

# Analysis and modelling of change in land use systems as exemplars of coupled natural and human systems.

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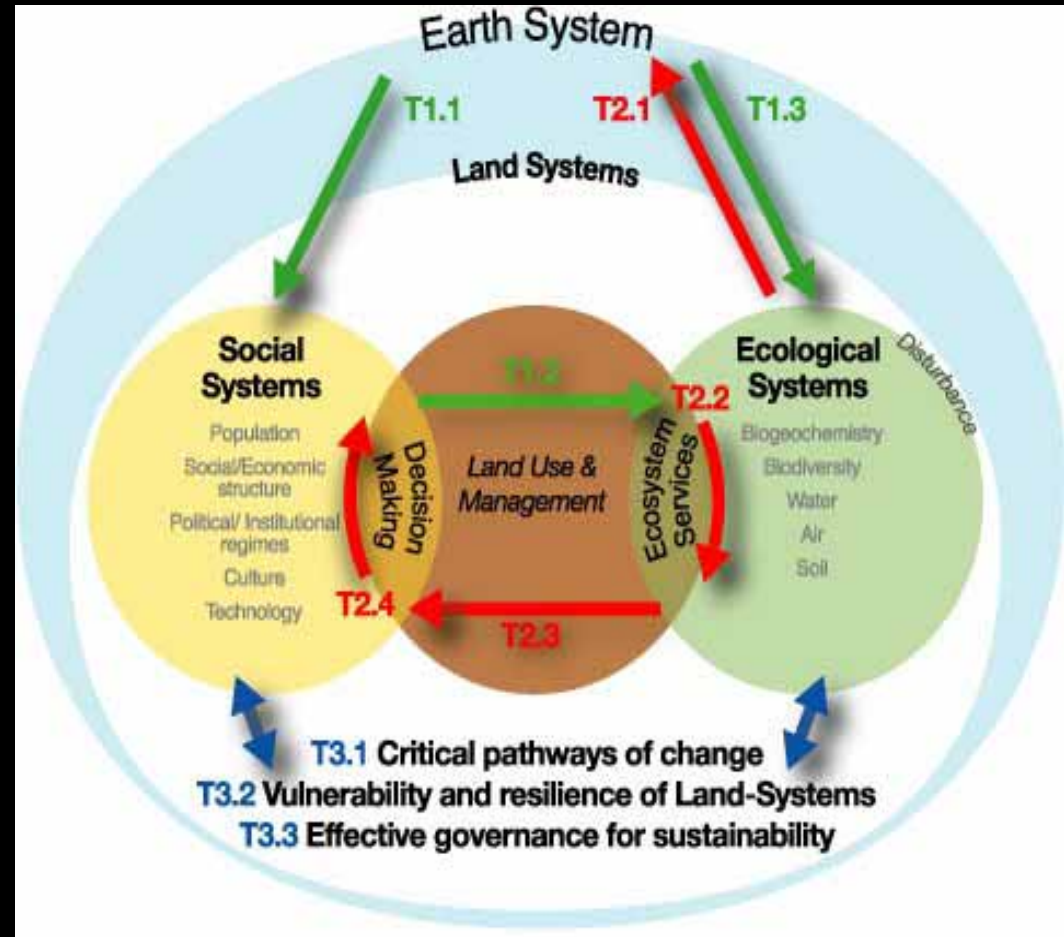
- Land use systems as exemplars of coupled natural and human systems
- Drivers and processes of change
- Case studies
  - Technological change
  - Structural change
  - Cultural change
  - Environmental
  - Economic
- Conclusions

# Land use systems

1. Coupled natural and human systems
2. Influence of processes, rather than drivers, of change
3. Land 'function' – how land systems work, what they do: ecological goods and services
4. Animal systems

# Land use systems

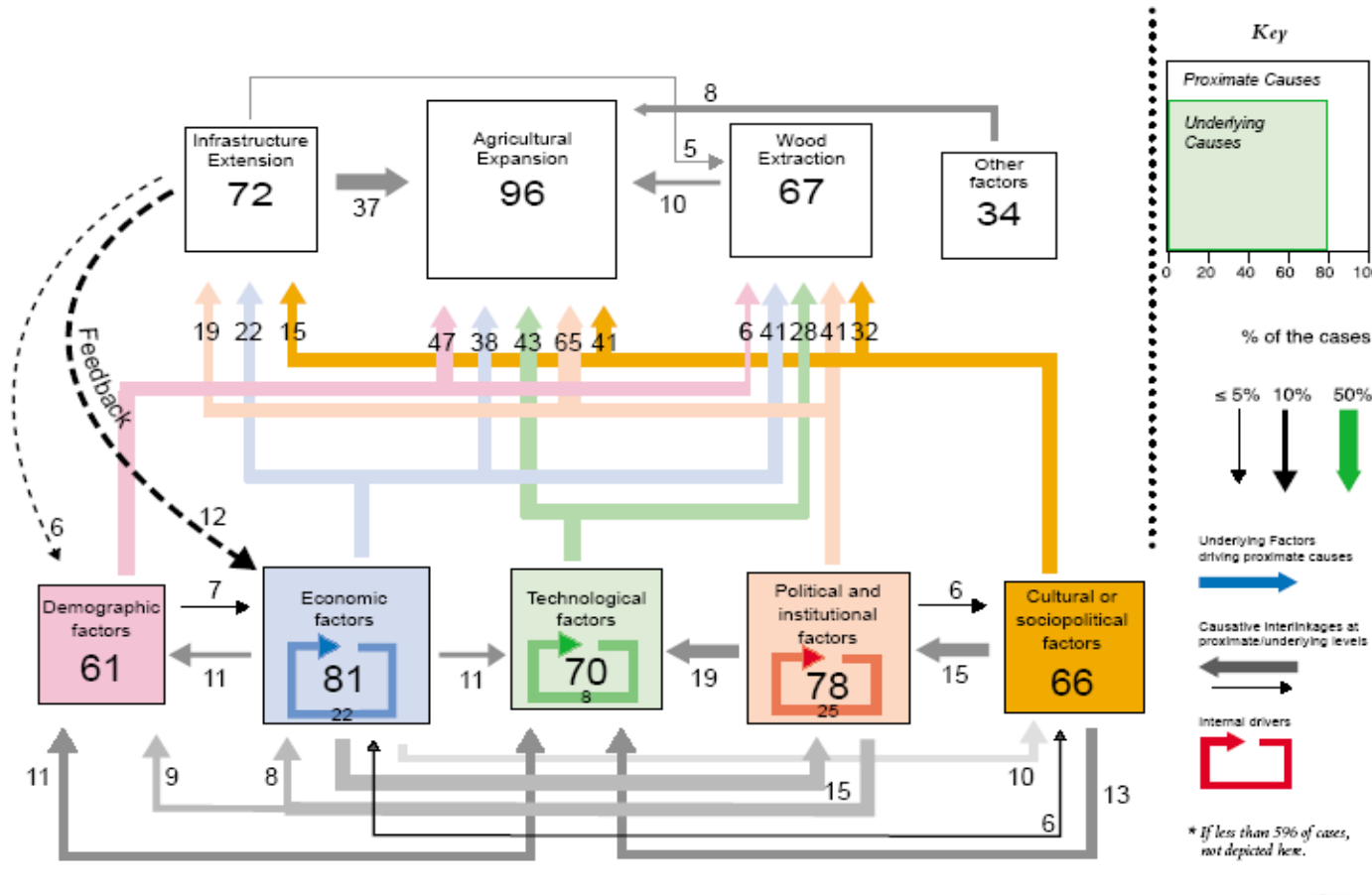
- Global Land Project recognises land use as coupled natural and human systems:
  - Interdependent
  - reciprocal causal relationships
- Complex systems
  - Complex
  - Contingent
  - Hierarchical
  - Irreducible



[www.globalandproject.org](http://www.globalandproject.org)

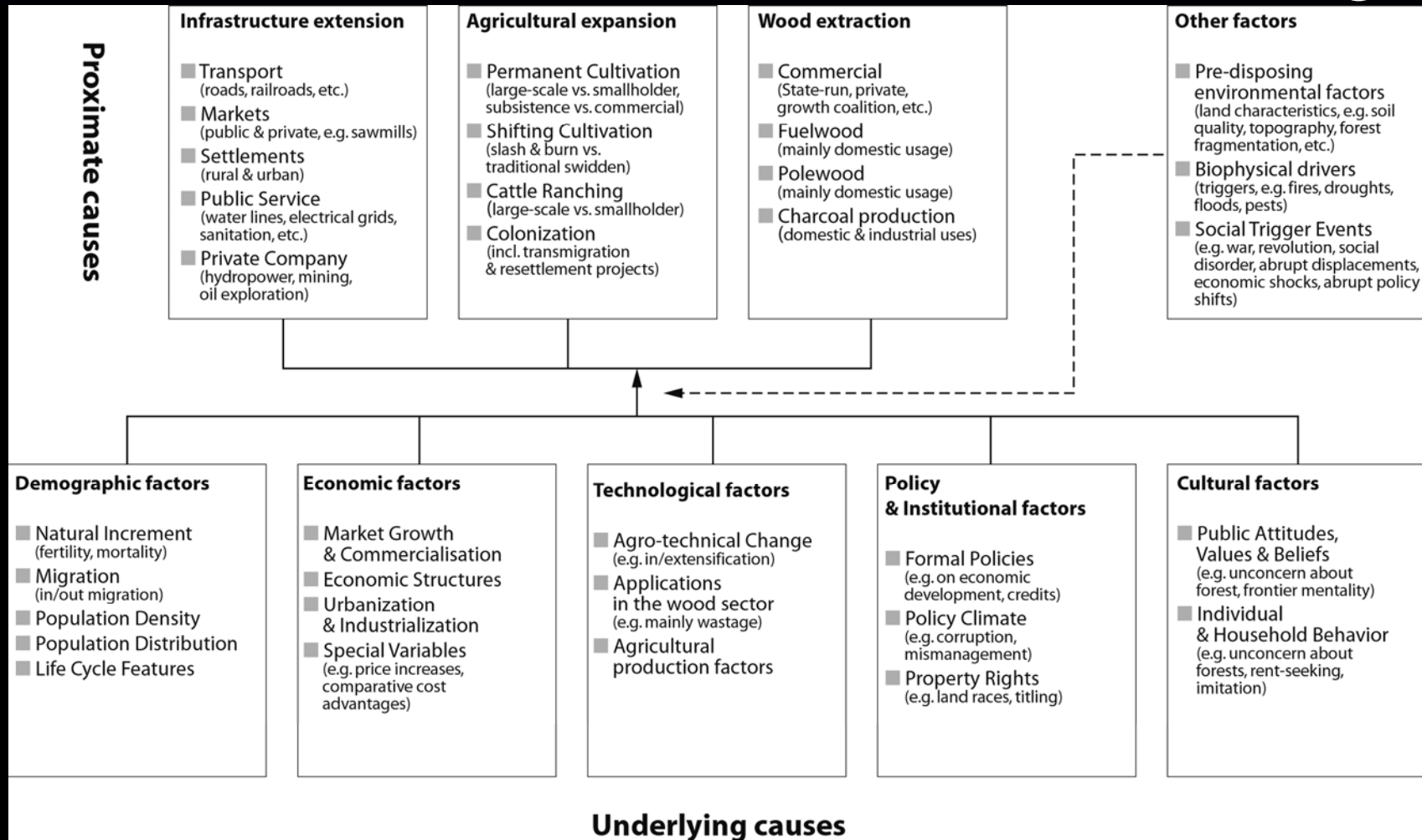
# Drivers of change...

Figure 9 A systemic and generalized view upon the causative pattern of tropical deforestation (N = 152 cases)\*



Geist, H. J. and Lambin, E. F. (2001) What drives tropical deforestation? A meta-analysis of proximate and underlying causes of deforestation based on subnational case study evidence. LUCR Report Series no. 4.

# Proximate and underlying causes of change



Geist, H. J. & Lambin, E. F. (2002) Proximate causes and underlying driving forces of tropical deforestation. *Bioscience*, 52, 143-150.

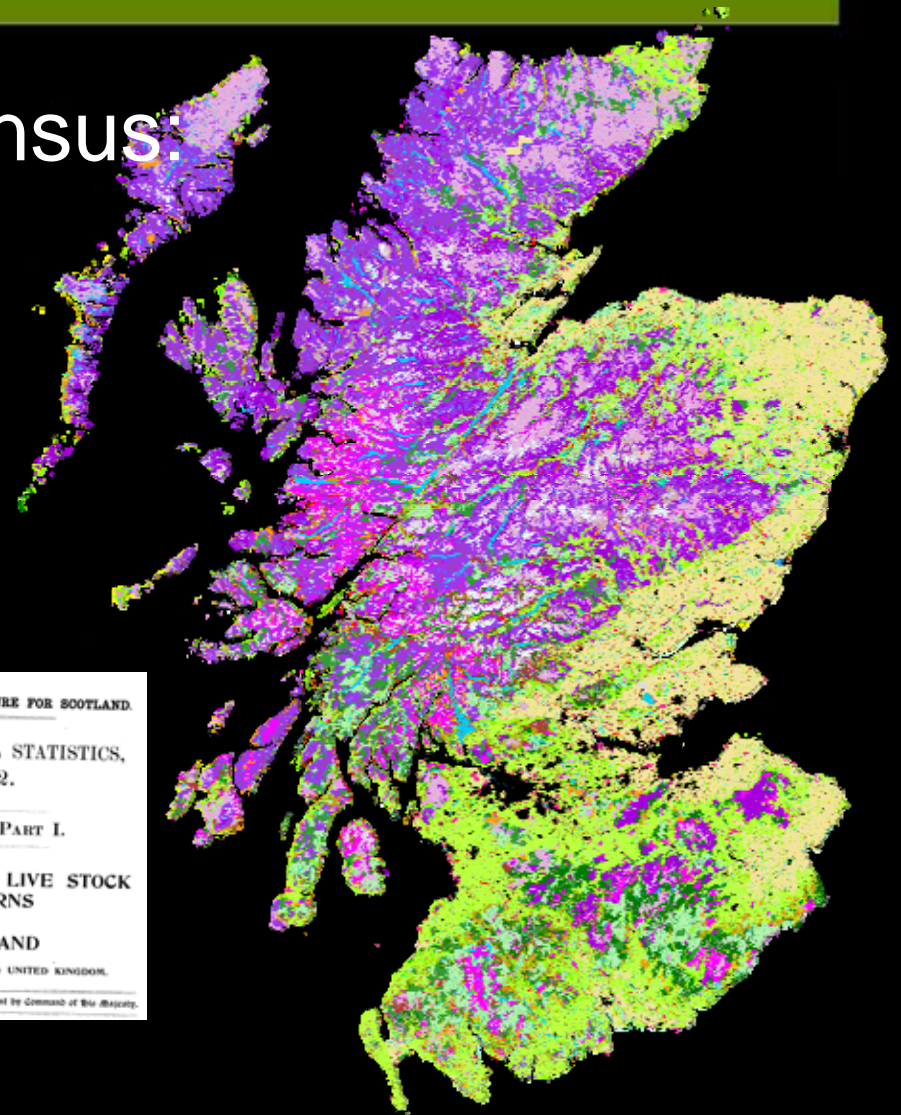
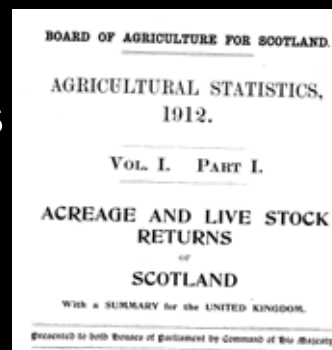


# Case studies

- What are the processes?
- What might we miss with snapshots (especially if based on land cover)?
- How are changes – and processes - related to provision of ecosystems services?

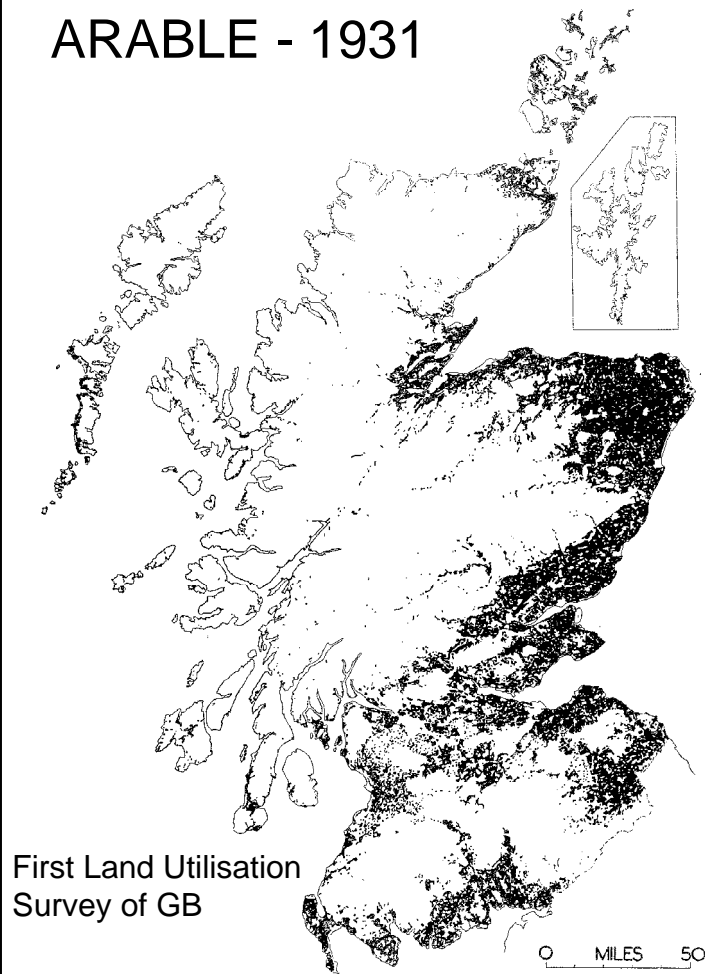
# Case studies - Data

- Agricultural (June) census: national, regional and local statistics
- Since 1866
- Data converted to metric units
  - Production: metric tons
  - Yield: metric tons/ha
  - Area: hectares



# Arable agriculture Scotland

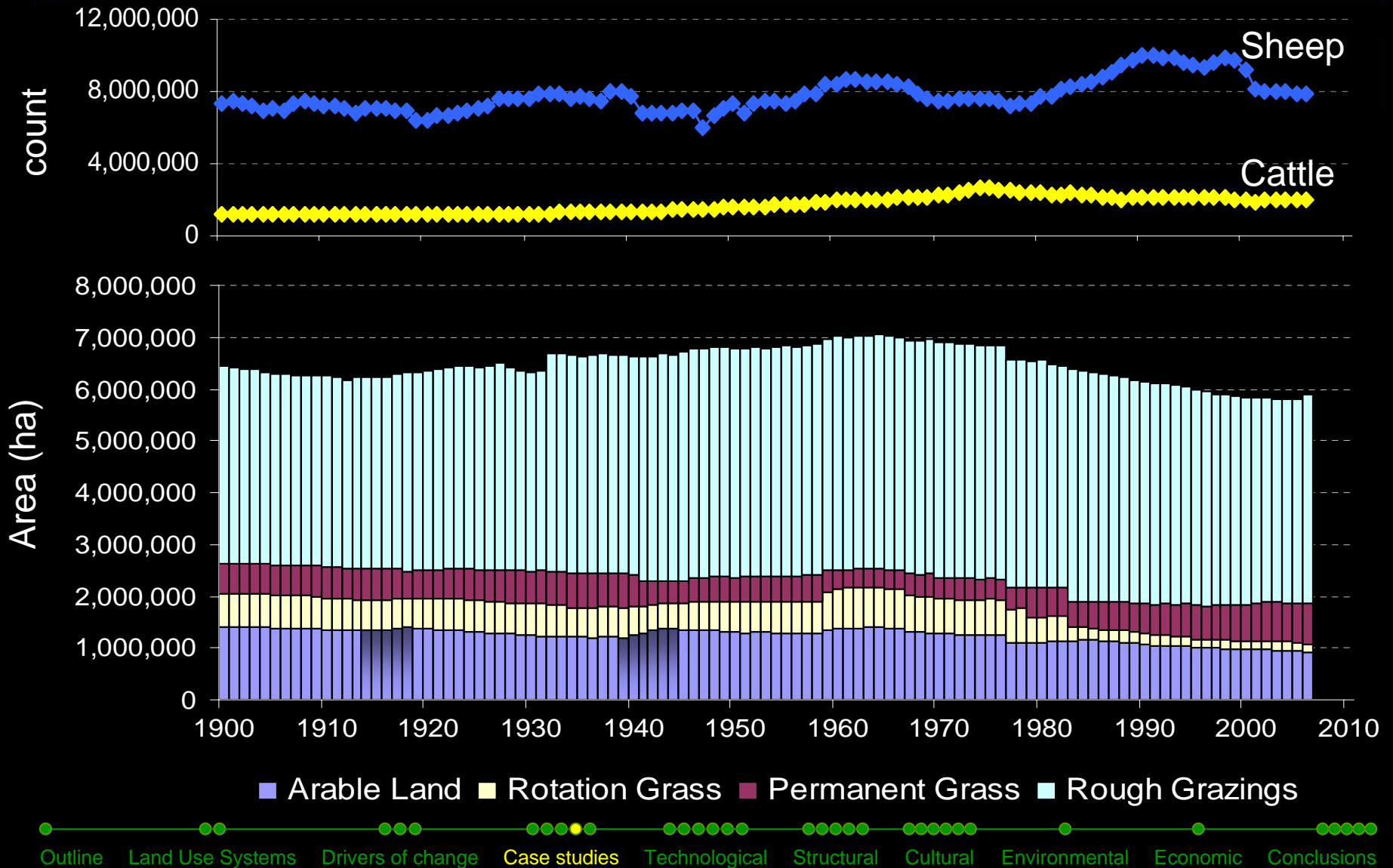
ARABLE - 1931



ARABLE - 1988



# Major land uses and animal numbers in Scotland

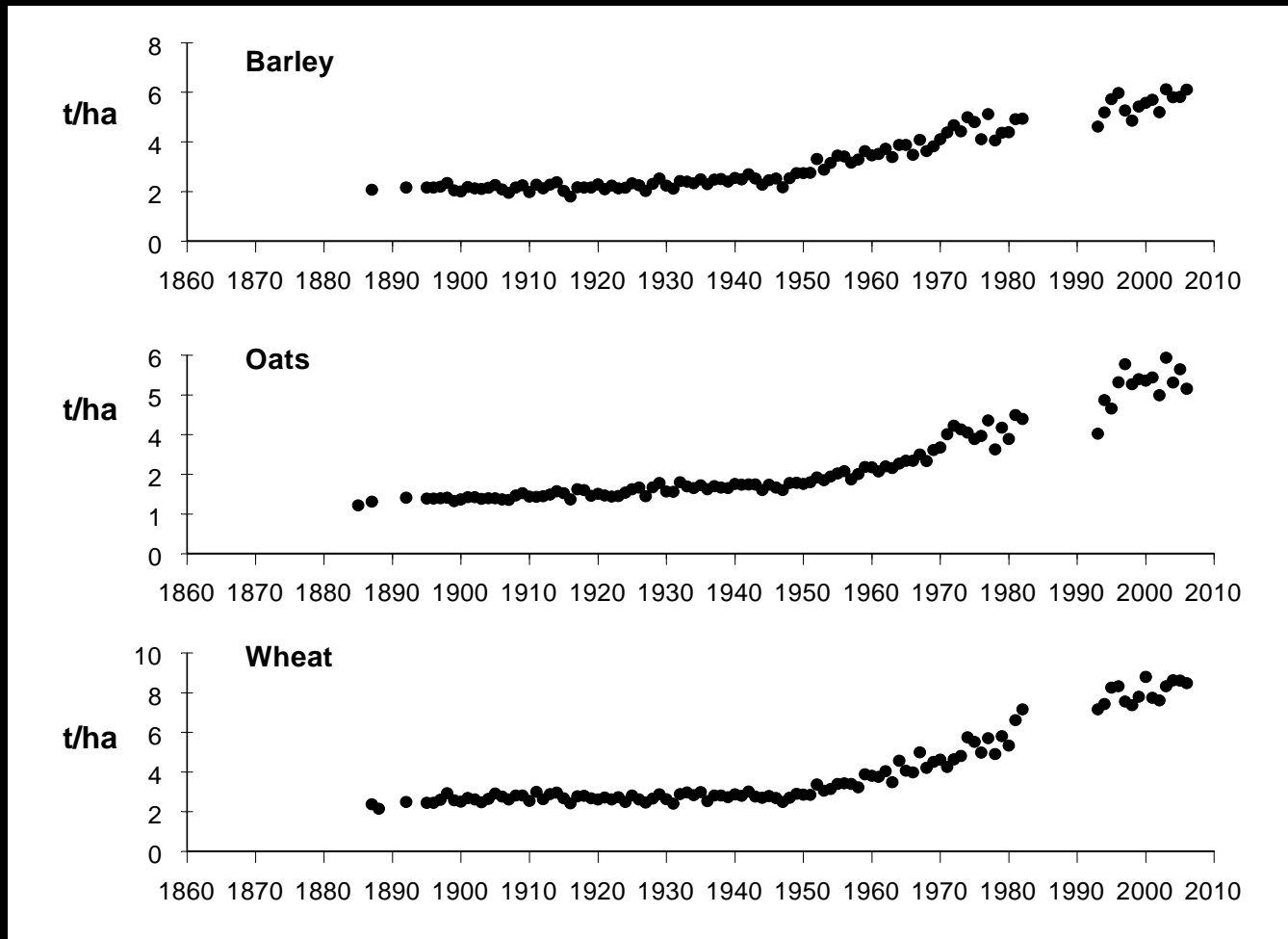




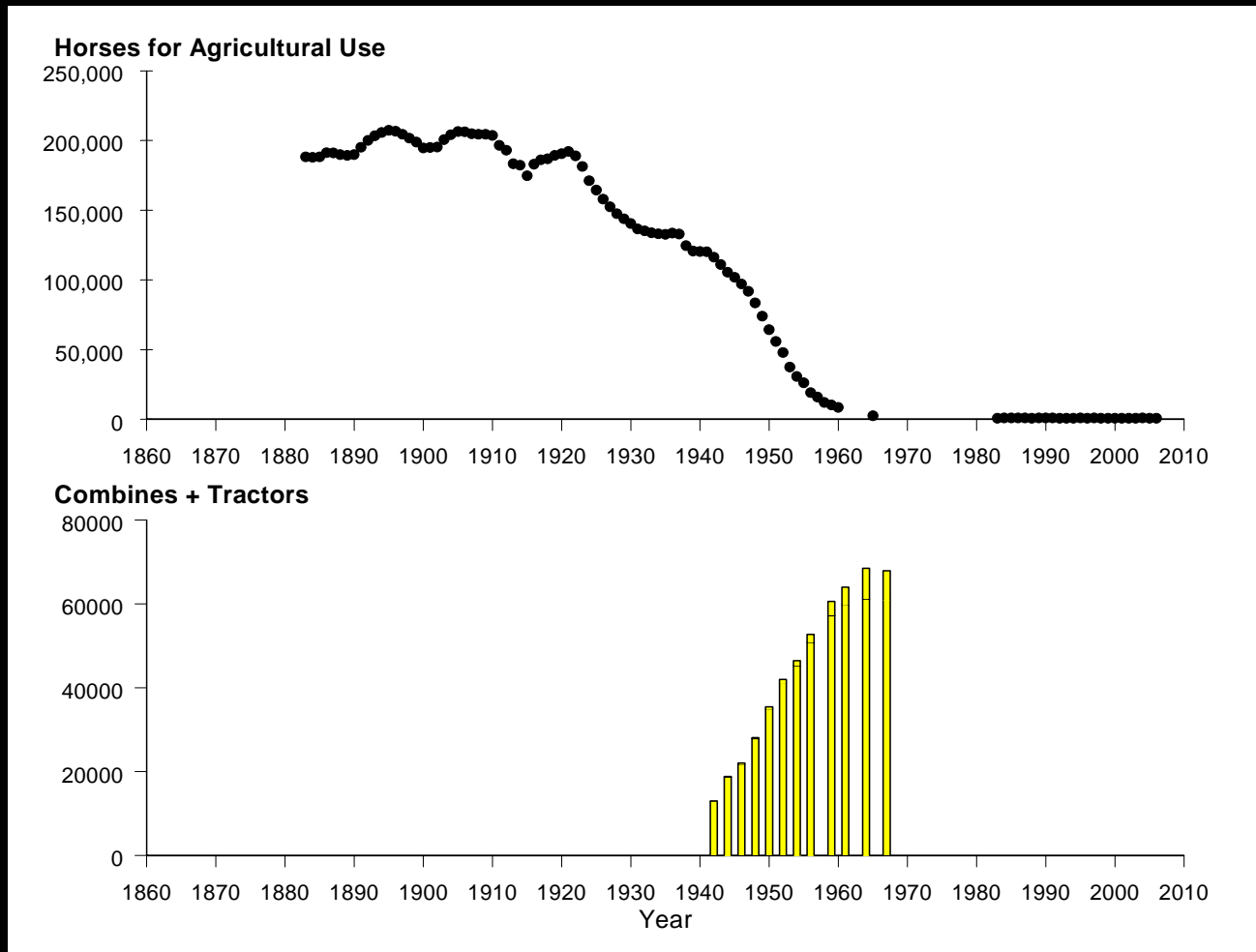
# 1. Technological change

- Crop breeding and yield/production
- Mechanisation of agriculture

# Crop breeding: increased yield



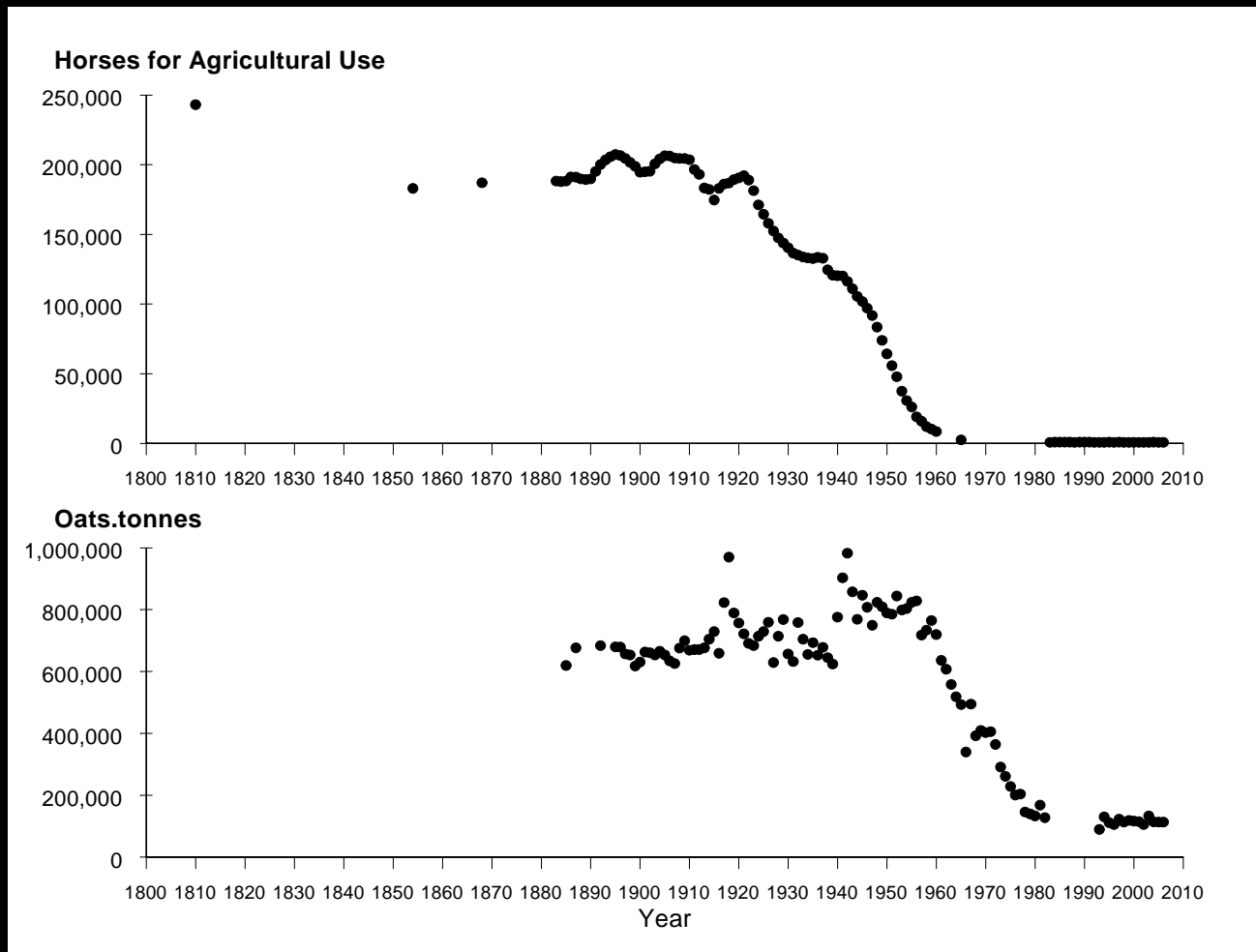
# Mechanisation of agriculture



# Technological change

- Processes
  - Technological innovation
  - Diffusion and adoption of technology
- Not a change in use or cover, but has considerable importance (for natural and human systems)

# Associated consequences



# Technological change: other candidates

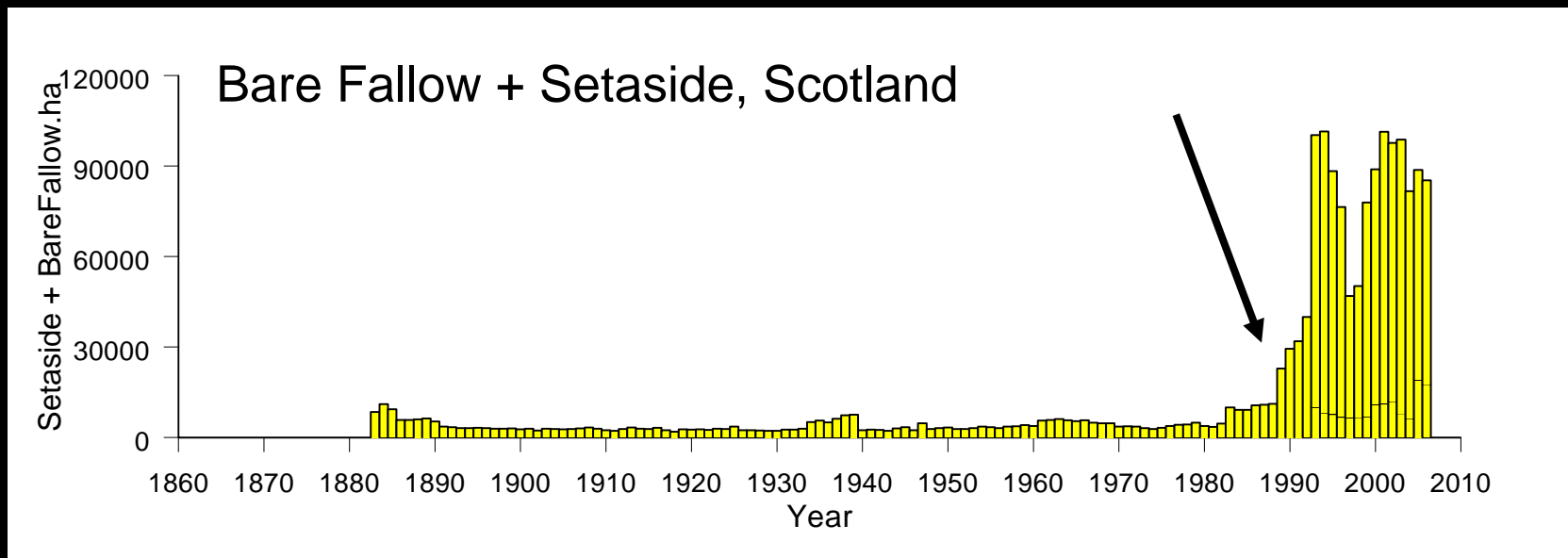
- Land reclamation
  - drainage, fertilisers, reseeded
    - upland pasture improvement (in the UK)
    - peatland reclamation
- Use of chemicals
- Transportation and access
- Food supply chains, marketing
- Energy technologies
  - Windfarms
  - Biofuels
- Construction practices and materials (e.g. urban)

## 2. Structural (Policy) change

- Common Agricultural Policy - price support, overproduction in 1980s
- Set aside (EU) – 1988 onwards



# Common Agricultural Policy: Set aside



- Policy creation: decision-making
- Adoption: decision-making  
(even, in some places, where this required a massive change in farming practice, for example from grazing to arable)

# Structural change: other candidates

- Spatial: across national and other political boundaries. For example, between Russia and China, the USA and Canada
- Temporal: following change in a political system. For example, from communism to democratic and capitalist systems in eastern and central Europe (eg Slovenia, Czech Republic, Slovakia, Russia)
- With change in land tenure, as in crofting areas in Scotland
- Expansion of ex-urban development in USA, often with associated changes in individual and community policy on development and land use
- FairTrade
- ...

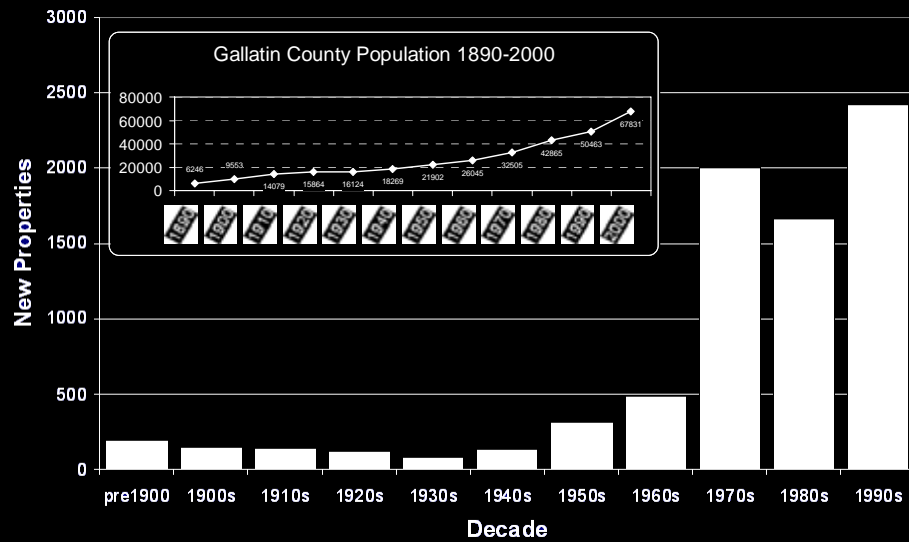
## 3. Cultural change

- amenity and lifestyles
  - Rocky mountains have seen explosive growth in number of people and in housing
  - Change linked to lifestyle and amenity preferences

(demographic and cultural change)

Example: Gallatin County, Montana, USA:  
a multi-model analysis

# Gallatin County: New Homes



Trouper Trail from Triple Tree Ranch Subdivision





# Models for different times

Model	Pre-1890	1890-1934	1935-1966	1967-1984	1985-2000
Variables	Bozeman Slope Water Forest	Railroad Slope Water Forest	Towns Slope Water Forest	Bozeman Slope Nat Forest	Bozeman Slope Nat Forest Visibility
Period					
Pre-1890	0.521	0.126	0.098	0.184	0.071
1890-1934	0.000	1.000	0.000	0.000	0.000
1935-1966	1.000	0.000	0.000	0.000	0.000
1967-1984	0.000	0.000	0.000	0.691	0.309
1985-2000	0.000	0.000	0.000	0.331	0.668

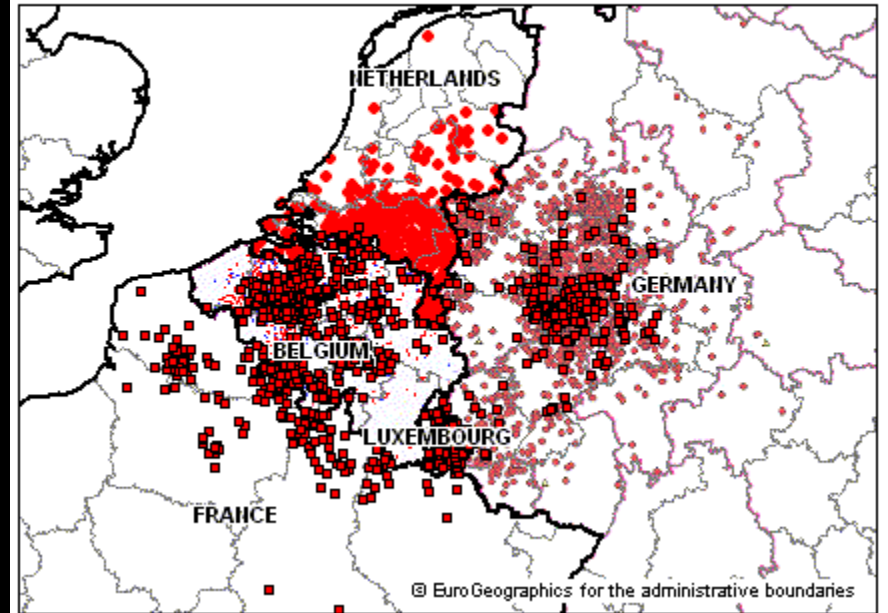
# Gallatin County

- Amenity is a relatively recent influence on change
- Processes: reflects choices and decisions based on values, attitudes, and beliefs

# 4. Environmental change

- Climate change
- Hazards
  - Flood
  - Drought
- Urban land use

Dutch source: [http://ec.europa.eu/food/committees/regulatory/scfcah/animal\\_health/bt\\_23082007\\_nl.pdf](http://ec.europa.eu/food/committees/regulatory/scfcah/animal_health/bt_23082007_nl.pdf)  
 Belgian source: [http://www.favv.be/crisis/sa-blueT/doc07/2007-09-05-KAART\\_v19.pdf](http://www.favv.be/crisis/sa-blueT/doc07/2007-09-05-KAART_v19.pdf)  
 German source: [http://www.fli.bund.de/253.html?&x\\_ttnews\[tt\\_news\]=297](http://www.fli.bund.de/253.html?&x_ttnews[tt_news]=297)



Bluetongue

## World wheat production

2005-6: 622 million metric tons

2006-7: 593 million metric tons

## 5. Economic change

- Globalization
- World markets
- Change in relative price and demand for fuel and food
- ...

US Maize production for ethanol:

2006-7: 2 billion bushels out of 12 million bushels (16.6%)

2007-8: forecast to rise to 3.5 billion bushels (35%)

70 new ethanol plants are under construction – this will double the amount of maize consumed for fuel

# Conclusions

A process-based view of drivers of change through decision-making

A variety of processes are relevant

- **Technological change**
  - *Innovation, diffusion*
- **Structural, Cultural, Economic**
  - *Decision-making*
- ***Decisions and choices***

# Processes?

## Human Systems

**Structural:  
Institutional and Policy**

**Technological  
*Innovation, diffusion***

**Economic**

**Cultural**

### ***Decision-making***

***Preferences***

***Attitudes, Norms, Habits***

***Individual/Household***

***Values and Beliefs***

***Choices  
and  
Decisions***

**Demographic**

**Land  
Use**

**Land  
Function**

**Land  
Cover**



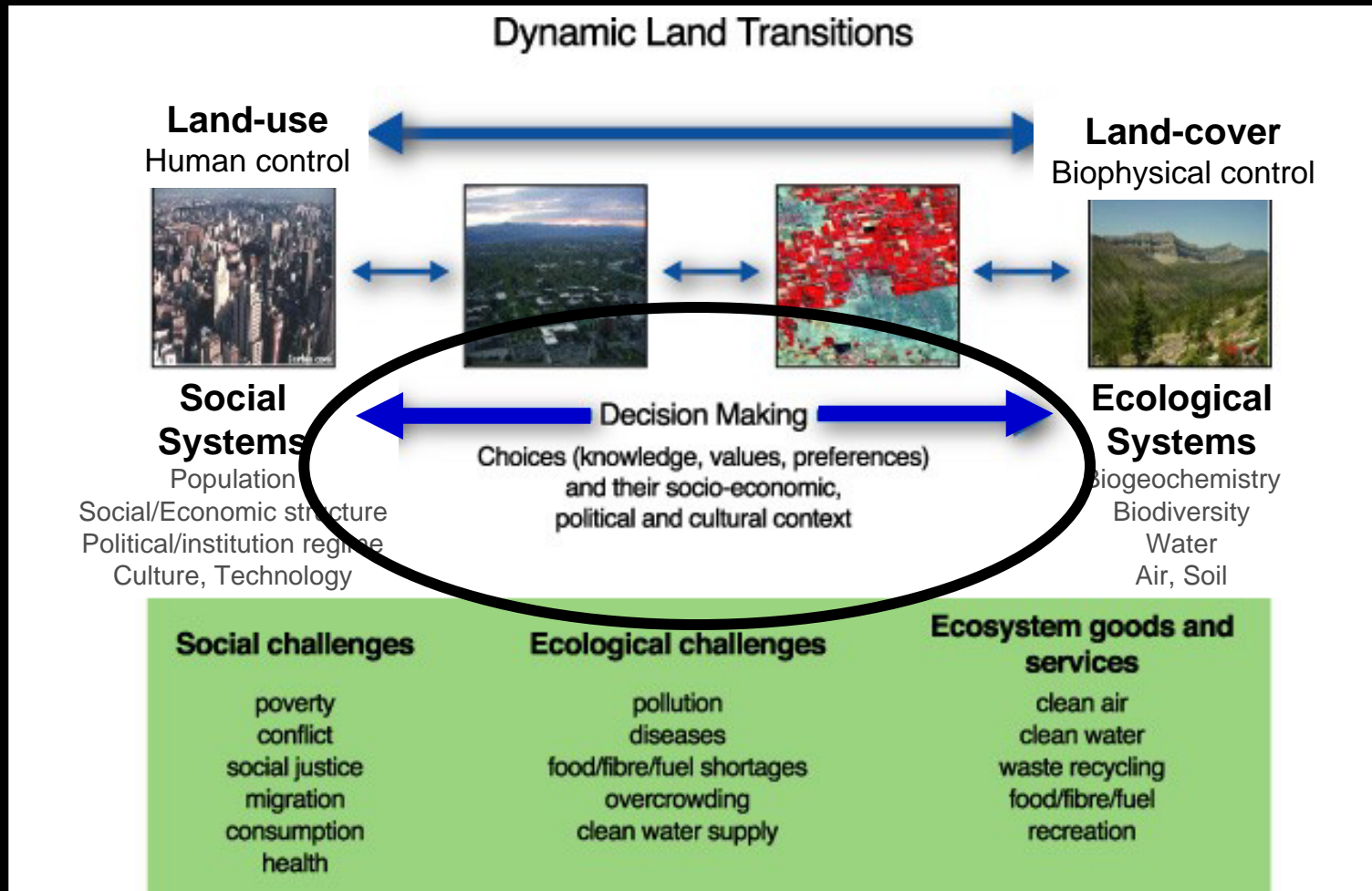
# Conclusions

Modelling and analysis of land use change can, and should, draw on a broad range of methodologies and enabling technologies

A variety of approaches

- Agricultural and environmental histories
- Narrative methods
- Quantitative methods and models

# Conclusions



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