Land-cover / Land-use Change and Carbon Fluxes in Central and Eastern Europe

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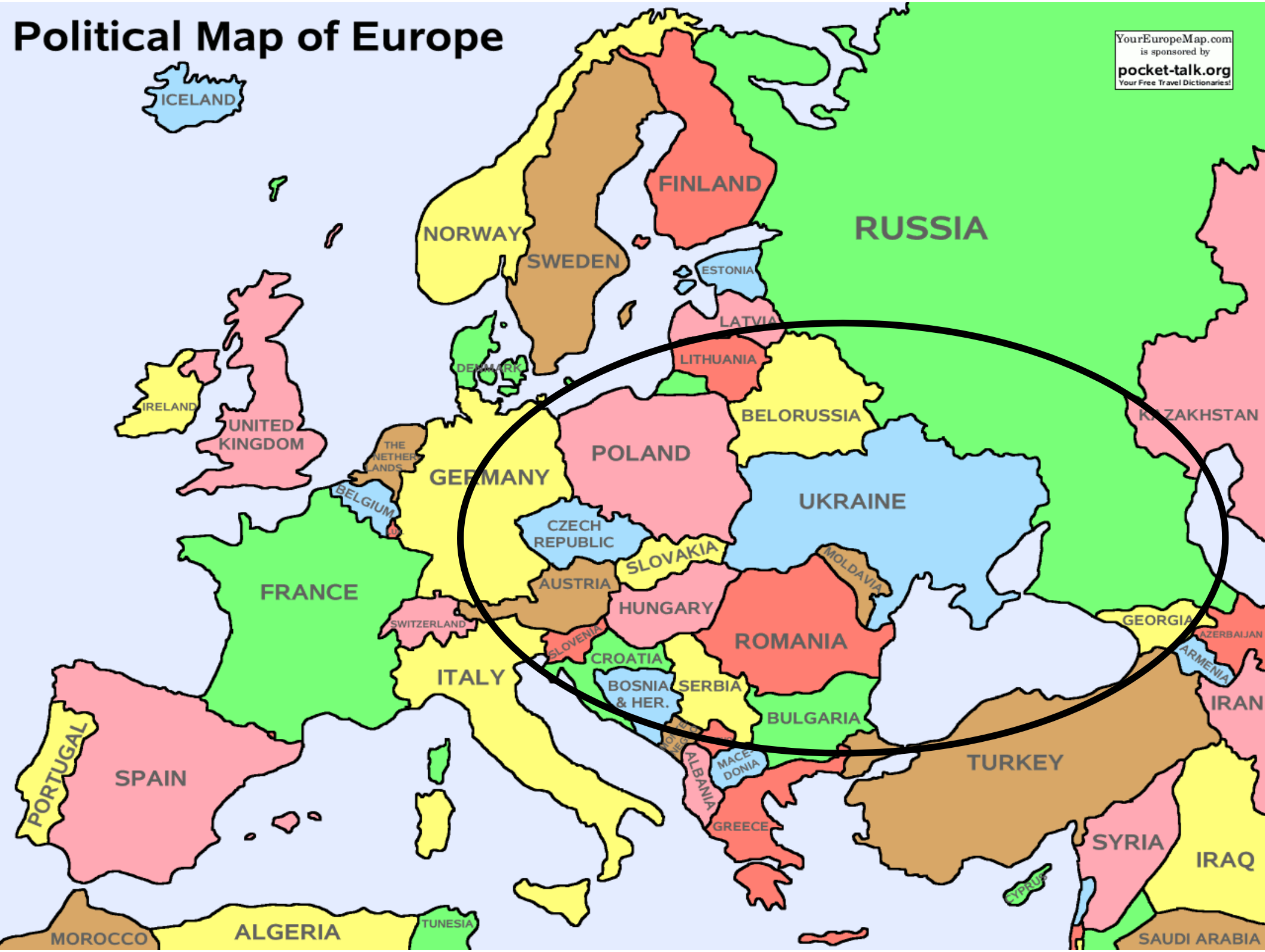
Goals

- Land-use/land-cover change and the carbon cycle
- Land-cover change includes forest loss, forest gain, agricultural abandonment, and agricultural intensification
- Historical land use change
- The satellite era
- Carbon bookkeeping model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TURKEY
GREECE
SYRIA
IRAQ
CYPRUS
MOROCCO
ALGERIA
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Physiographic Setting

- Rich in physiographic provinces
  - Topography partially determines land-cover and use
- Mountains
  - Caucasus, Carpathian
  - Dominated by forests
- Low relief plains
  - Dominated by agricultural lands and grasslands
- Large water bodies
- Major rivers

Historical Setting

- Over 3000 years of settled history
- Agriculture plays a dominant role
- Region of “conquests”
- Major migration routes
- Raw materials for wars (wood) and
- later industrial development
- Industrialization
- Soviet revolution
- Independence

Current Trends

- Demographic
  - Slow growth
  - Urbanization
  - Migration
- Economic and Industrial
  - European integration
  - Manufacturing hub and construction industry
  - Agricultural activities
- Natural
  - Forest harvest/re-growth
  - Mixed climate change signal

Research Questions

- How do recent drastic socioeconomic changes affect forest cover?
  - Forest loss / forest gain
- What are the best methods for monitoring these changes remotely?
  - Remote sensing, historical perspective
- What are the impacts of these changes on the regional terrestrial carbon budgets?
  - Carbon release; carbon uptake

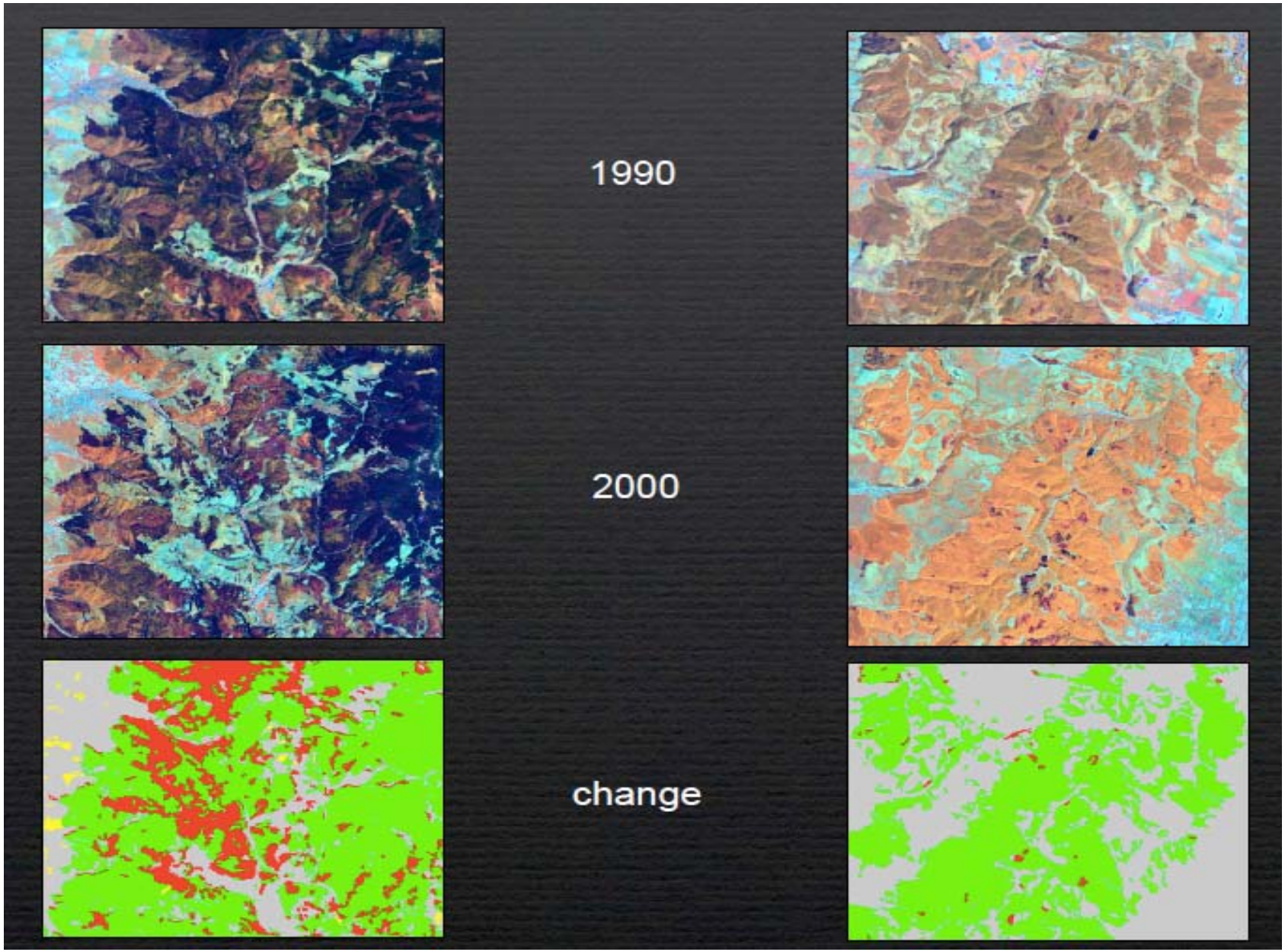
Forests of the region

- Forests dominate high elevation areas
  - Large forest area compared to central and western Europe
- Changes are location specific:
  - Hungary – privatization/renewable energy
  - Romania – privatization
  - Georgia - fuel wood
  - Ukraine – commercial extraction

Forest extent

UNEP-GRID 2000

Forest change (Romania)




Courtesy of Daniel Muller

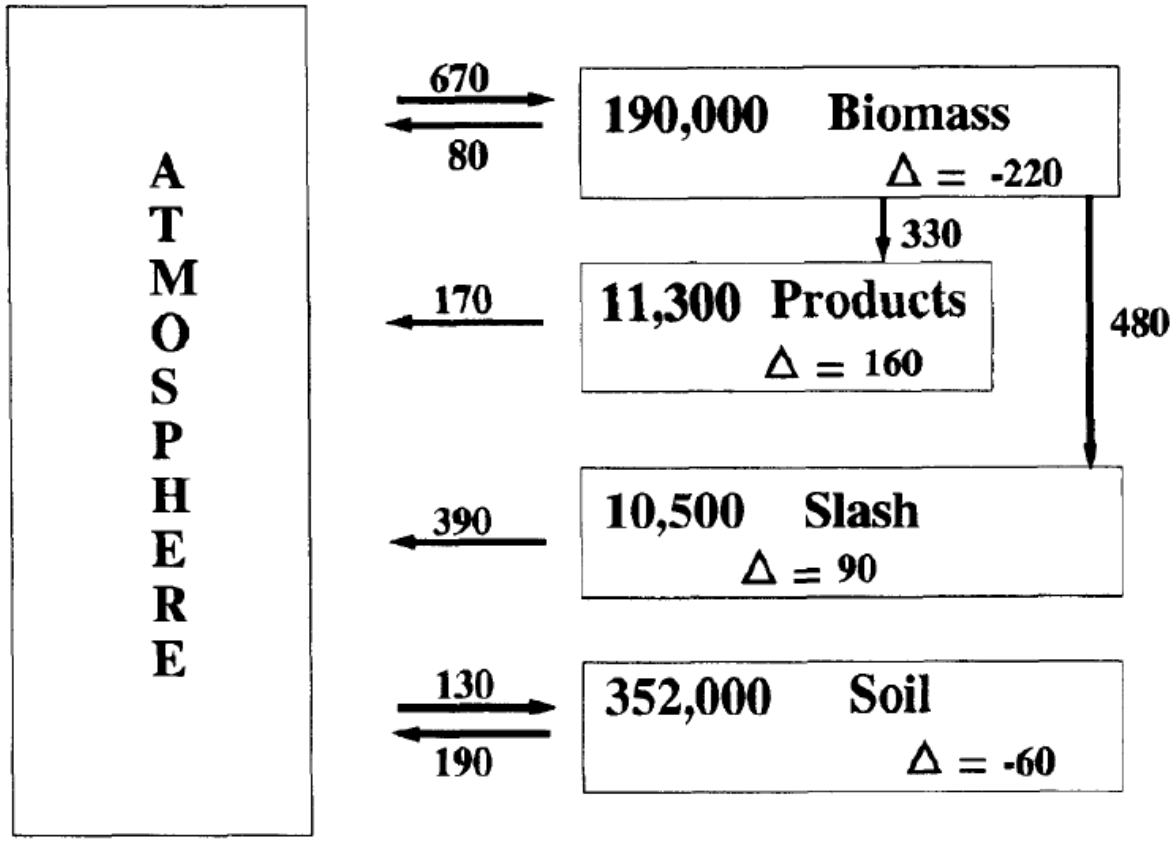

Courtesy of Daniel Muller

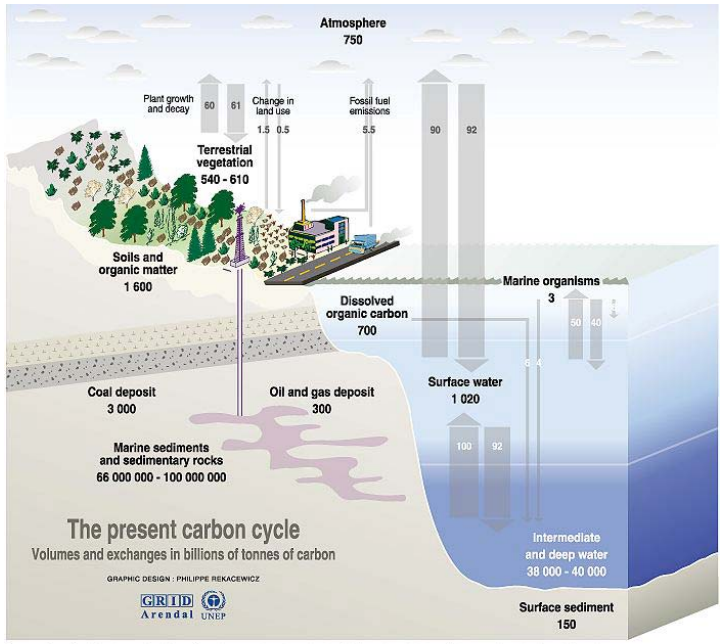
Carbon budgets associated with land change

Carbon book-keeping model

- Originally developed by Richard Houghton et al. (1983)
- Calculates the carbon emissions and uptake over time associated with land change events
- Events may include i) forest harvest, ii) conversion to cropland, iii) abandonment of farmland, etc.
- Makes use of forest inventory data for growth rates, age distributions and average biomass
- Includes the effects of decomposition of forest products

Carbon book-keeping model





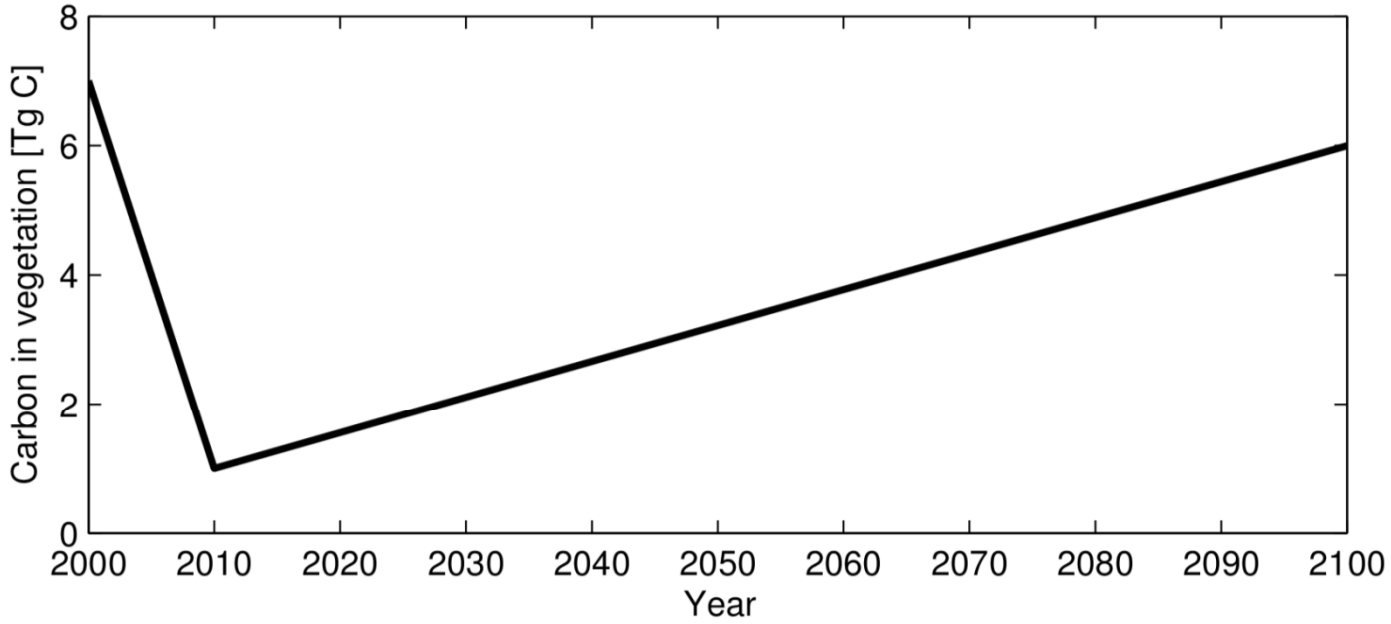
Sources: Center for climatic research, Institute for environmental studies, university of Wisconsin at Madison; Okanagan university college in Canada, Department of geography; World Watch, November-December 1998; Climate change 1995, The science of climate change, contribution of working group 1 to the second assessment report of the intergovernmental panel on climate change, UNEP and WMO, Cambridge press university, 1996.

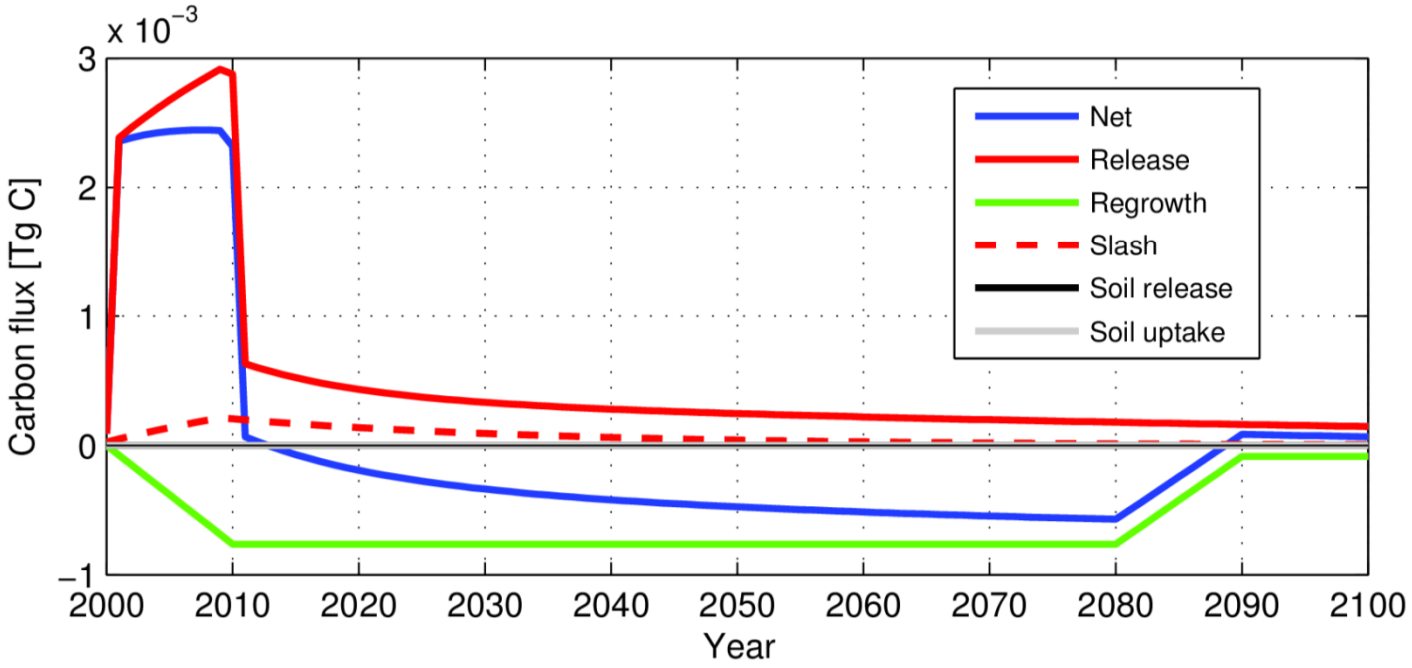
800 **Gross uptake**

830 **Gross release**

30 **Net release**

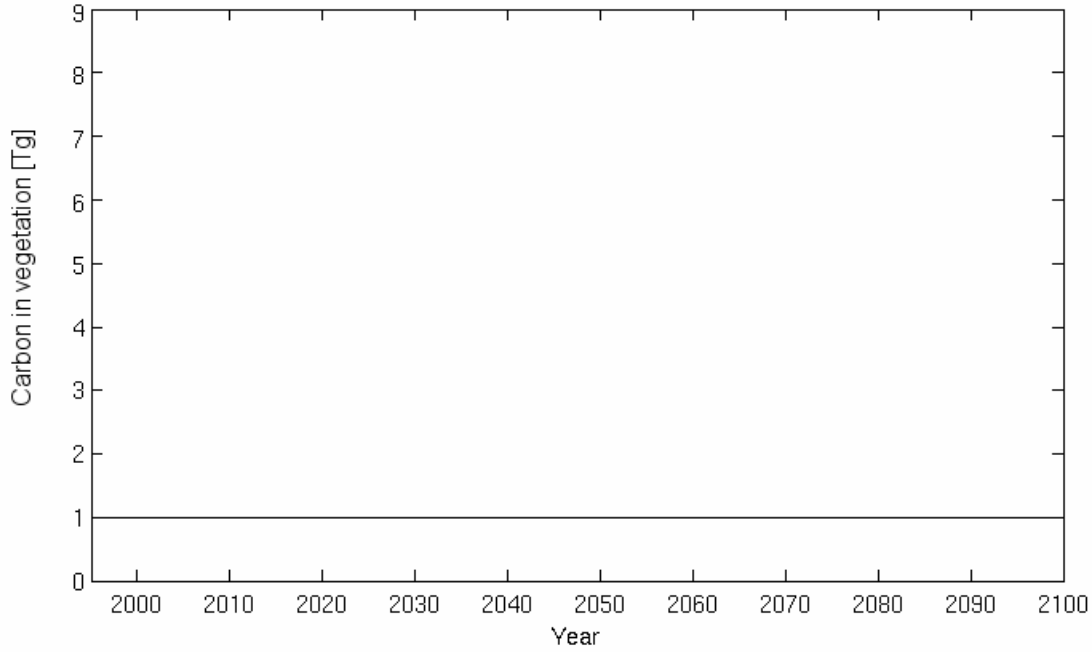
Harvest event

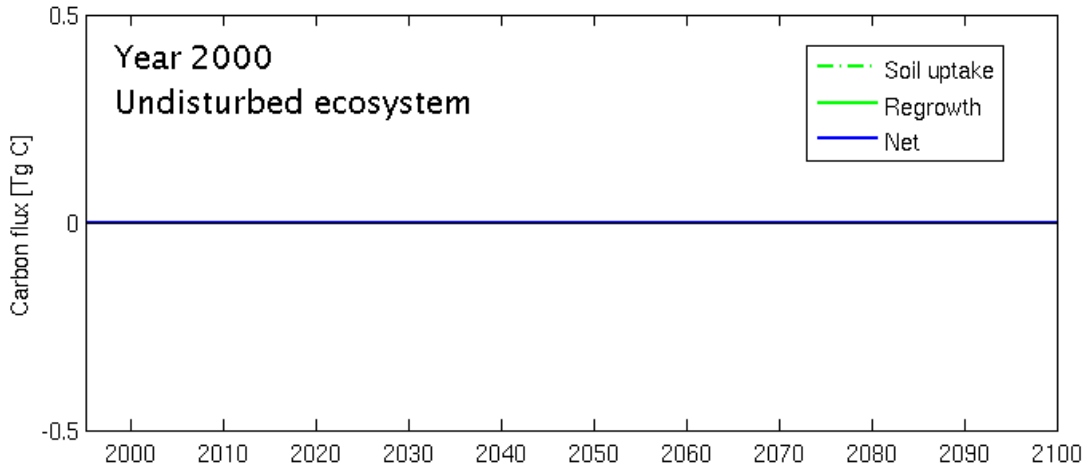




Animation 1: Event/disturbance

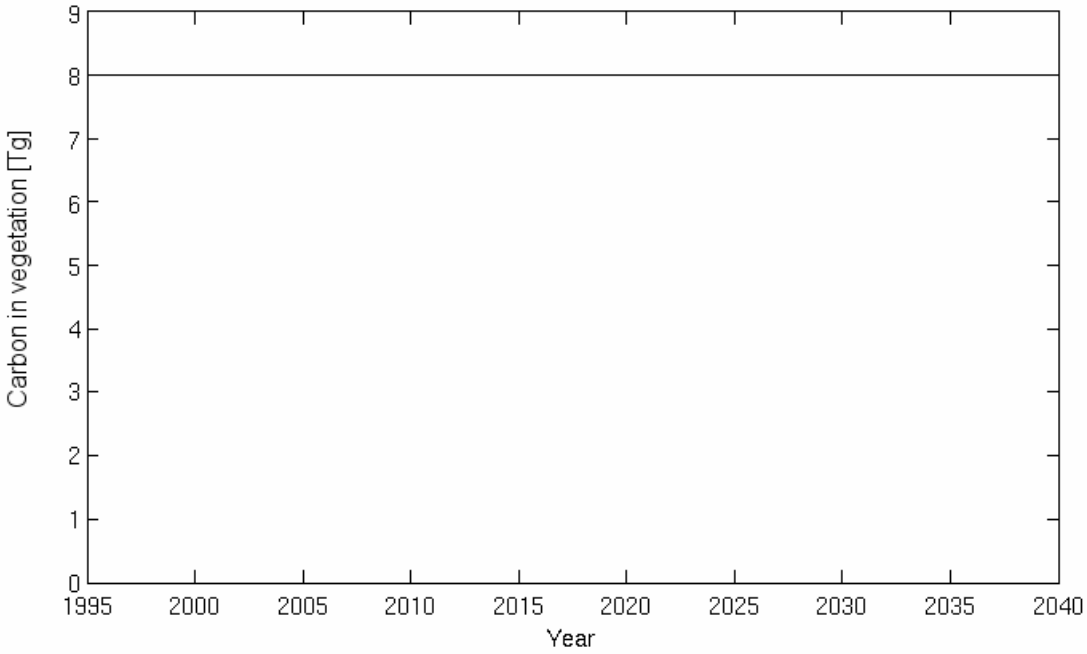
Afforestation or forest regrowth on abandoned farmland. 50 km2 of forest planted every year between 2001 and 2010.

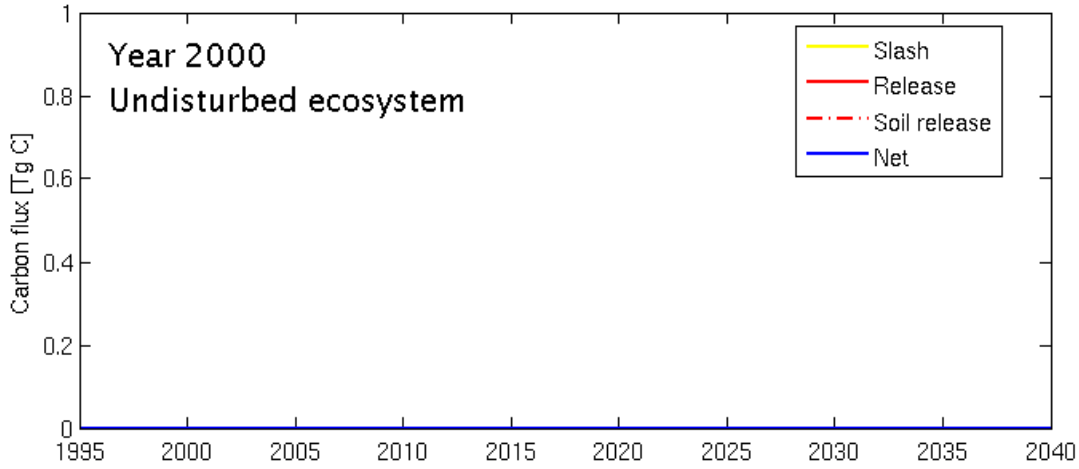




Animation 2: Event/disturbance

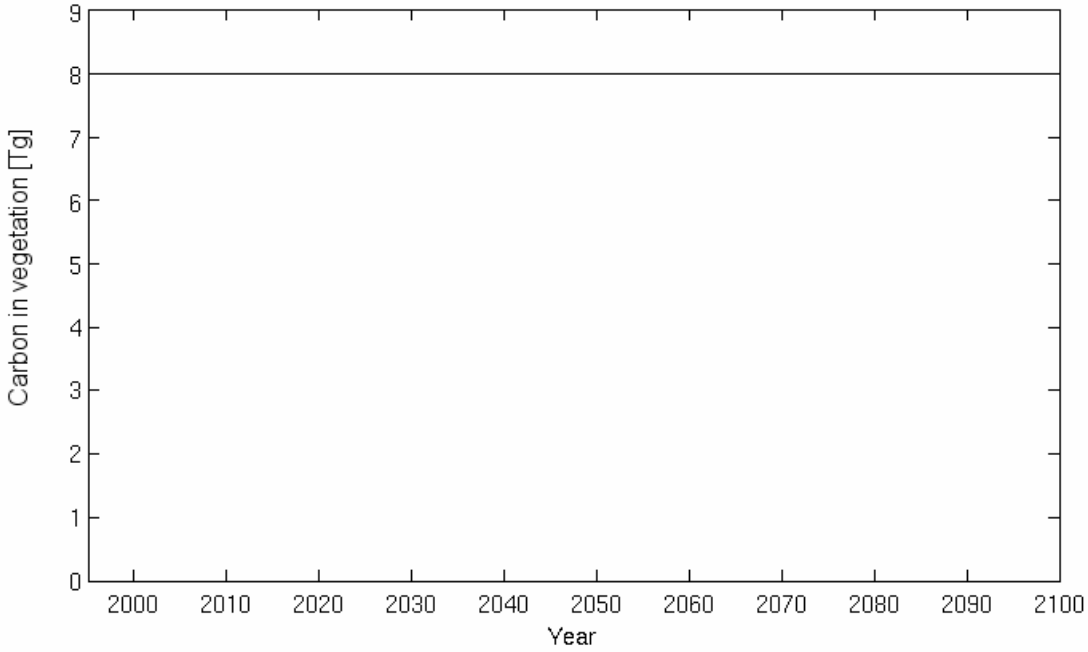
Clearing of forest, no forest regrowth. 50 km2 cleared every year between 2001 and 2010.

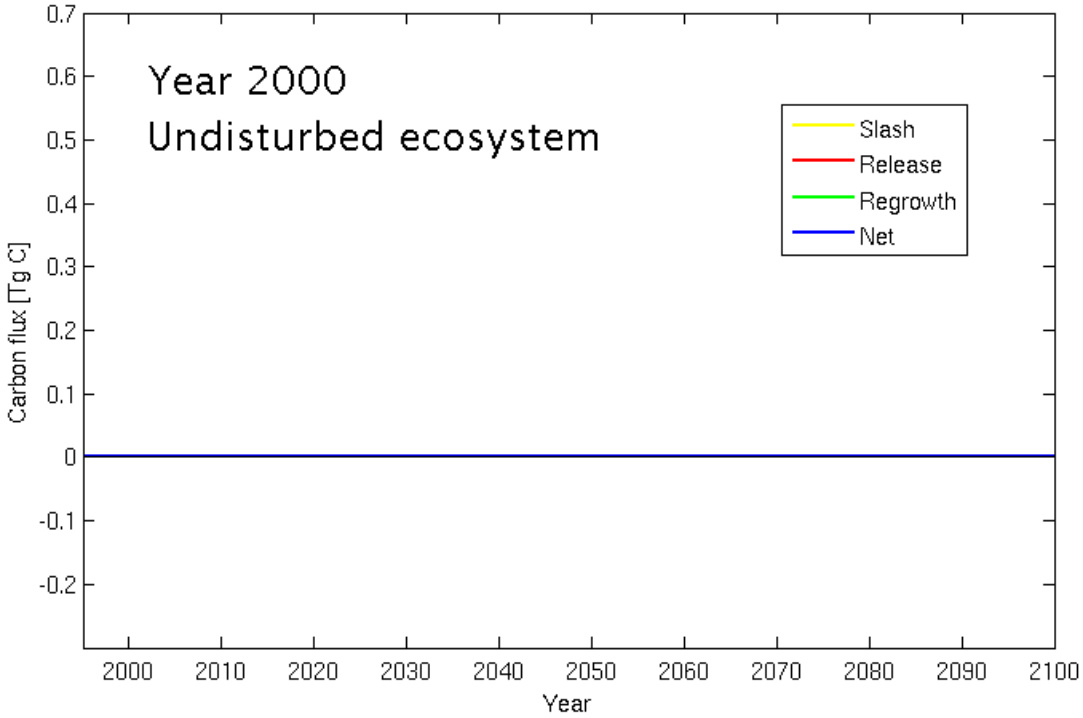




Animation 3: Event/disturbance

Harvest. Forest replanted after harvest. 50 km2 harvested annually 2001-2010.

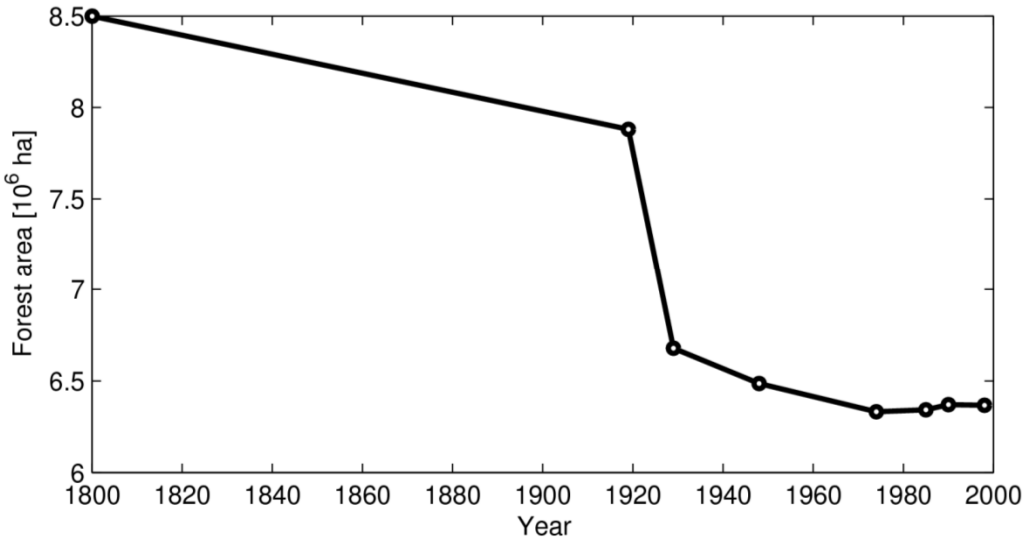


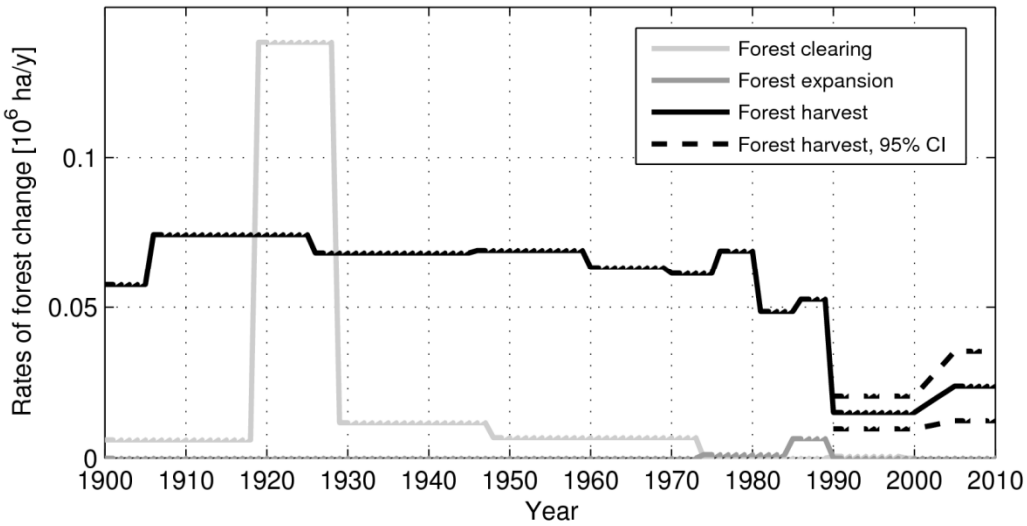


Romania

Historical and Current Land Use

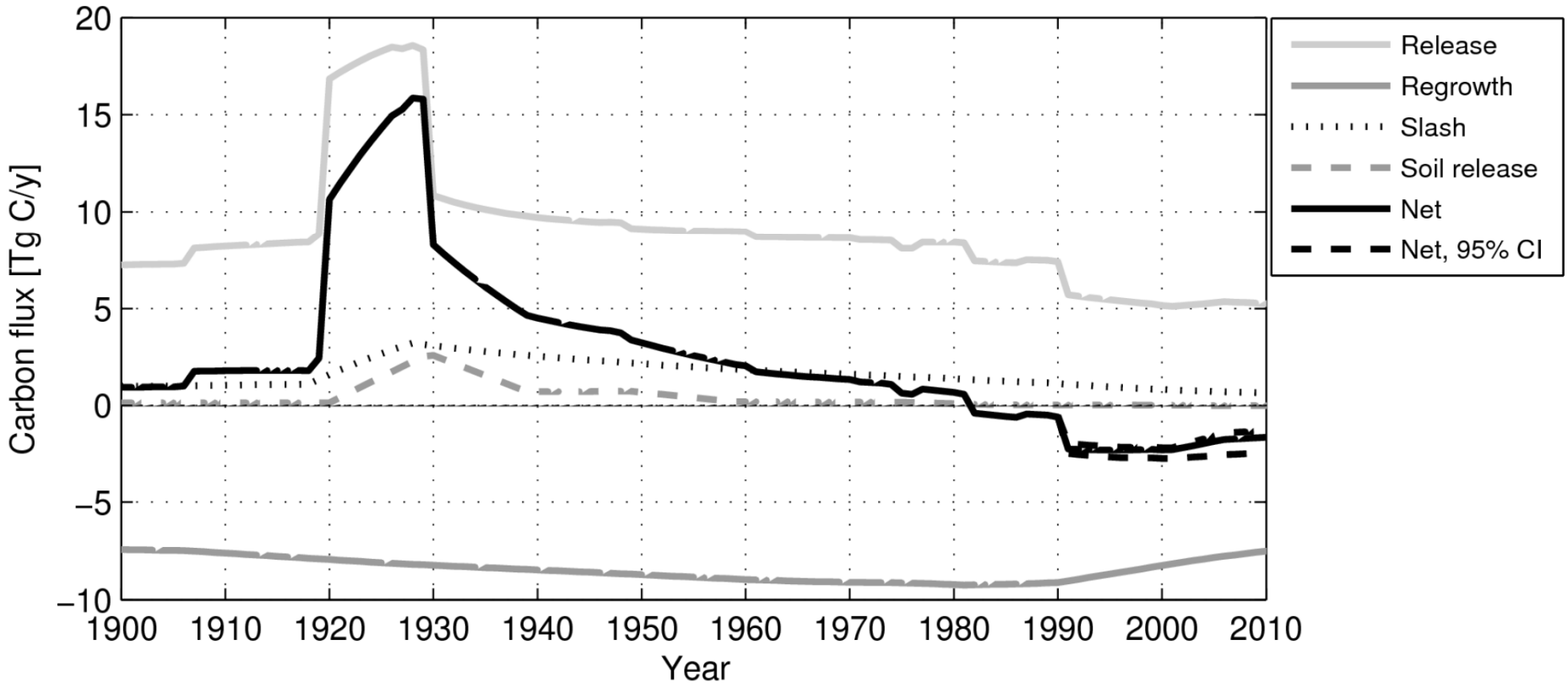
- Historical rates from records of forestry statistics
- Areas of stable and changing forest 1990-2000, and 2005-2010 mapped using Landsat data
- Vast areas of forest converted to farmlands historically
- Harvest rate dropped dramatically after collapse of Soviet Union
- But 60% harvest increase from 1990-2000 to 2005-2010





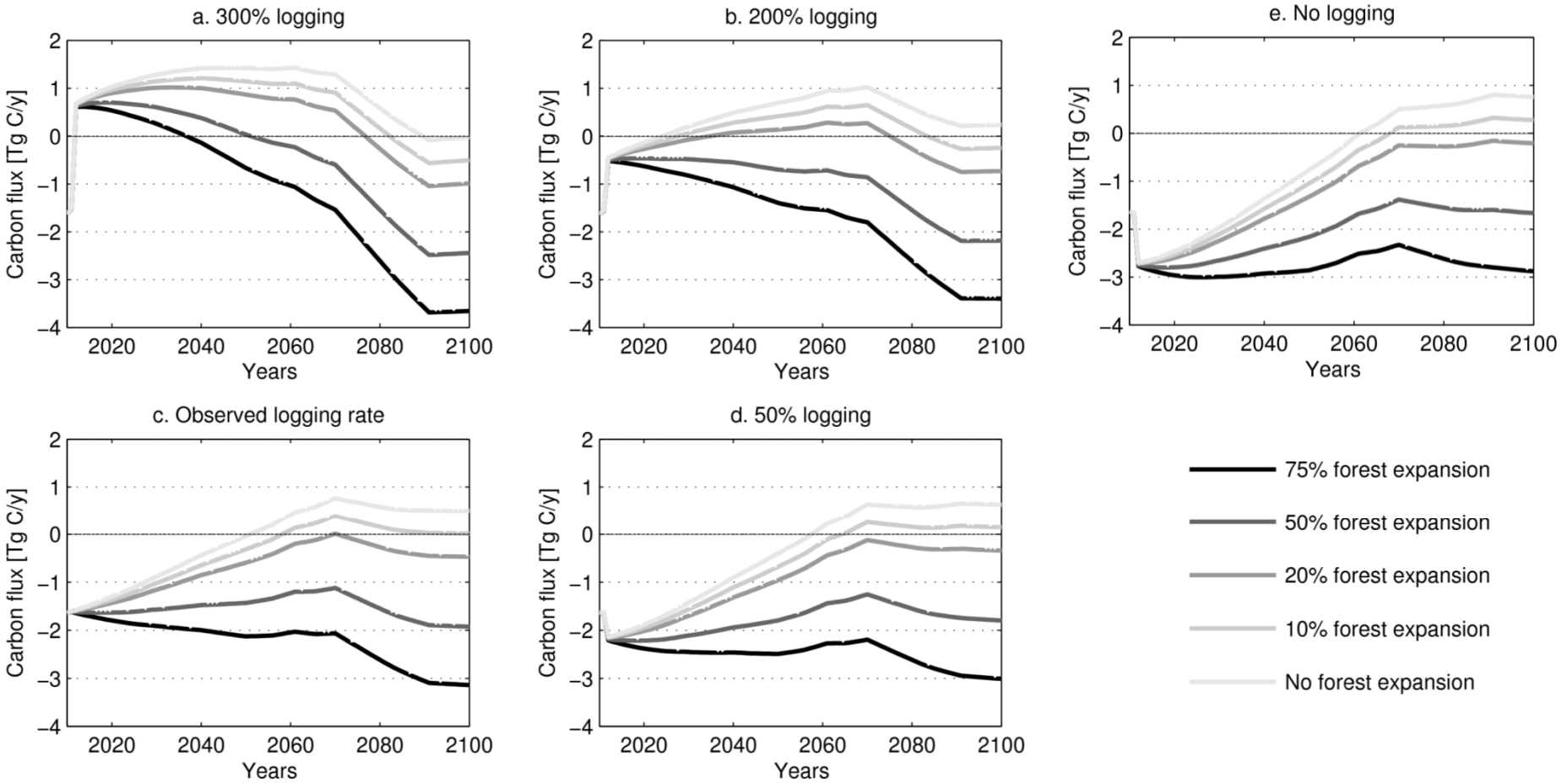
Carbon Fluxes

- Carbon book-keeping model run using historical and current rates of forest loss, gain and harvest
- Carbon implications of restitution small compared to terrestrial emissions from logging during 60s and 70s



Future Carbon Fluxes

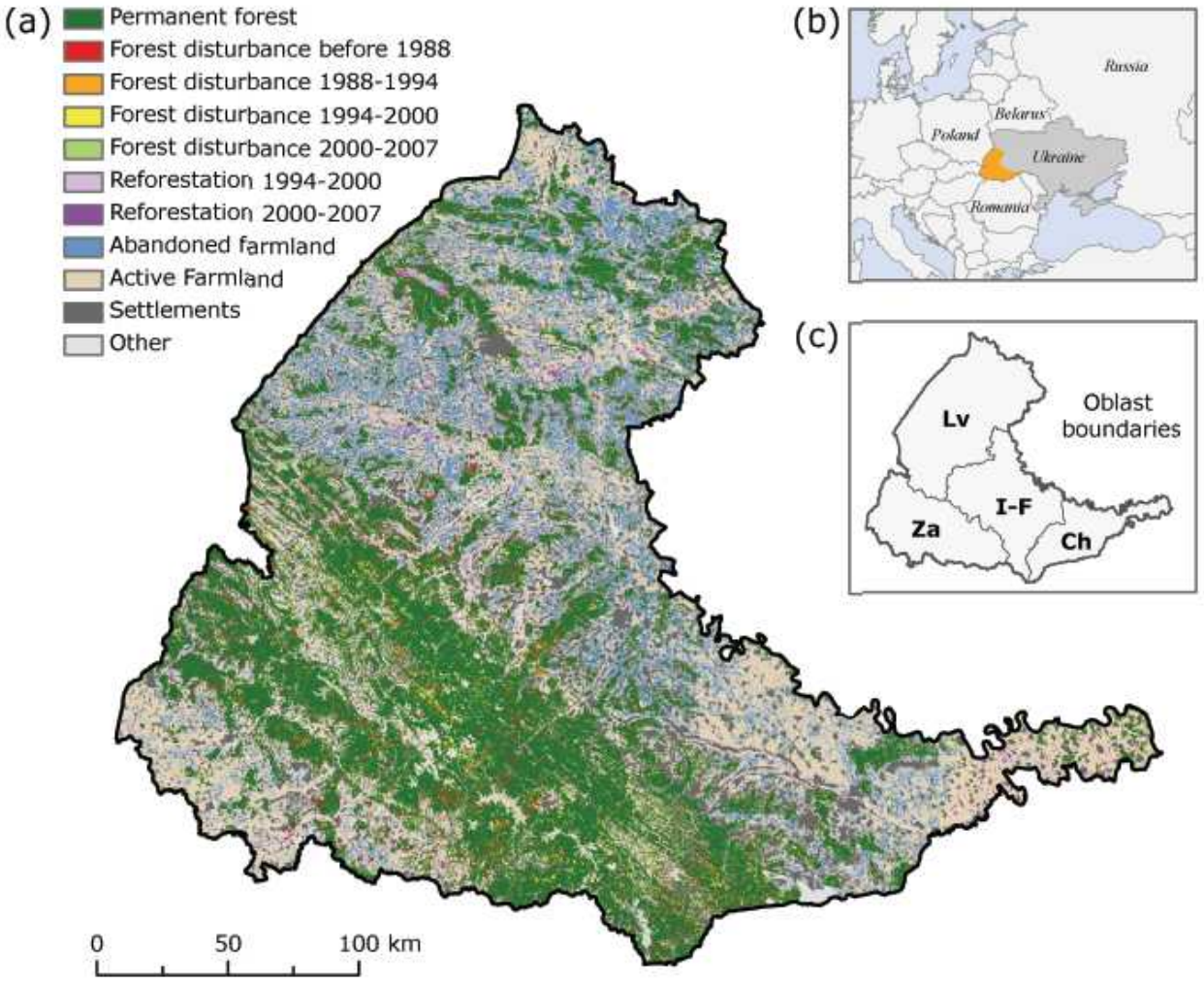
- Model run for future scenarios based on current logging rate and regrowth of forest on current abandoned or fallow farmland (2.9 million ha)

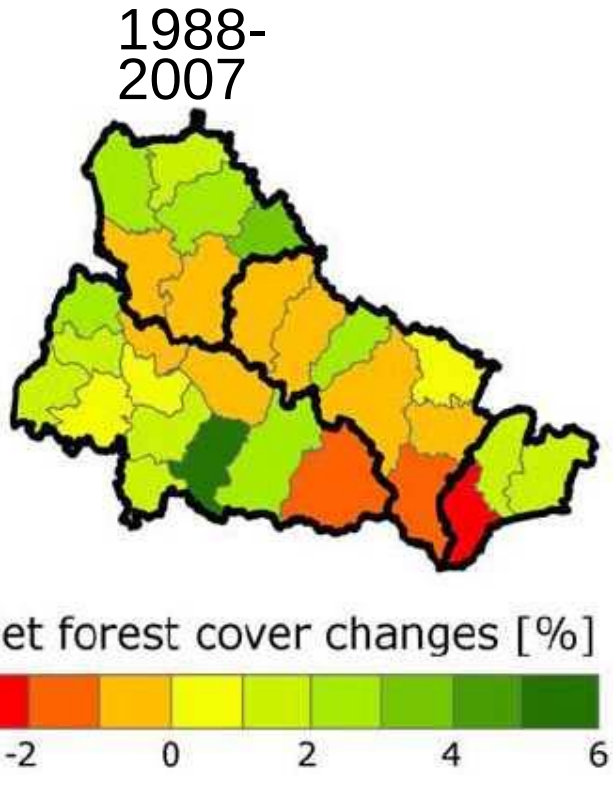


Ukraine

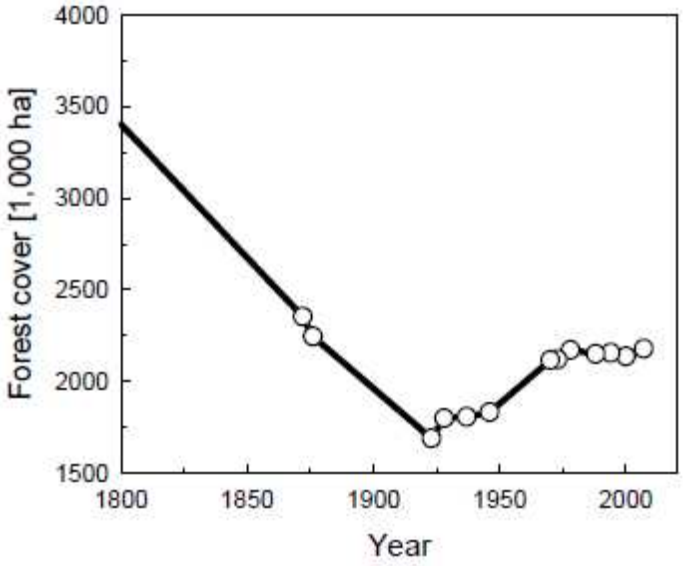
Kuemmerle, T., Olofsson, P et al. (2011) *Global Change Biology*, 17: 1335–1349

Changes in forest cover were mapped in a previous study (Kuemmerle, T., et al., Forest cover change..., *Remote Sensing of Environment* (2009), doi:10.1016/j.rse.2009.02.006)

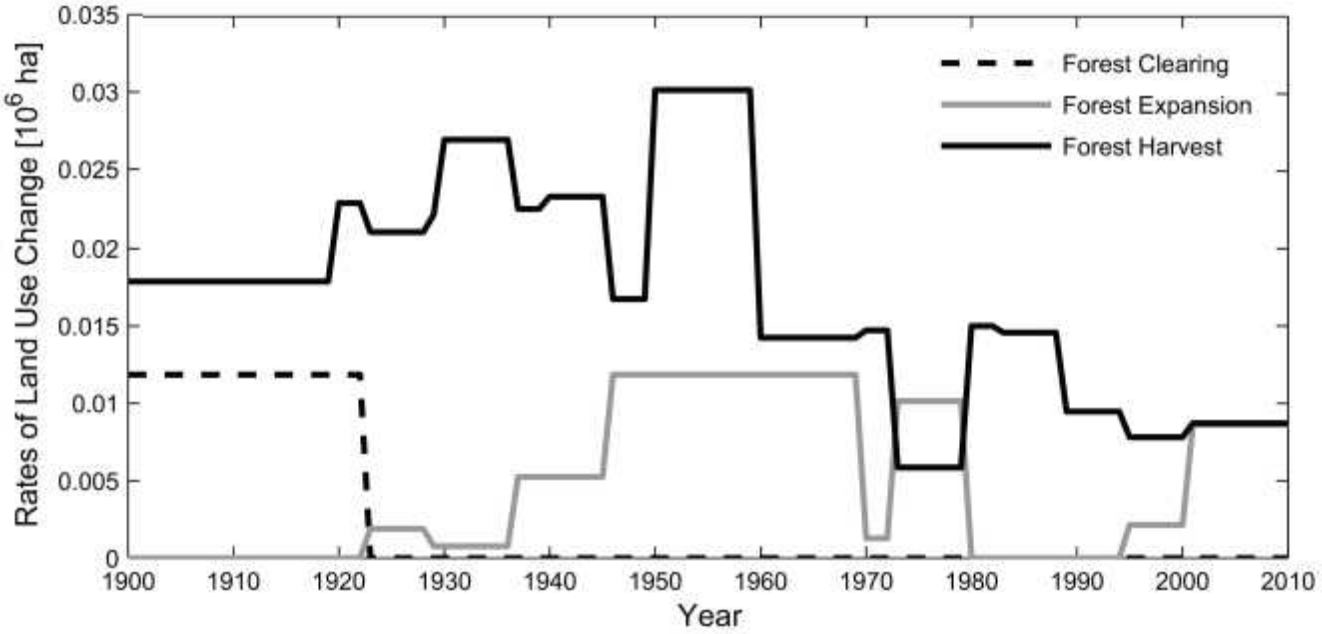




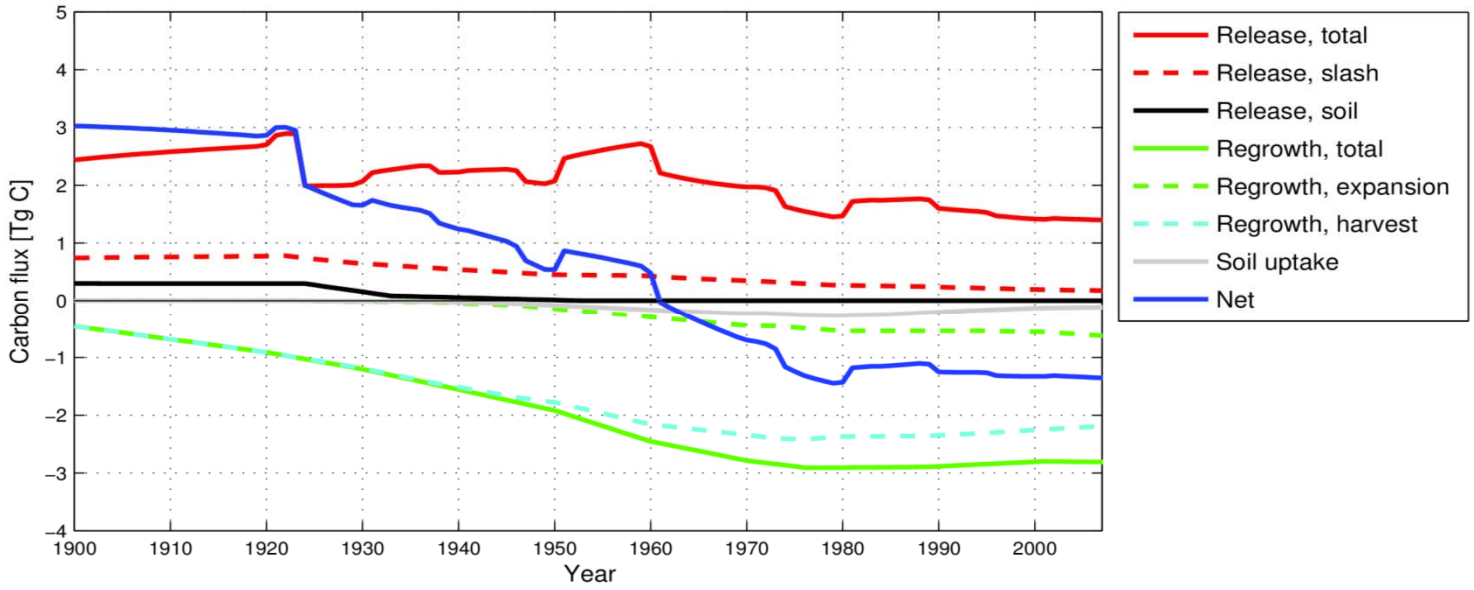
Historical total forest cover



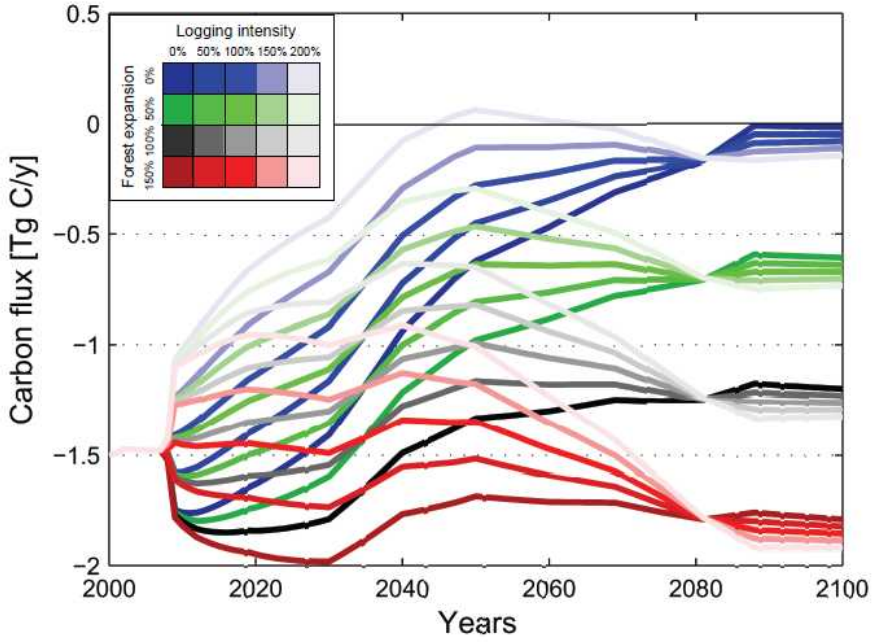
Estimated land use change rates from 1900



Carbon fluxes modeled using observed rates of land use change



Net flux under different scenarios

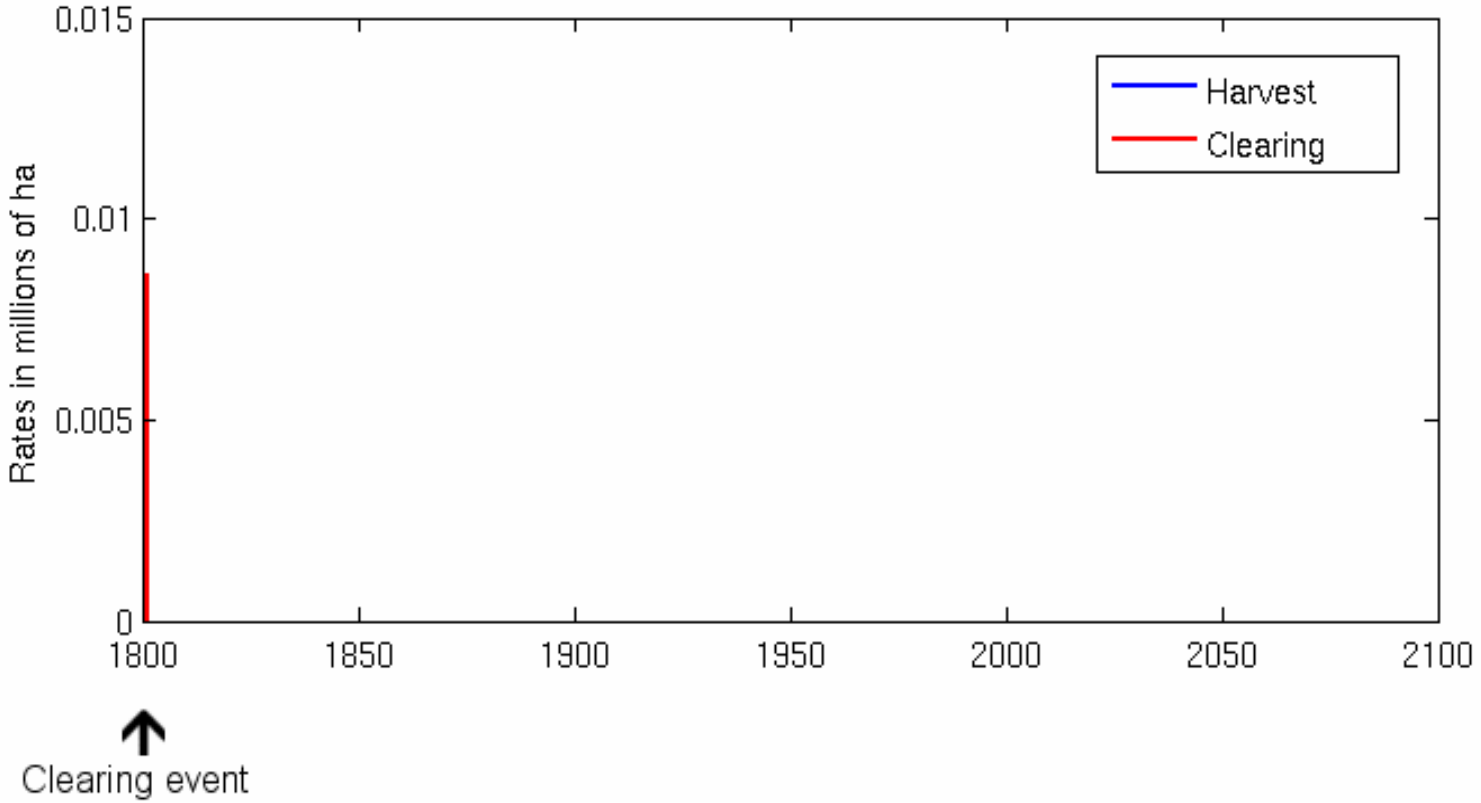


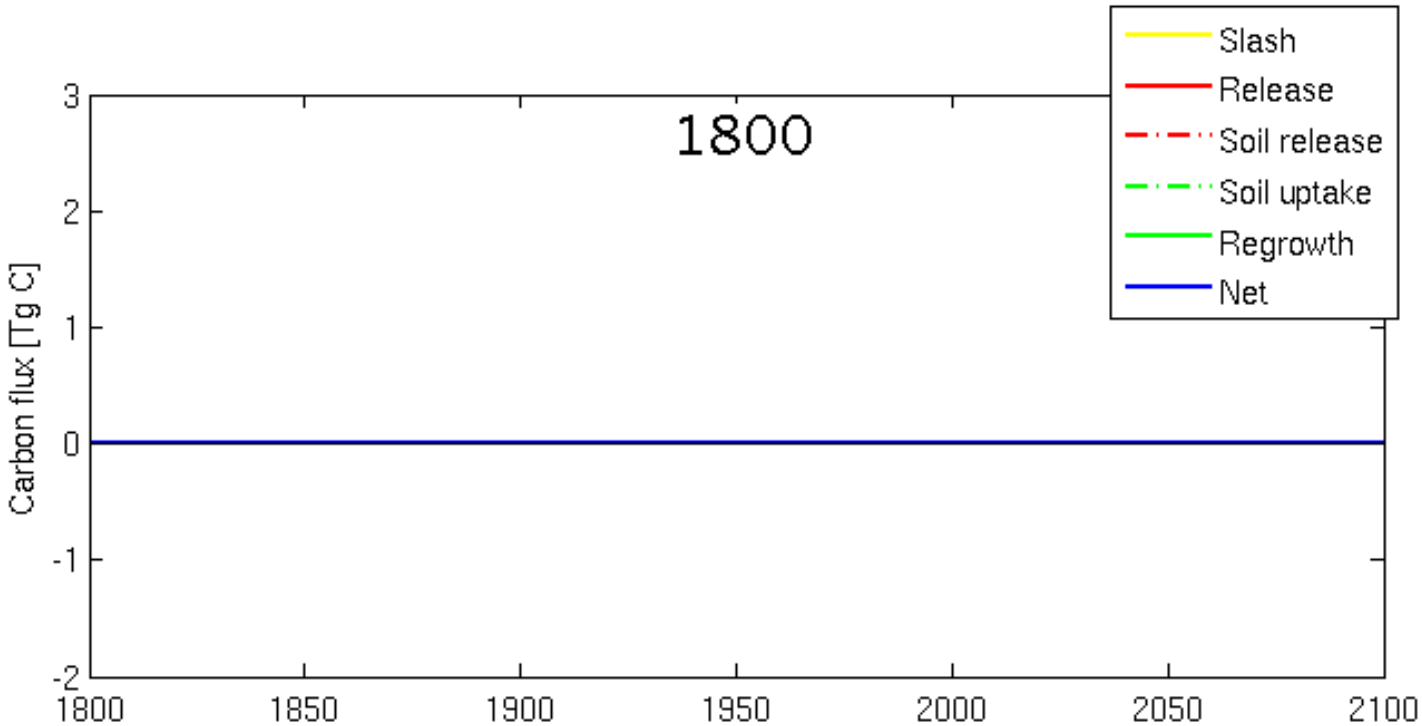
Conclusions: Ukraine

- Widespread change in forest cover 1988-2007
- Unsustainable logging (but probably no deforestation)
- Natural reforestation on abandoned farmland
- Slight net increase in forest cover 1988-2007
- Carbon sink now and in the future

Animation 4:
Example from Georgia

Forest clearing, afforestation and harvest from 1800 to 2100

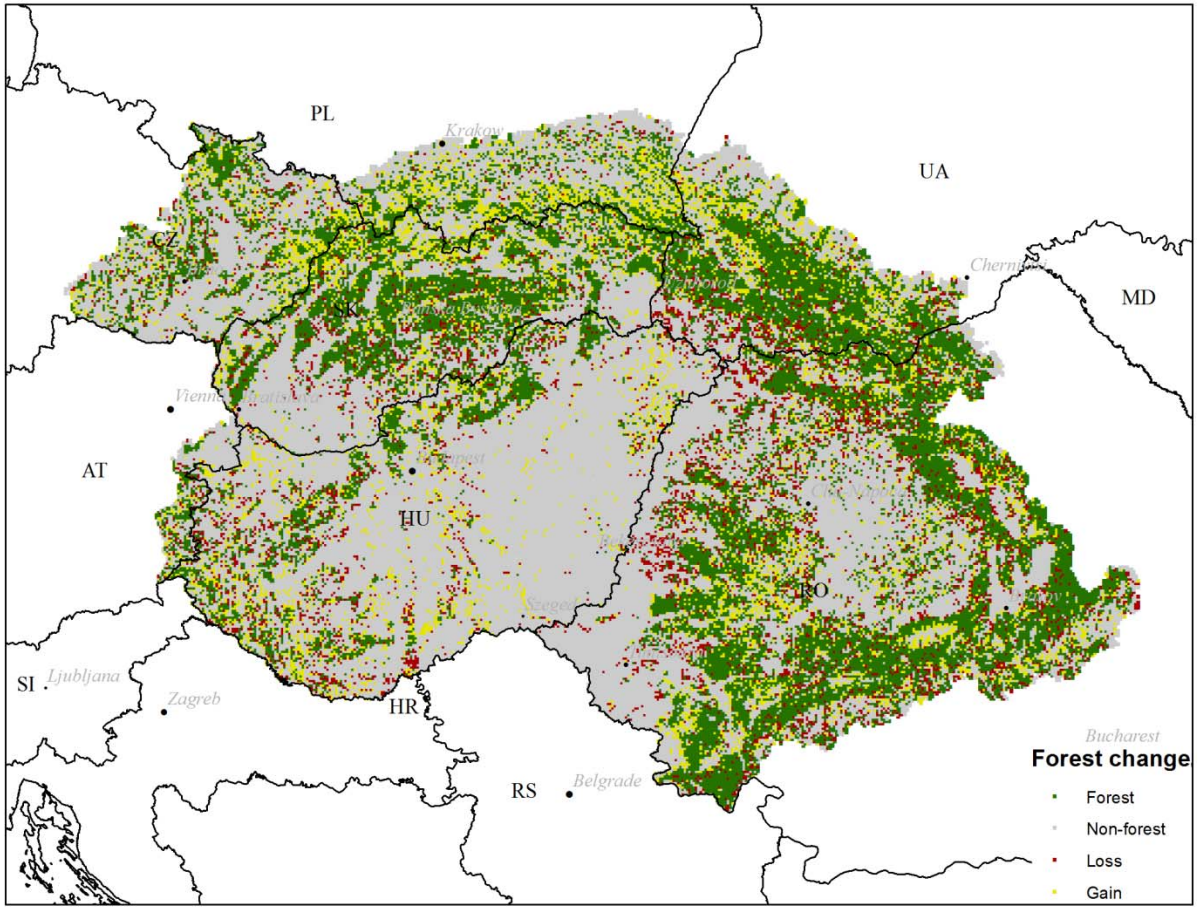


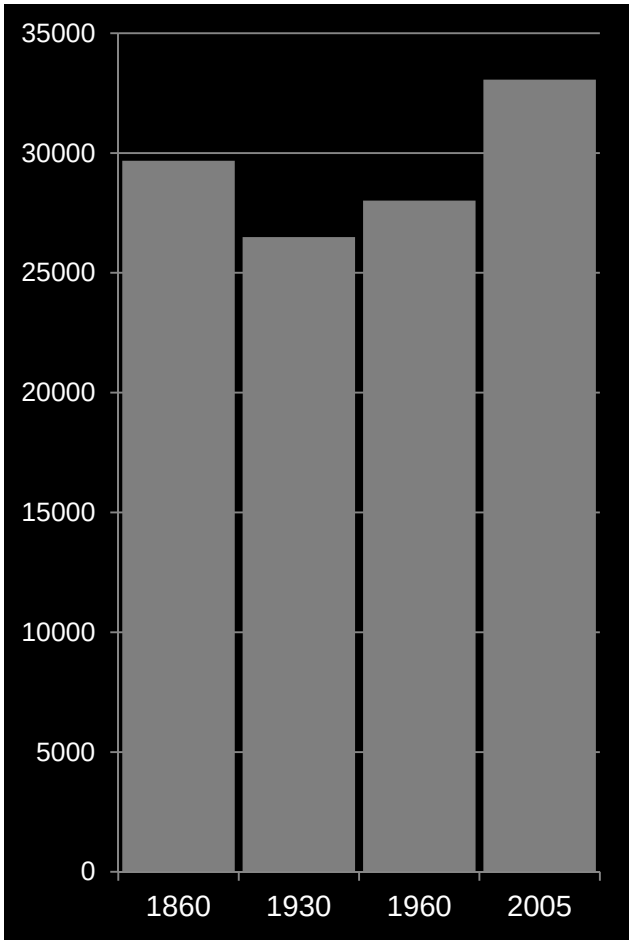


Future

- Include large area agricultural land abandonment rates into this analysis
- Carpathian Basin 200-year change maps – can we move to spatial version of carbon accounting?
- Will the abandoned lands continue to be left out of production?
- Past is important but the future is important too: i.e. EU policies and implications for carbon?

Forests - 1860 to 2005





Forest transition in the 1930s

- Habsburg management and War, agricultural expansion
- Abandonment of marginal areas, reforestation plans

Thank you

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