

# Land Cover and Land Use Change in Temperate Europe

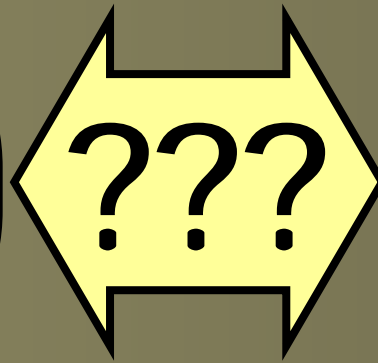


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# Introduction

People



Environ-  
ment

# Introduction



People

Land  
use

Environ-  
ment

# Introduction



The diagram consists of three overlapping rounded rectangular ovals arranged horizontally. The leftmost oval is red with a light blue border and contains the text 'People'. The middle oval is yellow with a light blue border and contains the text 'Land use'. The rightmost oval is green with a black border and contains the text 'Environment'. The ovals overlap in the center, with the 'Land use' oval overlapping both the 'People' and 'Environment' ovals.

People

Land  
use

Environ-  
ment

# Introduction

People

Land  
use

Environ-  
ment

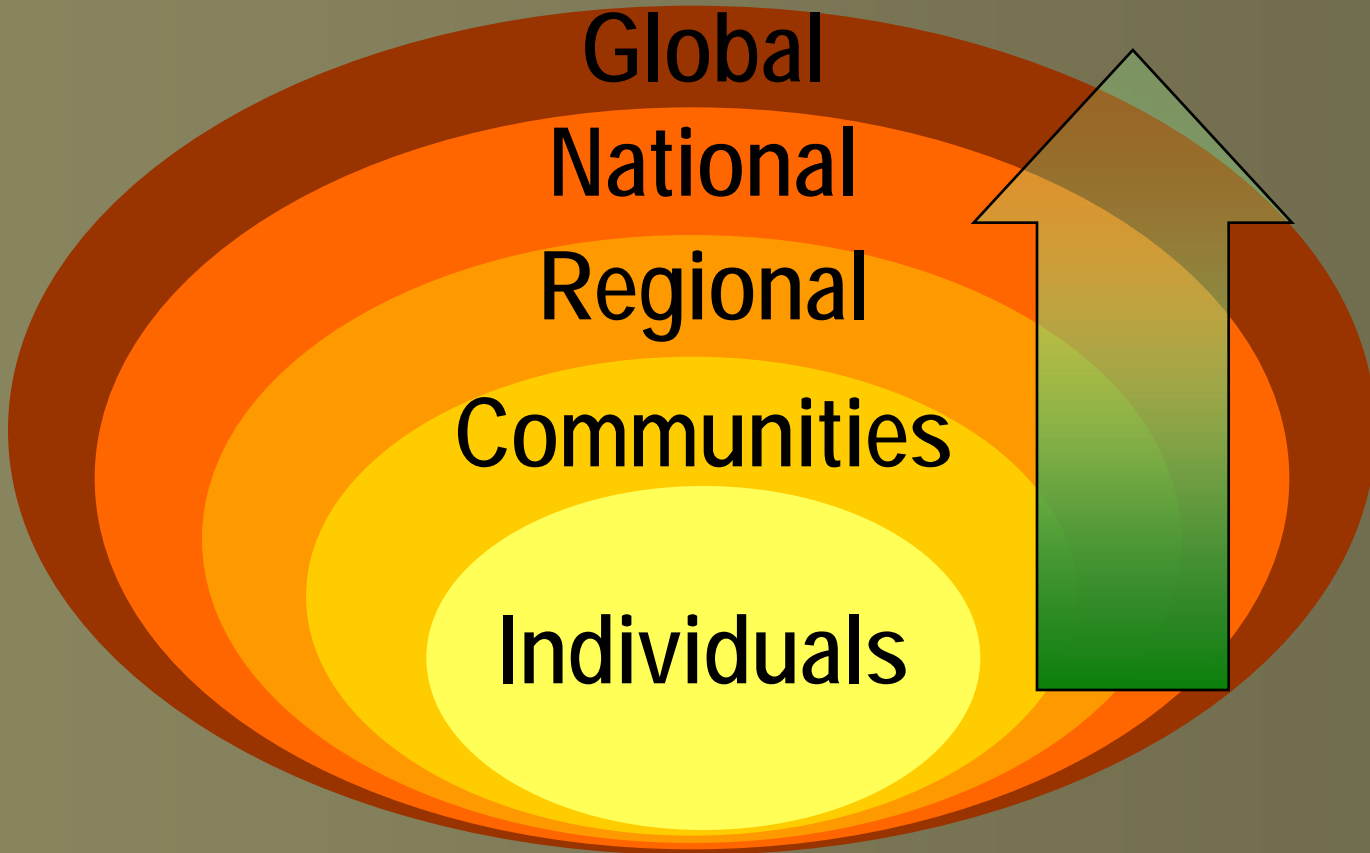


# Introduction

People

Land  
use

Environ-  
ment

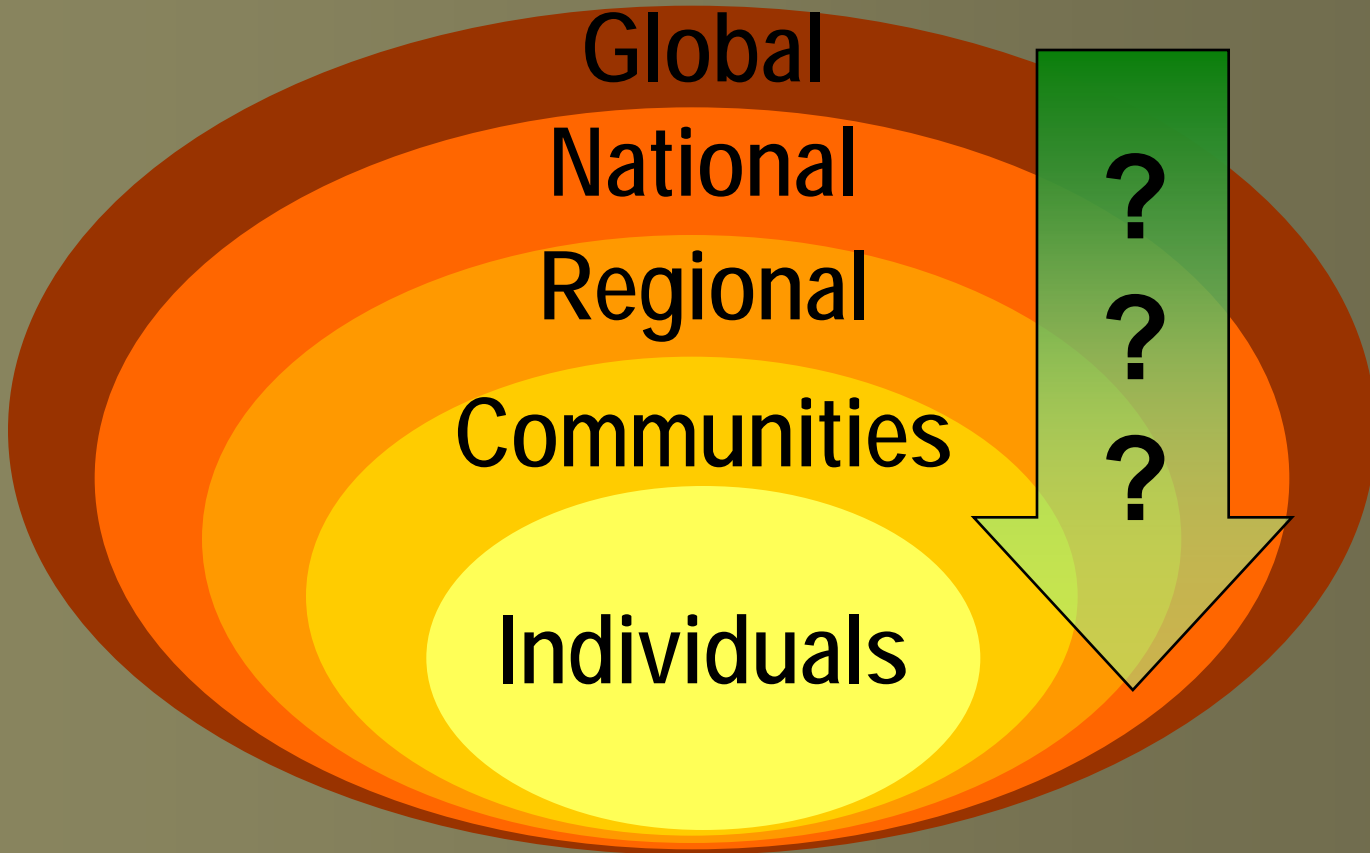


# Introduction

People

Land  
use

Environ-  
ment



# Introduction

People

Land  
use

Environ-  
ment

***1. How much do  
broad-scale drivers  
affect land use?***



# Introduction



The diagram consists of three overlapping rounded rectangular boxes arranged horizontally. The leftmost box is red and labeled 'People'. The middle box is yellow and labeled 'Land use'. The rightmost box is green and labeled 'Environment'. The boxes overlap in the center, with the yellow box being the most prominent in the middle. The entire diagram is set against a dark olive green background.

People

Land  
use

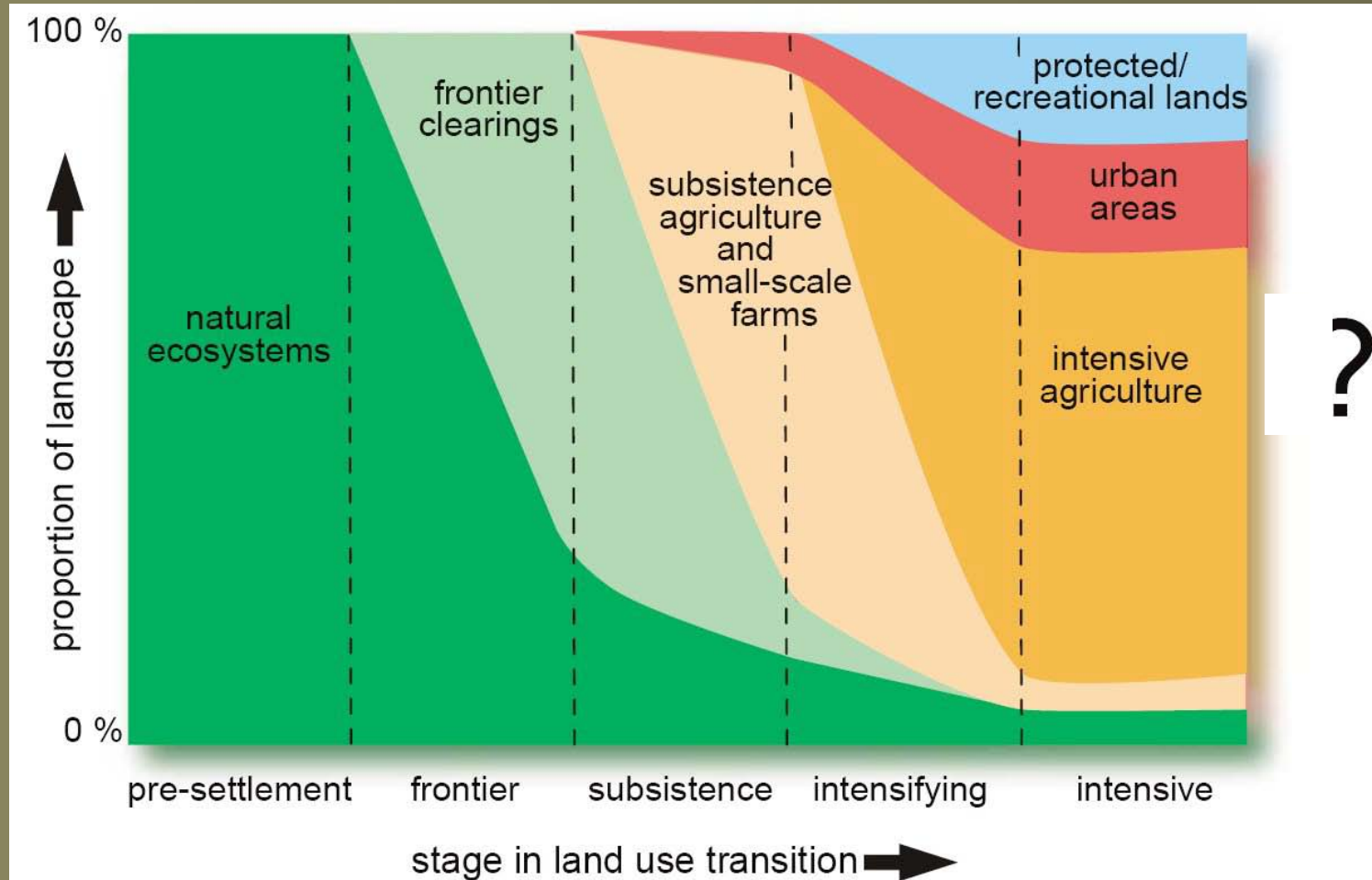
Environ-  
ment

# Introduction

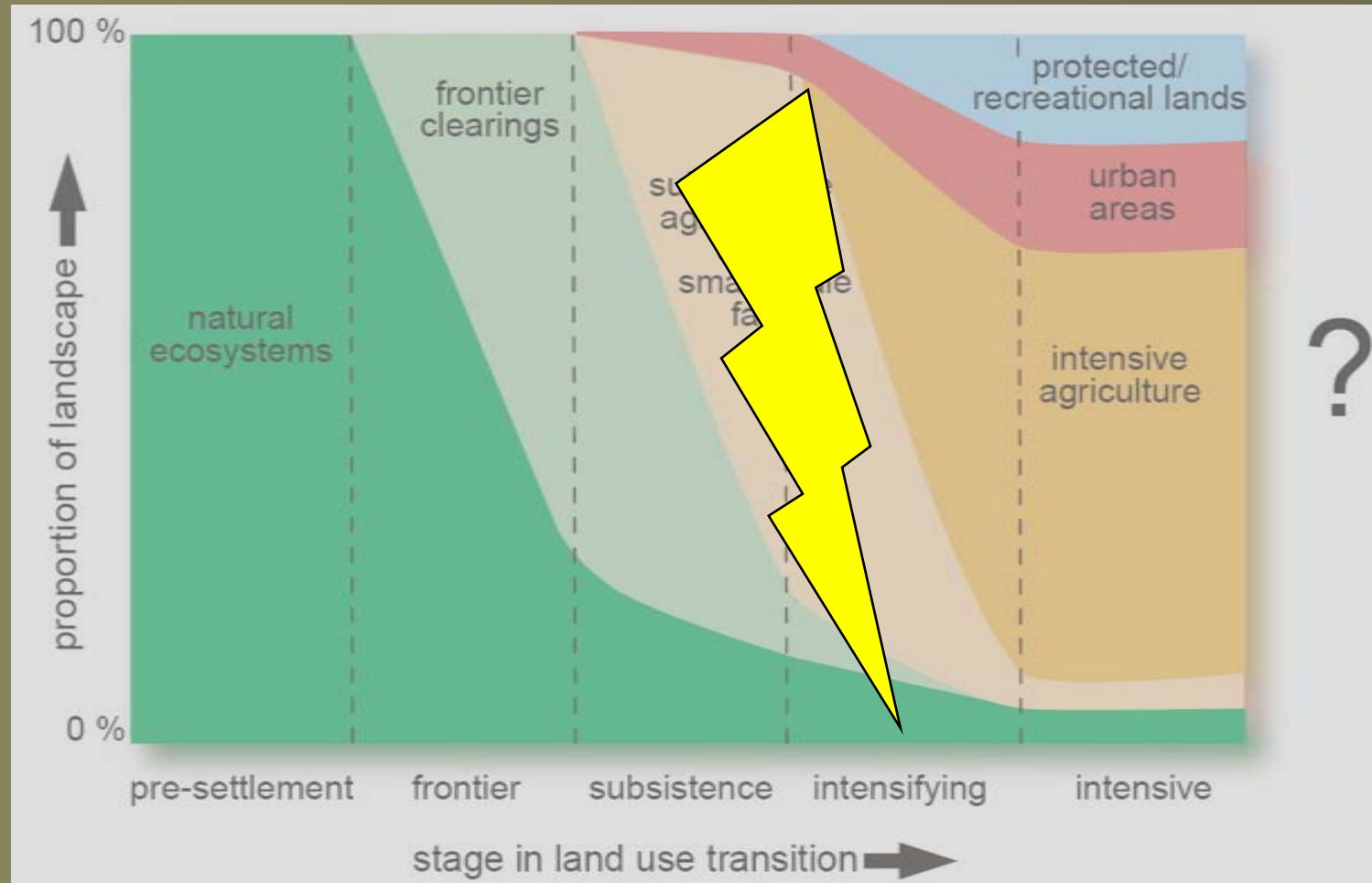
People

Land  
use

Environ-  
ment



# Introduction



# Introduction

People

Land  
use

Environ-  
ment

***2. How does disturbance  
affect land use?***

# Introduction



A diagram consisting of three overlapping rounded rectangular boxes arranged horizontally. The leftmost box is dark red with a thick black border and contains the word 'People'. The middle box is yellow with a white border and contains the words 'Land use'. The rightmost box is green with a white border and contains the words 'Environ-ment'. The boxes overlap in the center, with the 'Land use' box overlapping the 'People' box on its left and the 'Environ-ment' box on its right.

People

Land  
use

Environ-  
ment

# Introduction

People

Land  
use

Environ-  
ment



Bruegel, Pierre 1562

# Introduction

People

Land  
use

Environ-  
ment



Wenzel, Peter 1810

## *3. What happens to the environment when land use subsides?*



# Introduction

People

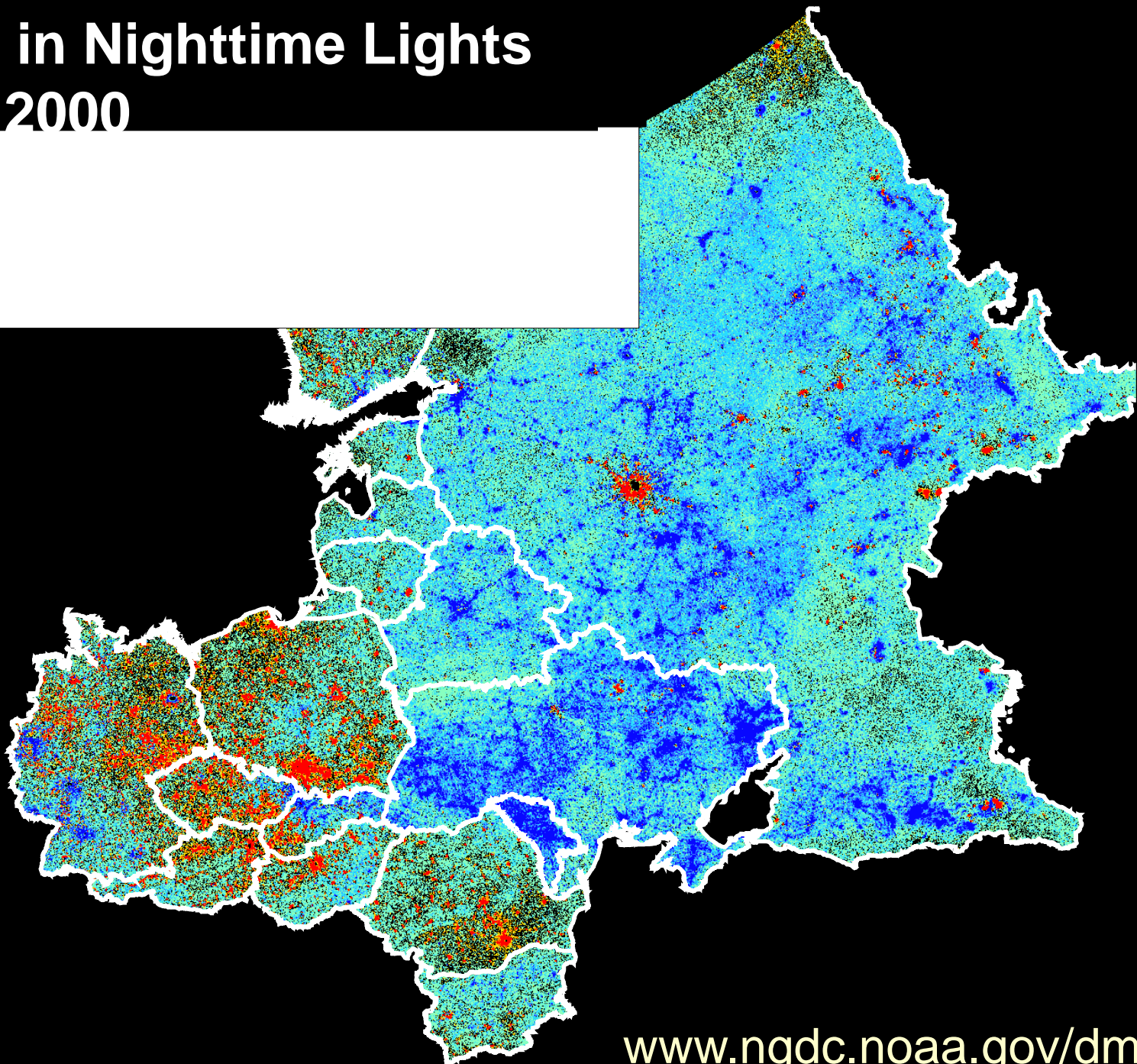
Land  
use

Environ-  
ment

- 1. Broad-scale drivers?***
- 2. Disturbance?***
- 3. Rewilding?***



# Change in Nighttime Lights 1992 to 2000



# Introduction

People

Land  
use

Environ-  
ment

*Eastern Europe  
provides a perfect  
'natural experiment'*

# Introduction

People

Land  
use

Environ-  
ment

- 1. Nations diverged*
- 2. Socioeconomic upheaval*
- 3. Land abandonment*

# Introduction

People

Land  
use

Environ-  
ment

- 1. Broad-scale drivers?***
- 2. Disturbance?***
- 3. Rewilding?***

# Introduction

People

Land  
use

Environ-  
ment

- 1. Broad-scale drivers?***
- 2. Disturbance?***
- 3. Rewilding?***



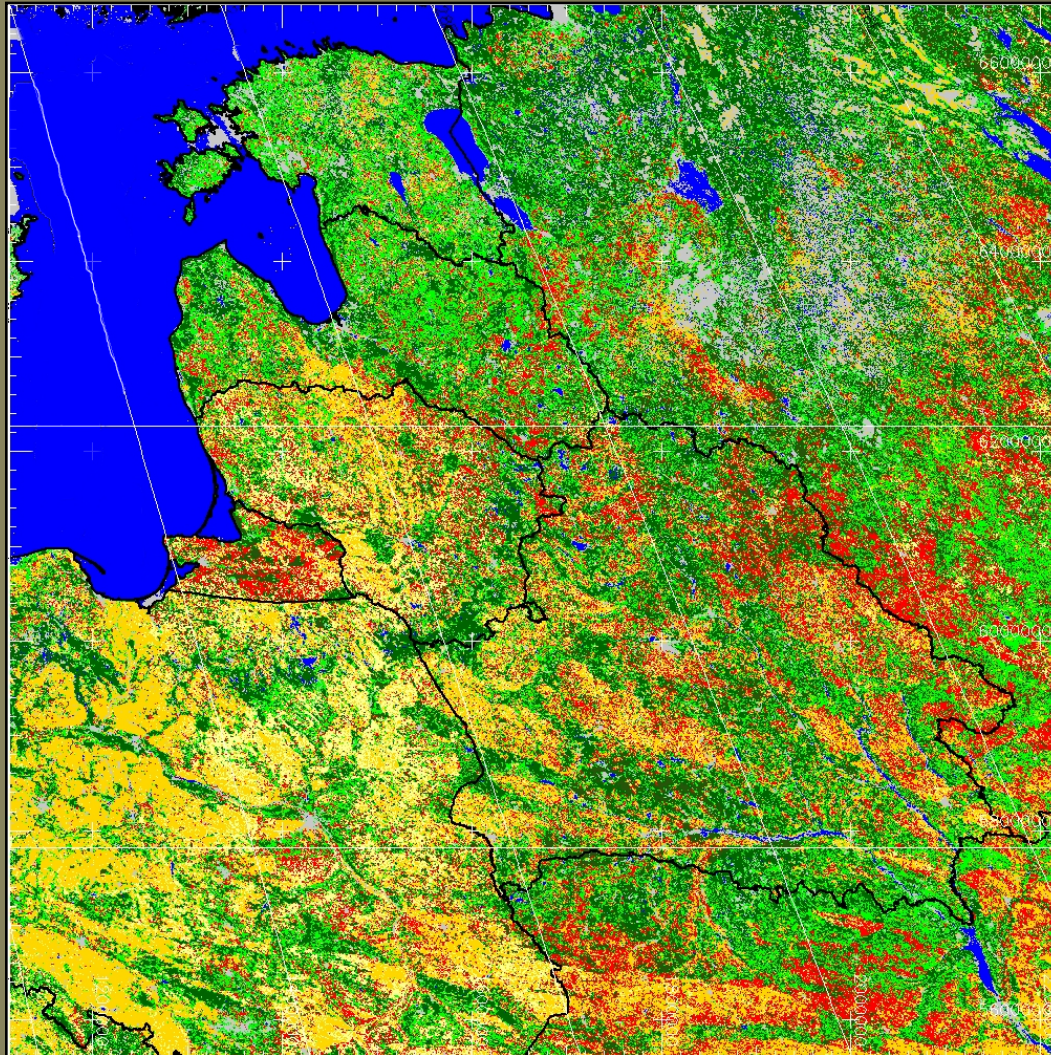


# 1. Broad-scale drivers

People

Land  
use

Environ-  
ment





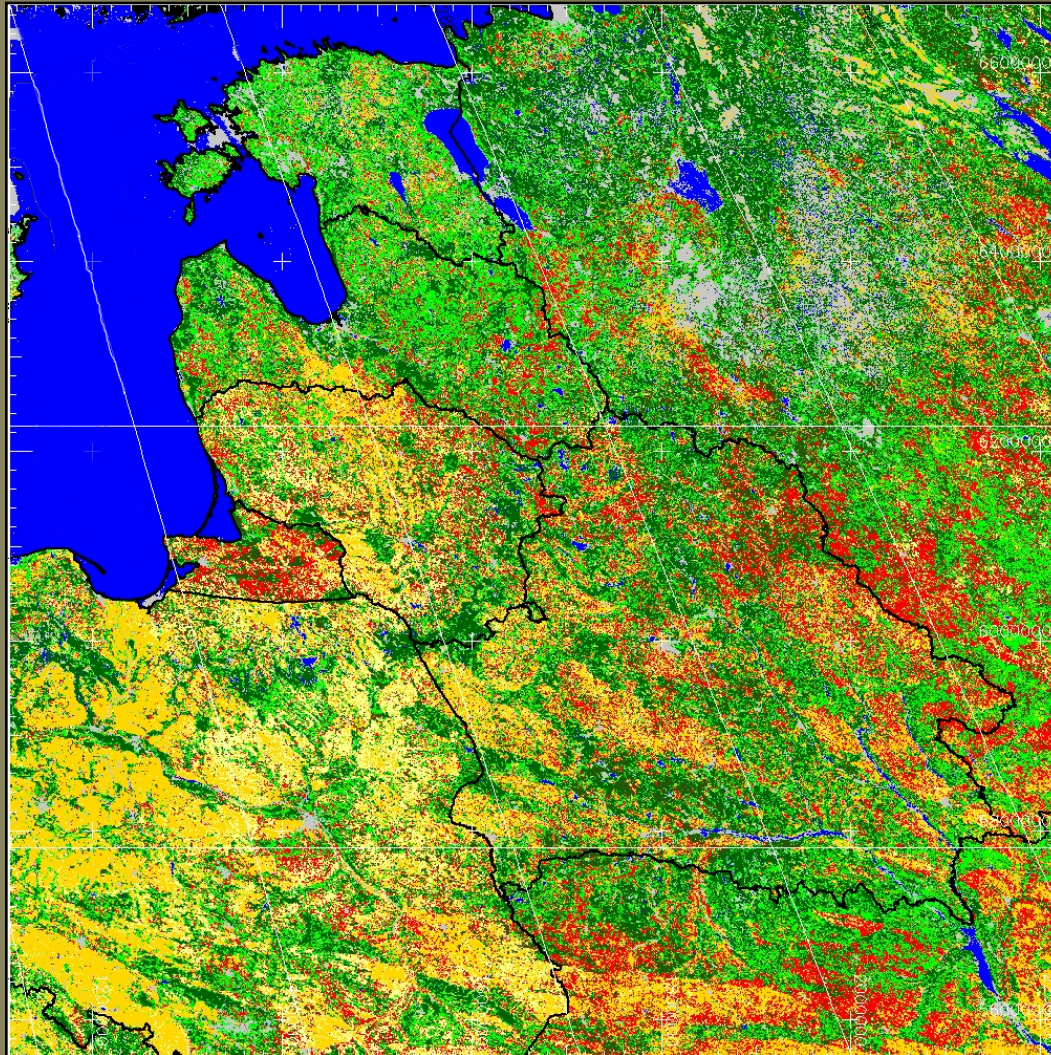


# 1. Broad-scale drivers

People

Land  
use

Environ-  
ment

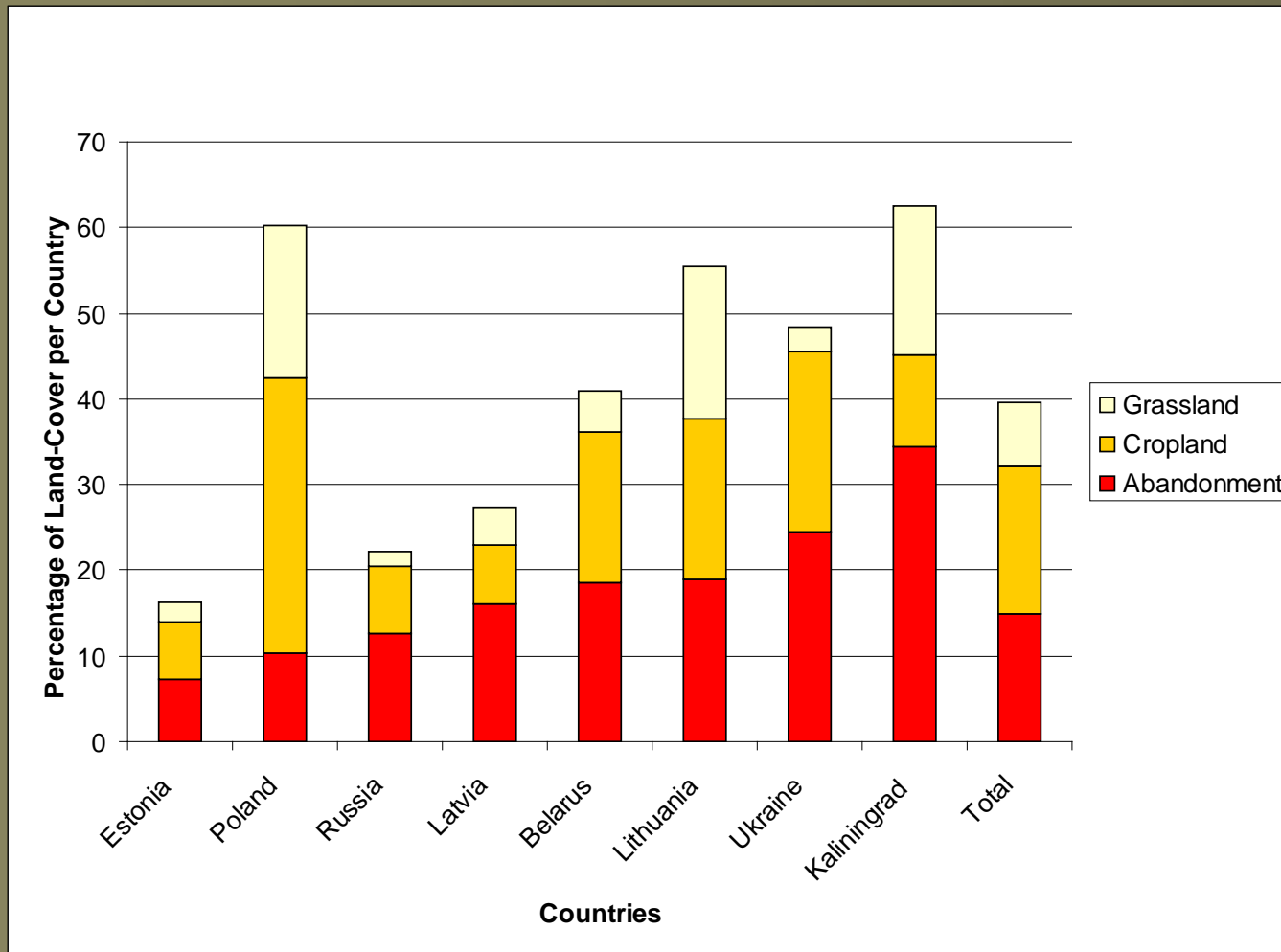


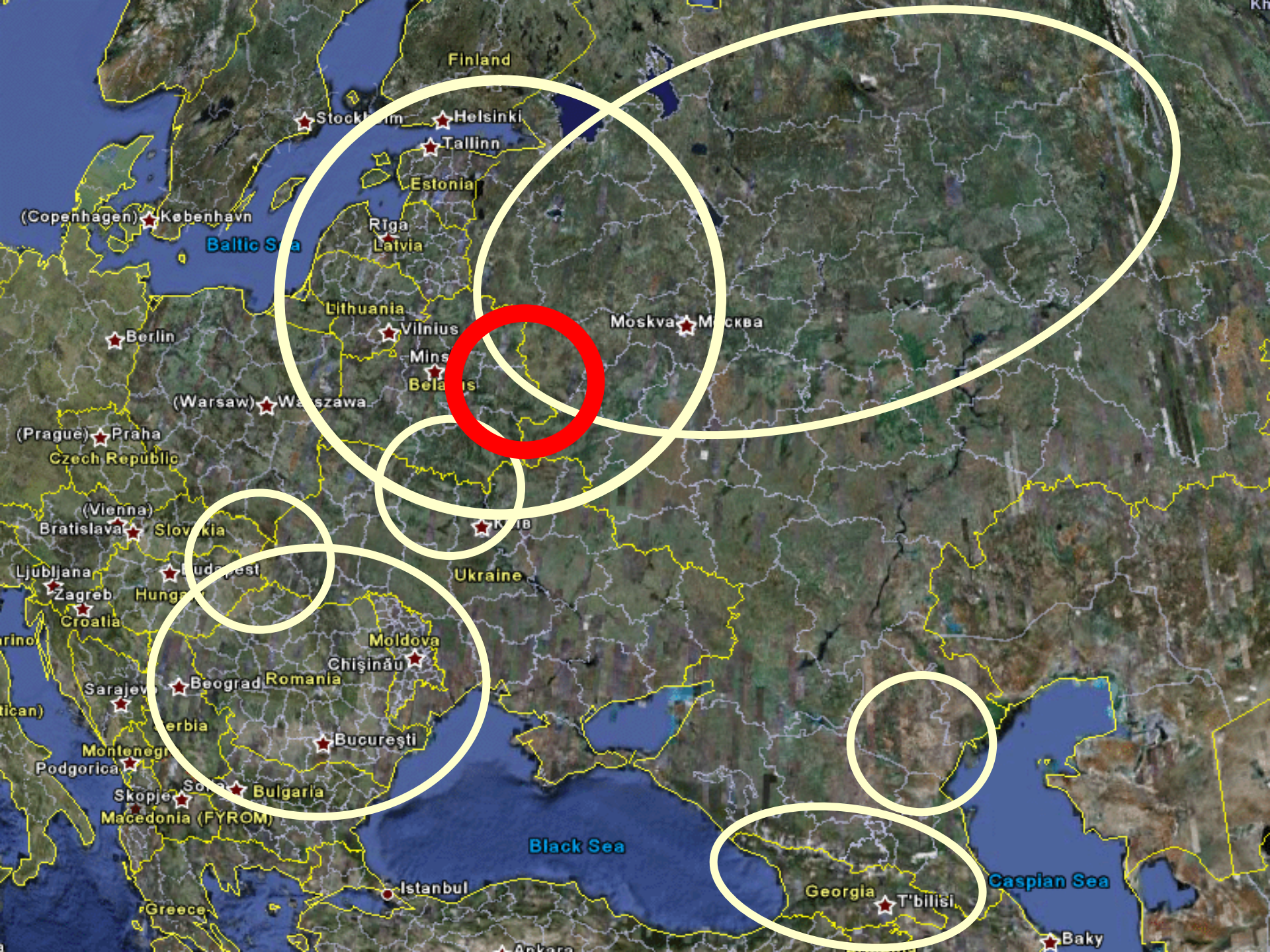
# 1. Broad-scale drivers

Humans

Land  
use

Environ-  
ment





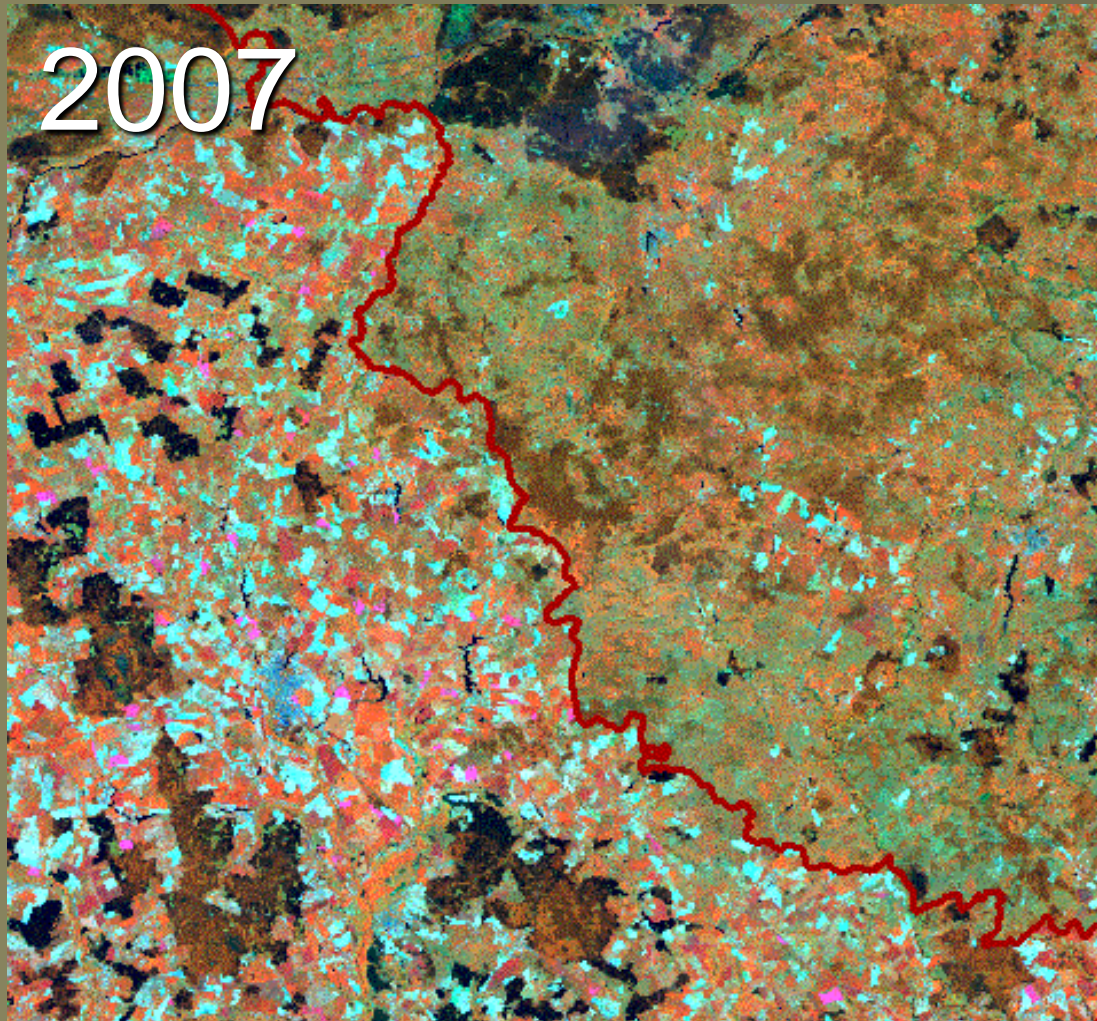
# 1. Broad-scale drivers

People

Land  
use

Environ-  
ment

2007



# 1. Broad-scale drivers

People

Land  
use

Environ-  
ment







Finland

Stockholm Helsinki

Tallinn

Estonia

Riga

Latvia

Baltic Sea

(Copenhagen) København

Lithuania

Vilnius

Moskva Москва

Minsk

Belarus

Berlin

(Warsaw) Warszawa

(Prague) Praha

Czech Republic

(Vienna)

Bratislava Slovakia

Ljubljana Budapest

Zagreb Hungary

Croatia

Ukraine

Moldova

Chişinău

Beograd Romania

Bucureşti

Sarajevo

Montenegro

Podgorica

Skopje

Serbia

Macedonia (FYROM)

Bulgaria

Black Sea

Istanbul

Georgia

T'bilisi

Caspian Sea

Baky

Greece

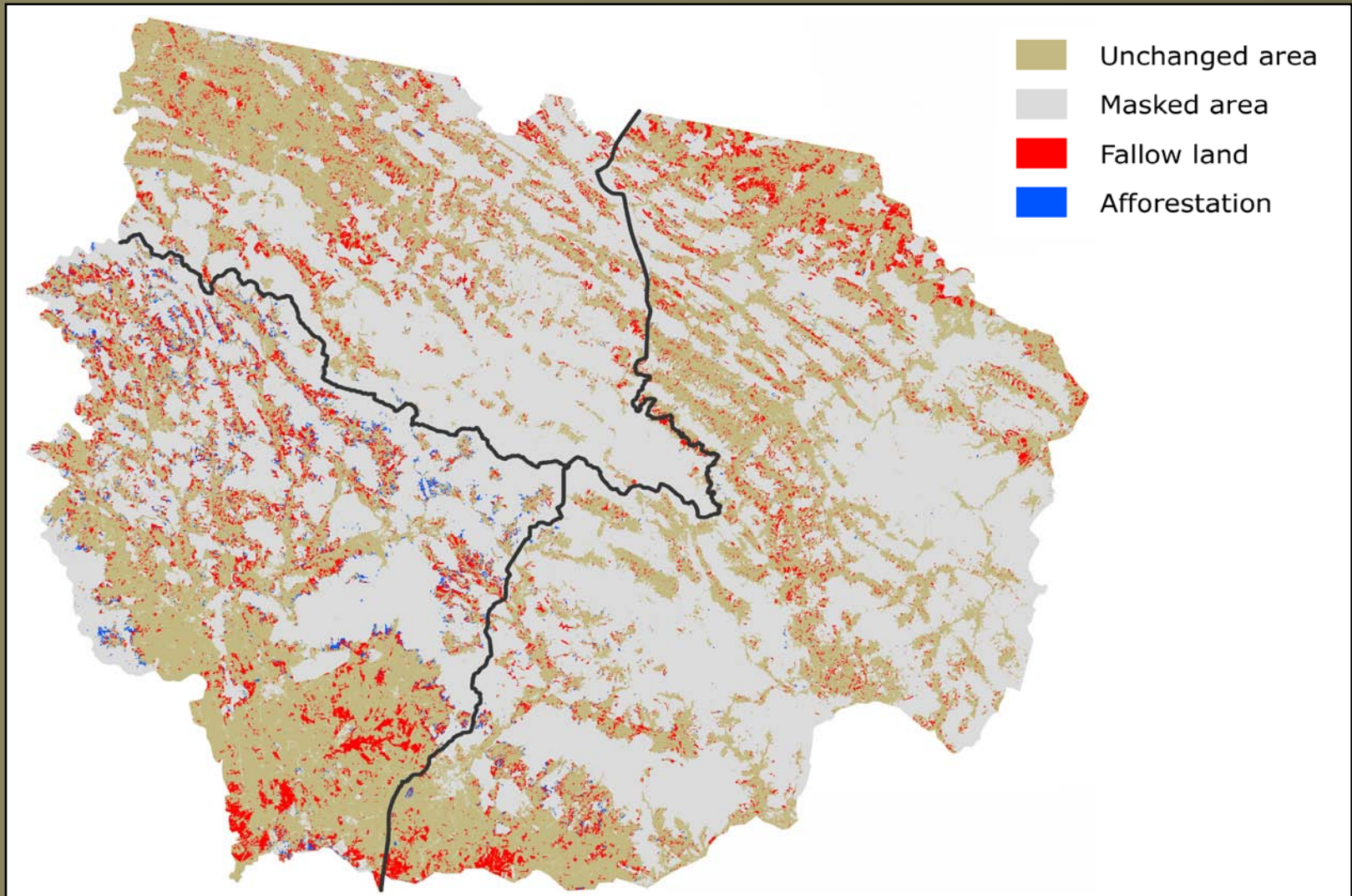
Ankara

# 1. Broad-scale drivers

People

Land  
use

Environ-  
ment

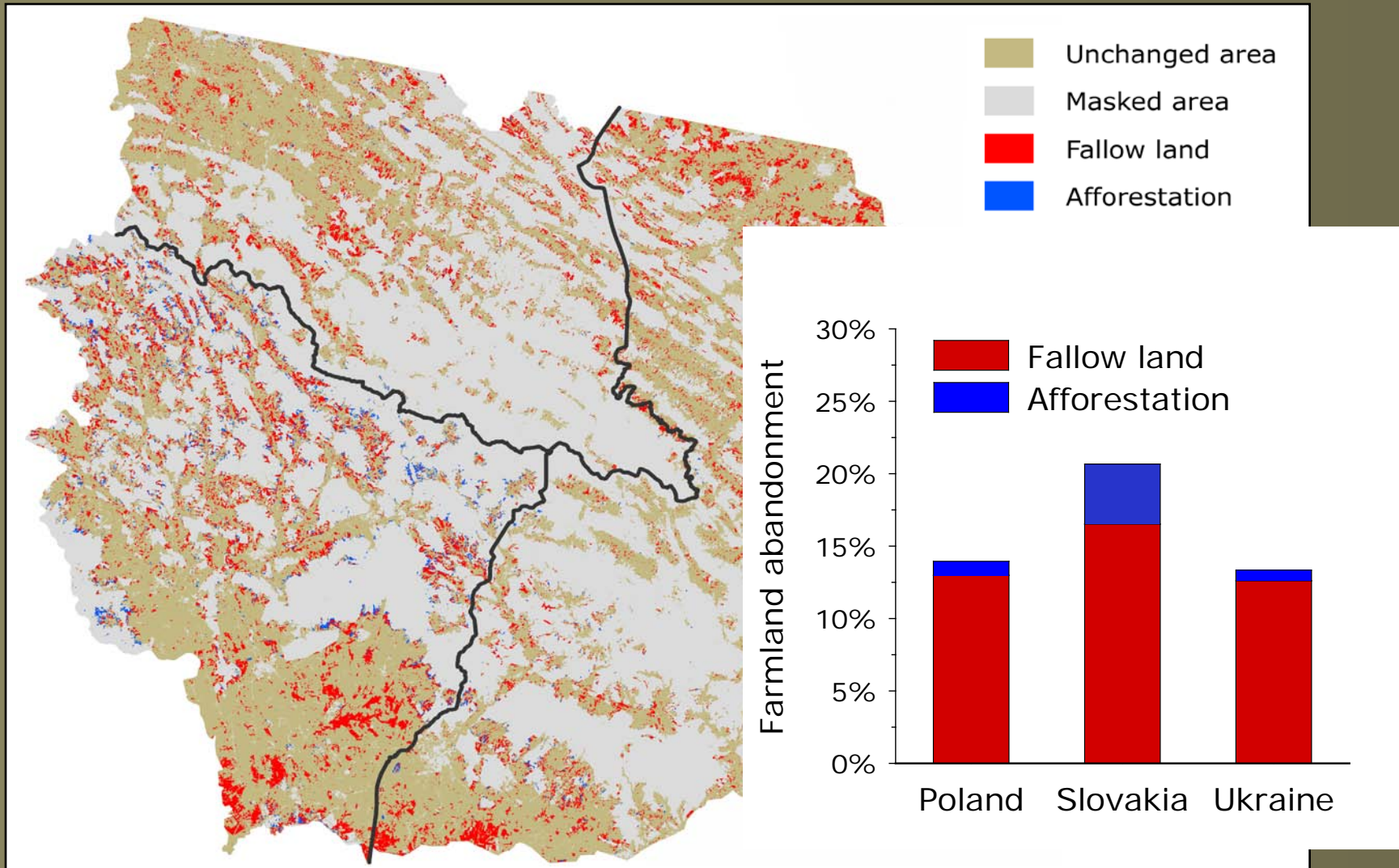


# 1. Broad-scale drivers

People

Land  
use

Environ-  
ment



# 1. Broad-scale drivers

People

Land  
use

Environ-  
ment



## 2. Disturbance

People

Land  
use

Environ-  
ment

**1. *Broad-scale drivers***

**2. *Disturbance?***

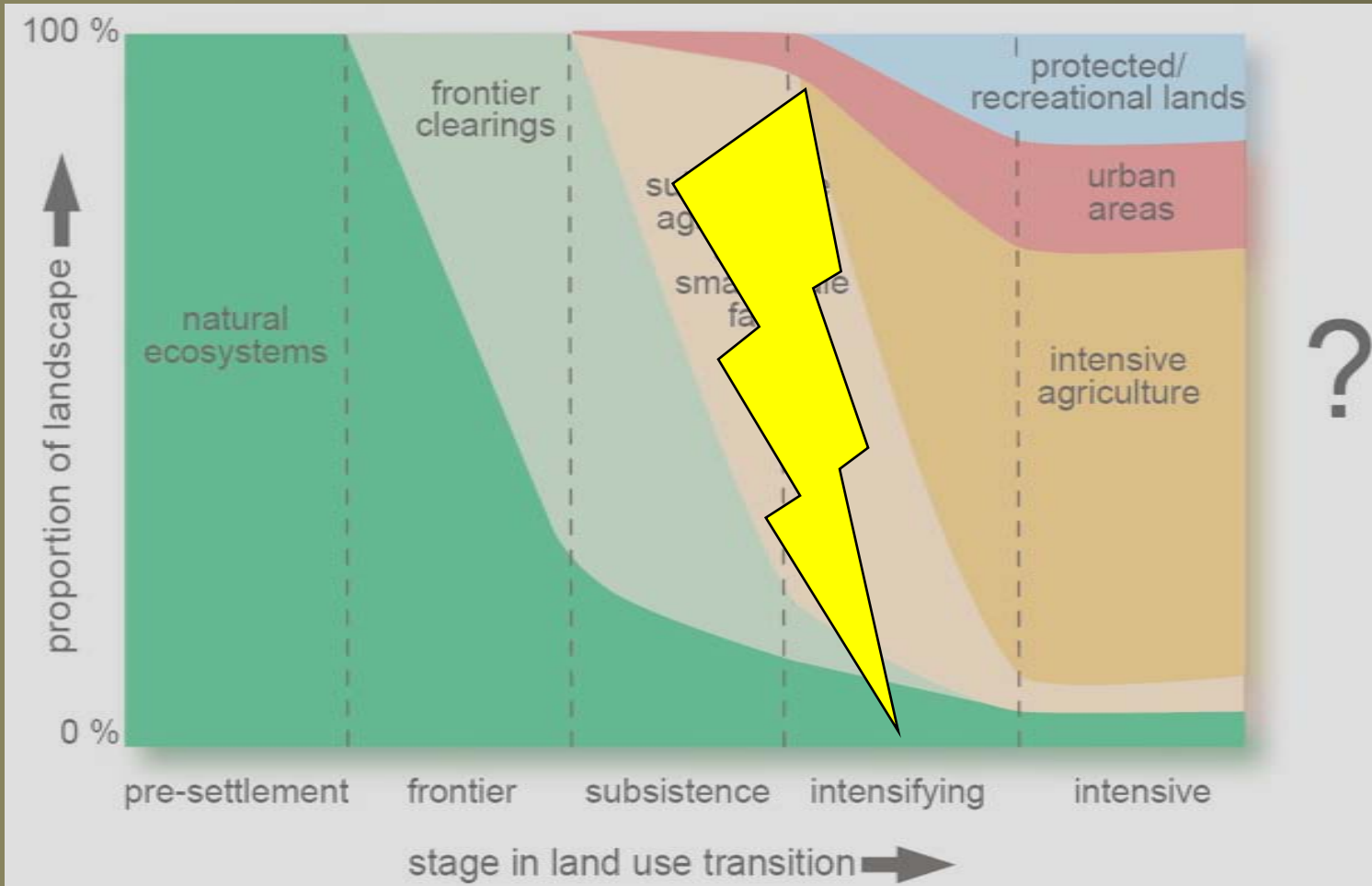
**3. *Rewilding?***

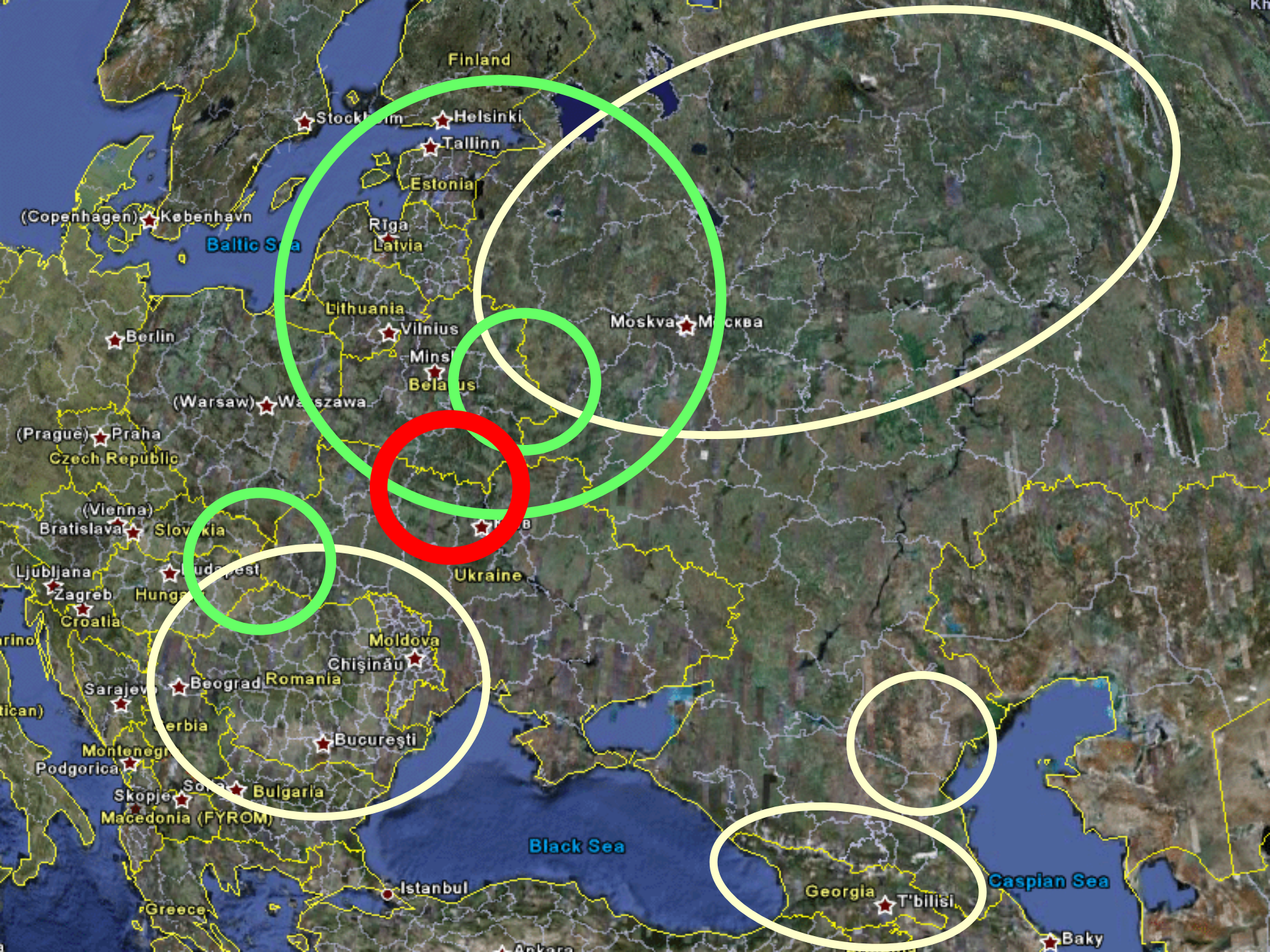
# 2. Disturbance

People

Land use

Environment





Finland

Stockholm

Helsinki

Tallinn

Estonia

Riga

Latvia

Lithuania

Vilnius

Minsk

Belarus

Moskva

Москва

(Warsaw) Warszawa

Berlin

(Prague) Praha

Czech Republic

(Vienna)

Bratislava

Slovakia

Ljubljana

Budapest

Hungary

Zagreb

Croatia

Sarajevo

Beograd

Romania

Moldova

Chişinău

Bucureşti

Serbia

Montenegro

Podgorica

Skopje

Macedonia (FYROM)

Sofia

Bulgaria

Greece

Istanbul

Black Sea

Georgia

Tbilisi

Caspian Sea

Baky

Ankara

## 2. Disturbance

People

Land  
use

Environ-  
ment



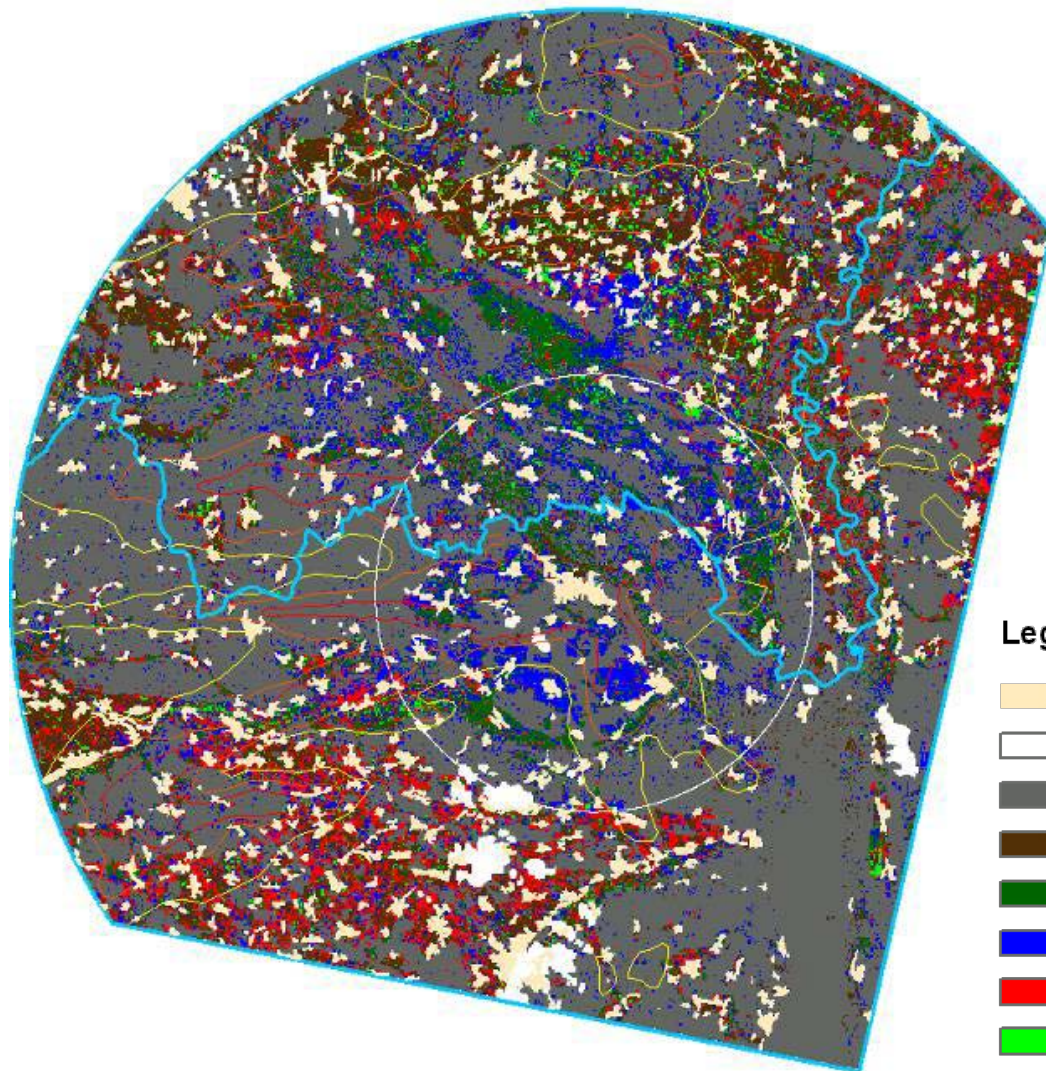


## 2. Disturbance

People

Land  
use

Environ-  
ment



### Legend

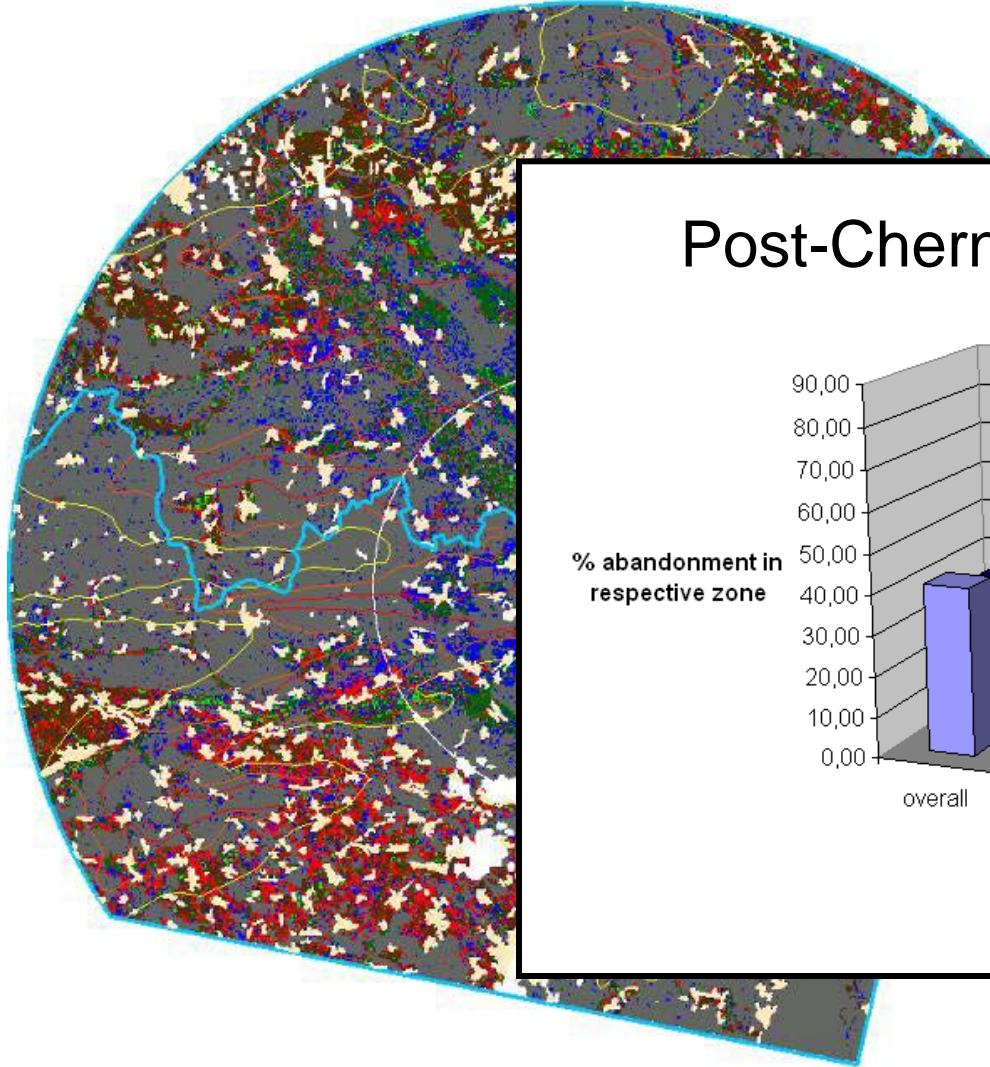
- digitized settlements
- Unclassified
- other
- permanent agriculture
- permanent grassland
- post-Chernobyl abandonment
- post-socialist abandonment
- recent re-cultivation

# 2. Disturbance

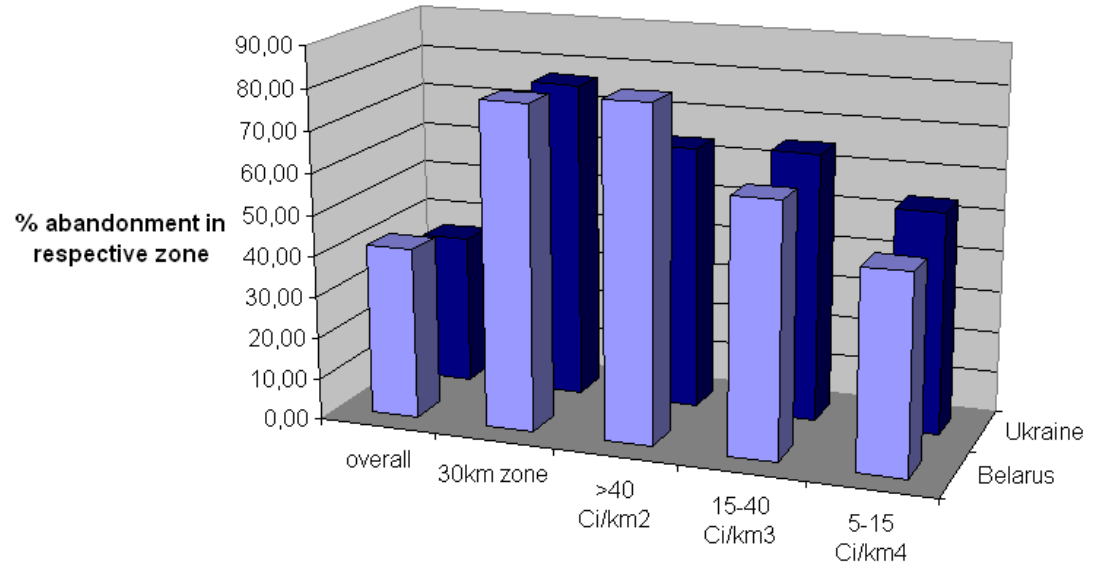
People

Land use

Environment



### Post-Chernobyl Abandonment

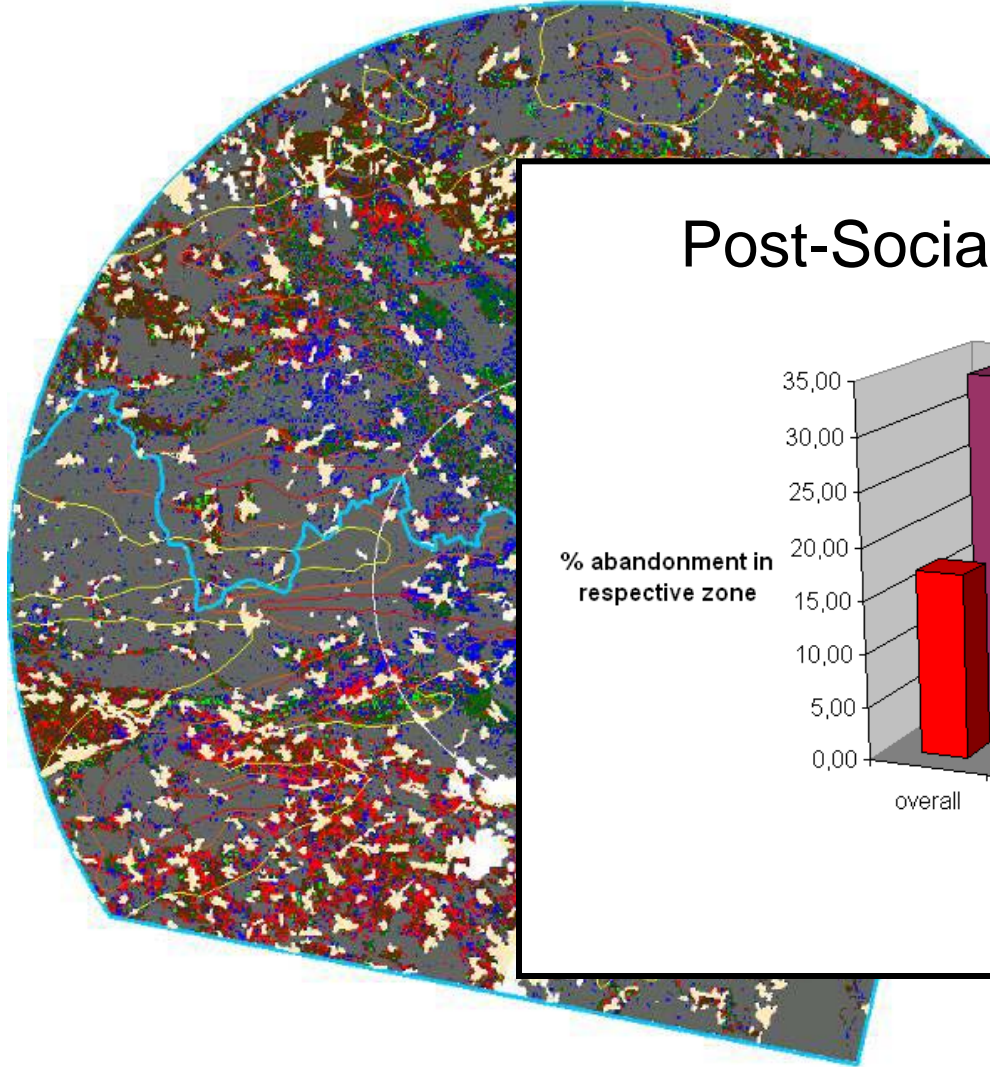


# 2. Disturbance

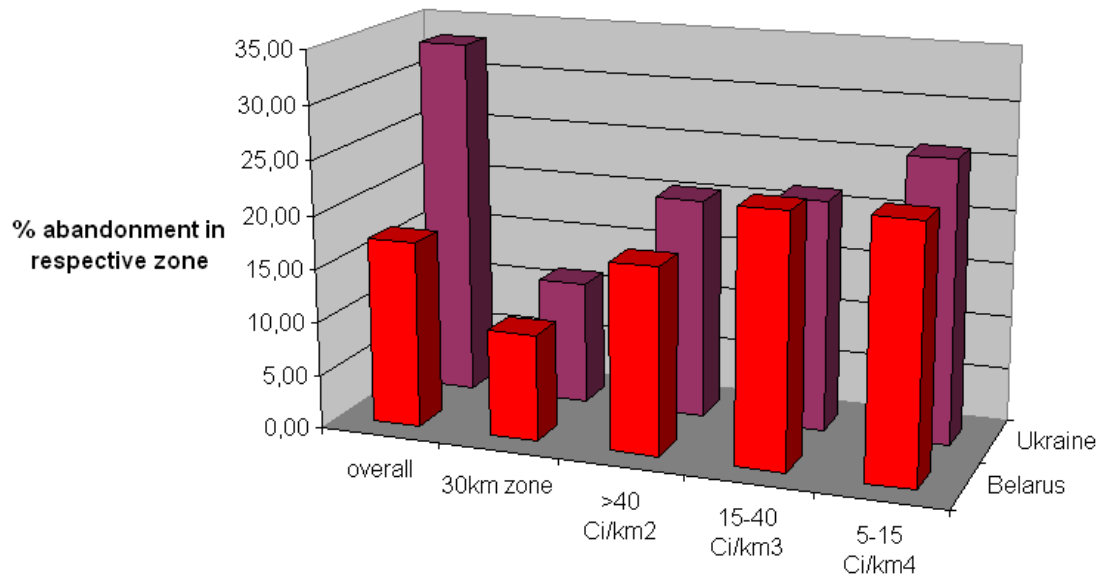
People

Land use

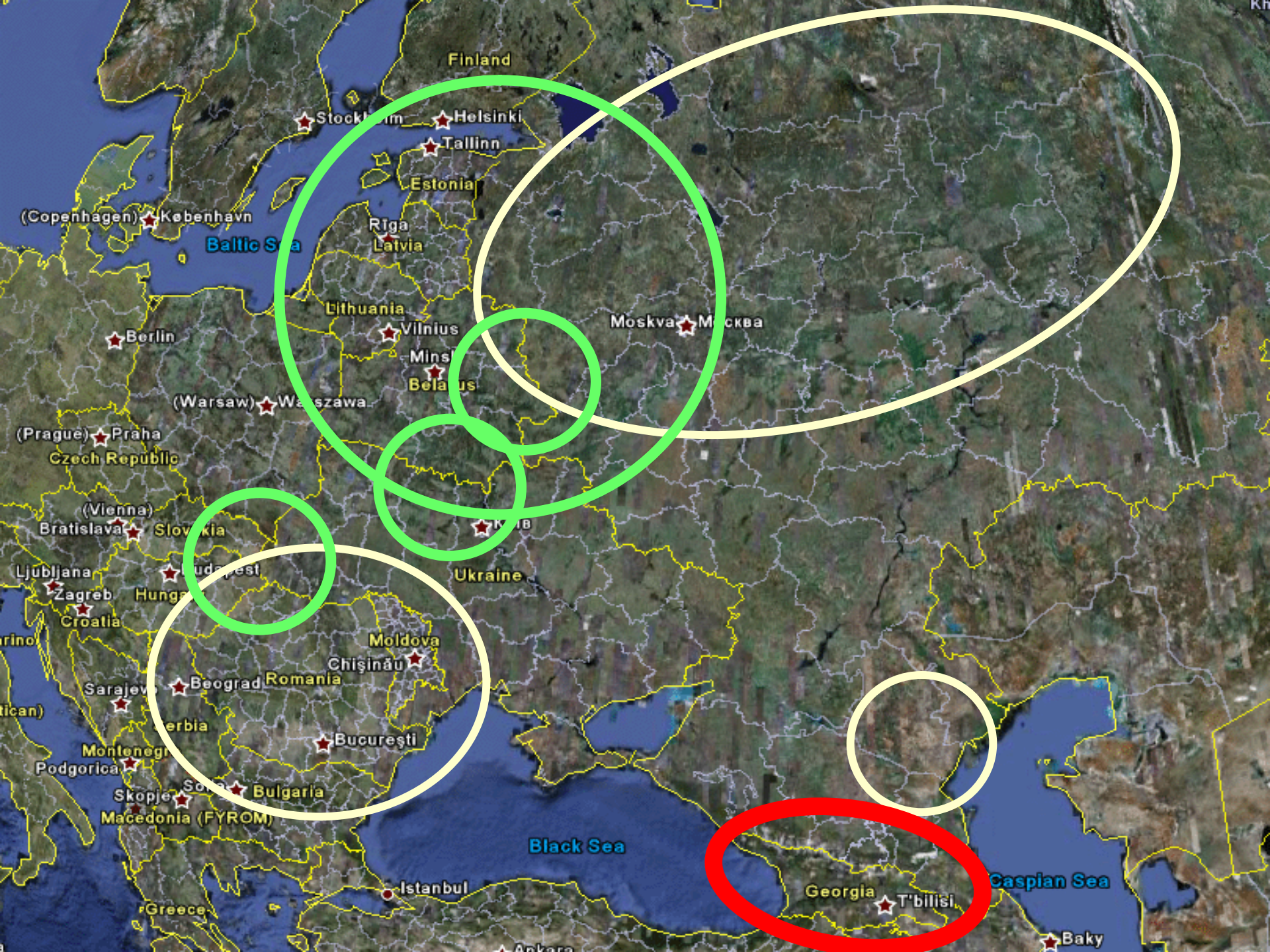
Environment



### Post-Socialist Abandonment



post-socialist abandonment  
recent re-cultivation



Finland

Stockholm

Helsinki

Tallinn

Estonia

Riga

Latvia

Baltic Sea

(Copenhagen) København

Lithuania

Vilnius

Moskva Москва

Berlin

Minsk

Belarus

(Warsaw) Warszawa

(Prague) Praha

Czech Republic

(Vienna)

Bratislava Slovakia

Ljubljana Hungary

Zagreb Croatia

Sarajevo

Podgorica

Montenegro

Skopje

Macedonia (FYROM)

Greece

Ankara

Istanbul

Bulgaria

Beograd

Serbia

Chişinău

Moldova

Bucureşti

Romania

Ukraine

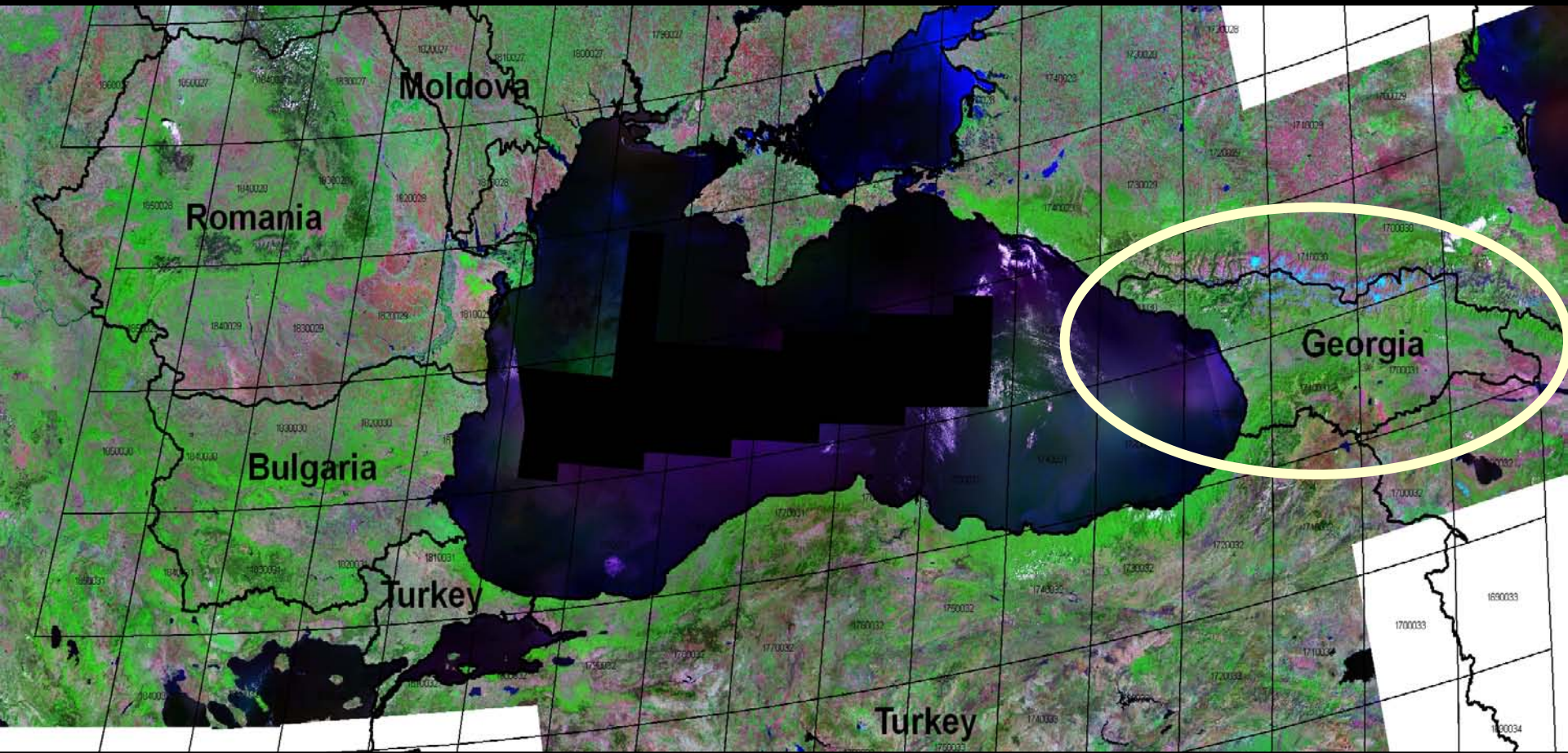
Black Sea

Georgia

T'bilisi

Caspian Sea

Baky



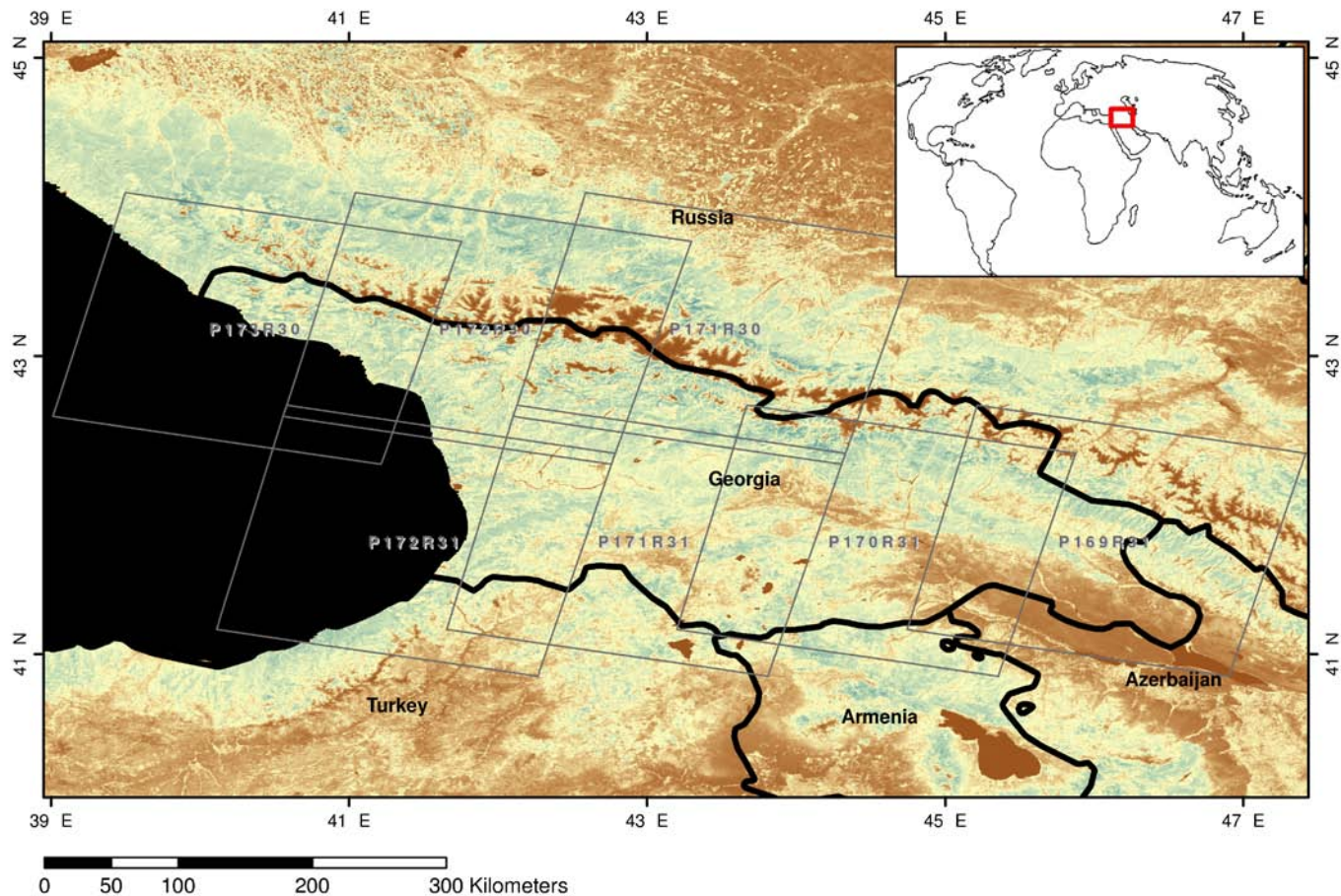
# 2. Disturbance

People

Land use

Environment

## Landsat change detection 1990-2000



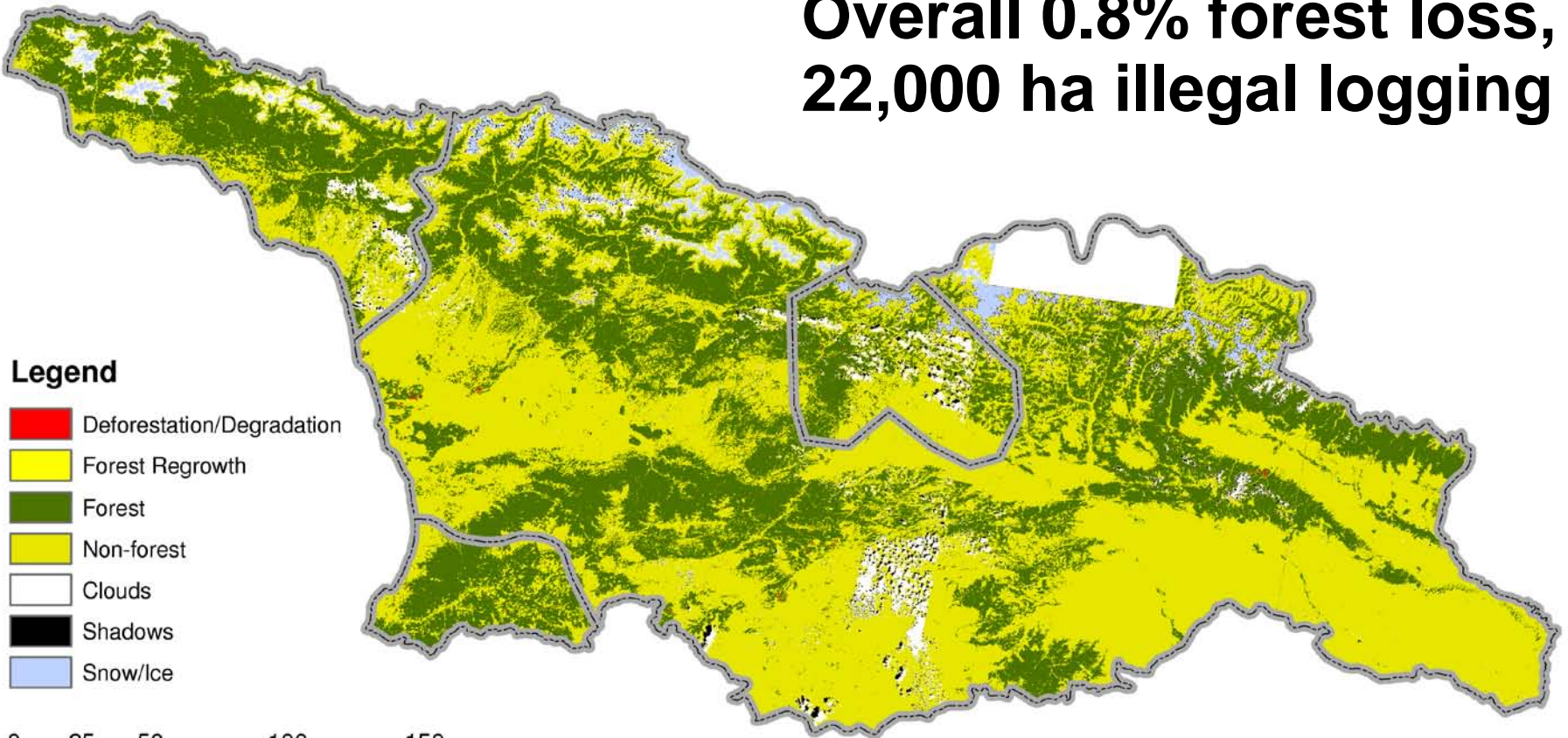
# 2. Disturbance

People

Land use

Environment

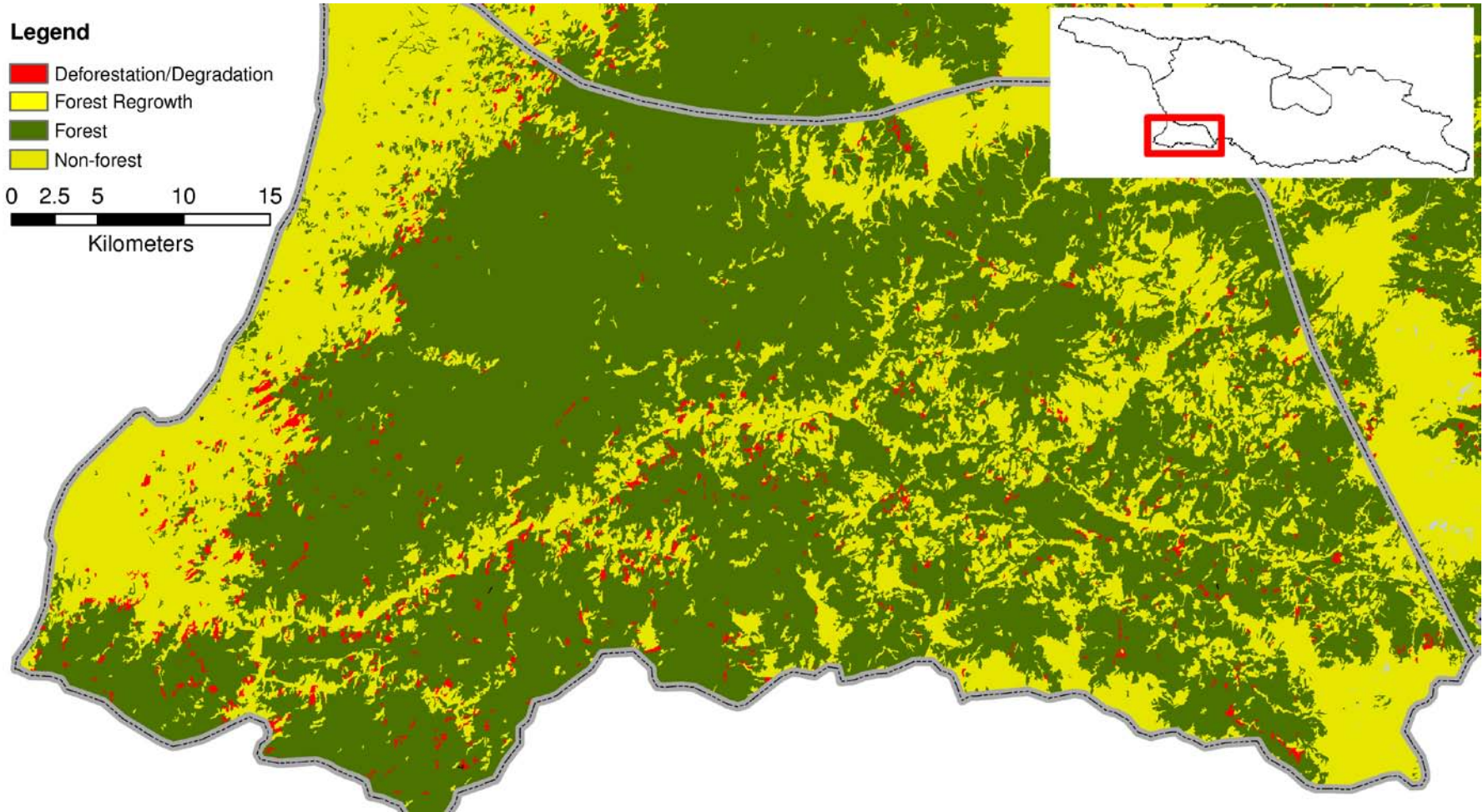
**Overall 0.8% forest loss,  
22,000 ha illegal logging**



# 2. Disturbance



## Autonomous Republic of Adjara, southwestern Georgia, 2.6% change





# 2. Disturbance

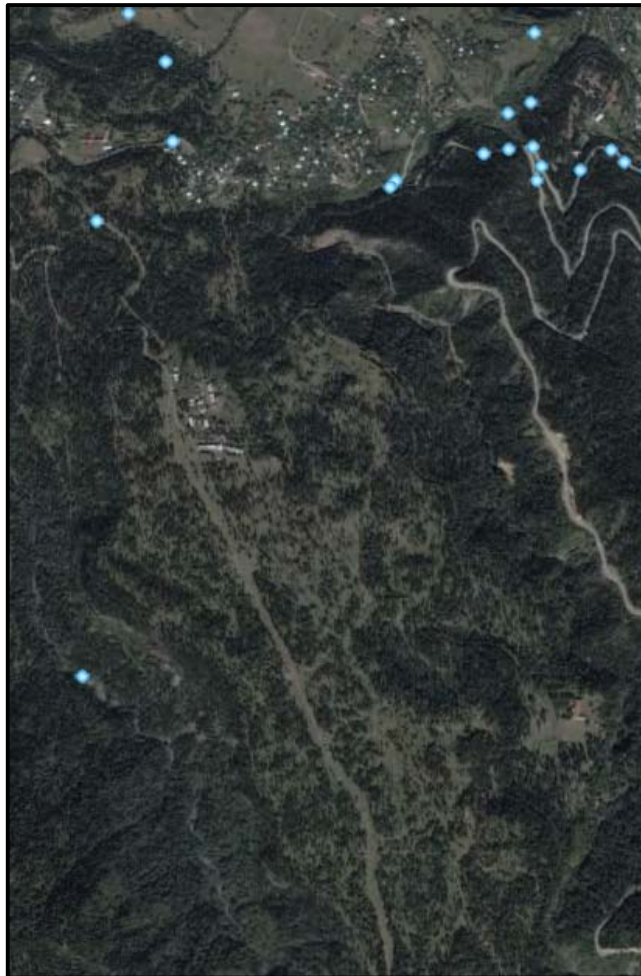
People

Land use

Environment

Quickbird image from GoogleEarth

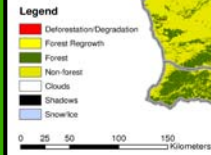
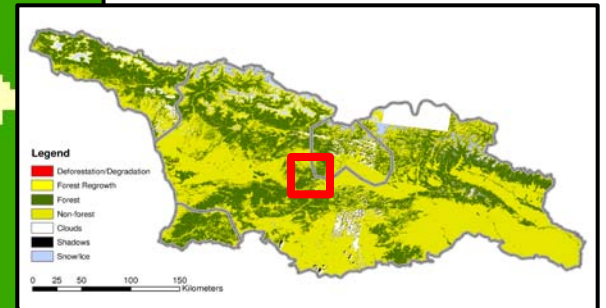
Classification result (red = change; green = stable forest; yellow = stable non-forest)



## Typical illegal logging:

logging:

- No clear cut
- Close to village
- Close to roads



# 2. Disturbance



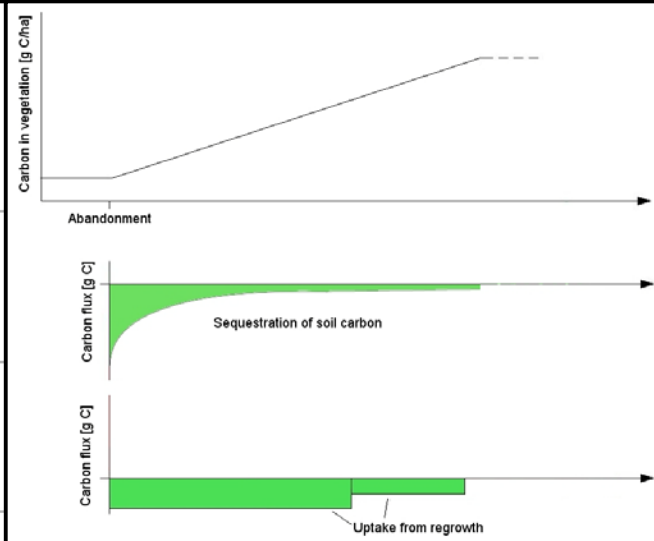
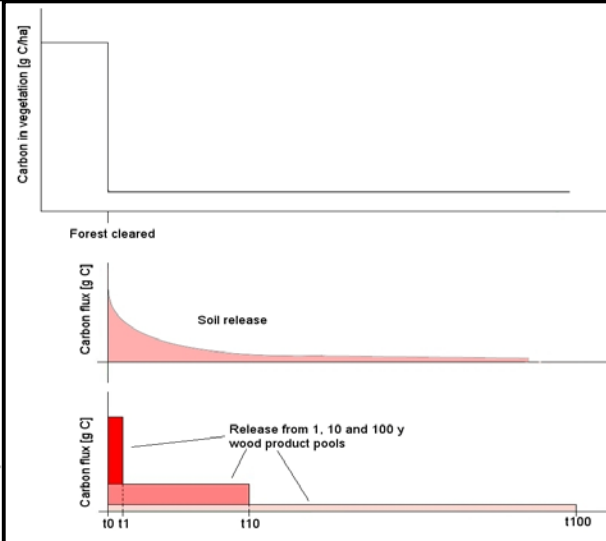
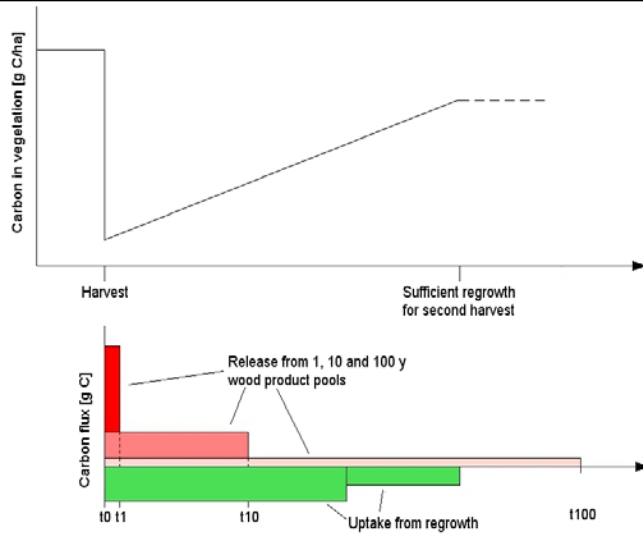
The Carbon “book-keeping model” (Houghton 1980s)

- Tracks changes in carbon stocks from year to year
- Uses harvest and clearing estimates; estimates decomposition of wood products

I. Forest harvest and regrowth: C released and accumulated

II. Forest loss, Carbon release

III. Reforestation C accumulated

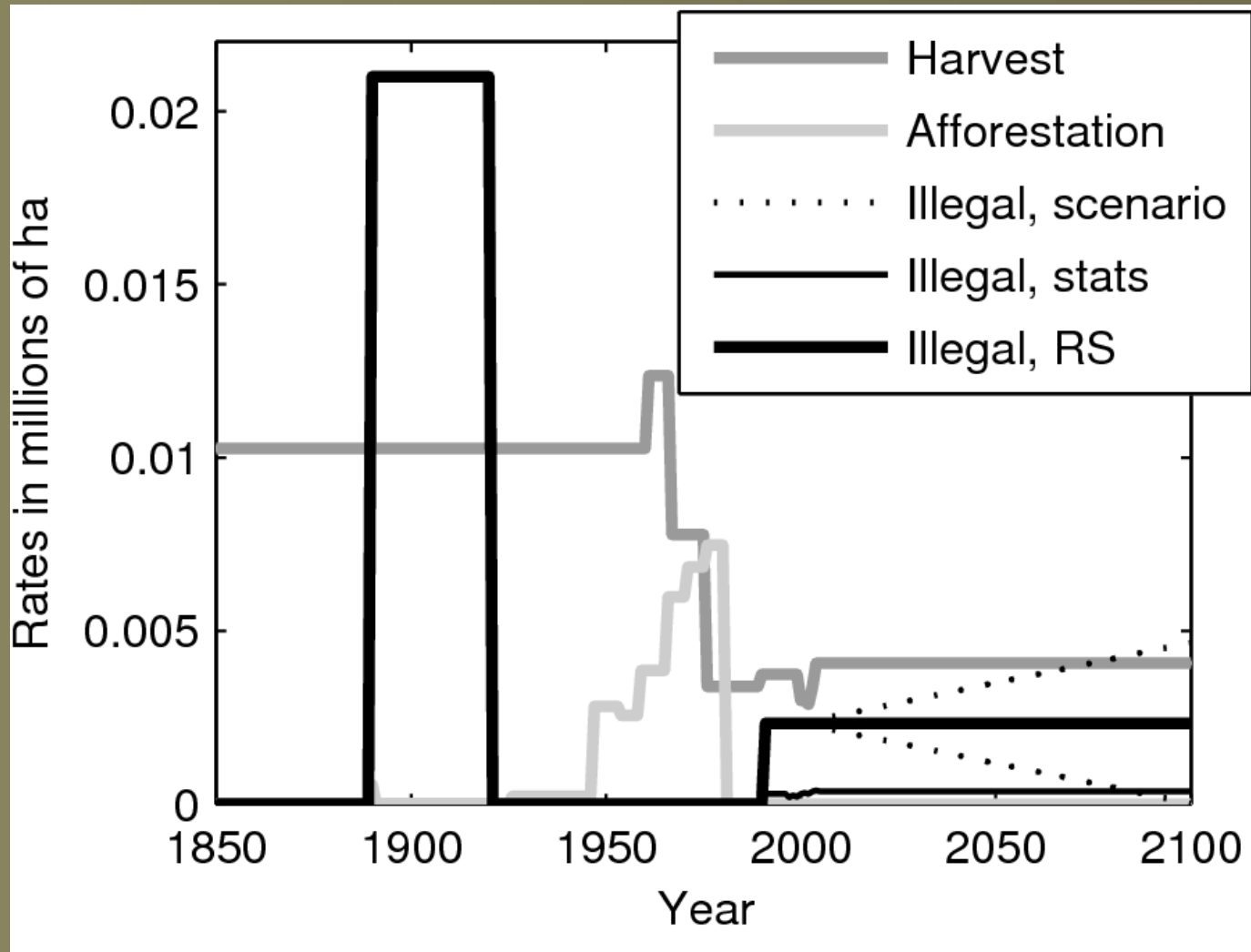


## 2. Disturbance

People

Land  
use

Environ-  
ment



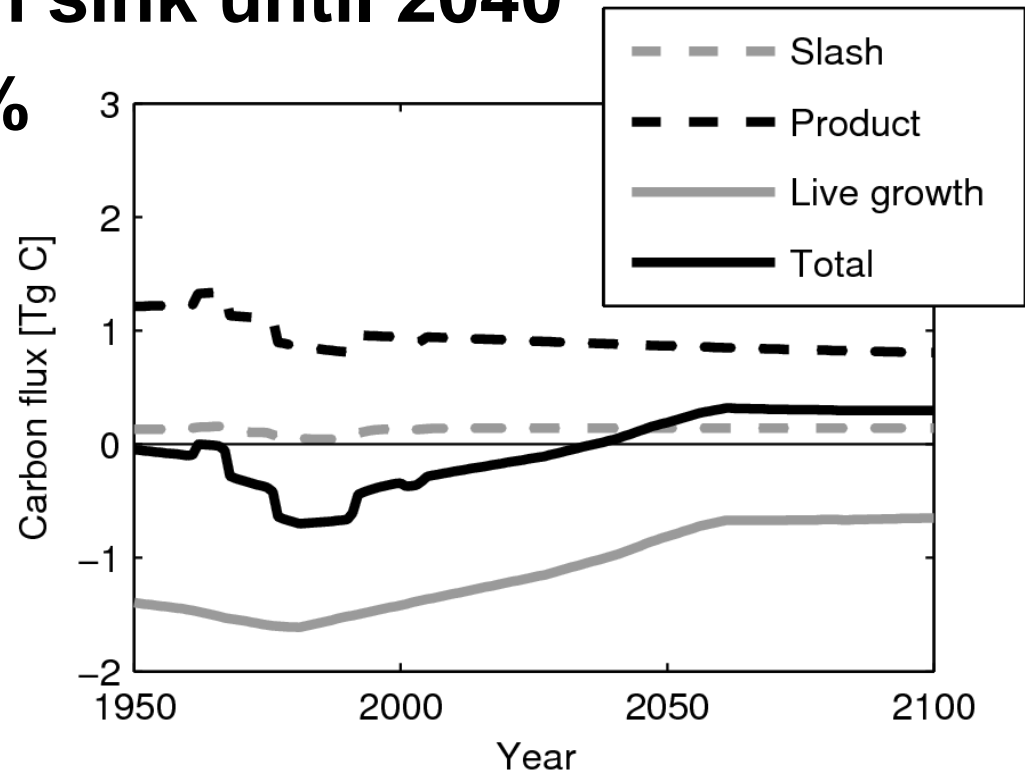
## 2. Disturbance

People

Land  
use

Environ-  
ment

- Georgian forests are a carbon sink ( $\sim 0.3$  Tg/yr.)
- Georgia will remain sink until 2040
- Sink strength  $\sim 30\%$  of Georgia's carbon emissions





Finland

Stockholm

Helsinki

Tallinn

Estonia

Riga

Latvia

Lithuania

Vilnius

Minsk

Belarus

Moskva

Москва

Berlin

(Warsaw) Warszawa

(Prague) Praha

Czech Republic

(Vienna)

Bratislava

Slovakia

Ljubljana

Slovenia

Zagreb

Hungary

Croatia

Sarajevo

Beograd

Romania

Moldova

Chişinău

Bucureşti

Skopje

Macedonia (FYROM)

Bulgaria

Ukraine

Black Sea

Georgia

T'bilisi

Caspian Sea

Baky

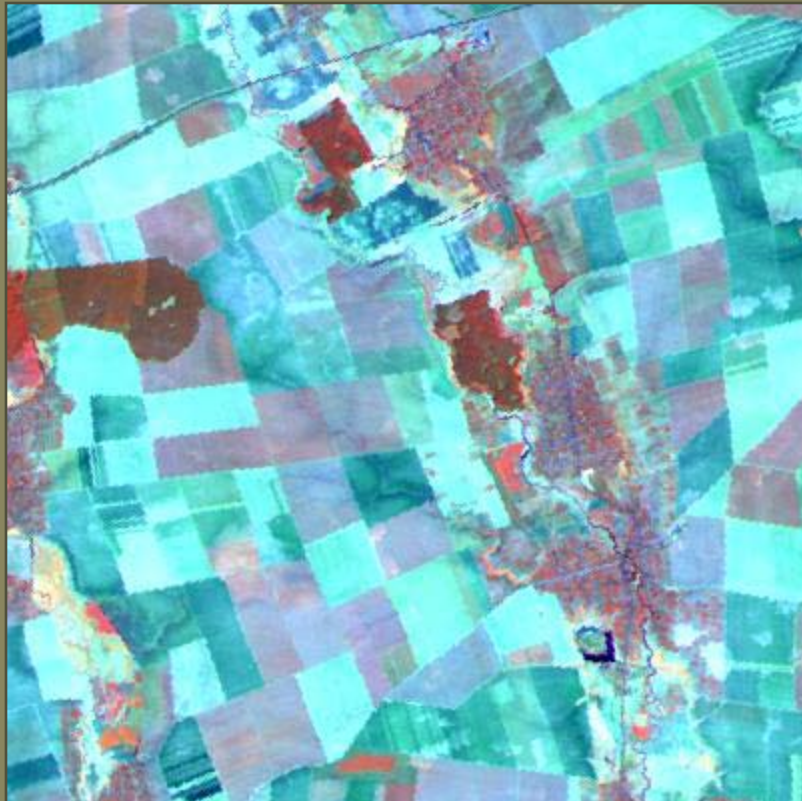
## 2. Disturbance

People

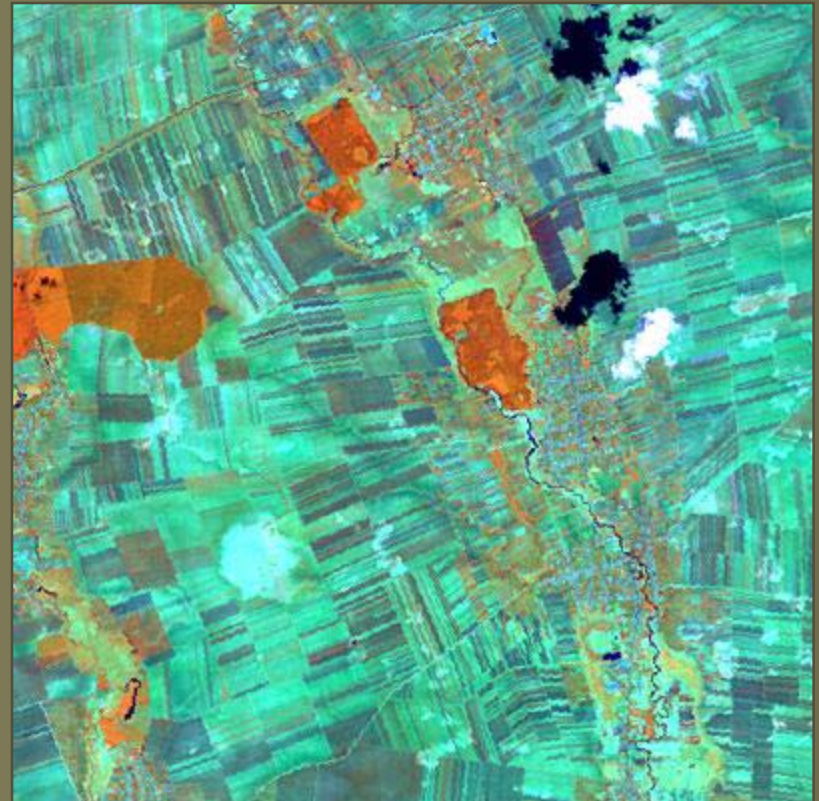
Land  
use

Environ-  
ment

1990



2000

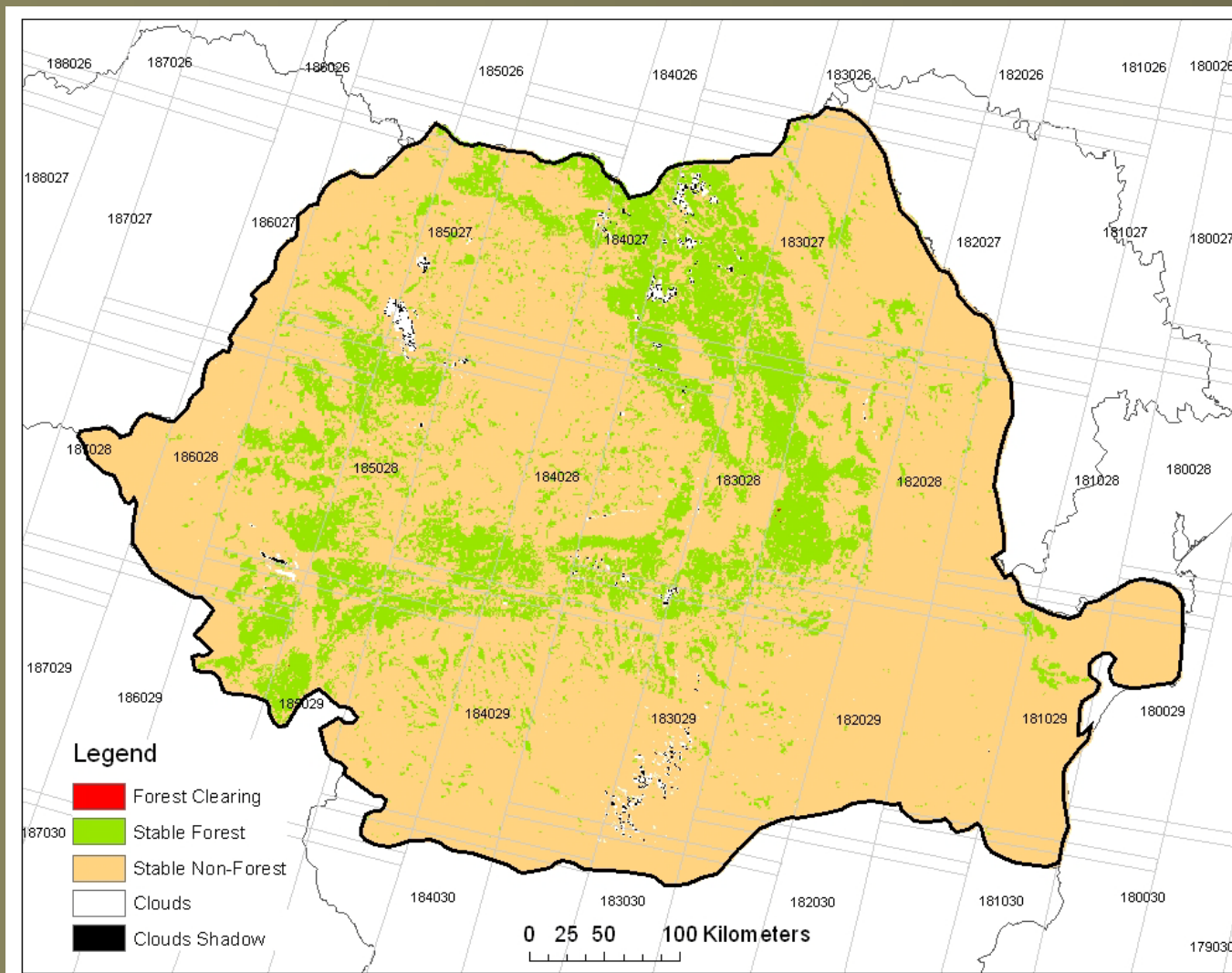


# 2. Disturbance

People

Land use

Environment



## 2. Disturbance

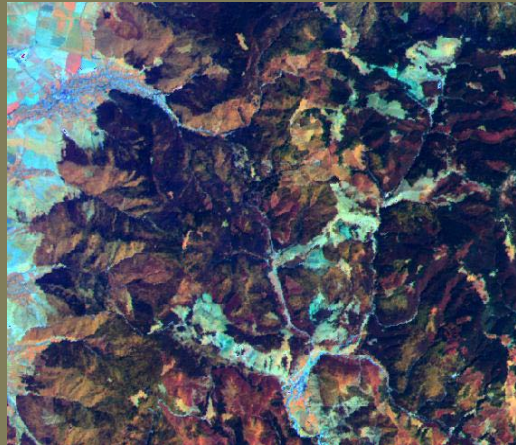
People

Land  
use

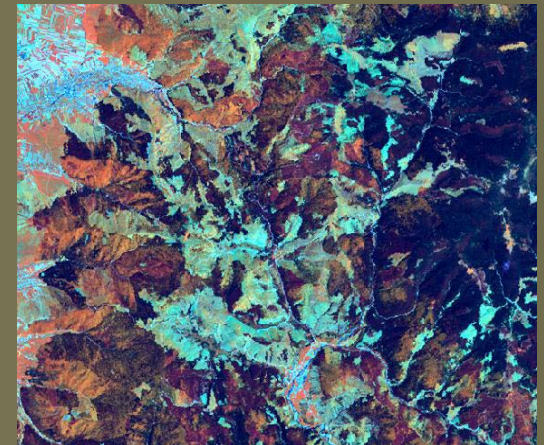
Environ-  
ment

- 1990 – 2000:  
2.4% forest lost
- 2000 – 2005:  
3.1% forest lost
- Average change  
size 7.9 ha
- Harvesting  
concentrated,  
and mostly on  
private land

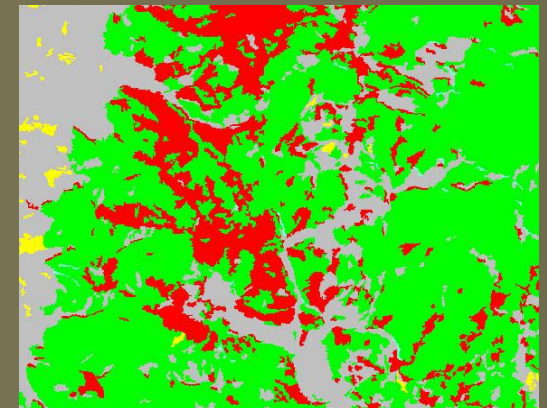
1990



2000



Change



Deforestation

Stable Forest

Stable non Forest

Forest re-growth



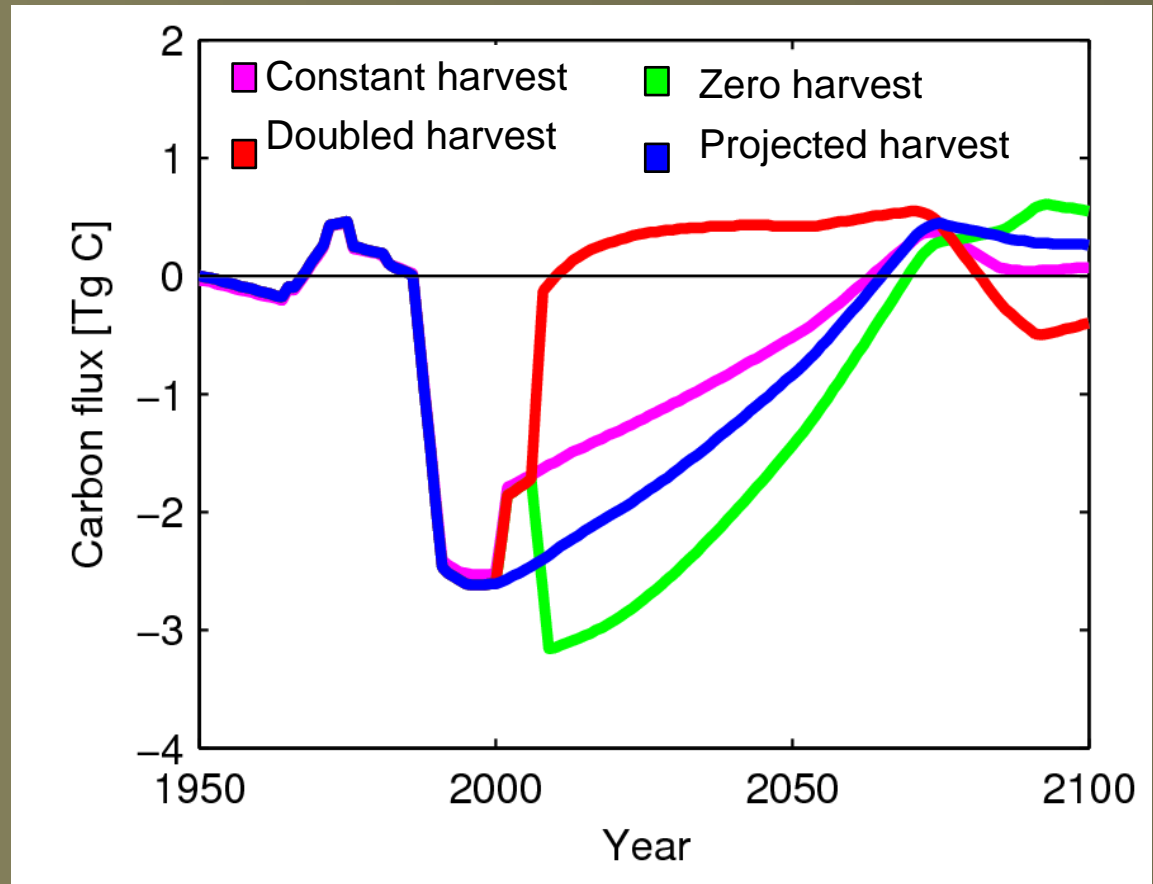
## 2. Disturbance

People

Land  
use

Environ-  
ment

- Romania is a carbon sink, probably until 2070
- Sink strength  
~10% of  
Romania's  
carbon  
emissions

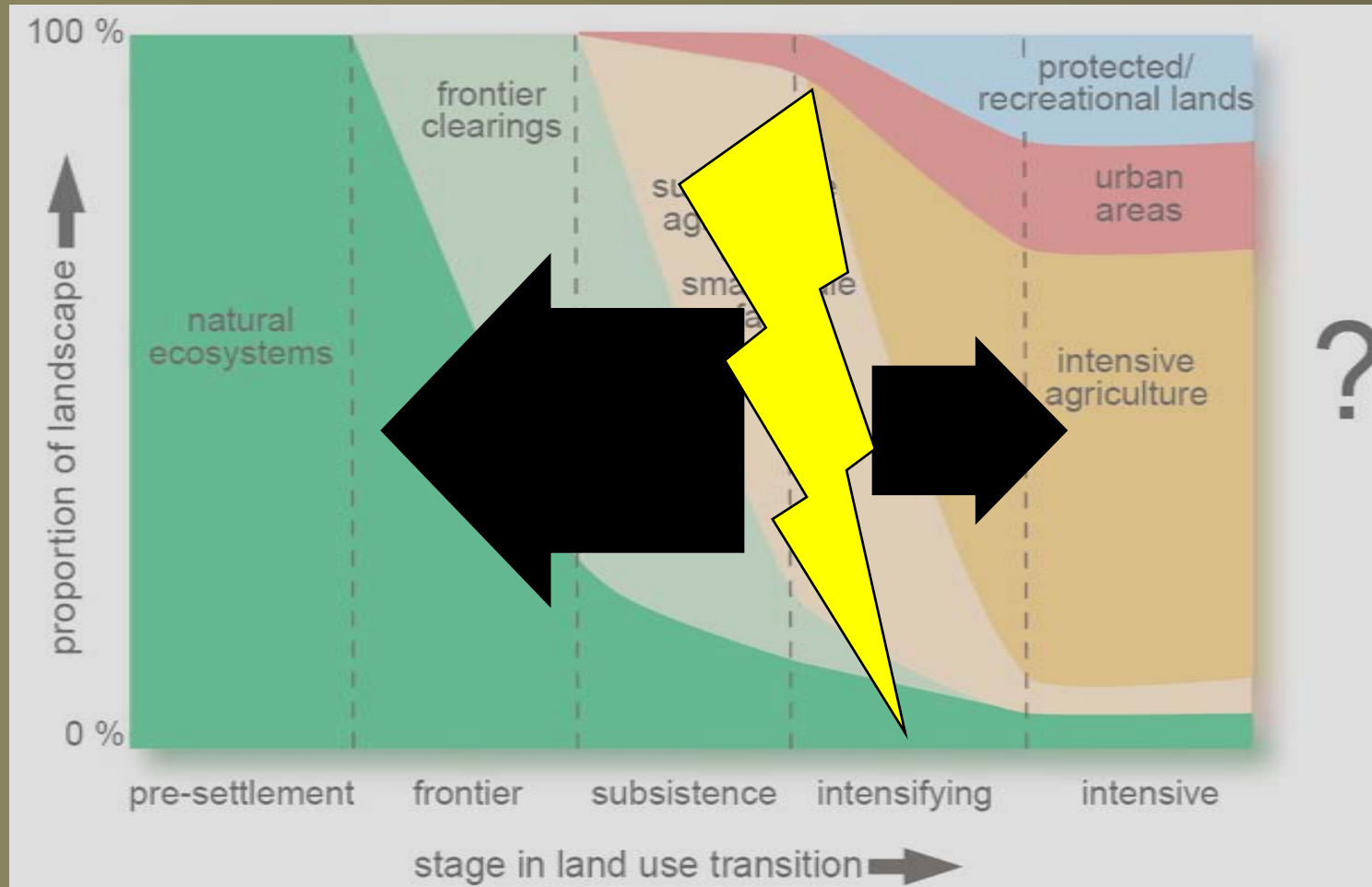


# 2. Disturbance

People

Land use

Environment



## 3. Rewilding

People

Land  
use

Environ-  
ment

- 1. Broad-scale drivers*
- 2. Disturbance*
- 3. Rewilding?*



Finland

Stockholm Helsinki

Tallinn

Estonia

Rīga

Latvia

Lithuania

Vilnius

Minsk

Belarus

Moskva Москва

(Copenhagen) København

Baltic Sea

Berlin

(Warsaw) Warszawa

(Prague) Praha

Czech Republic

(Vienna)

Bratislava Slovakia

Ljubljana Budapest

Zagreb Hungary

Croatia

Sarajevo

Beograd Romania

Moldova

Chişinău

Bucureşti

Serbia

Montenegro

Podgorica

Skopje

Southern Bulgaria

Macedonia (FYROM)

Ukraine

Black Sea

Georgia

T'bilisi

Caspian Sea

Baky

# 3. Rewilding

Humans

Land  
use

Environ-  
ment

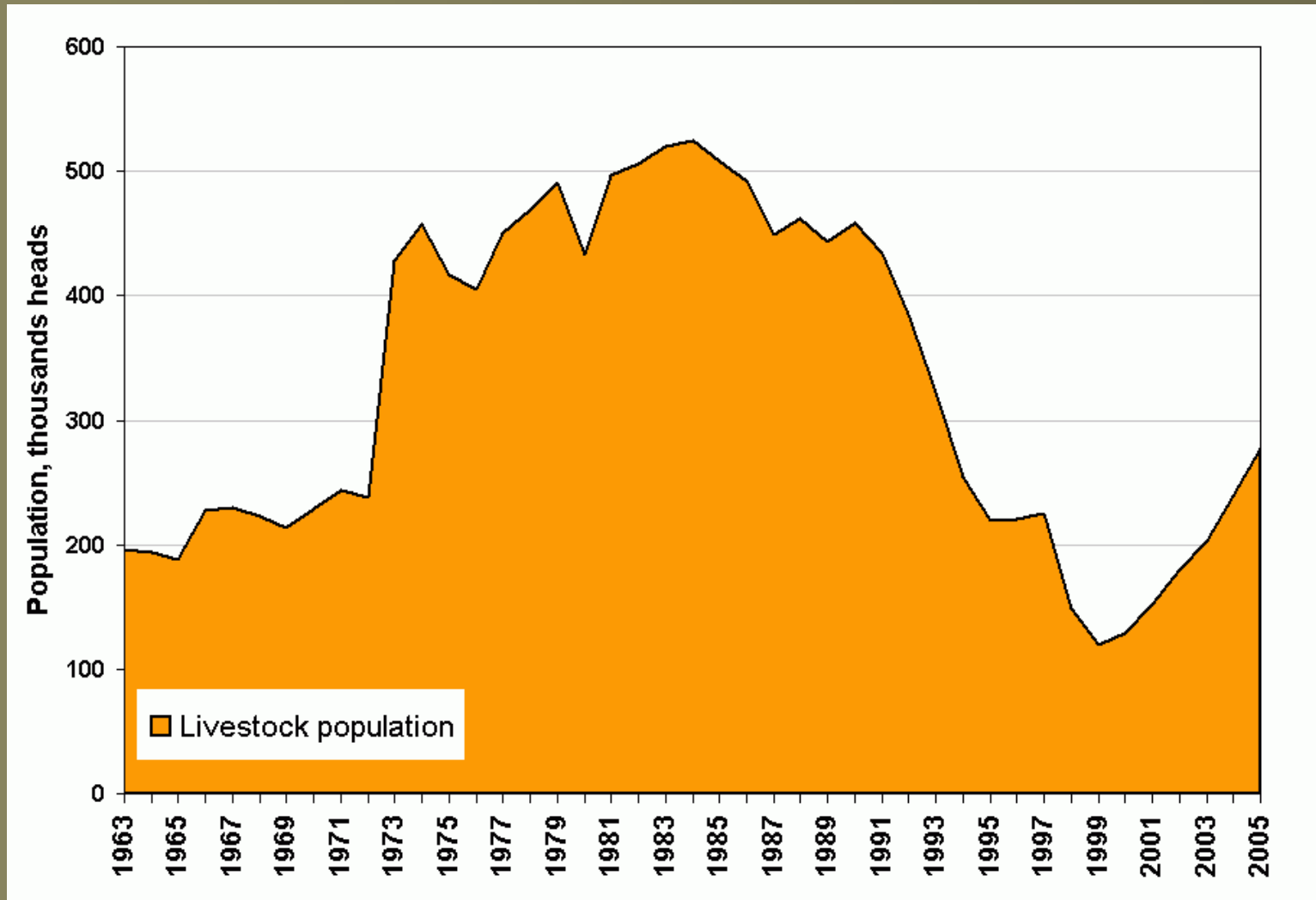


# 3. Rewilding

People

Land  
use

Environ-  
ment



# 3. Rewilding

People

Land  
use

Environ-  
ment

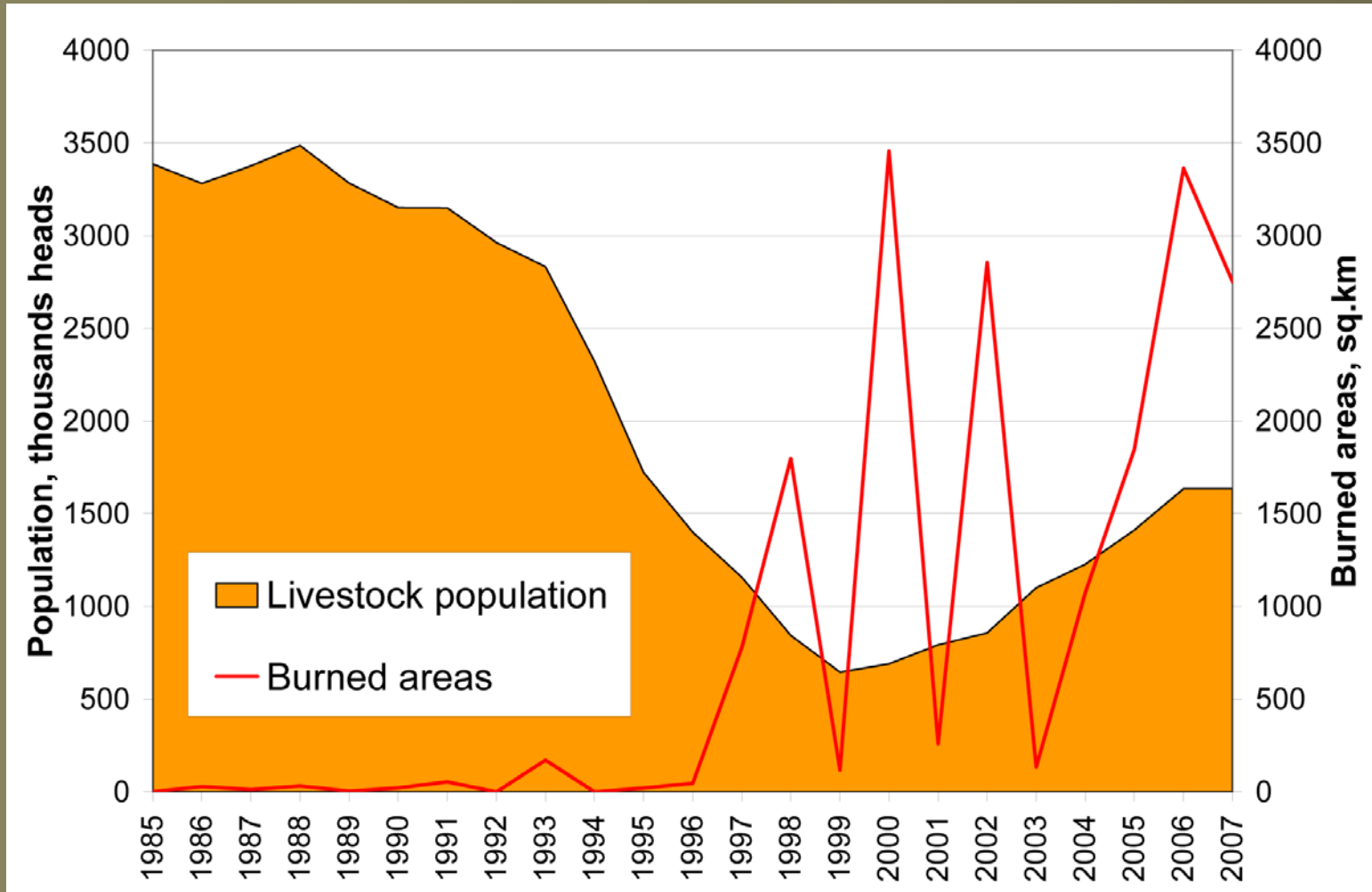


# 3. Rewilding

People

Land use

Environment





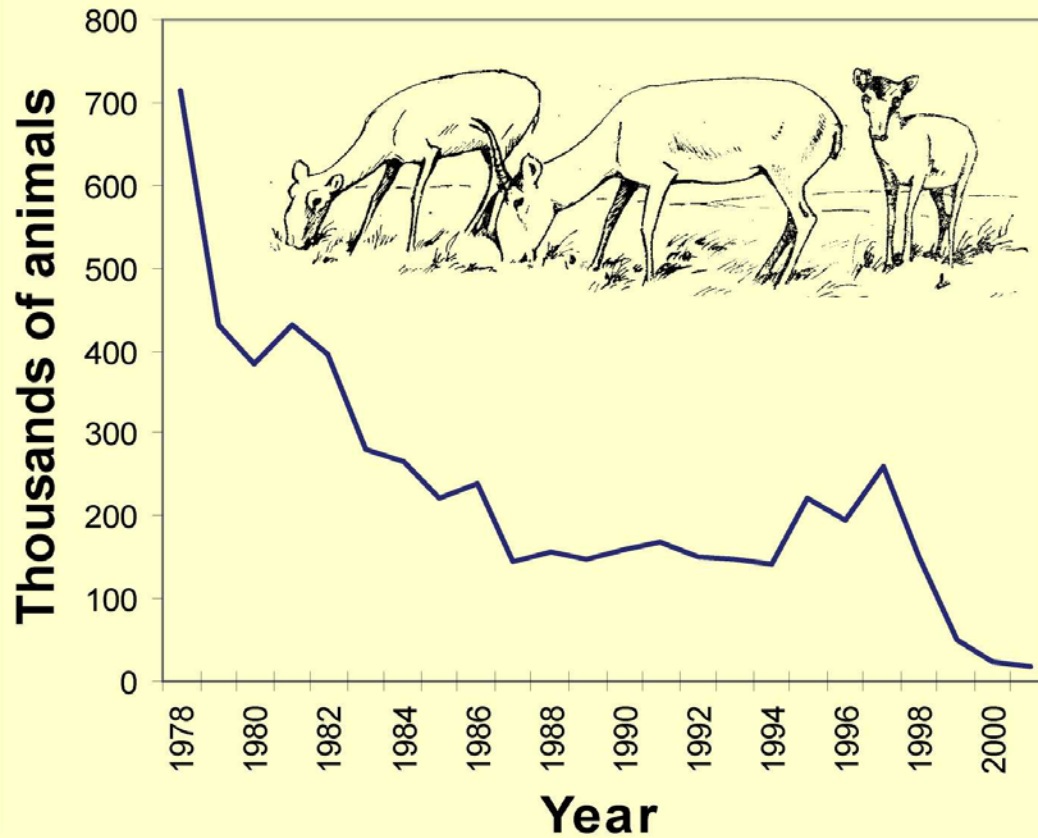
# 3. Rewilding

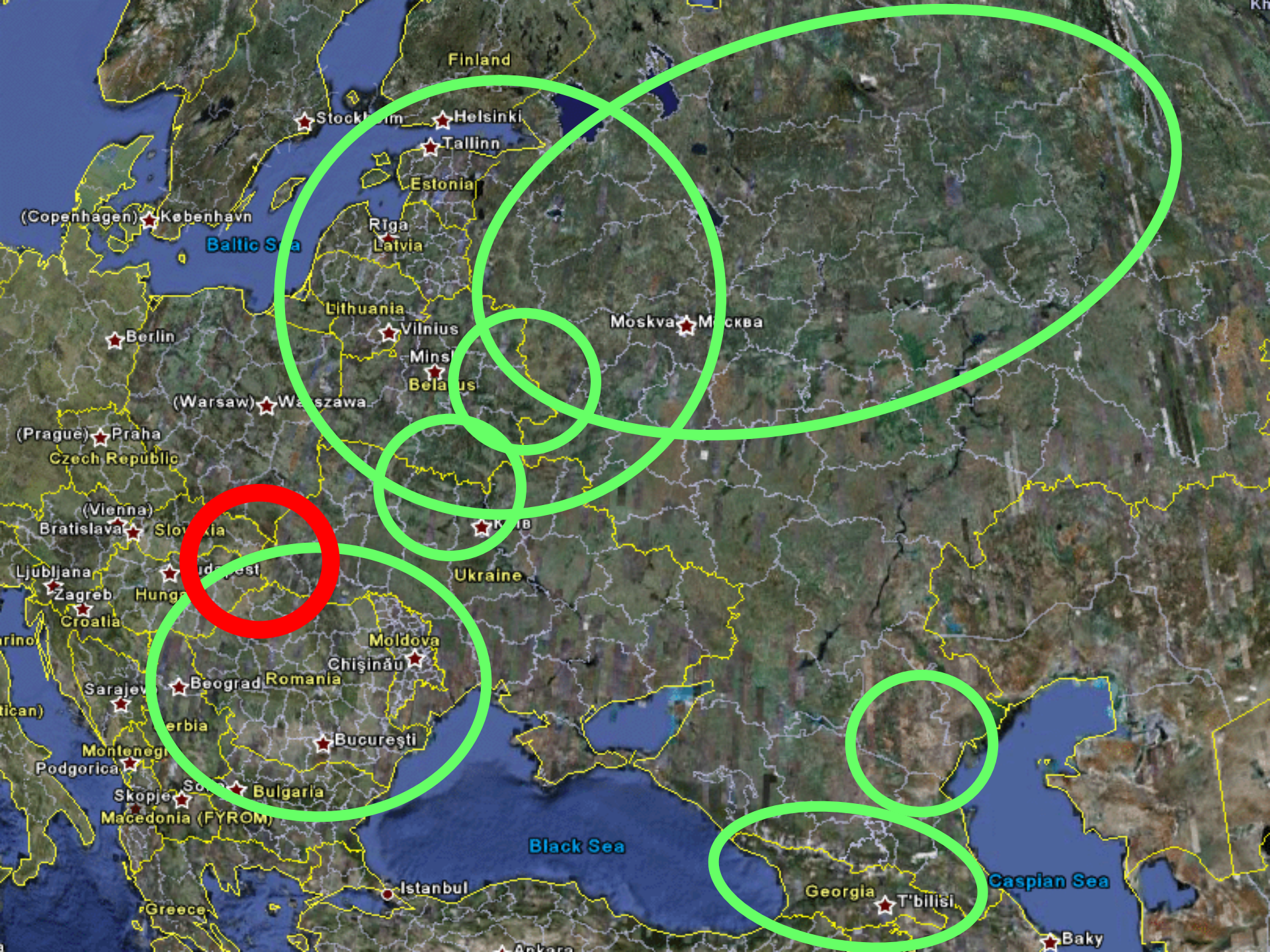
People

Land use

Environment

## Population dynamics in 1976-2001





Finland

Stockholm

Helsinki

Tallinn

Estonia

Rīga

Latvia

Lithuania

Vilnius

Minsk

Belarus

Moskva

Москва

(Copenhagen) København

Baltic Sea

Berlin

(Warsaw) Warszawa

(Prague) Praha

Czech Republic

(Vienna)

Bratislava

Slovakia

Ljubljana

Budapest

Hungary

Zagreb

Croatia

Sarajevo

Beograd

Romania

Moldova

Chişinău

Bucureşti

Serbia

Montenegro

Podgorica

Skopje

Southern

Bulgaria

Macedonia (FYROM)

Ukraine

Black Sea

Georgia

T'bilisi

Caspian Sea

Bakı

# 3. Rewilding

People

Land  
use

Environ-  
ment



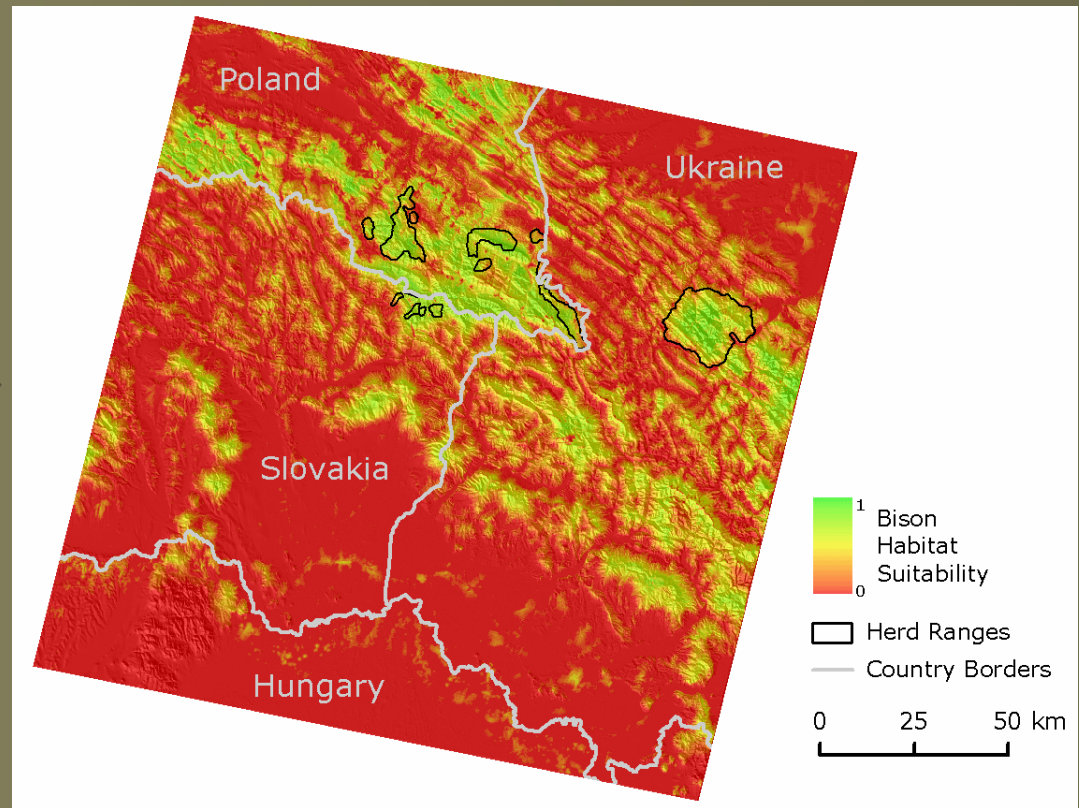
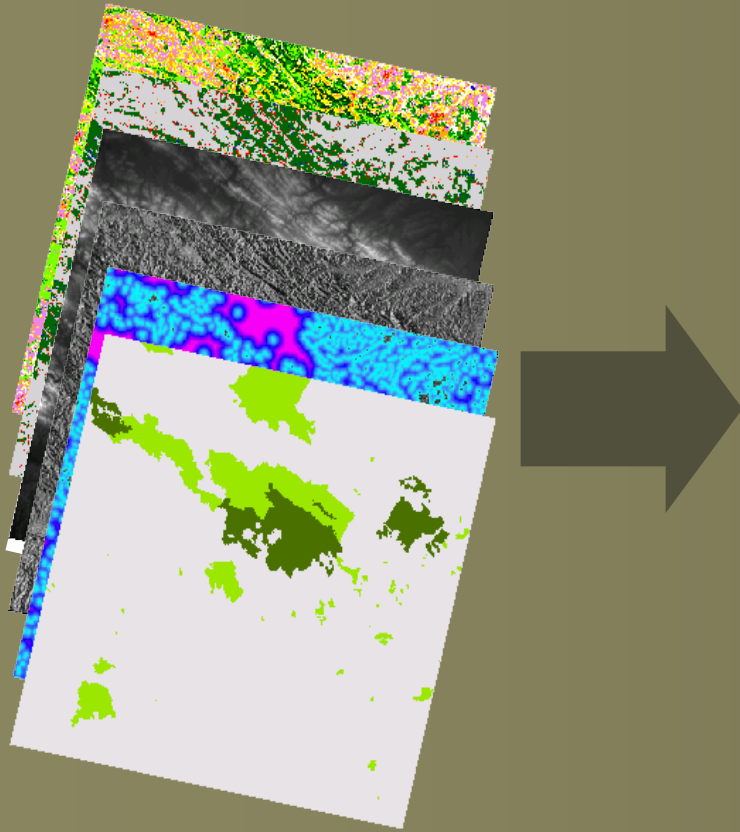


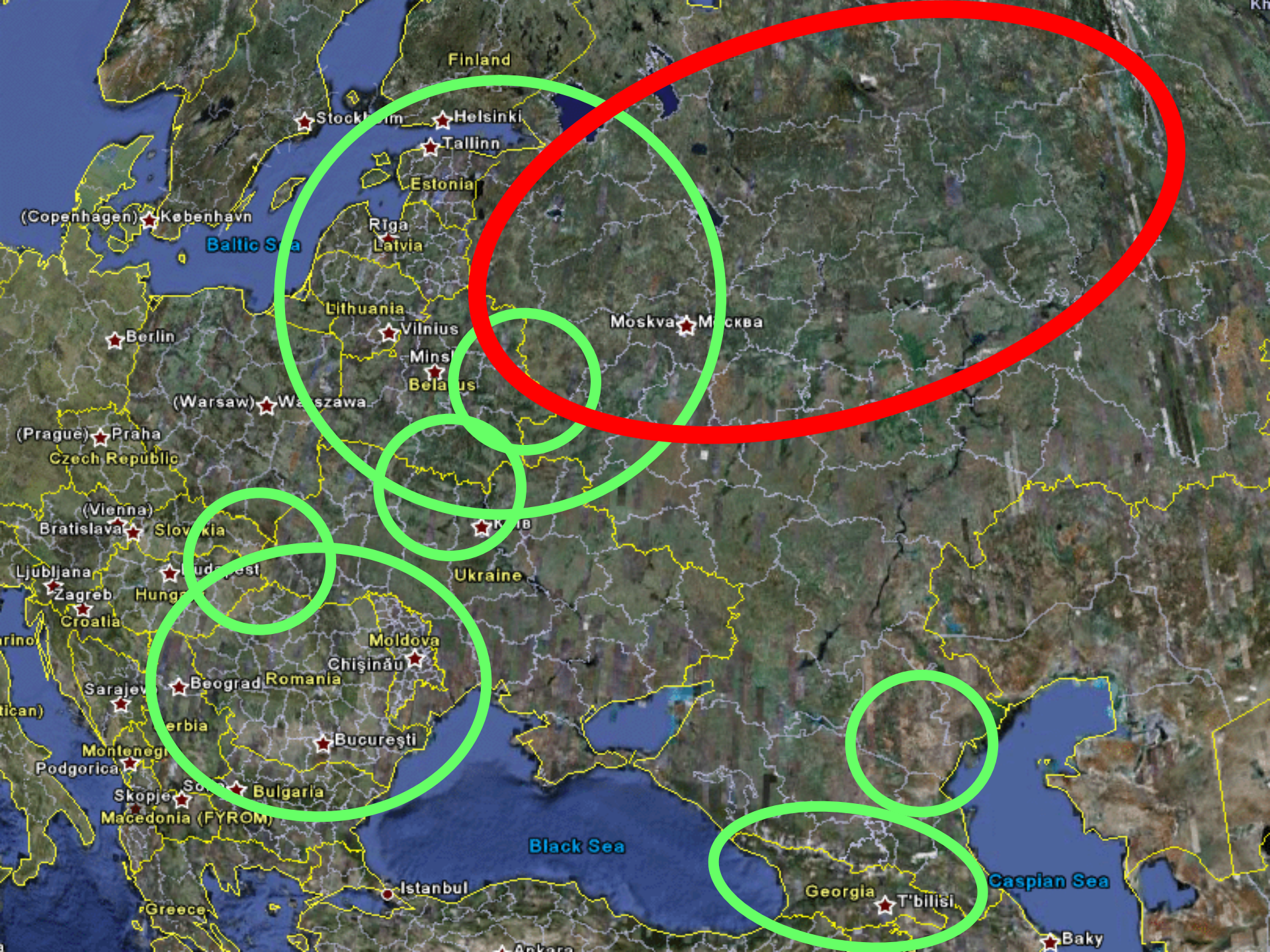
# 3. Rewilding

People

Land  
use

Environ-  
ment





Finland

Stockholm

Helsinki

Tallinn

Estonia

Riga

Latvia

Lithuania

Vilnius

Minsk

Belarus

Moskva

Москва

(Copenhagen) København

Baltic Sea

Berlin

(Warsaw) Warszawa

(Prague) Praha

Czech Republic

(Vienna)

Bratislava

Slovakia

Ljubljana

Budapest

Hungary

Zagreb

Croatia

Sarajevo

Beograd

Serbia

Moldova

Chişinău

Romania

Bucureşti

Ukraine

Montenegro

Podgorica

Skopje

Macedonia (FYROM)

Bulgaria

Black Sea

Istanbul

Georgia

T'bilisi

Caspian Sea

Baky

# 3. Rewilding

People

Land  
use

Environ-  
ment

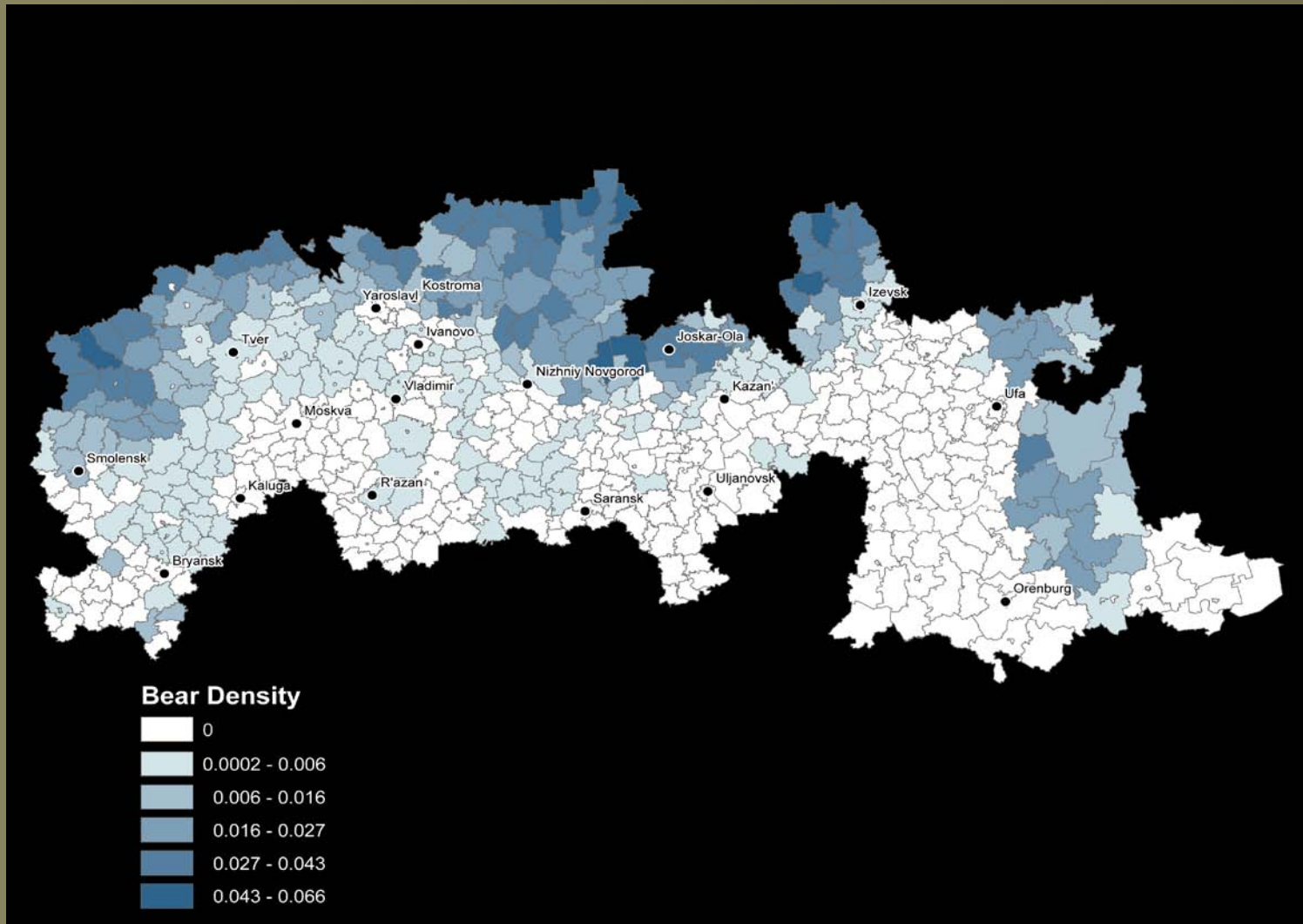


# 3. Rewilding

People

Land  
use

Environ-  
ment



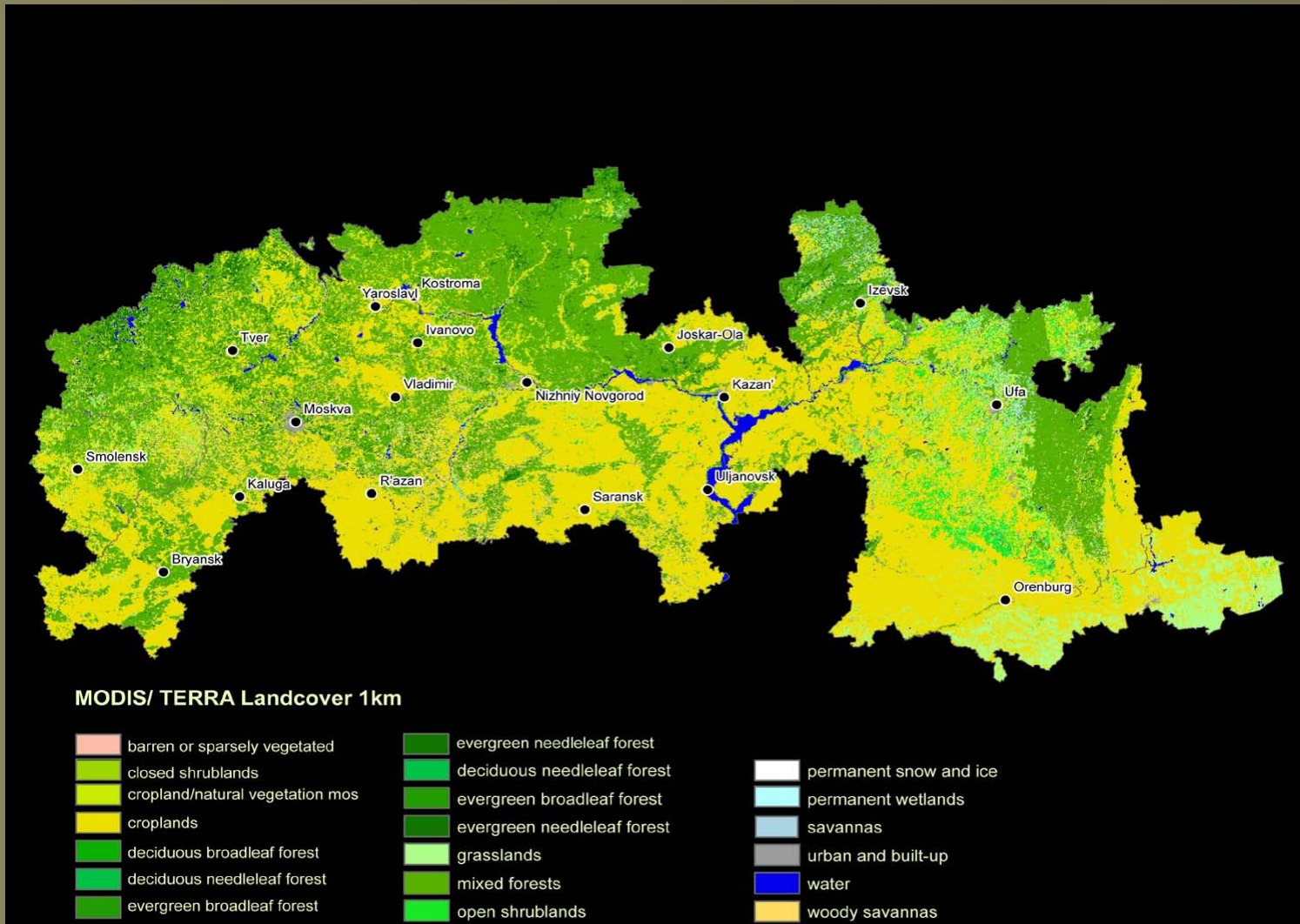


# 3. Rewilding

People

Land use

Environment

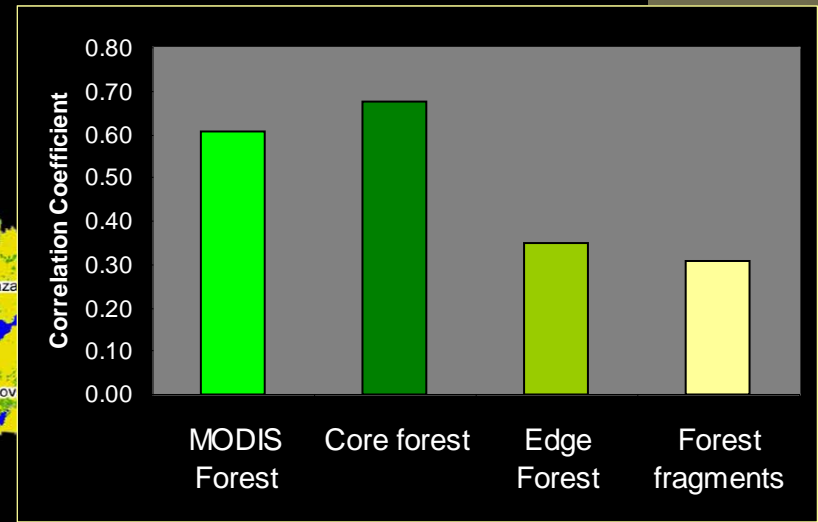
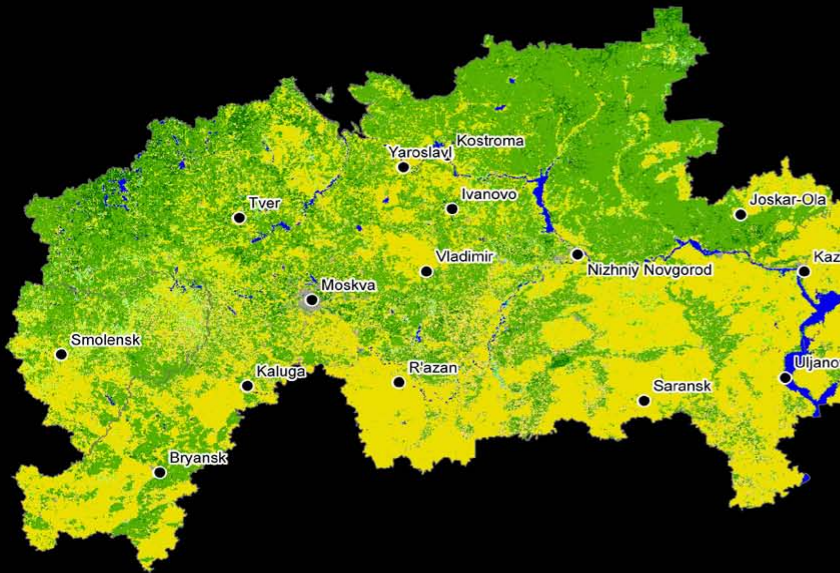


# 3. Rewilding

People

Land use

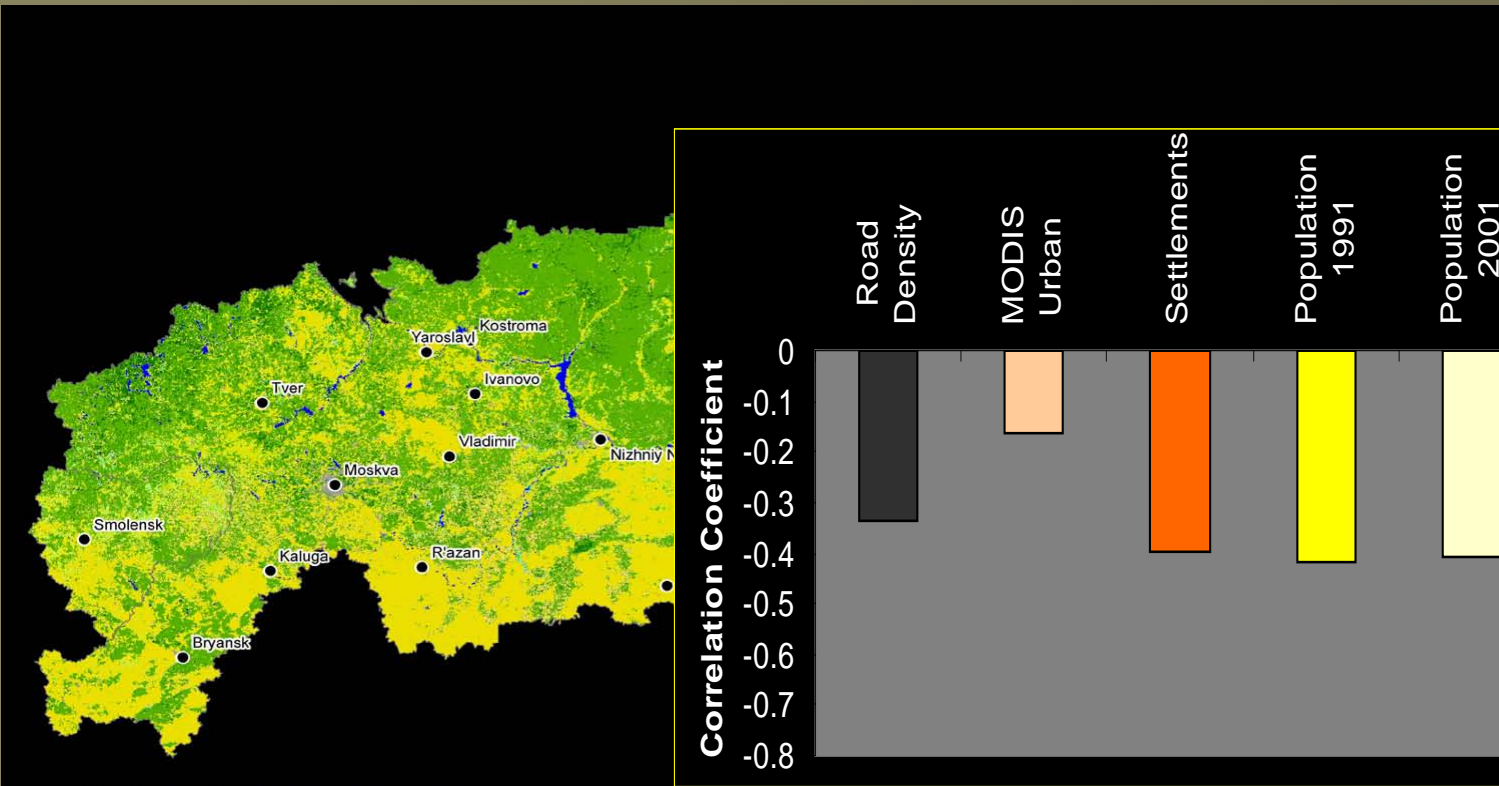
Environment



MODIS/ TERRA Landcover 1km

- |                                 |                             |                        |
|---------------------------------|-----------------------------|------------------------|
| barren or sparsely vegetated    | evergreen needleleaf forest | permanent snow and ice |
| closed shrublands               | deciduous needleleaf forest | permanent wetlands     |
| cropland/natural vegetation mos | evergreen broadleaf forest  | savannas               |
| croplands                       | evergreen needleleaf forest | urban and built-up     |
| deciduous broadleaf forest      | grasslands                  | water                  |
| deciduous needleleaf forest     | mixed forests               | woody savannas         |
| evergreen broadleaf forest      | open shrublands             |                        |

# 3. Rewilding



MODIS/ TERRA Landcover 1km

- |                                 |                             |                        |
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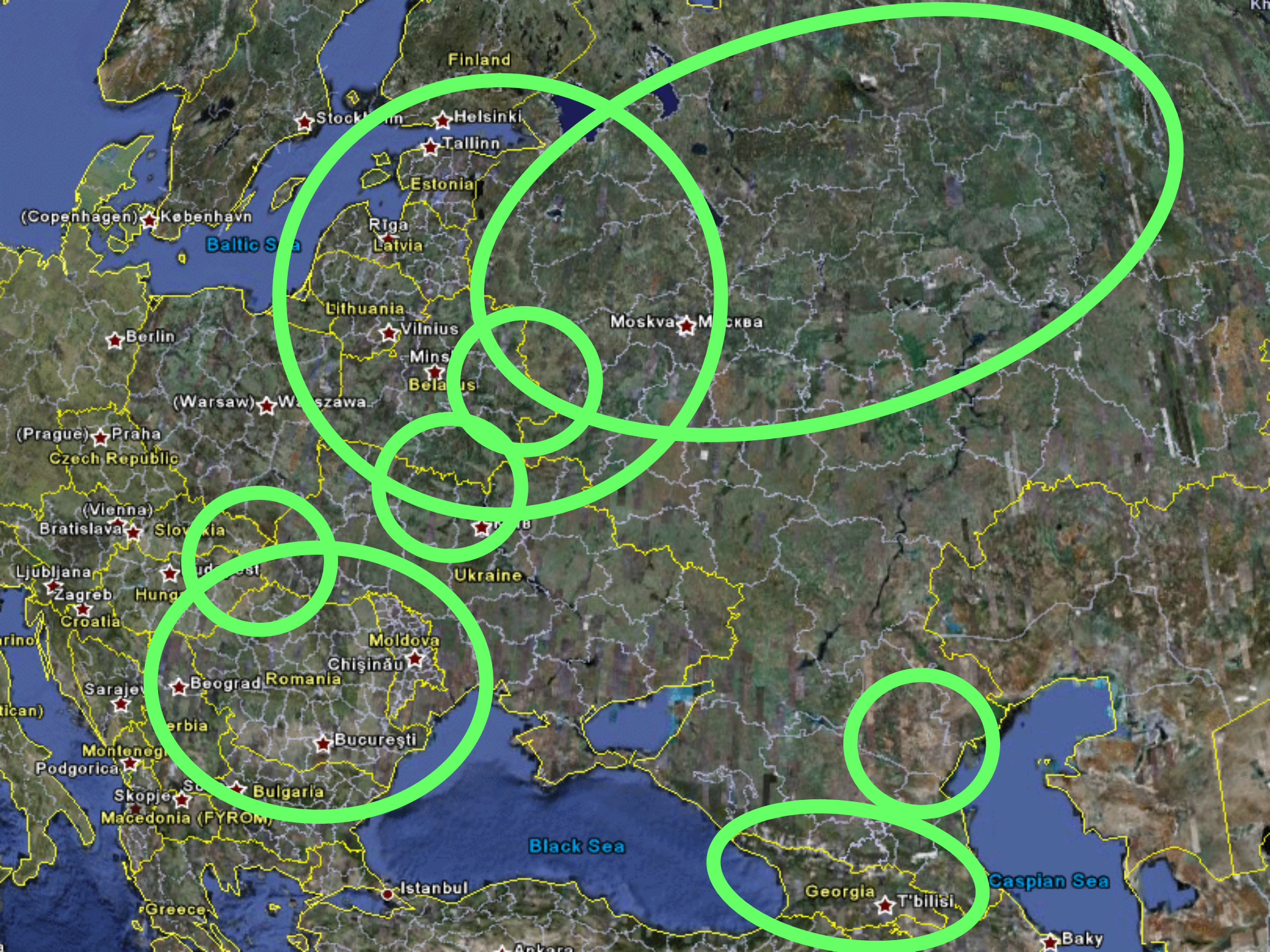
# 3. Rewilding

People

Land  
use

Environ-  
ment





## Conclusions

People

Land  
use

Environ-  
ment

- *Nations mattered, stark cross-border differences*
- *Disturbance triggered both abandonment and logging*
- *Carbon sinks, bears thrived, but saiga declined*

# Conclusions

People

Land  
use

Environ-  
ment

***1. How much do  
broad-scale drivers  
affect land use?***



# 1. Broad-scale drivers

People

Land  
use

Environ-  
ment



# Conclusions



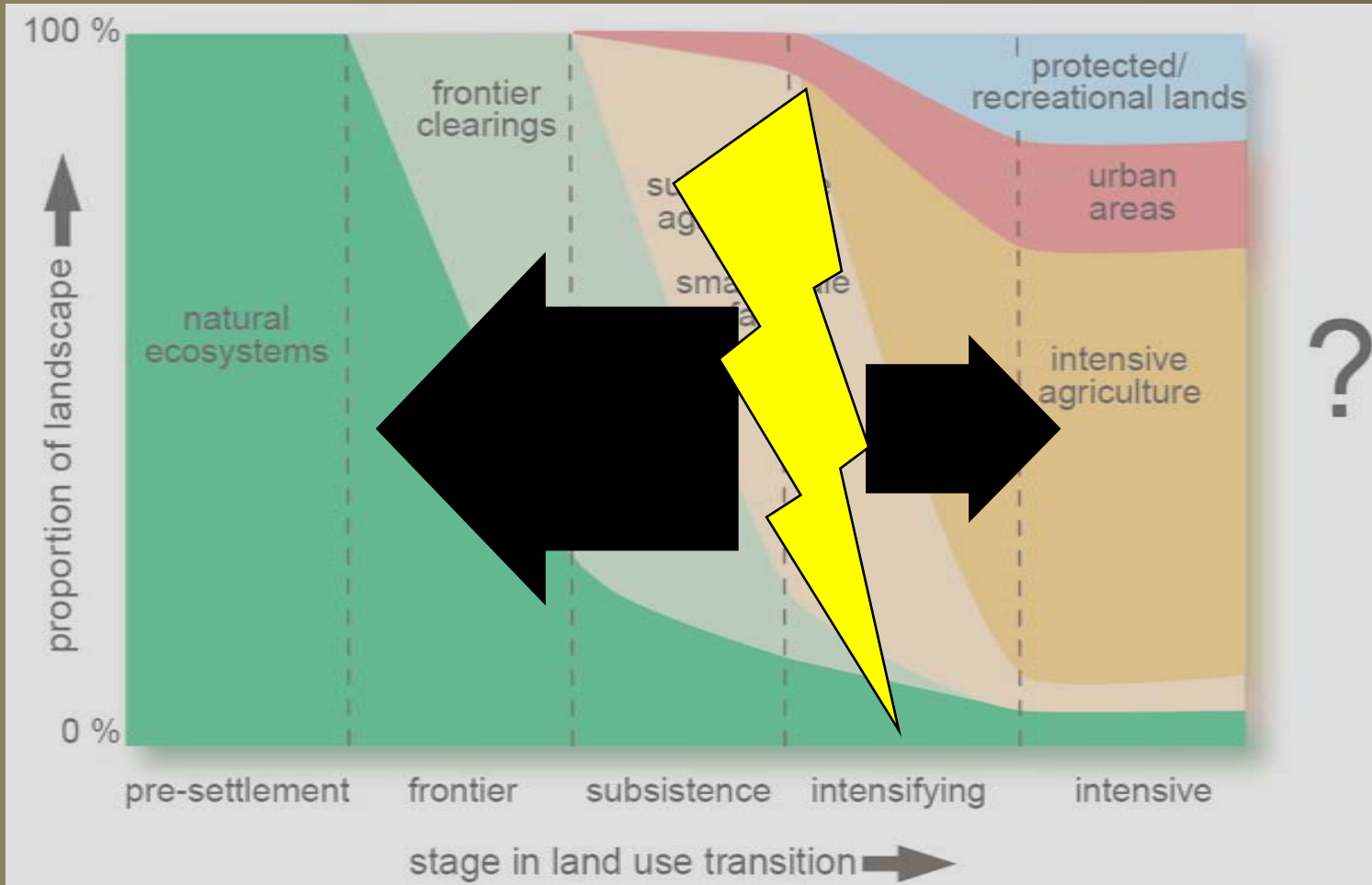
***2. How does disturbance affect land use?***

# 2. Disturbance

People

Land use

Environment



# Conclusions



People

Land  
use

Environ-  
ment

***3. What happens to the environment when land use subsides?***

# 3. Rewilding

People

Land  
use

Environ-  
ment



*Thanks to collaborators  
and graduate students!*



A large crowd of people is gathered in front of the Brandenburg Gate in Berlin. The gate is a prominent neoclassical monument with six Doric columns. The scene is set during the day under a clear blue sky. A flag is visible on a tall pole to the right. The crowd is dense, and some people are holding signs, including one that says "Test for all!". The text "Thanks to NASA LCLUC, ESSF and NIP !!" is overlaid in a large, white, bold, sans-serif font across the center of the image.

***Thanks to  
NASA LCLUC,  
ESSF and NIP  
!!***



***Thanks to you!!!  
radeloff@wisc.edu***