

*Land use change scenarios in  
the European context:  
interpreting regional scenarios  
from global storylines*

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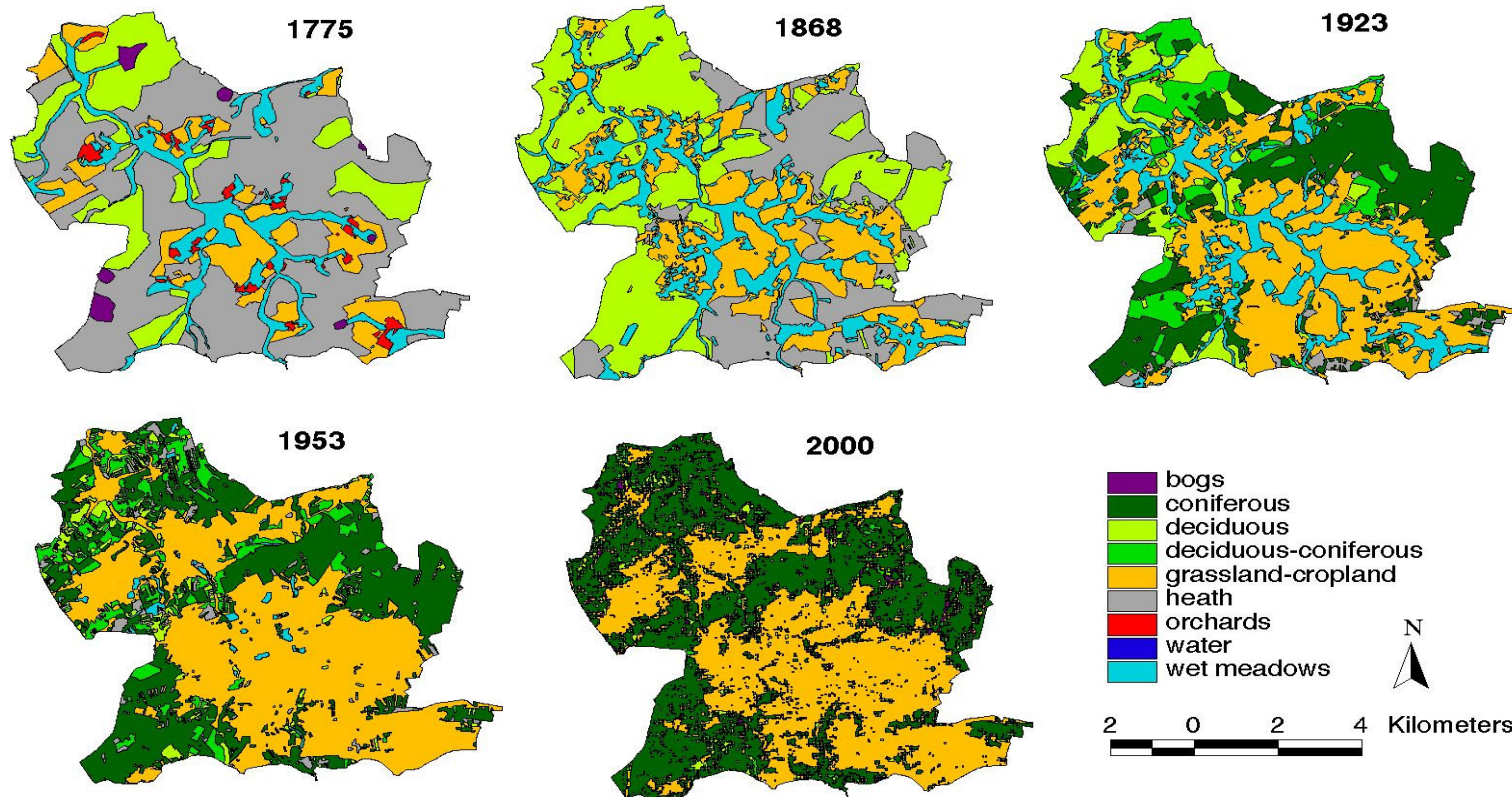
*Louvain-la-Neuve, Belgium*

# Acknowledgements

- Claude, Nicolas, Lilibeth, UCL, B
- Frank, Rik, Wageningen Uni, NI
- Tim, Susanna, Syke, Finland
- Pete Smith, Gill Tuck, Aberdeen/Rothamsted, UK
- Everyone else I forgot

# Last use has always changed ...

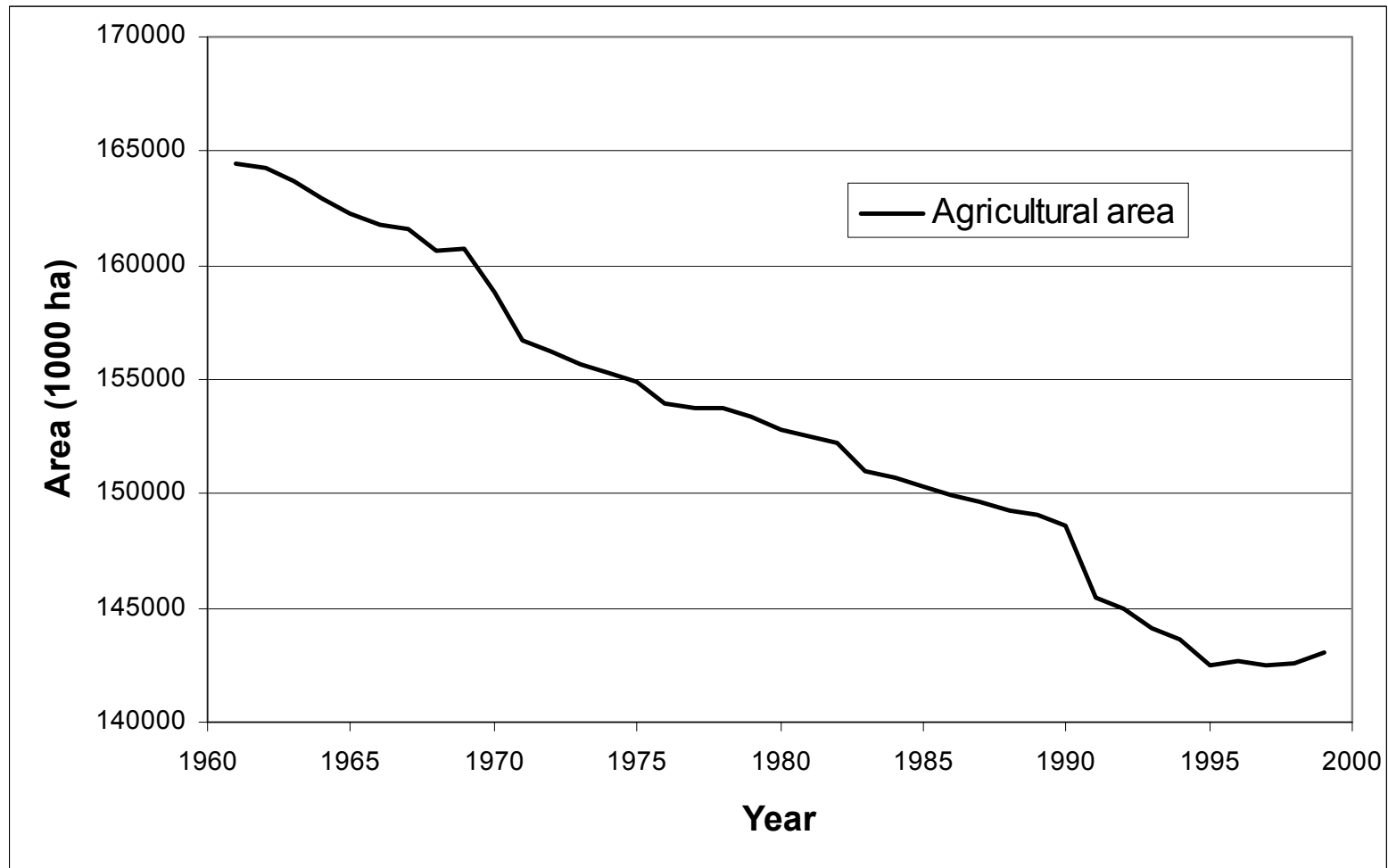
Land cover in Lierneux (Belgian Ardennes): 1775-2000



(Carine Petit, thèse de doctorat, UCL, 2001)

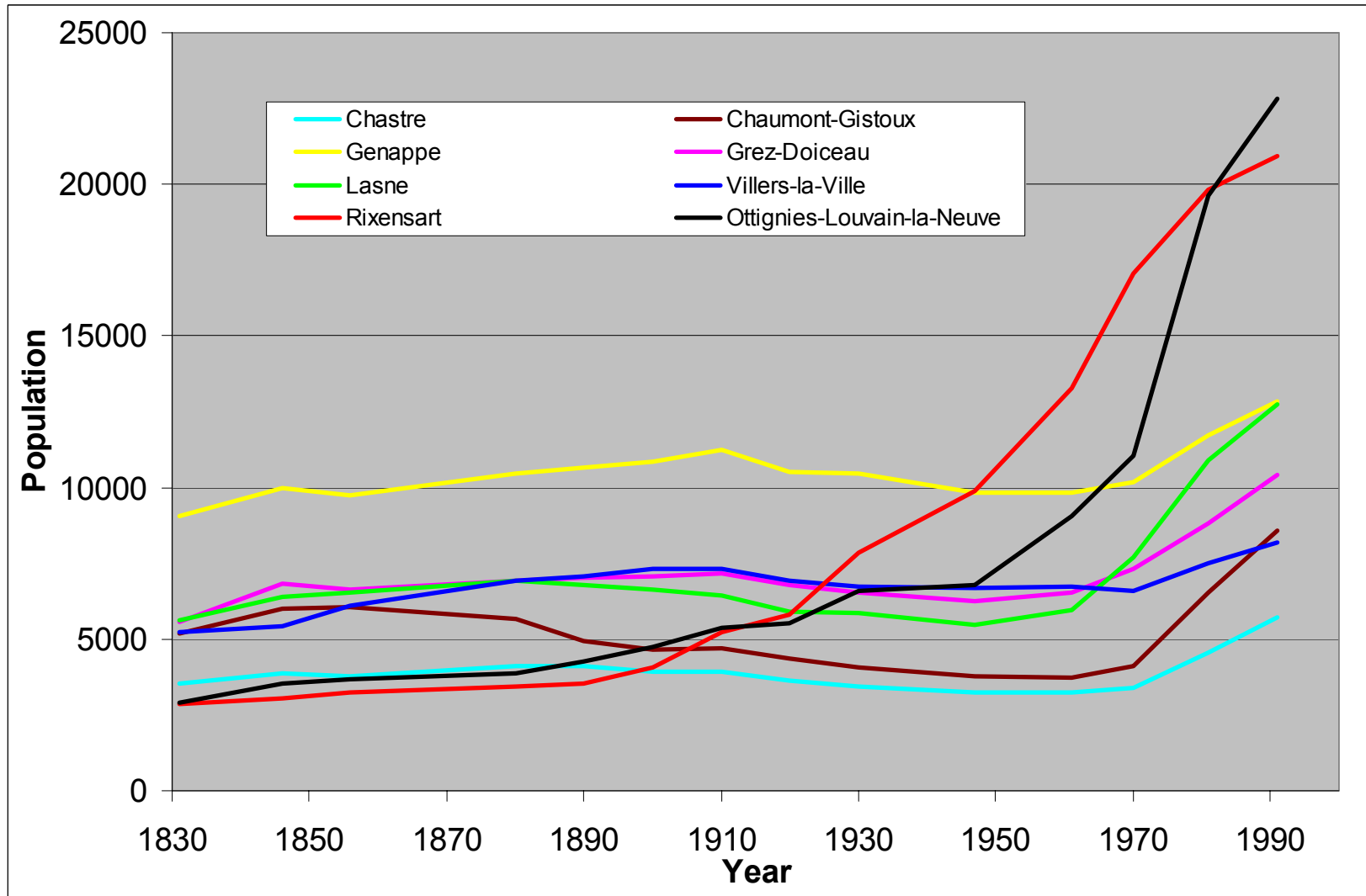


... and continues to do so ...

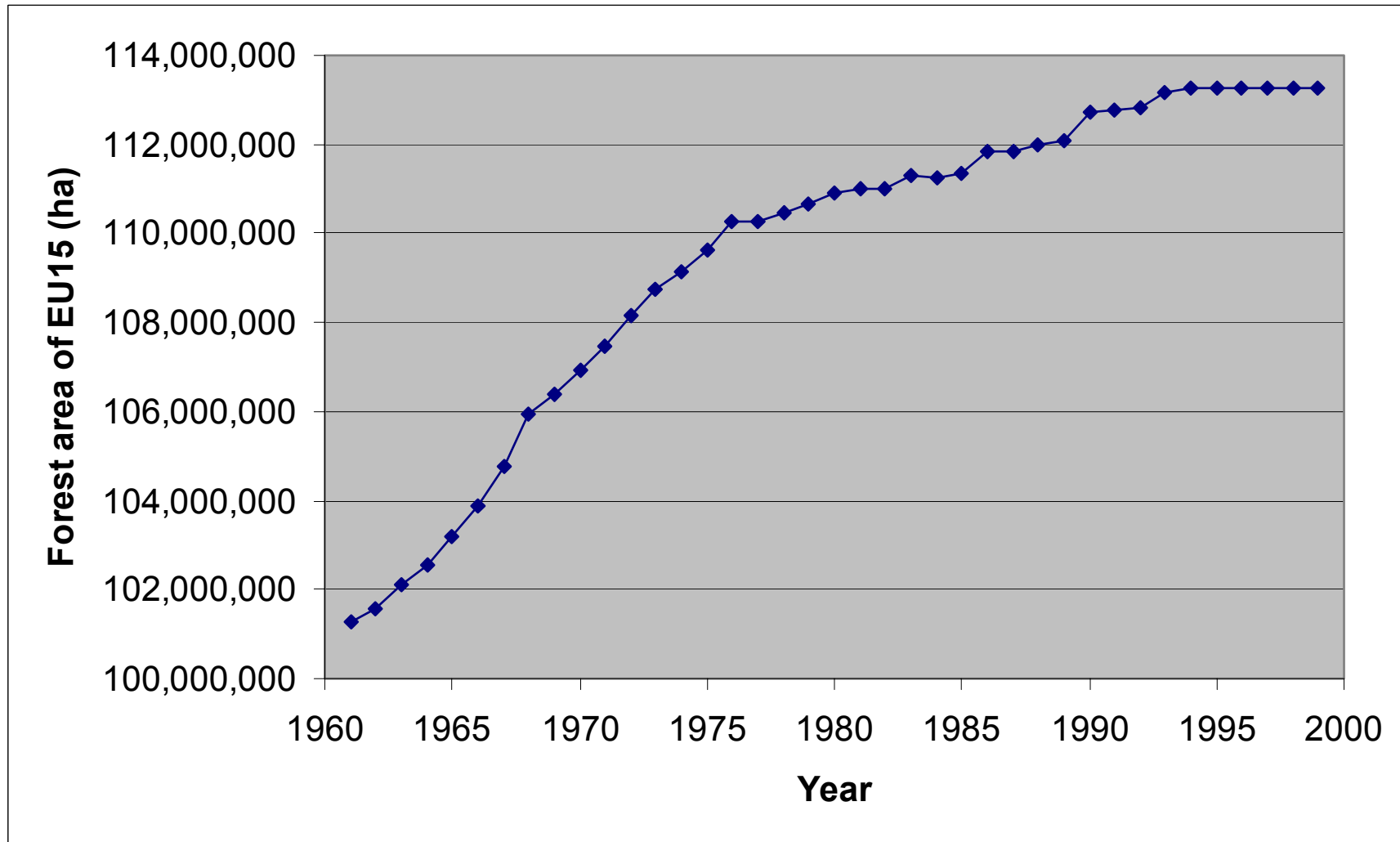


Source: FAO (EU15)

# Urbanisation: south of Brussels



# Reforestation in Europe



Source: FAO statistics ([www.fao.org](http://www.fao.org))

# Why scenarios?

*« The whole problem with the world is that fools and fanatics are always so certain of themselves, but wiser people so full of doubts. »*

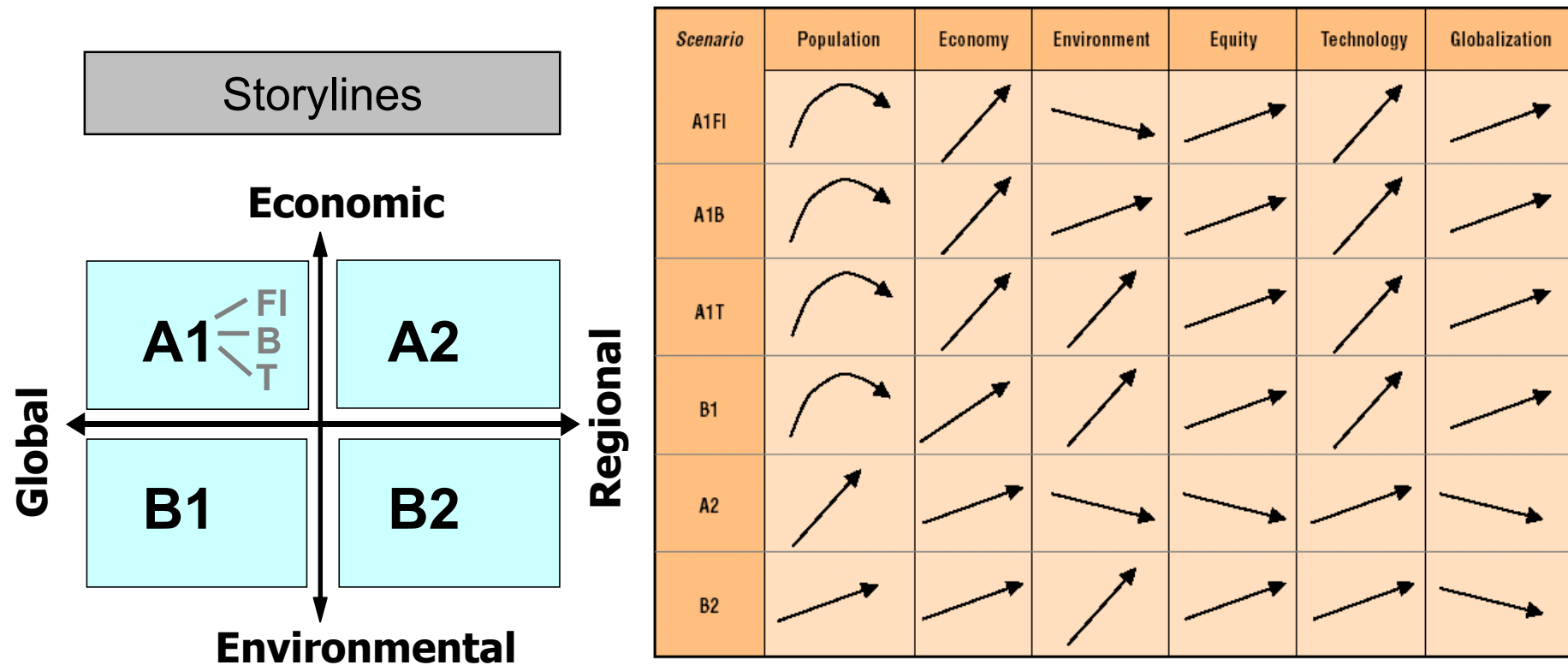
Bertrand Russell

# How to develop scenarios\*

- Select a *scenario logic* (to aid internal consistency and coherence)
- develop *narrative storylines* (descriptions of plausible, alternative futures) of the *key drivers*
- Translate narratives into *quantitative model inputs*, e.g. to
- *Simulate* land use change quantities and location

\*Shell plc in the 1970s

# Scenario logic: the IPCC SRES\* framework



\*Special Report on Emissions Scenarios

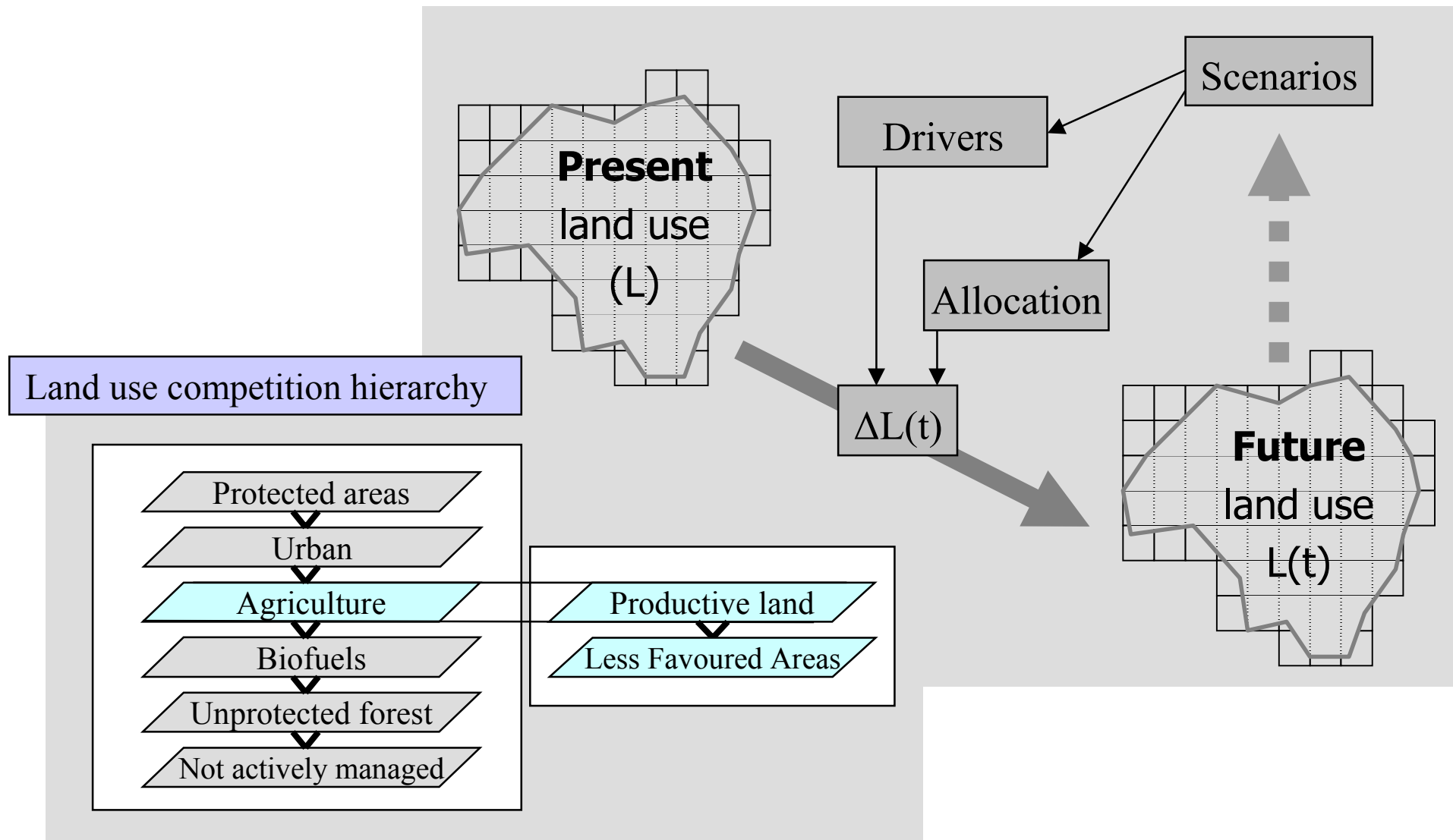
# European scale drivers (qualitative)

	A1	A2	B1	B2
<b>Economy - GDP</b>	rapid growth, convergence	growth, uneven	growth, convergence	slow growth, uneven
<b>Population</b>	declining	growing	declining	stable
<b>Technological change</b>	rapid	slow and uneven	rapid	uneven
<b>Institutions and government</b>	weak	weak, diverse	strong	weak, except local
<b>Rural development</b>	not a focus area	result of self-reliance	key issue	increase (self-reliance)
<b>Recreation, tourism</b>	increase	increase, decrease resp.	increase, decrease resp.	increase, decrease resp.
<b>Spatial planning</b>	convergent, less restrictive	heterogeneous	convergent, restrictive	heterogeneous restrictive
<b>EU enlargement</b>	rapid	slow	moderate	stopped

# European agricultural drivers

Policy	Macro-(socio)economics	
	Demand	Supply
Market intervention (subsidies, quotas)	Population (consumption)	Resource competition (e.g. urban)
Rural development (LFAs)	Consumer preferences (meat, organic)	Climate change (temp, precip, CO <sub>2</sub> )
Environmental policy (NVZs, ESAs)	Market liberalisation (WTO)	Technology & management
	EU enlargement	

# Modelling land use change

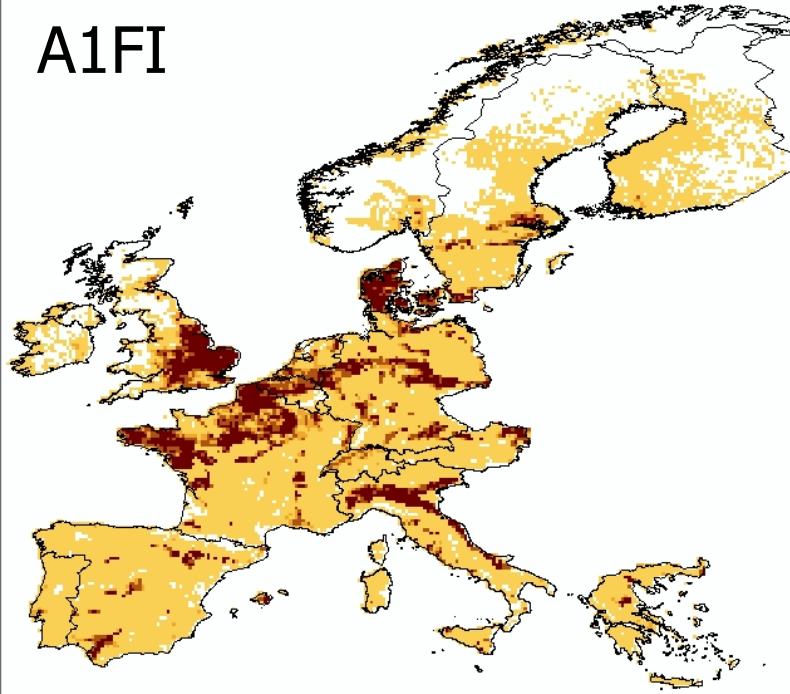


Land use specific quantity models and spatial allocation rules

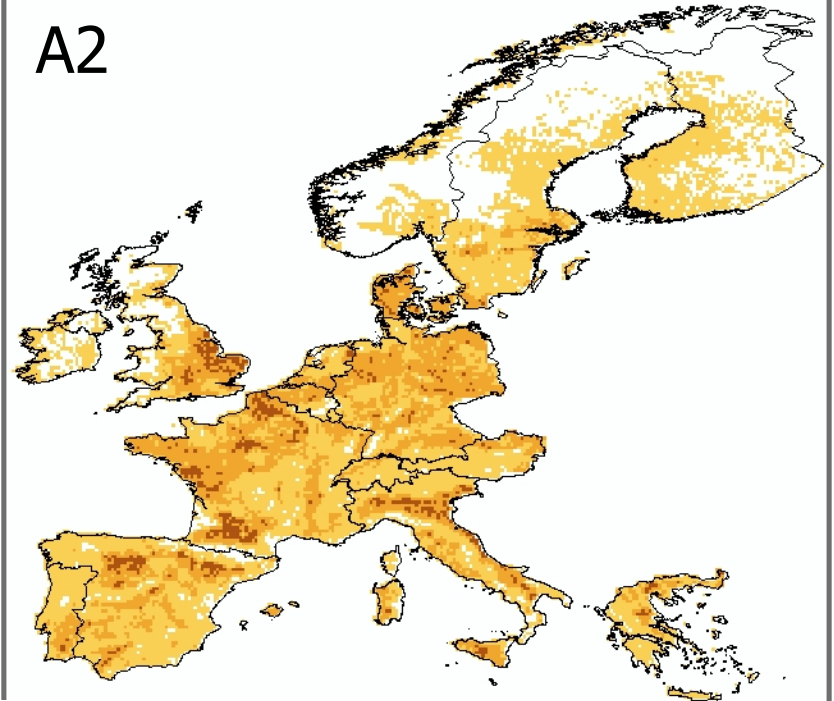
# Crop land in 2080

(HADCM3)

A1FI

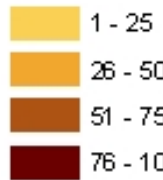


A2

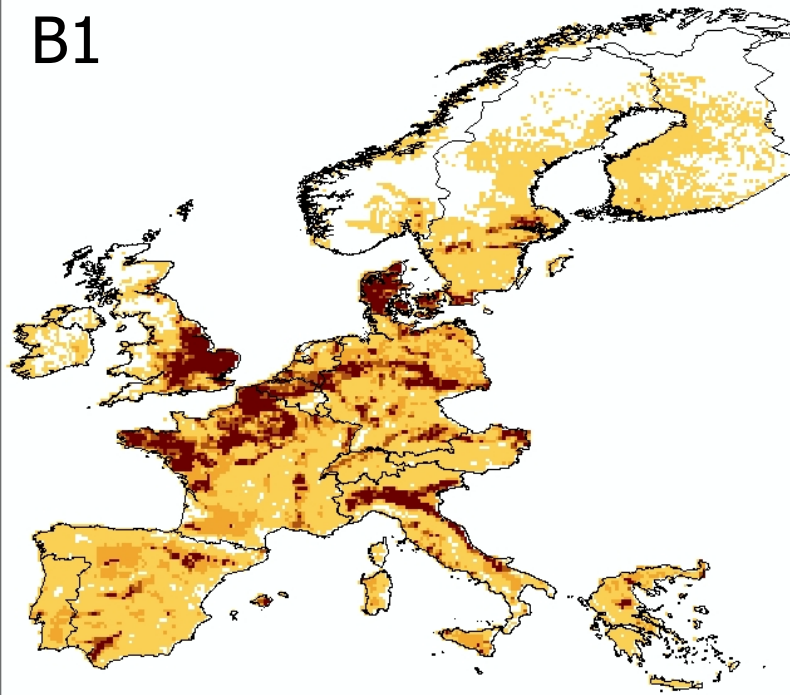


Percentage of arable land per ATEAM cell

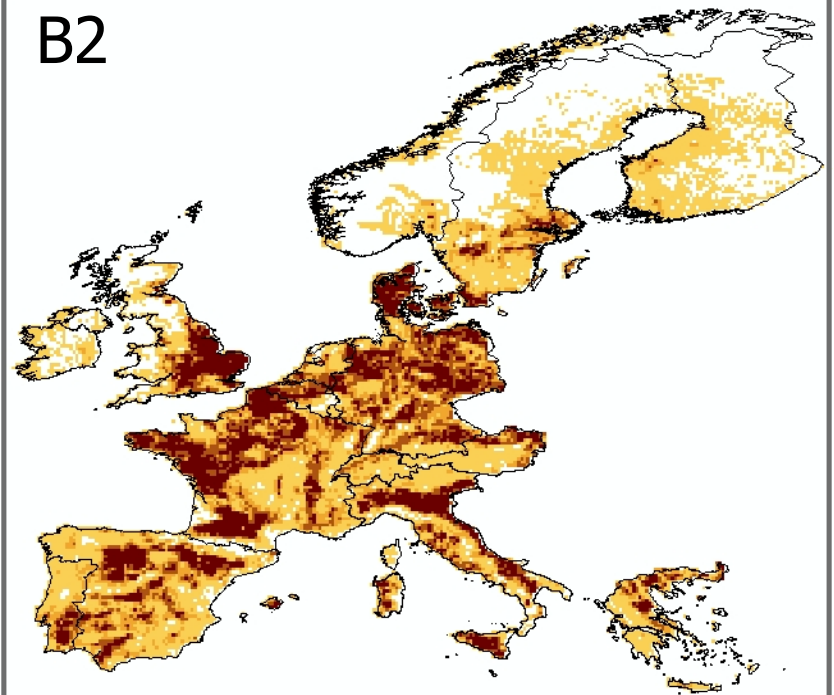
0



B1

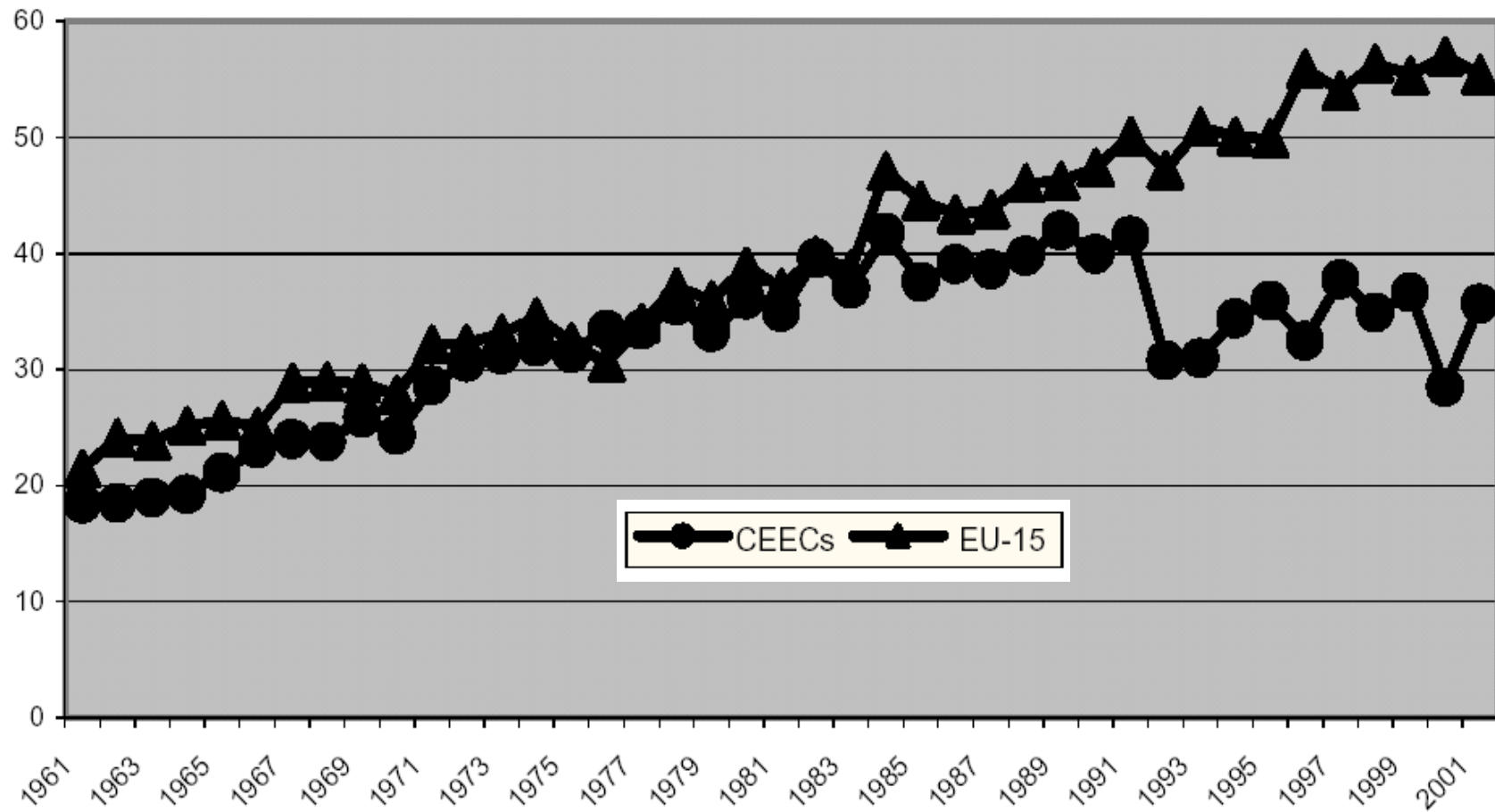


B2



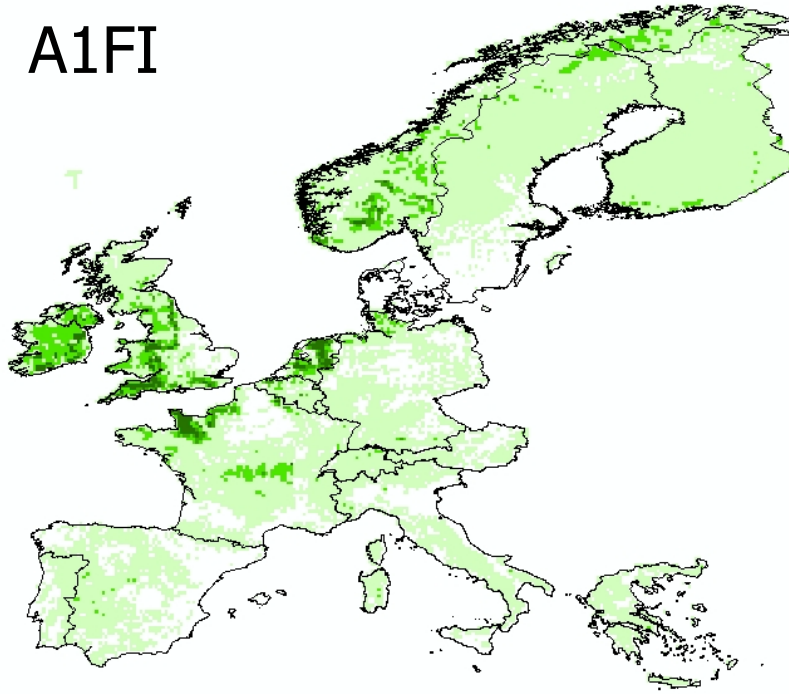
# Change in wheat yields

t/ha (x10)

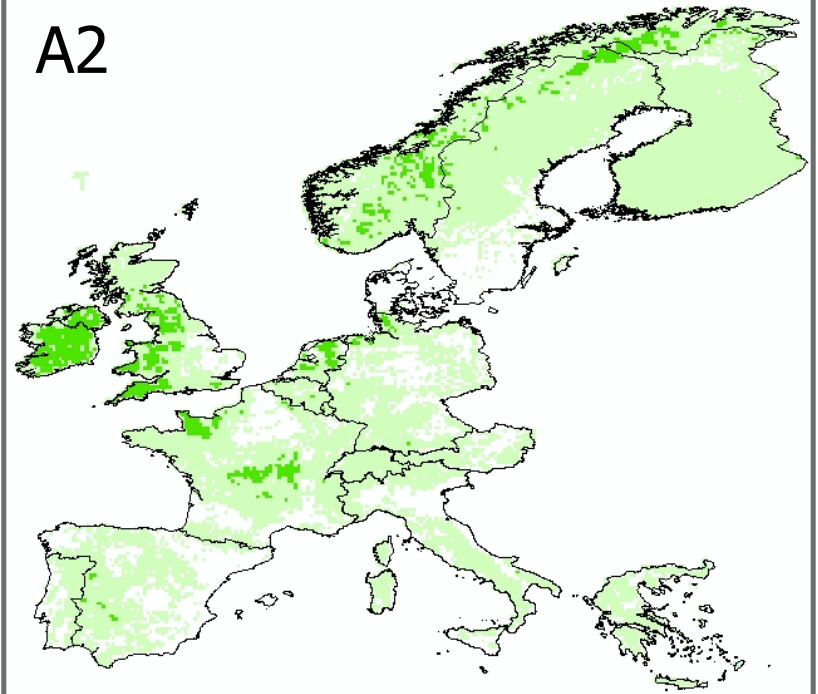


**Grass  
land in  
2080  
(HADCM3)**

A1FI



A2



Percentage of  
grassland per  
ATEAM cell

0

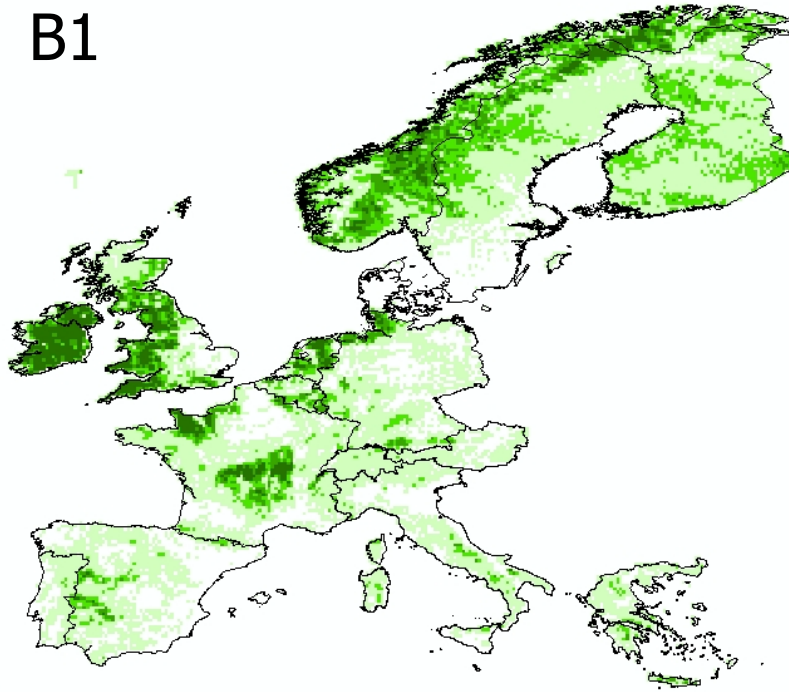
1 - 25

26 - 50

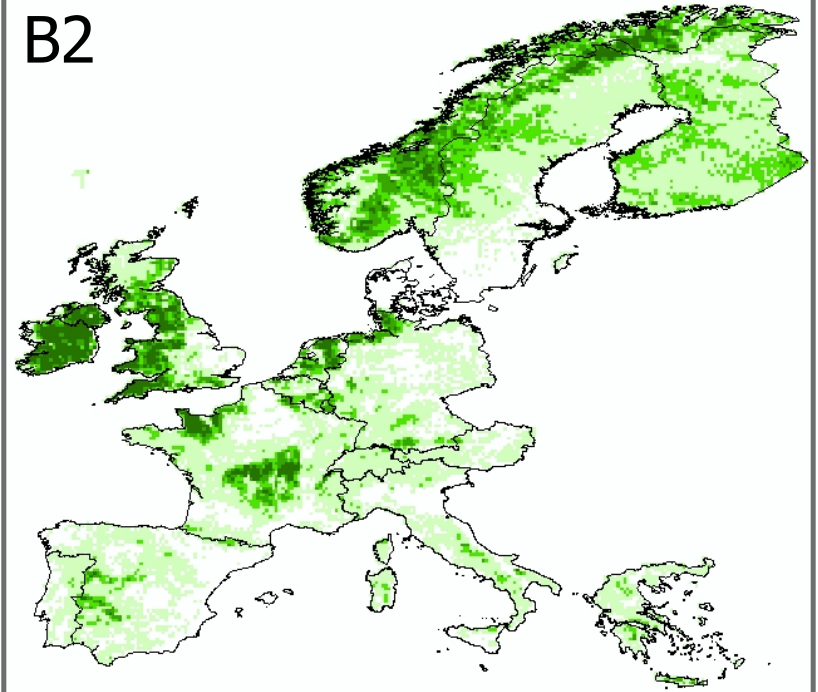
51 - 75

76 - 100

B1

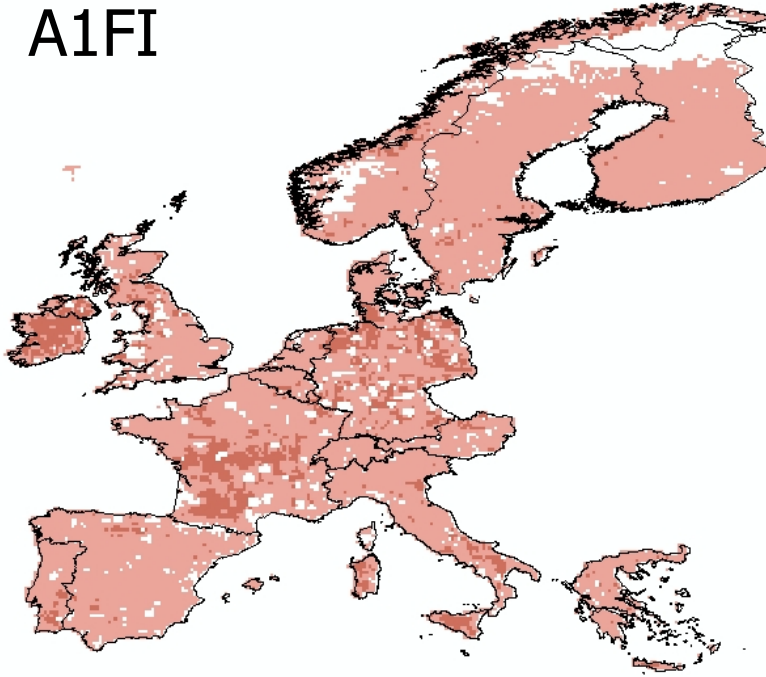


B2

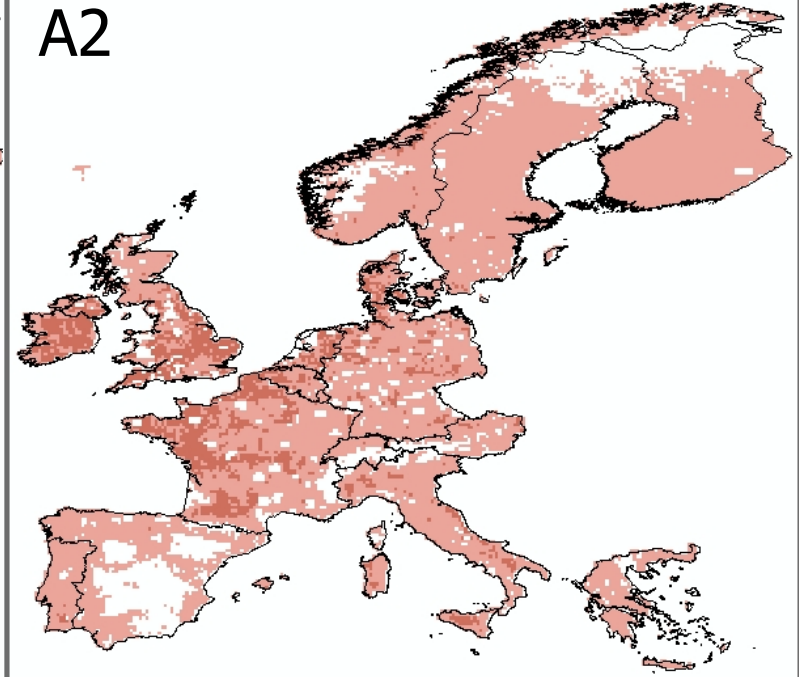


# Biofuels in 2080 (HADCM3)

A1FI



A2



Percentage of  
biofuels per  
ATEAM cell

0,00

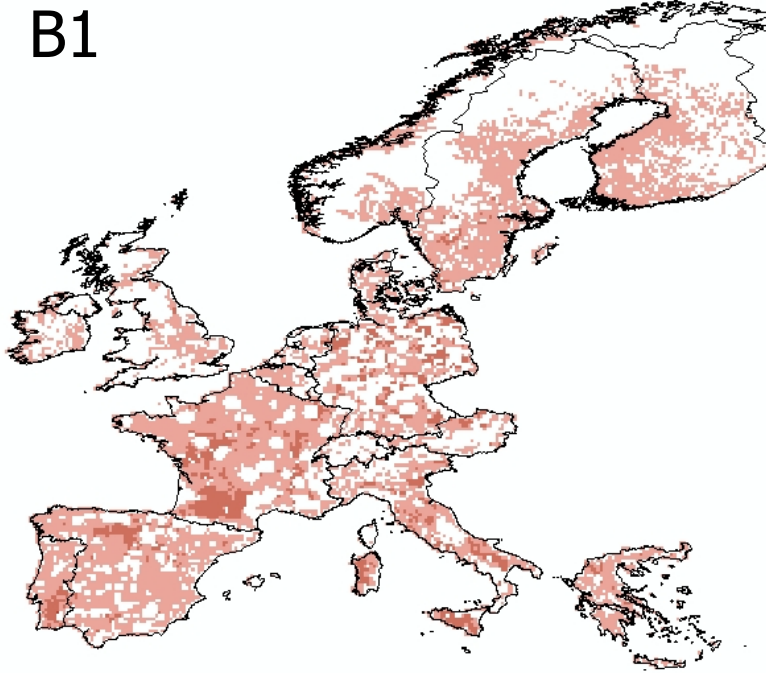
0,01 - 25,00

25,01 - 50,00

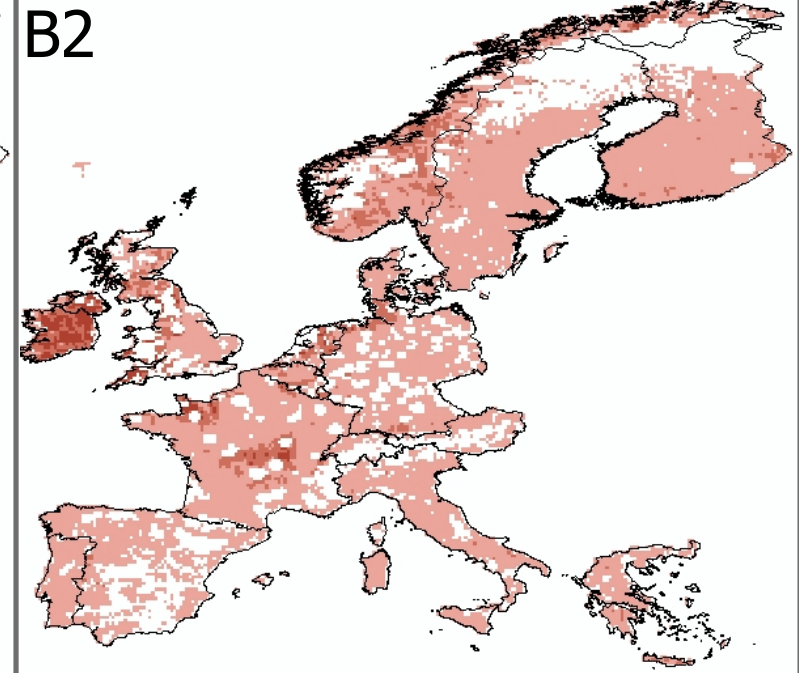
50,01 - 75,00

75,01 - 100,00

B1

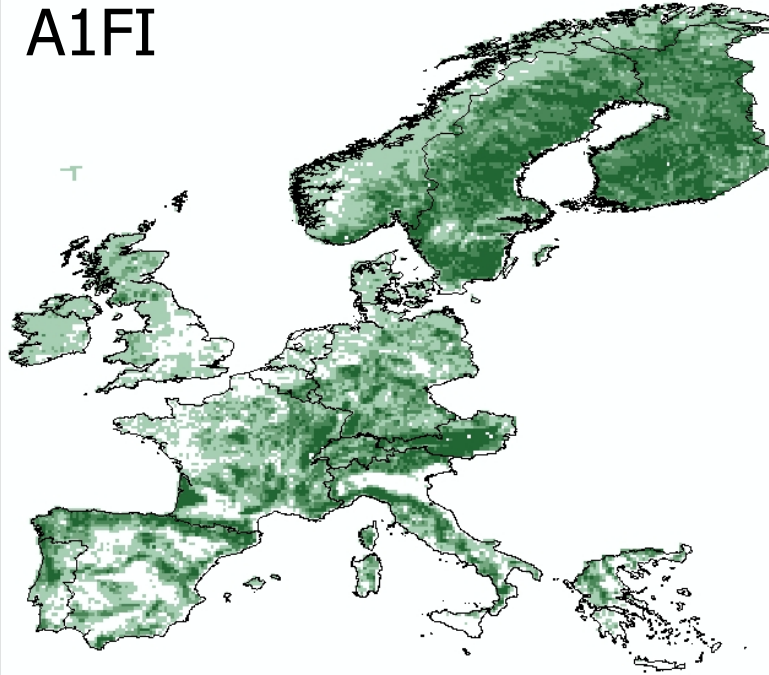


B2

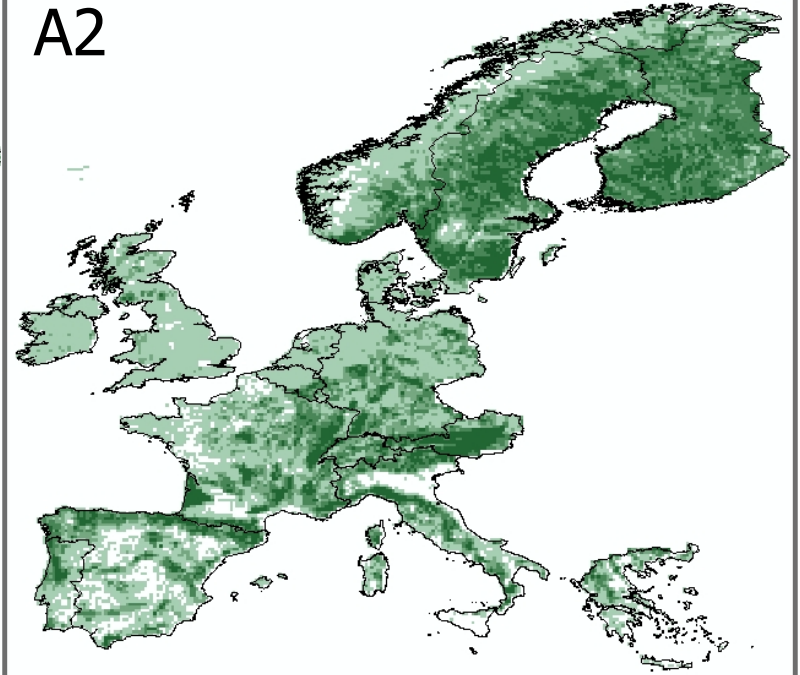


**Forest in  
2080  
(HADCM3)**

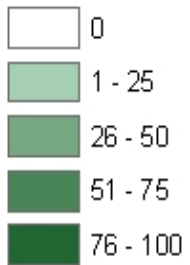
A1FI



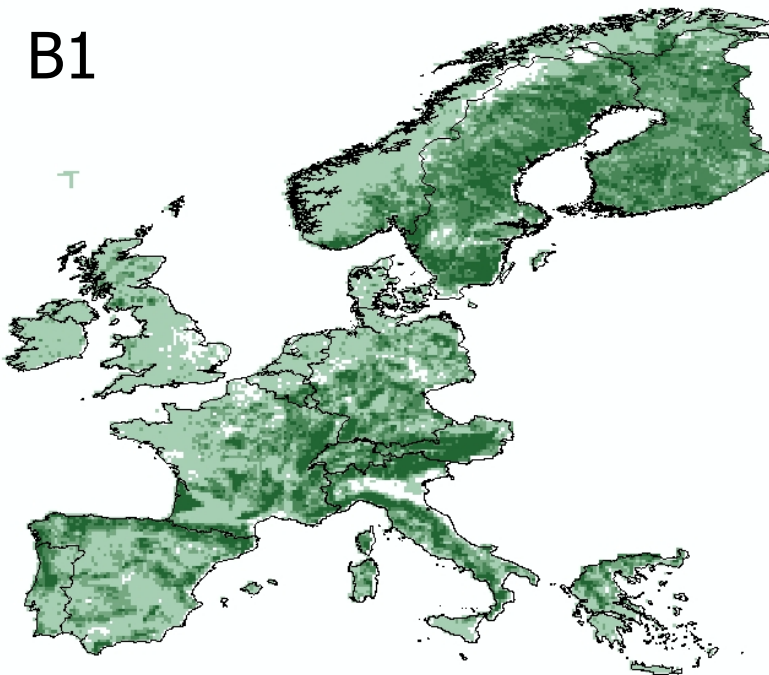
A2



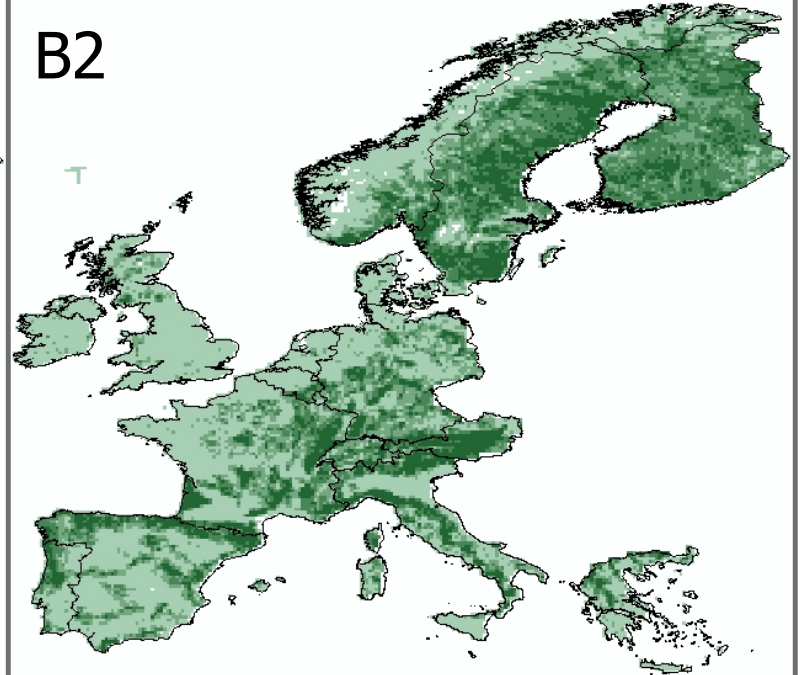
Percentage of  
forest per ATEAM  
cell



B1

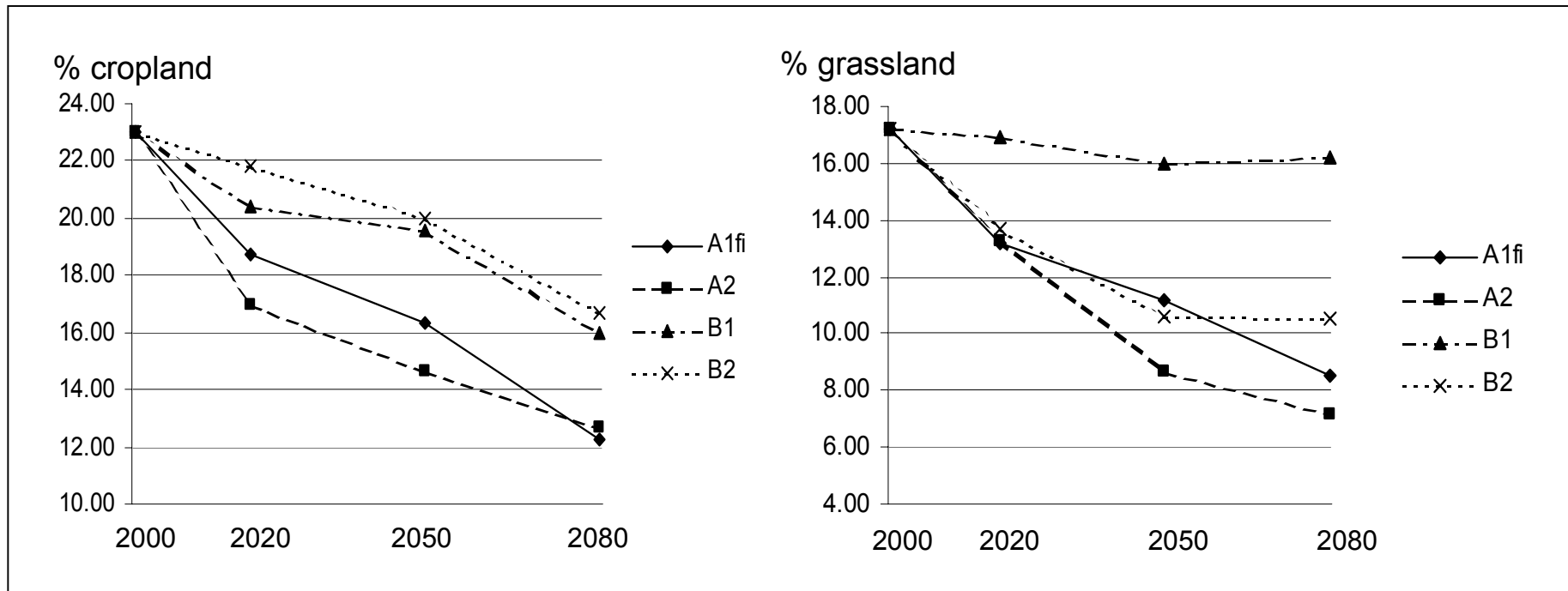


B2



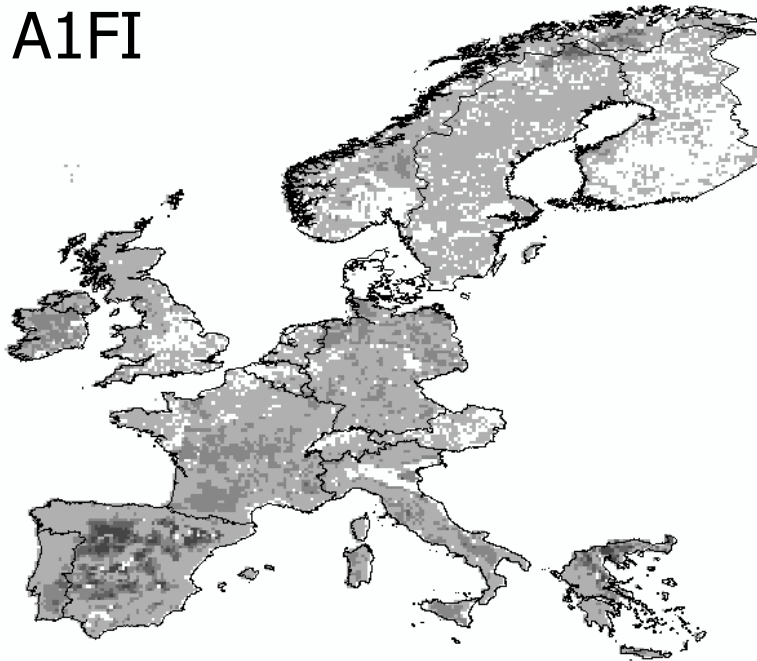
# European change quantities

- Ca. 50% declines in agricultural (food) production areas by 2080!

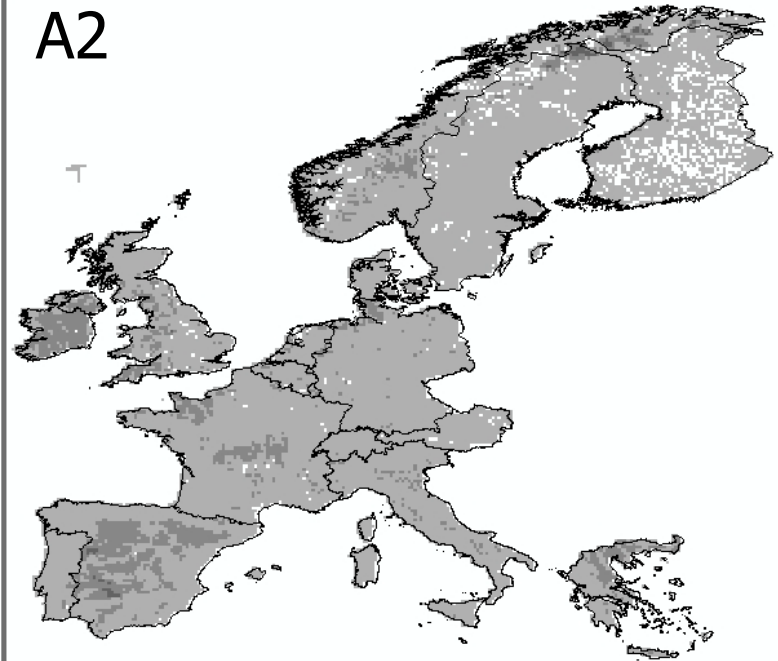


**Surplus  
land in  
2080  
(HADCM3)**

**A1FI**



**A2**



Percentage of  
surplus land per  
ATEAM cell

0,00

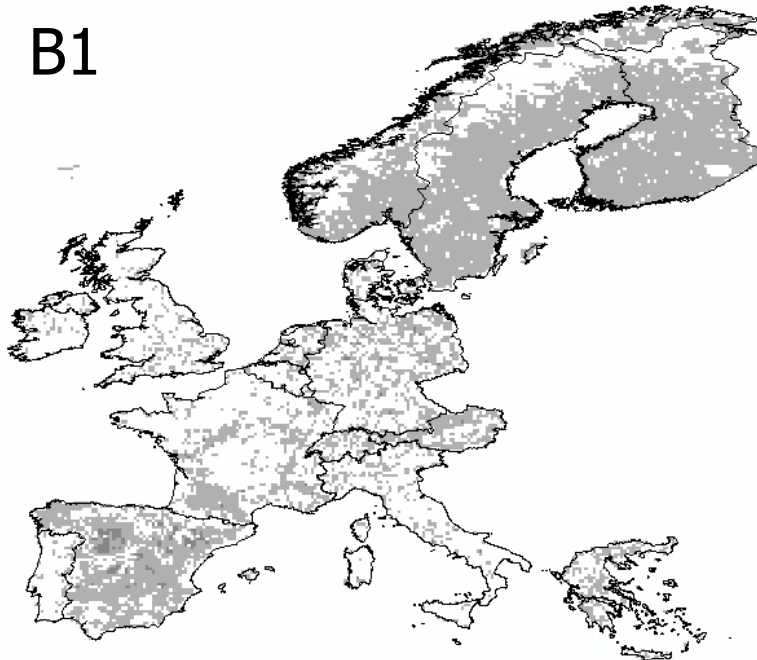
0,01 - 25,00

25,01 - 50,00

50,01 - 75,00

75,01 - 100,00

**B1**



**B2**

No surplus



# Key points from ATEAM

- Climate change – effects are minimal and the role of socio-economics is overriding
- Urban – always increases, but spatial patterns differ greatly between scenarios
- Agriculture – technology is the most important driver (but also the most ‘uncertain’) resulting in large losses of agricultural land for food production, but some substitution by energy crops
- Surplus land (abandoned agricultural land) – what is feasibility/reality of this? What would happen to this land? More biofuels, forest, conservation areas, ...?

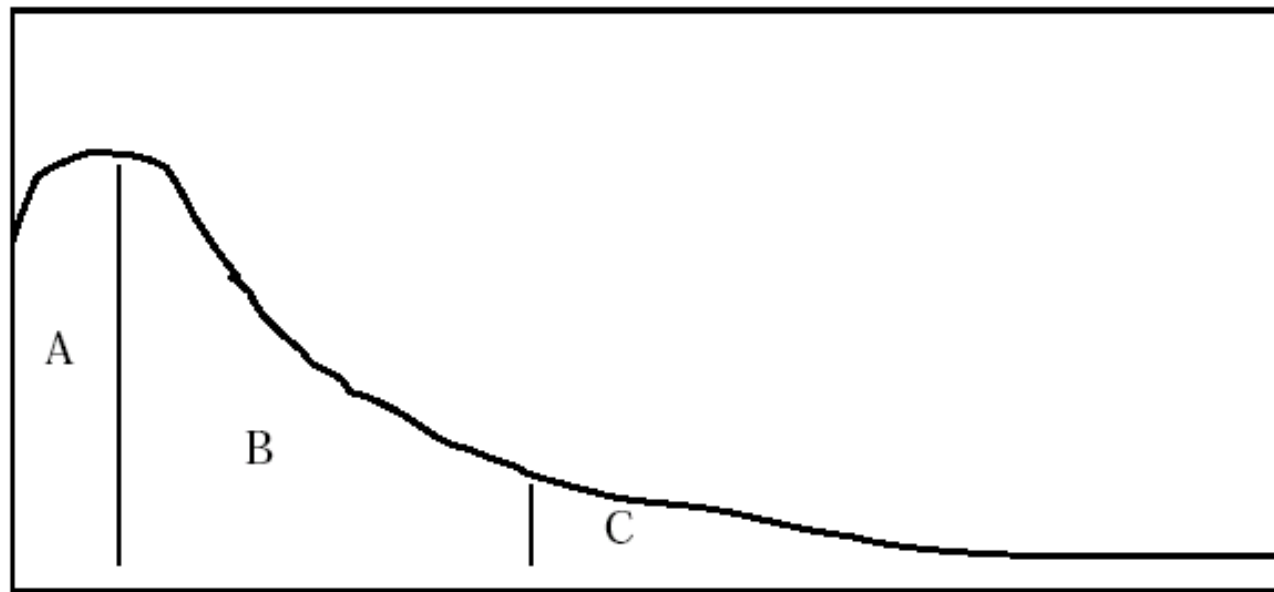
# Consequences of surplus land

- So, what are the consequences of this?
- Negative and positive for ecosystems and biological resources
- Depending on the quantity of change and its location

# Agricultural intensity and biodiversity



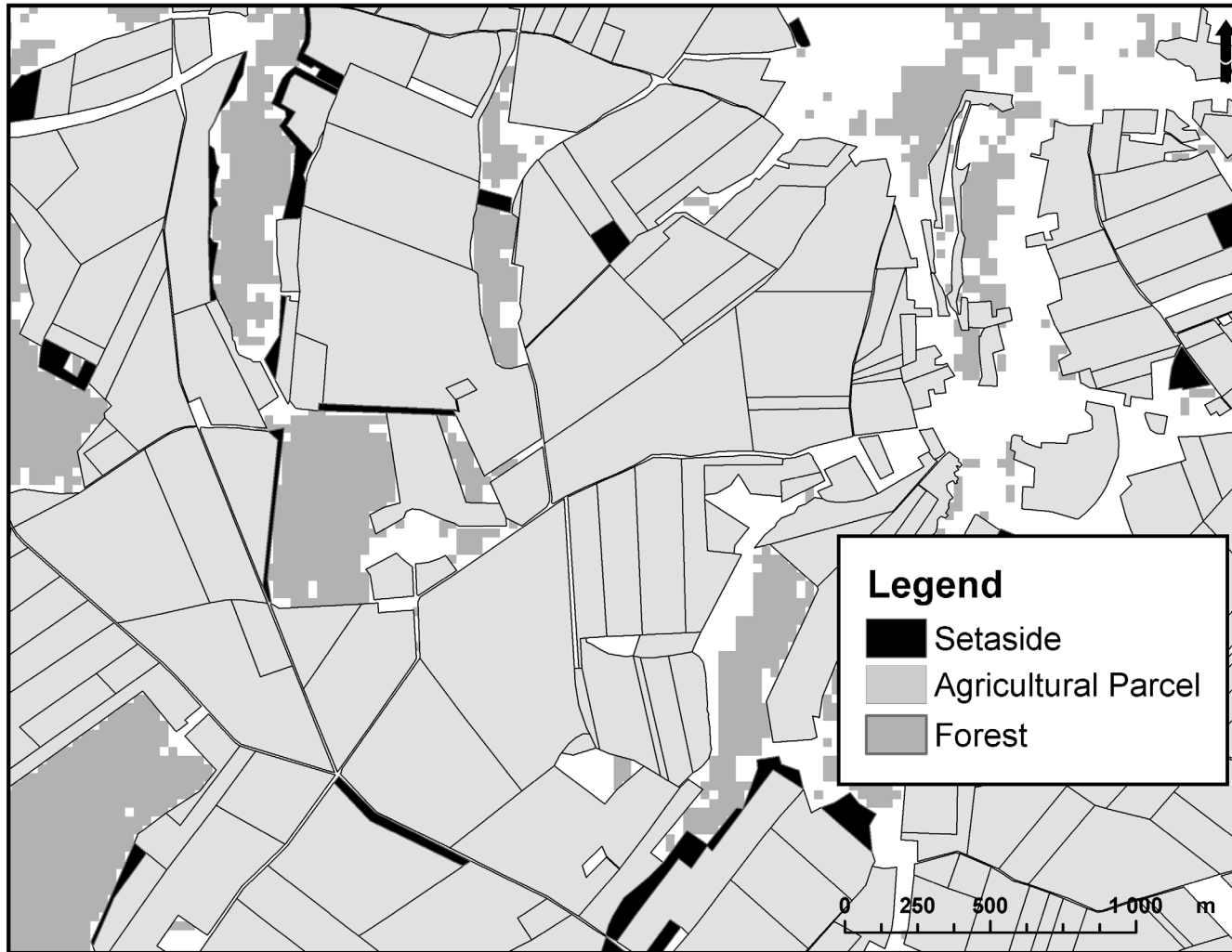
*Species diversity*



Intensity of agriculture

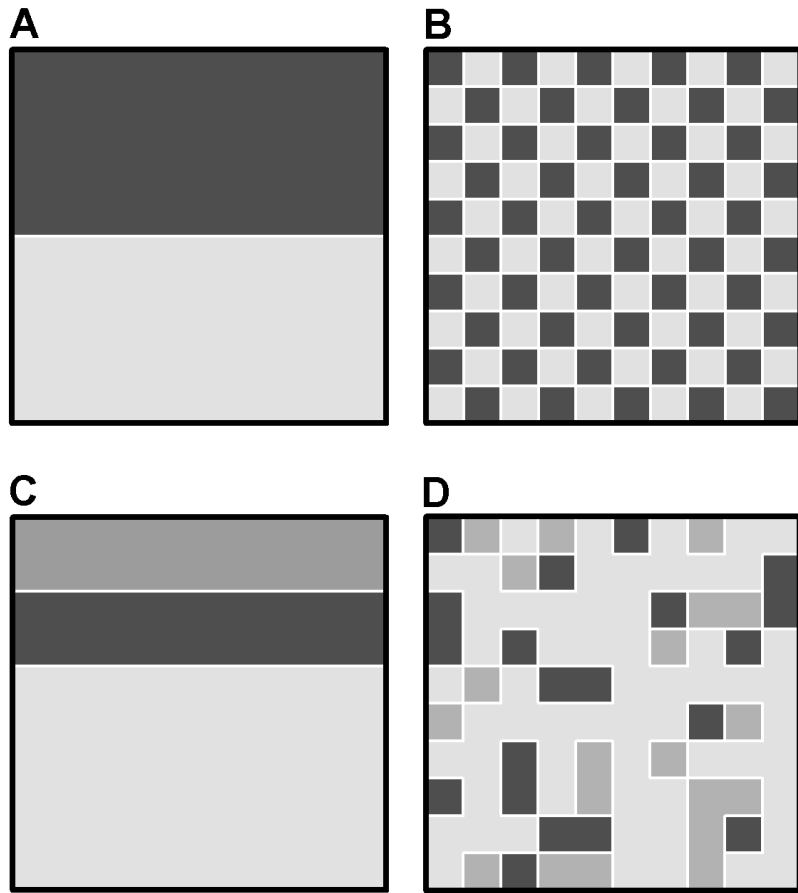
(Source: Ybele Hoogeveen, EEA)

# Distribution of abandonment



**Setaside is located at the border with woodland and on small parcels**

# Spatial patterns

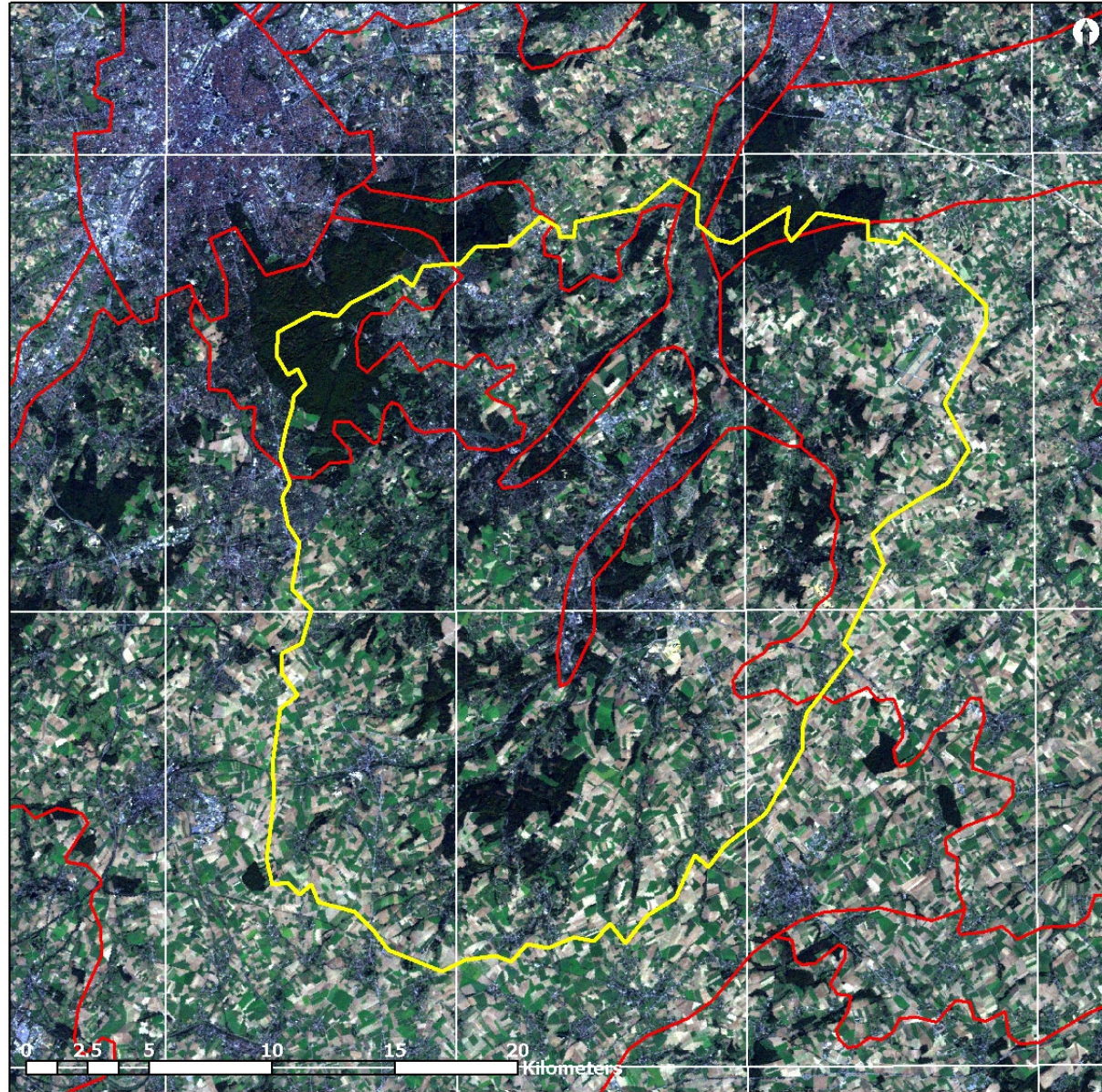


Legend: ■ Forest ■ Agriculture ■ Urban

## Scale issues:

### Problem:

It can be difficult to explain and model fine resolution agricultural land use with coarse resolution input data.



## II. The Data



At the scale of a catchment:

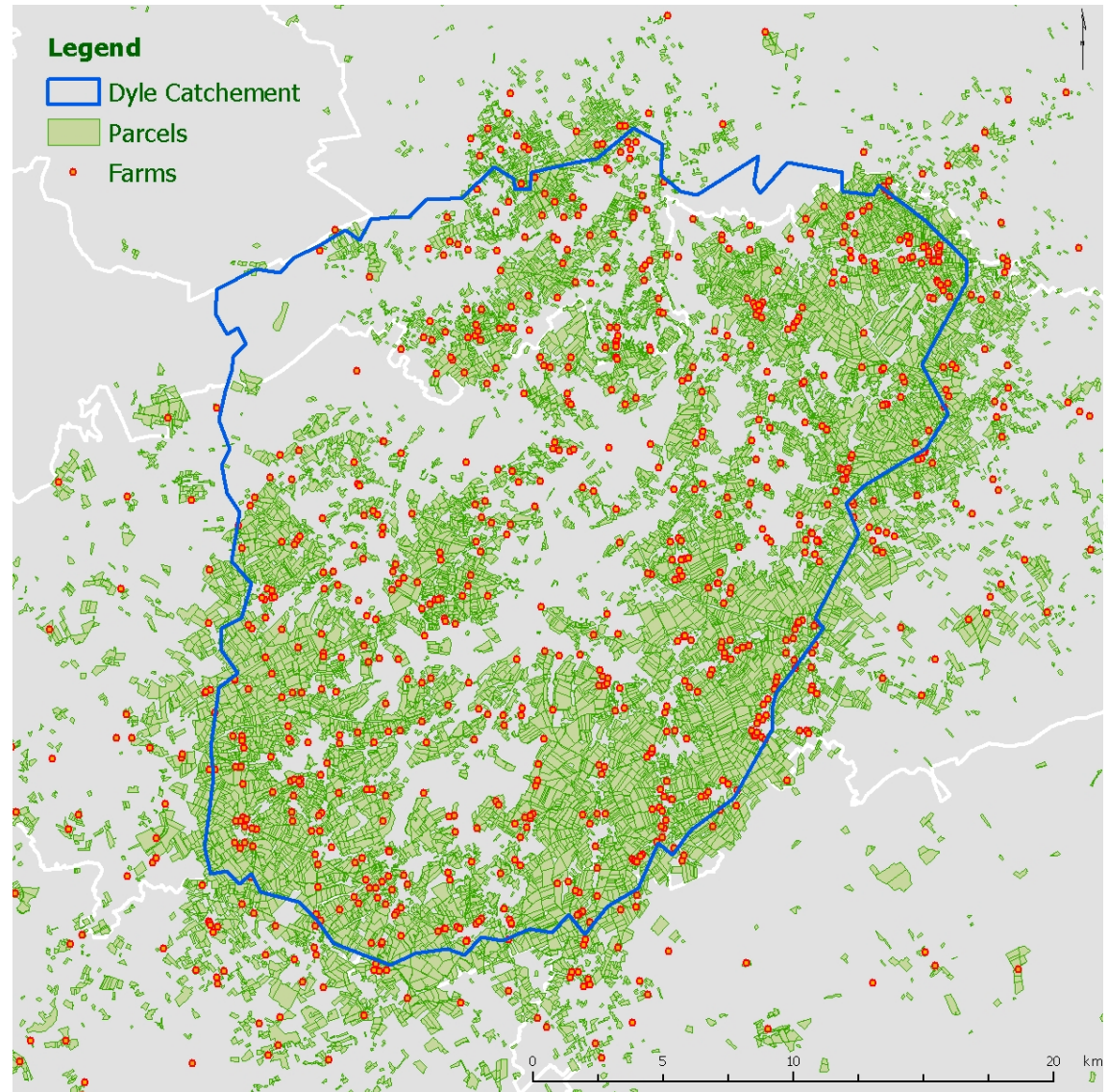
Individual parcel data:

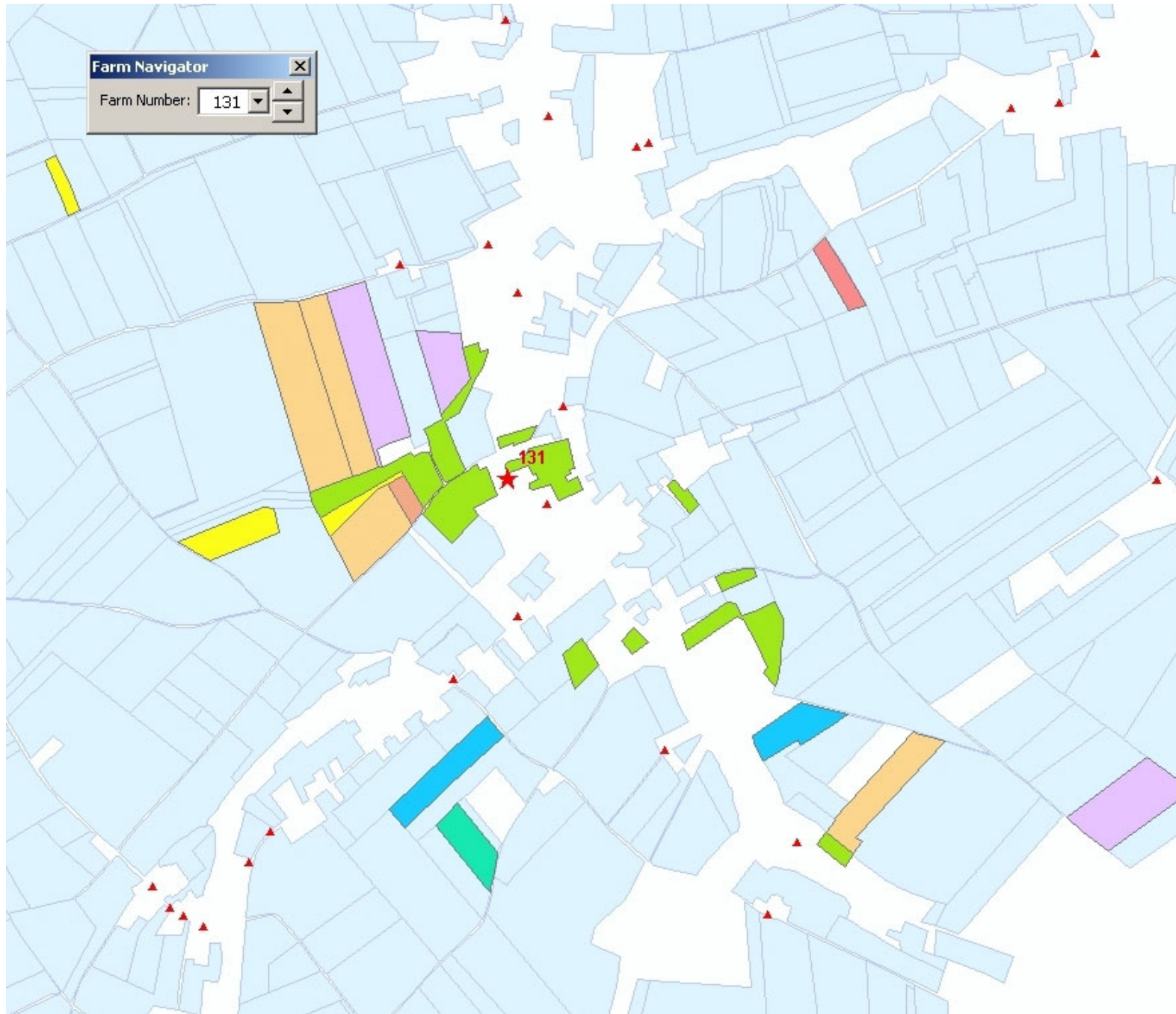
- Parcel Id
- Farm Id
- Land use in 1999

Individual farm data:

- Farm id
- Farm location

Other data: Soils, Climate, DEM, road and river network, administrative units, Plan Secteur, Aerial photograph...





Farm Navigator  
Farm Number: 131

- CULTURE\_T
- 201
  - 202
  - 311
  - 312
  - 321
  - 322
  - 34
  - 35
  - 36
  - 39
  - 411
  - 412
  - 42
  - 45
  - 51
  - 52
  - 61
  - 62
  - 71
  - 72
  - 73
  - 742
  - 743
  - 81
  - 82
  - 83
  - 84
  - 85
  - 851
  - 861
  - 891
  - 90
  - 91
  - 921
  - 931
  - 932
  - 94
  - 95
  - 96
  - 97
  - 981
  - 982
  - 99



## Observed Dyle catchement data:

Dispersed farm location

Concentrated farm location



## In Practice:



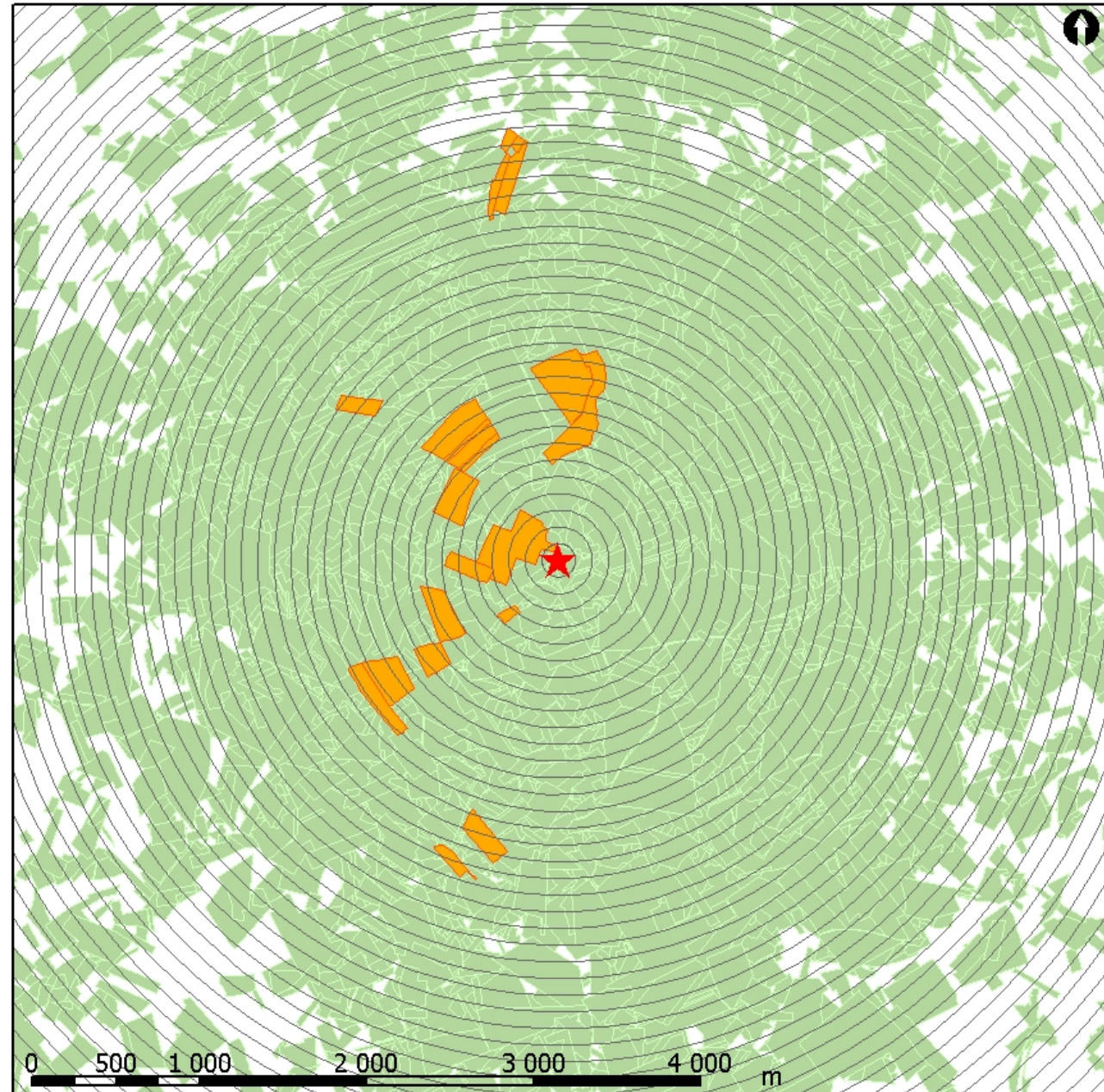
- Translation of parcels from:

*Absolute Space*

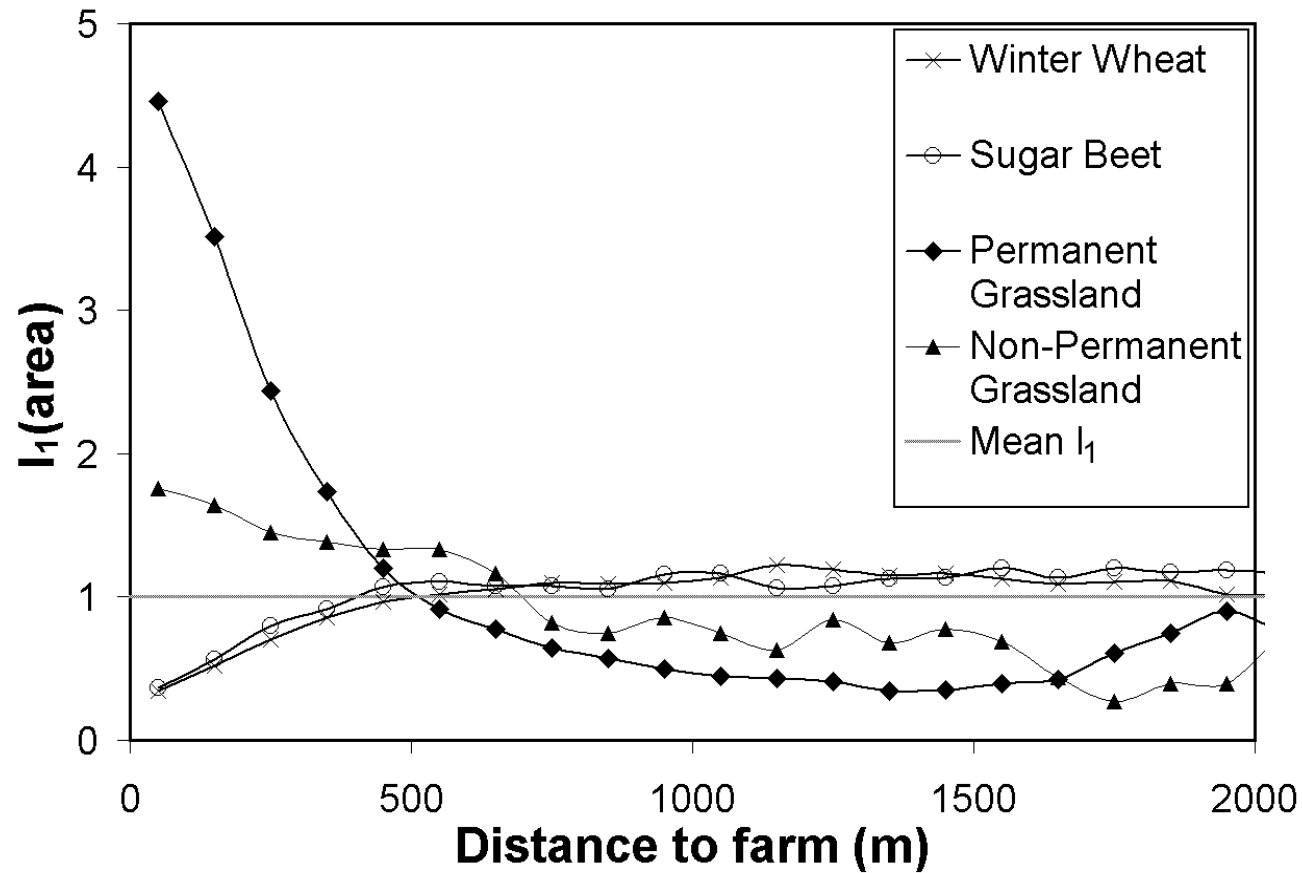


*Relative Space*

- Create 100 m buffers around farm
- Intersect buffers with parcels



# Land use within landscapes

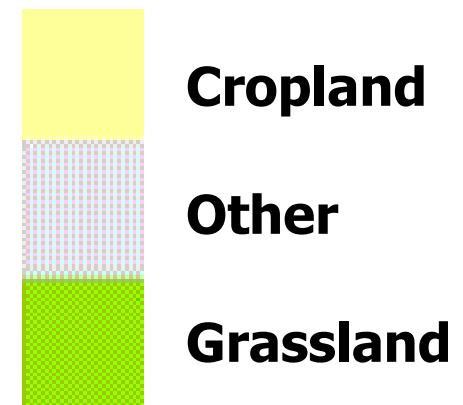
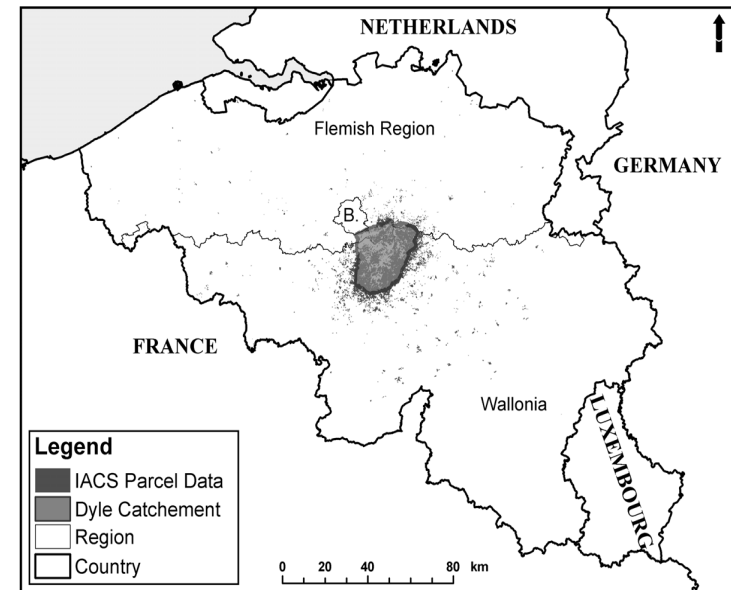


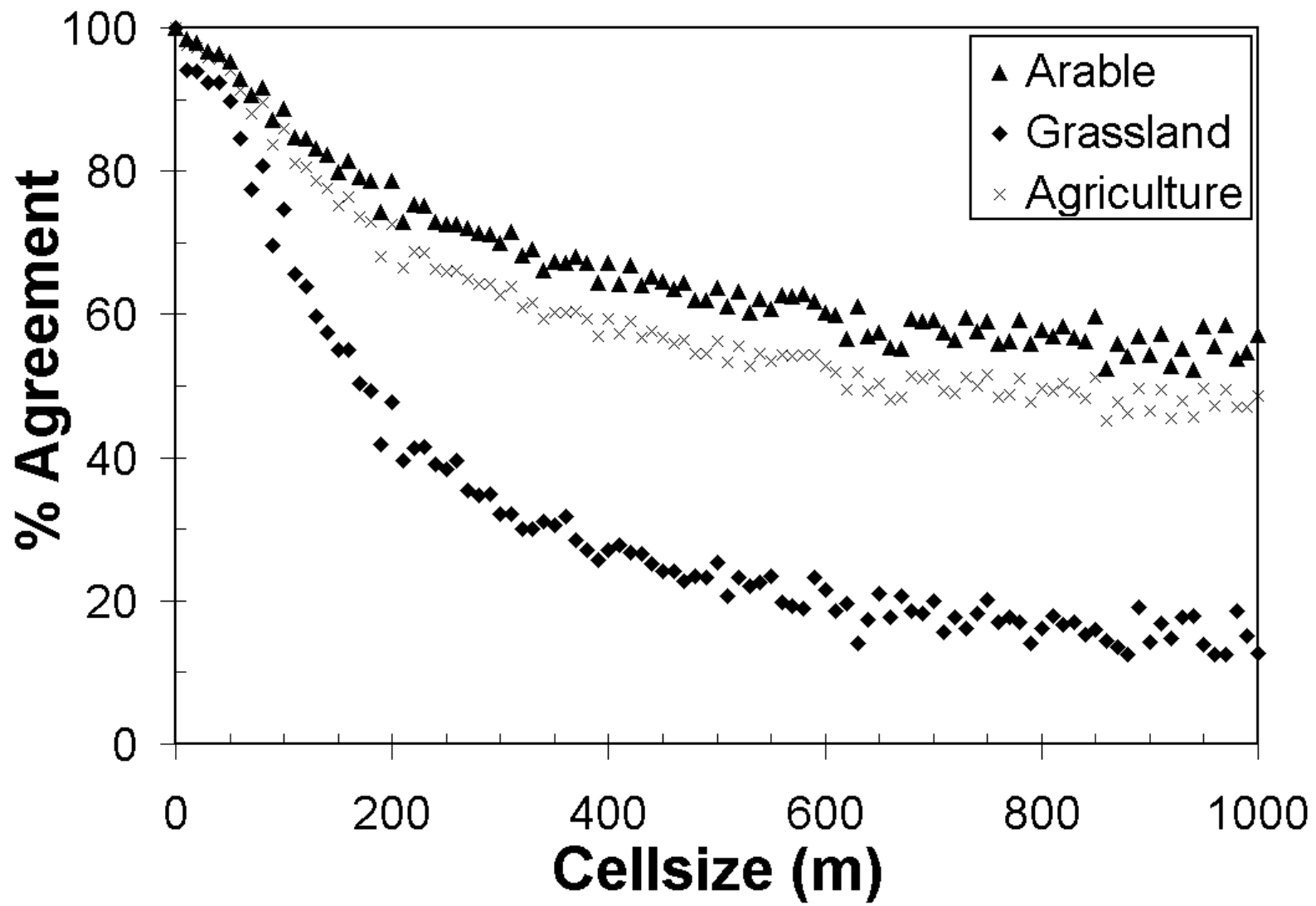
**Agricultural  
land use as a  
function of  
the distance  
from farms**

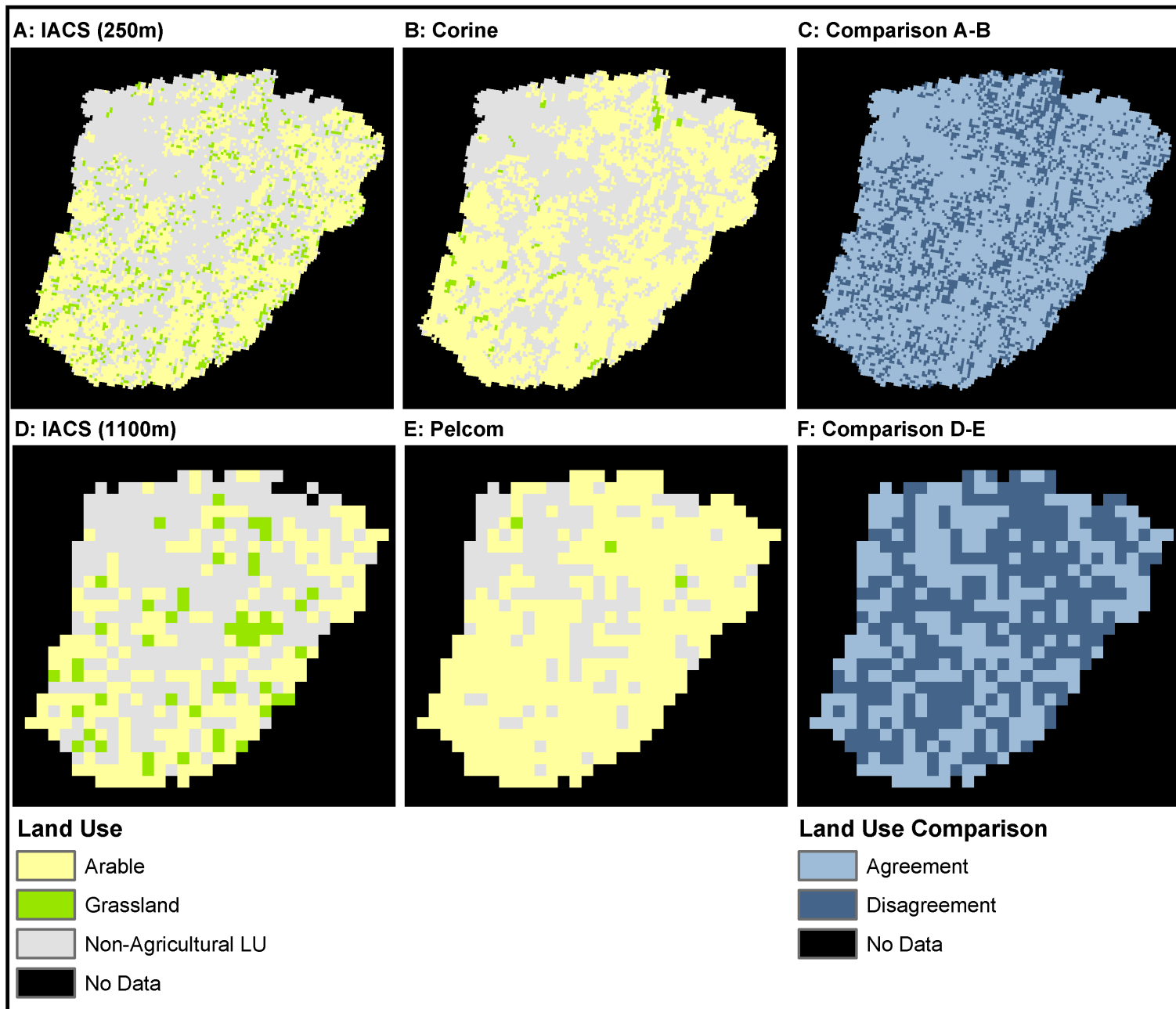
# A parsimonious, rule-based land use change model

10 to 1000m = 10m steps  
1000-5000m = 100m steps  
5000-10000m = 500m steps

## Land use change model

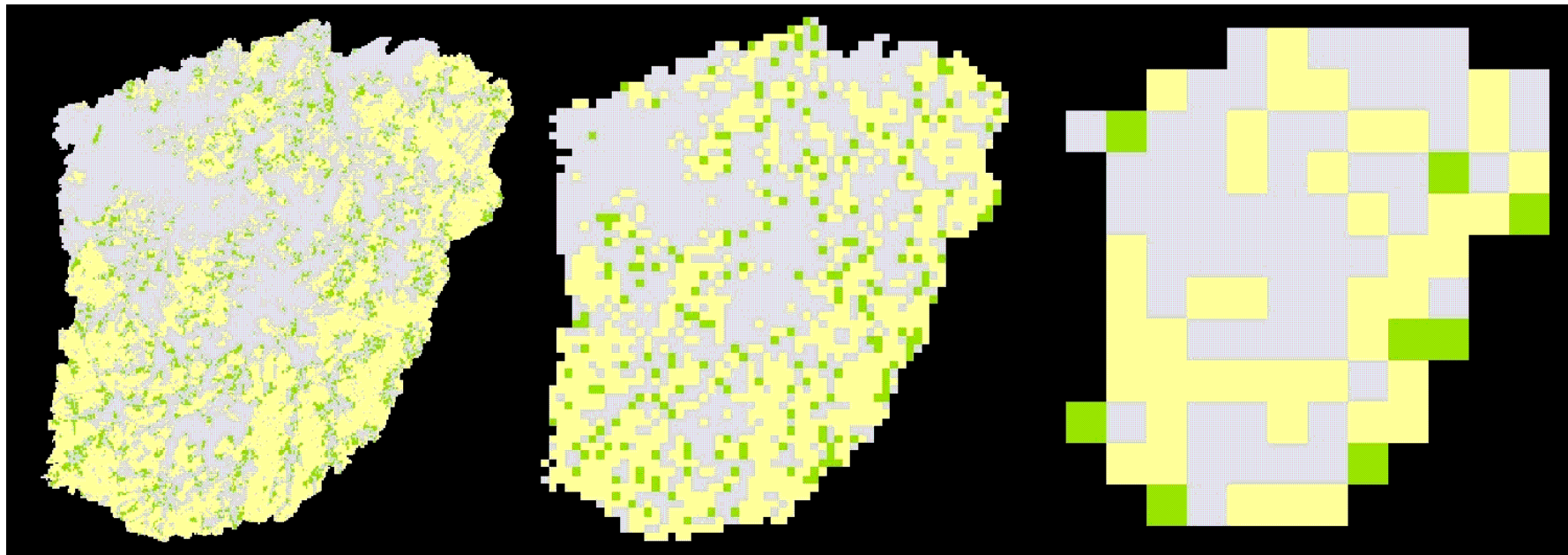






Kappa Corine Comparison: 0.78; Kappa Pelcom Comparison: 0.14

# What is the observation?

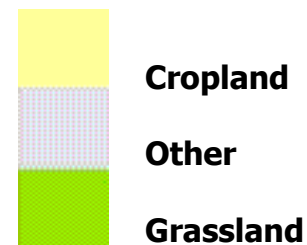


100 m

1000 m

2500 m

Implications for model validation?



# How to validate scenarios?\*

- No observation for the future!
- But, we have observations from the past
- But, the past is only one realisation of what could have happened (other « histories » were possible)
- So, we need « parallel universes » from which observations could be obtained to validate models
- But, ...

\*The scenario assumptions and models used to quantify them

# Spatial and temporal analogues

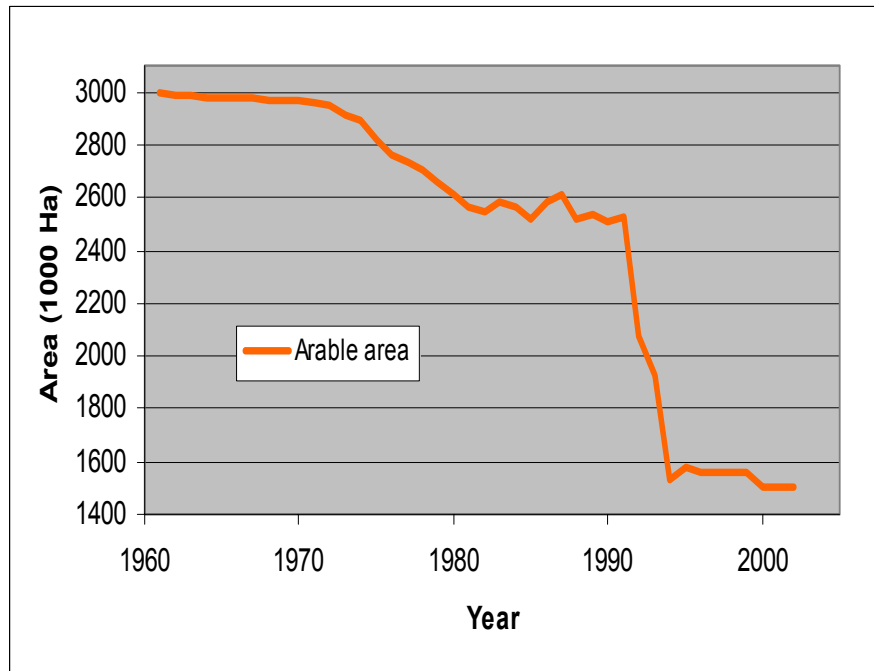
- Compare the « world » described in a particular scenario to similar world's at different geographic locations or at different points in time
- New Zealand post 1984 – test hypotheses about free market scenarios

# Post 1984 New Zealand

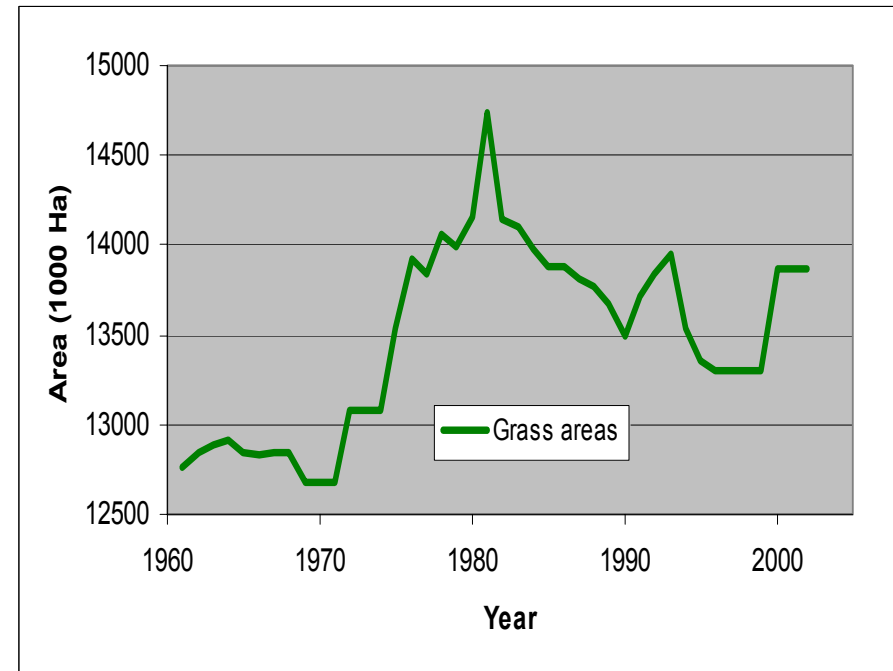
- Deregulation of agricultural sector in 1984 (almost complete removal of subsidies)
- Our scenarios assume that this would lead to agricultural land abandonment
- But, at the same time an increase in crop yields arising from more efficient and innovative management and technology use
- And, constant or increasing production (supply) depending on the demand for agricultural goods

# NZ land use area changes\*

## Arable land use



## Grassland use

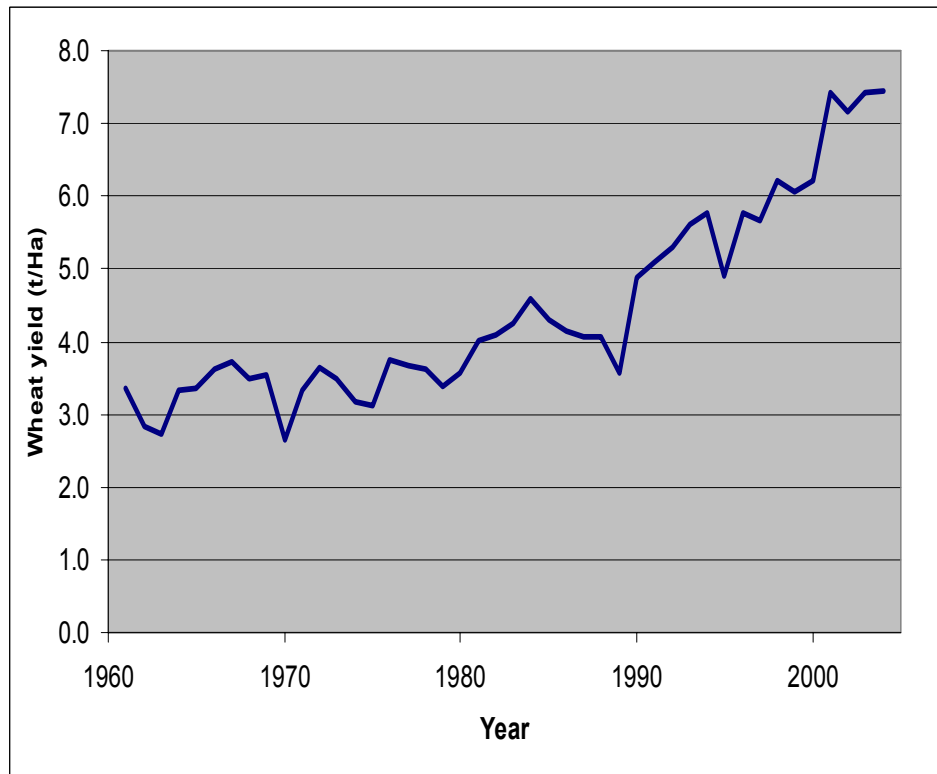


Source: FAO

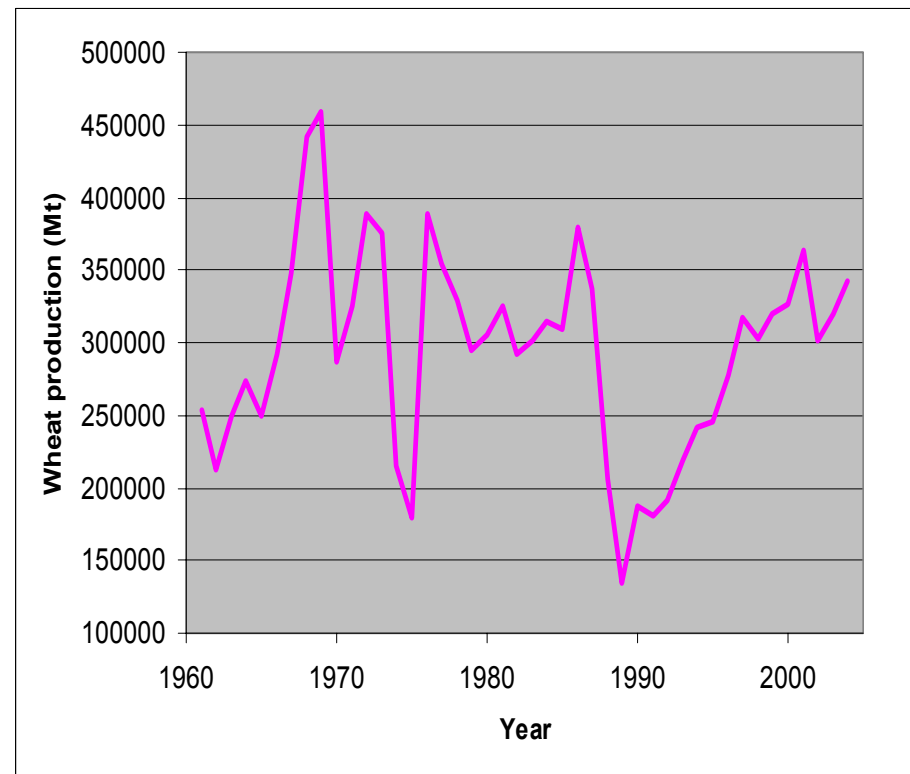
\*Surprisingly, it is not necessarily the worst farmers that abandon farming

# NZ crop yield changes

## Wheat yields (t/Ha)



## Wheat production (Mt)

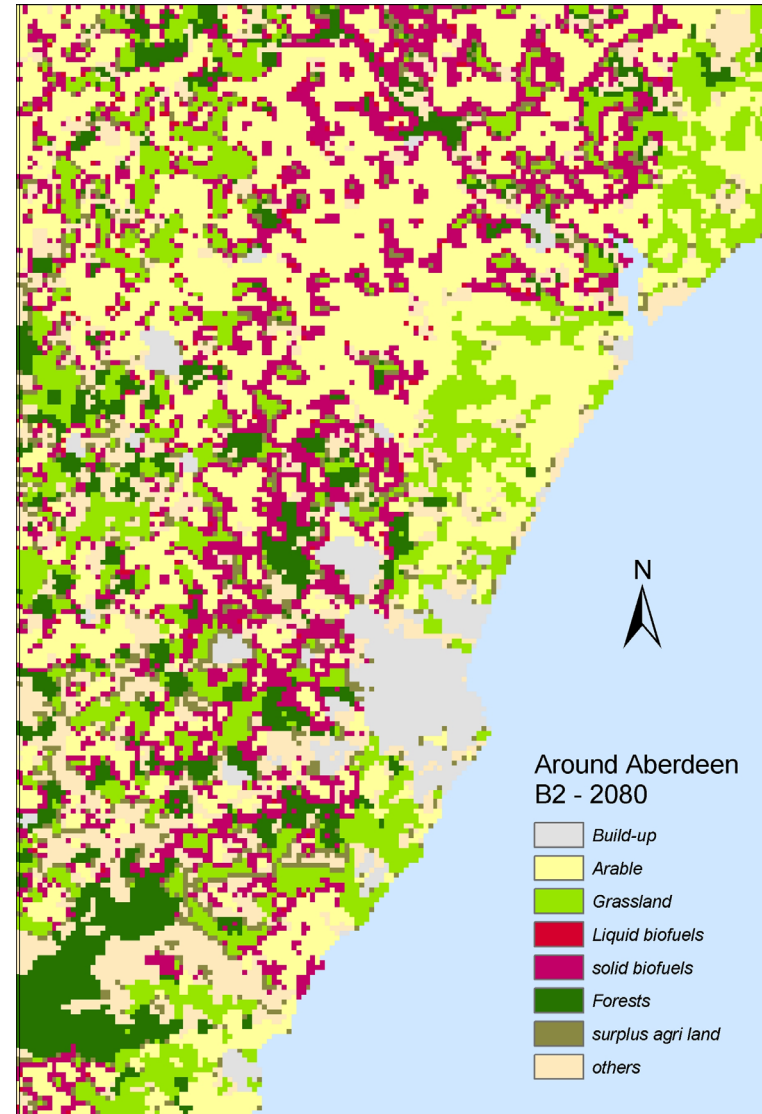
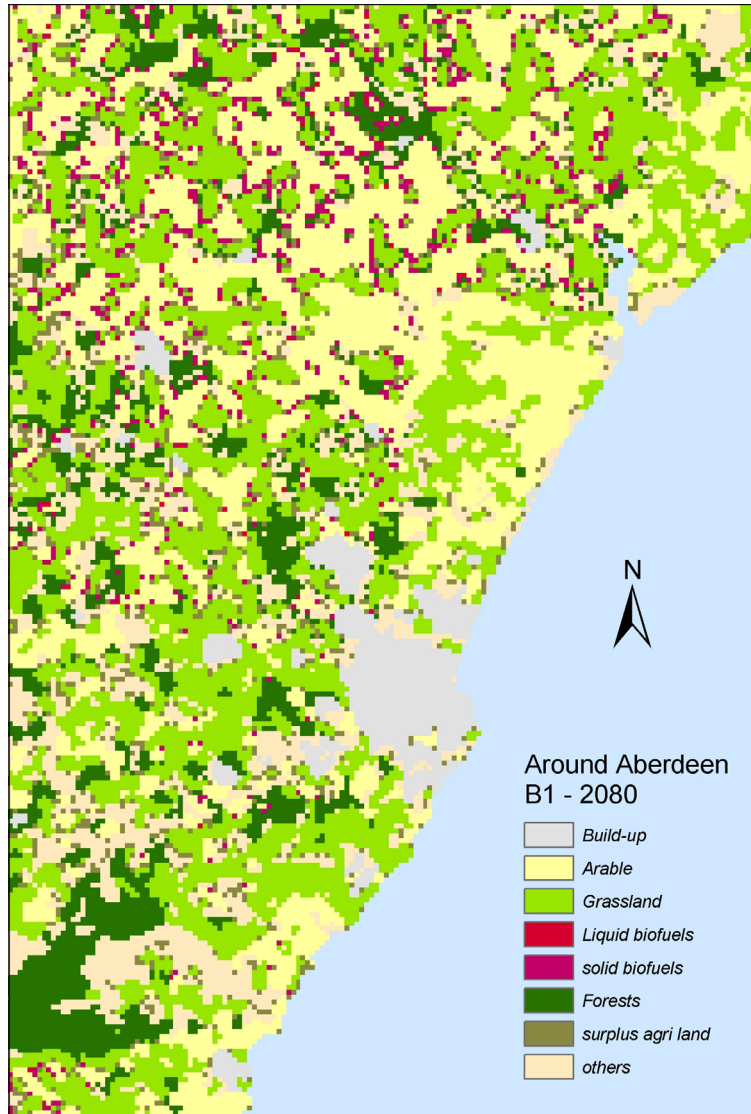


Source: FAO

# Downscaling scenarios

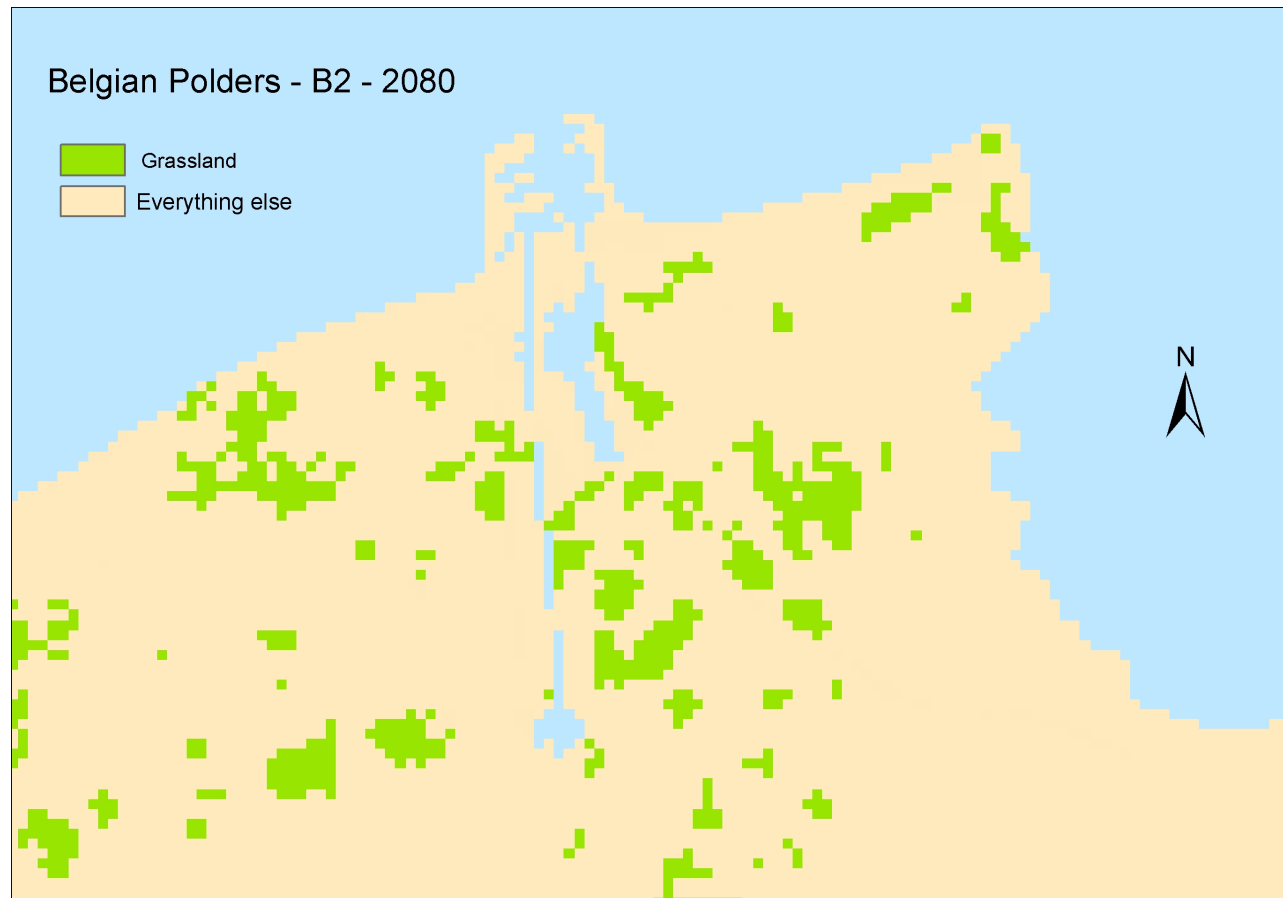
- Now we know that (maybe) our scenarios are not too bad (i.e. they approximate to something like reality)
- And, that landscape structure is important
- We can look to spatial downscaling techniques

# Around Aberdeen – 4 scenarios - 2080



Source: Nicolas Dendoncker, UCL

# Grassland – Belgian Polders – 4 scenarios



Source: Nicolas Dendoncker, UCL

# Agent-Based Models (ABM)

- Statistical downscaling techniques depend on the land use patterns observed in the past
- So, what are the alternatives to statistical downscaling?
- Landscape scale, land use change models that are able to incorporate human decisions and landscape characteristics and,
- Which can be tested against real observation

# Last things to say ...

- More awareness of data limitations in scenario development,
- The need for hierarchical approaches (of scale) and feedbacks
- Recognition that people are central to understanding environmental change
- So, the need for methods/model that really integrate the human dimensions of change – not just talking about it
- Thanks!