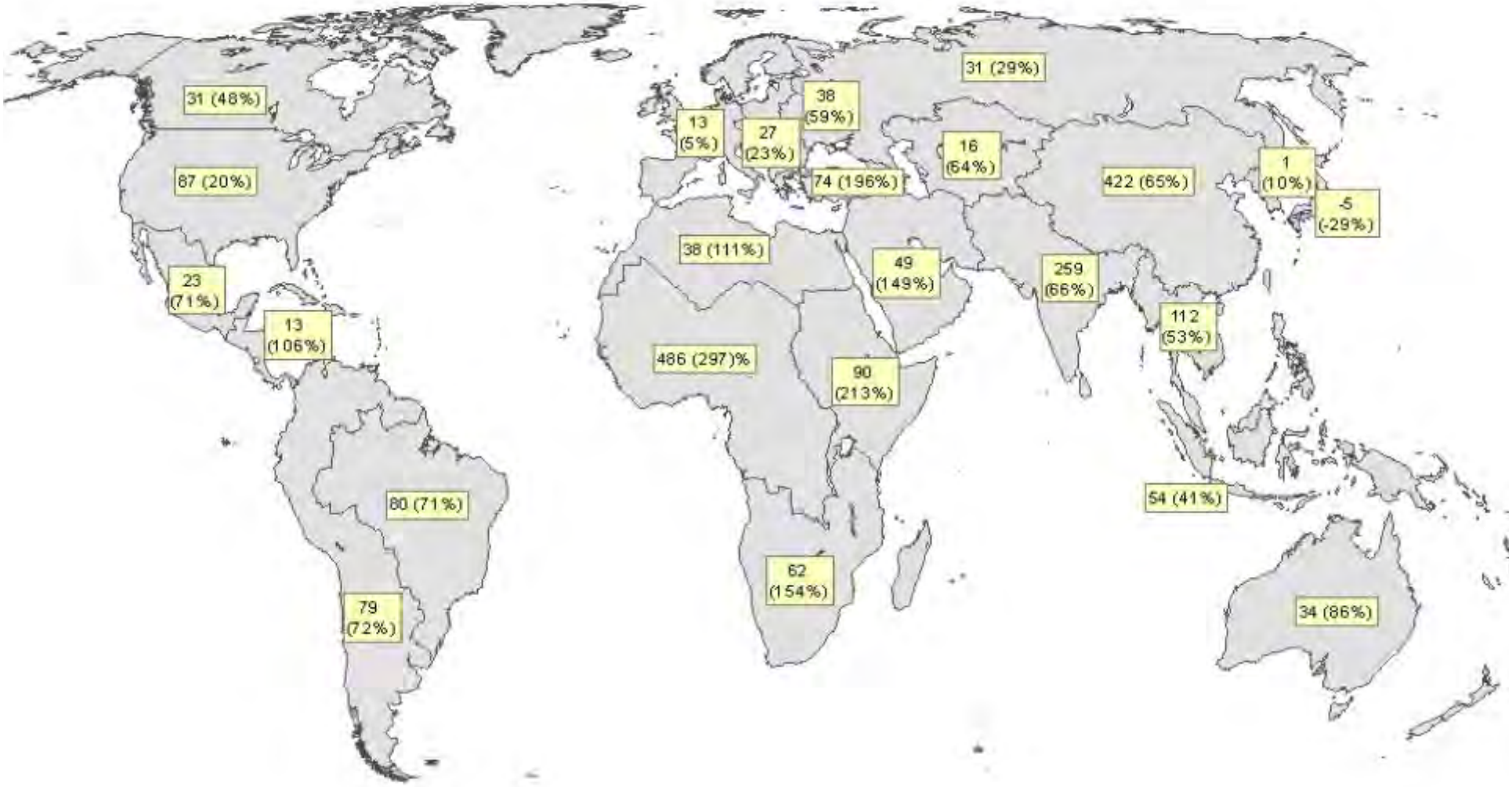
Bare systems

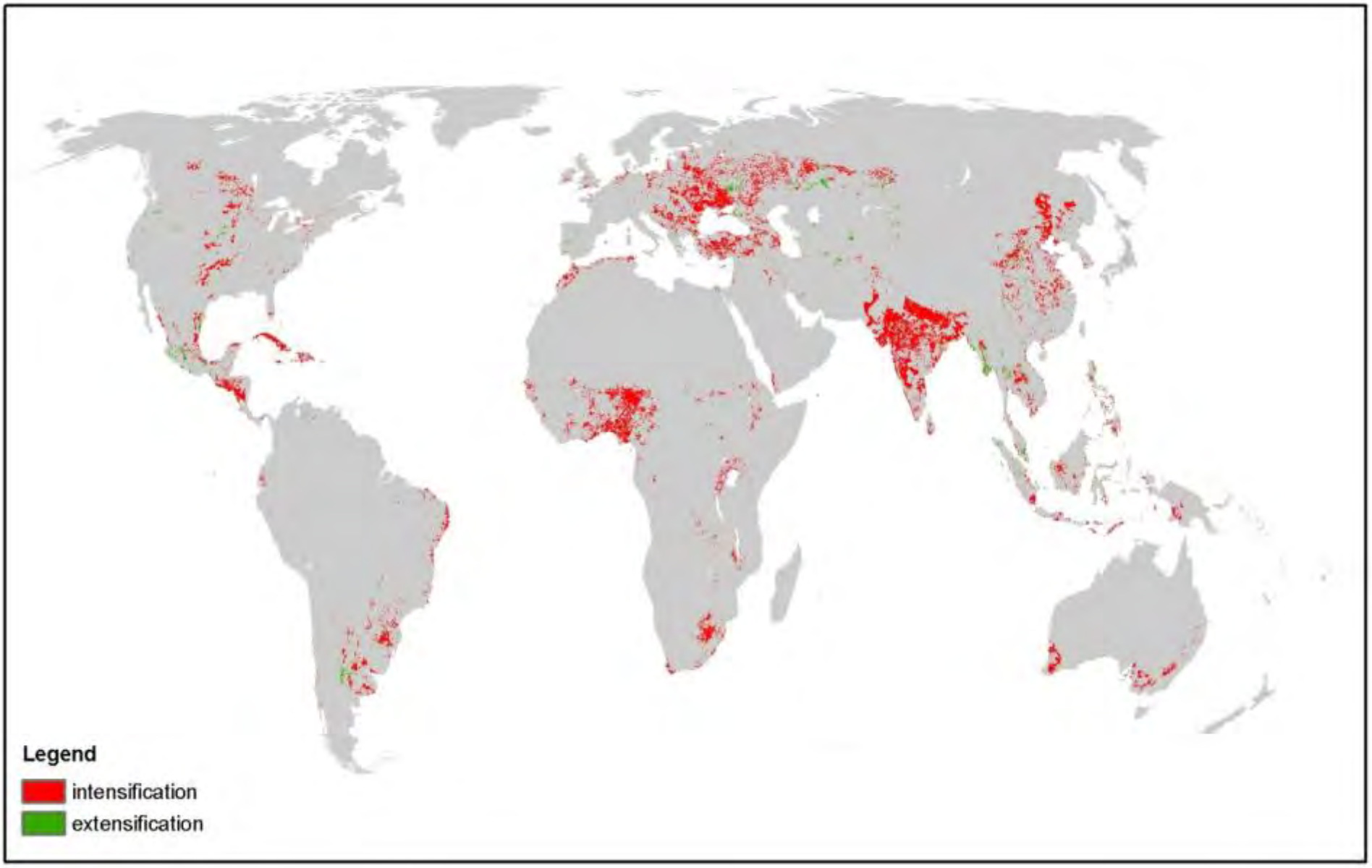
- Bare
- Bare with few livestock

Settlement systems

- Peri-urban and villages
- Urban

Increase in crop production




Legend
intensification
extensification

Land change and sustainable development

Land change is a CONSEQUENCE of global change

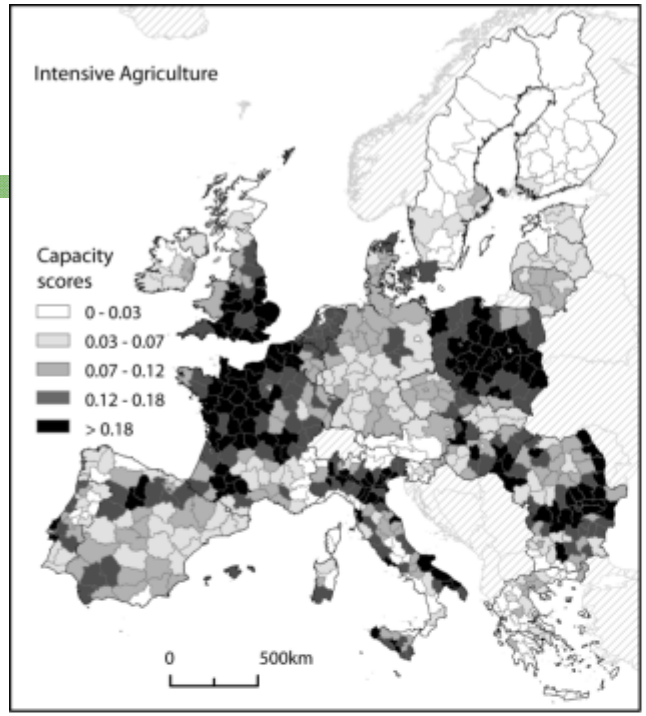
Land change is a major CAUSE of global change

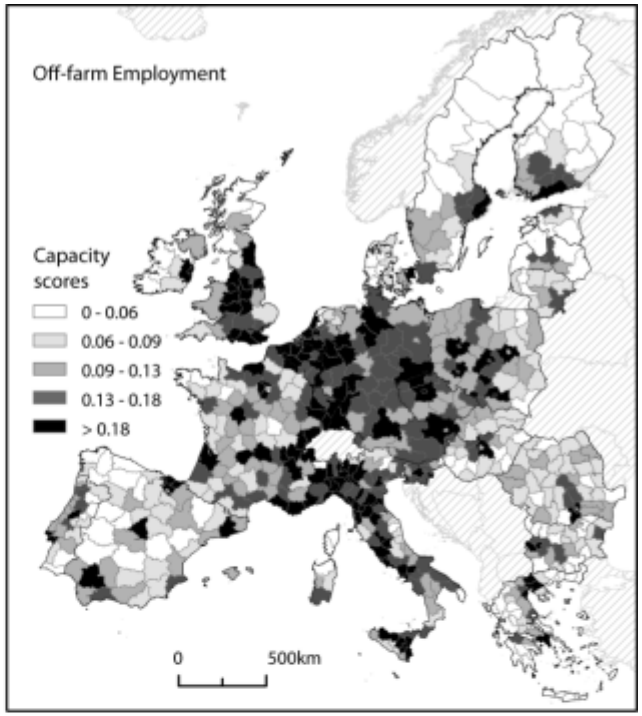
Land change is a possible SOLUTION to global change

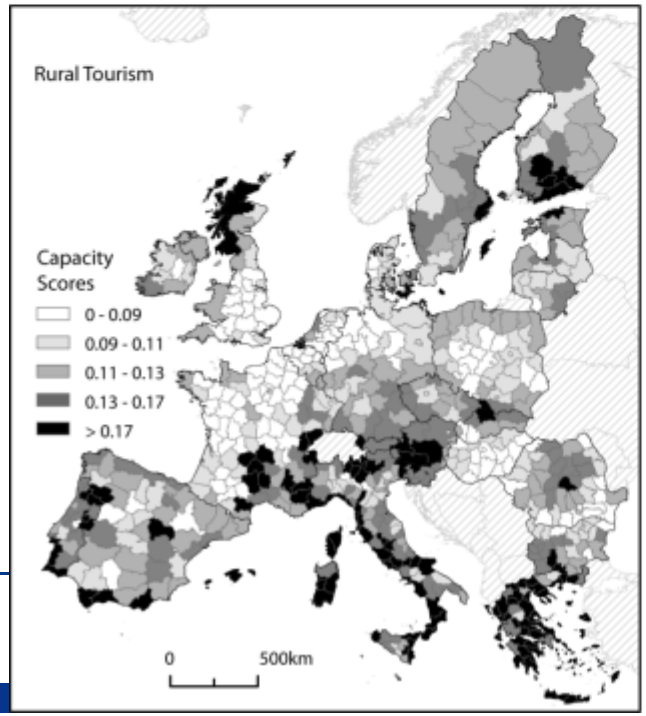
- Land governance
- Land system architecture

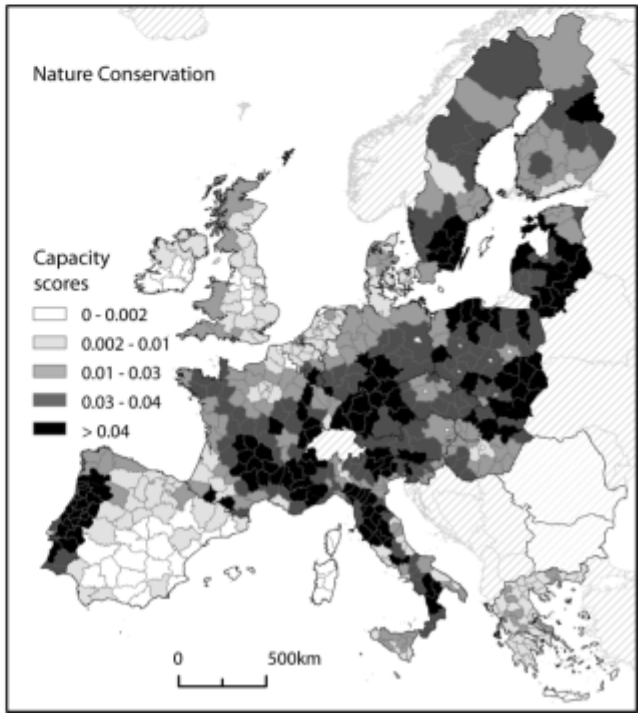
Rural development potentials

(Van Berkel and Verburg, Land use policy)









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TABAK KOFFIJ

Baseline

New Communalism Scenario

Territorial Sustainability Scenario

Key messages

- Land change happens at the interface of the human and physical earth system
- Contextualized, place-based land governance solutions are needed to meet the sustainable development targets of the millenium development goals
- Local solutions adapted to the global context are needed
- Land science can act as a platform integrating research efforts, connecting different perspectives across scales

Thank you!

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Global LAND Project

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Call for Session proposals closes on January 31st, 2013