

Multi scale trend analysis for evaluating climatic and anthropogenic effects on the vegetated land surface in Russia



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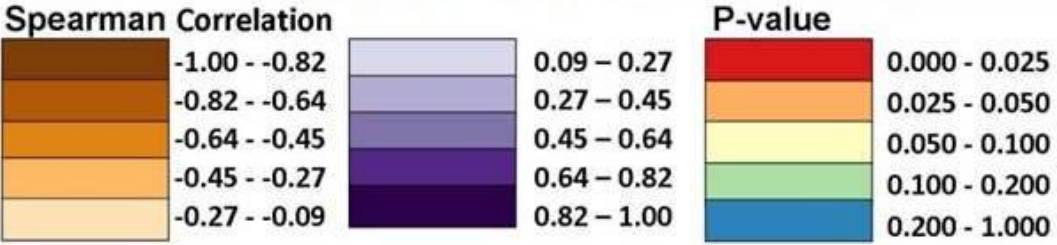
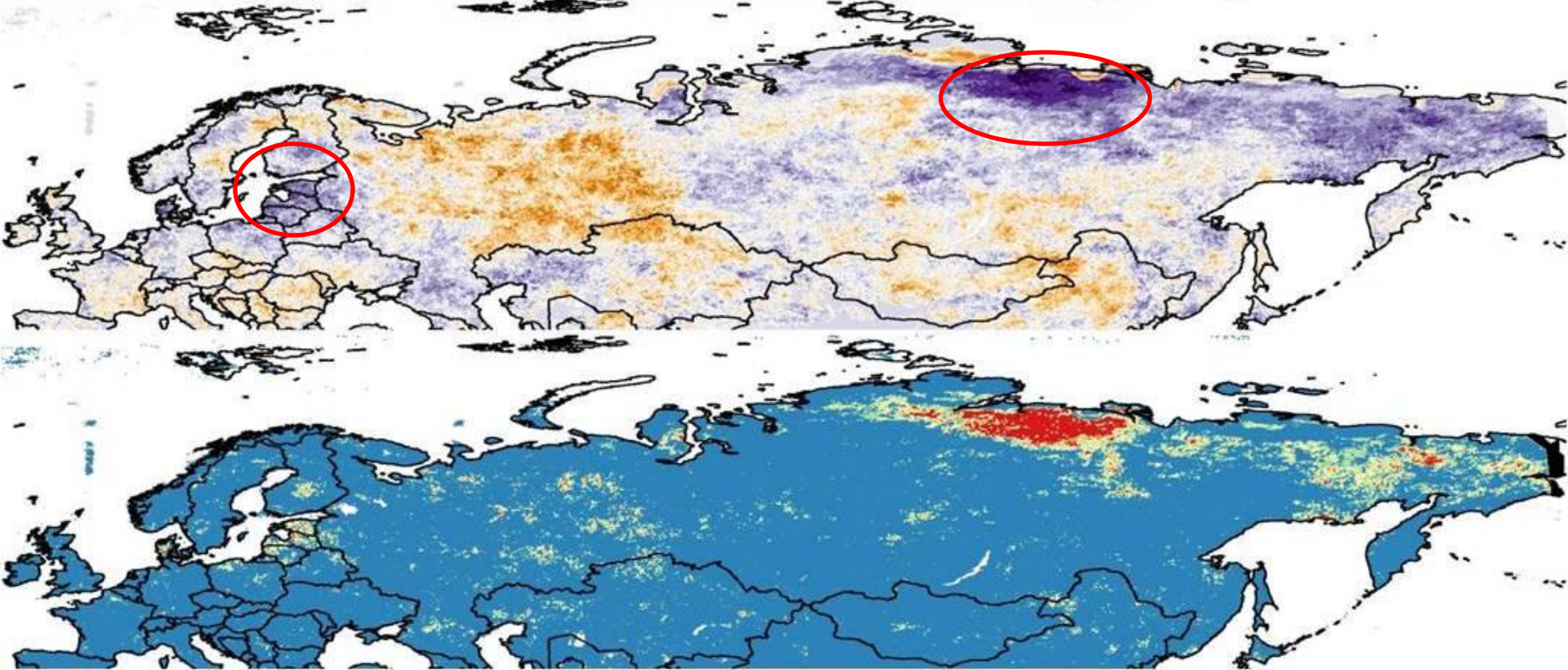
Ioannis Kokkinidis

Semiha Caliskan



Overview

- Coarse scale analysis: climatic effects →
 - Atmospheric Oscillations
 - Vegetation trend
- Moderate scale analysis: climate & human impacts
- Fine scale analysis: human impacts

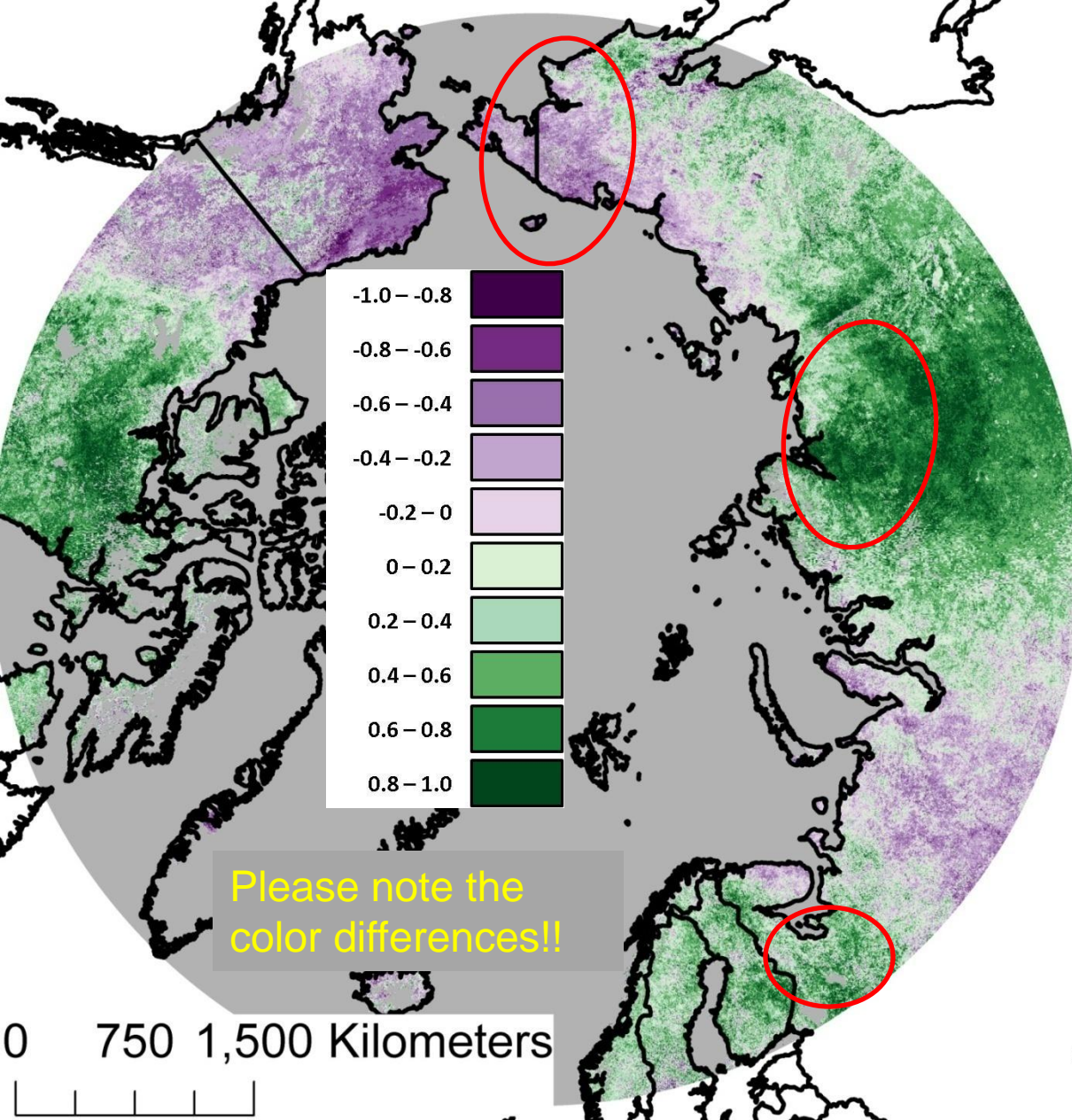


de Beurs, K.M., and G.M. Henebry. 2008. Northern Annular Mode effects on the land surface phenologies of Northern Eurasia. *Journal of Climate* 21: 4257-4279.

- NDVI data: GIMMS AVHRR
- AGDD data: NCEP NCAR reanalysis data (2°x 2° spatial resolution)

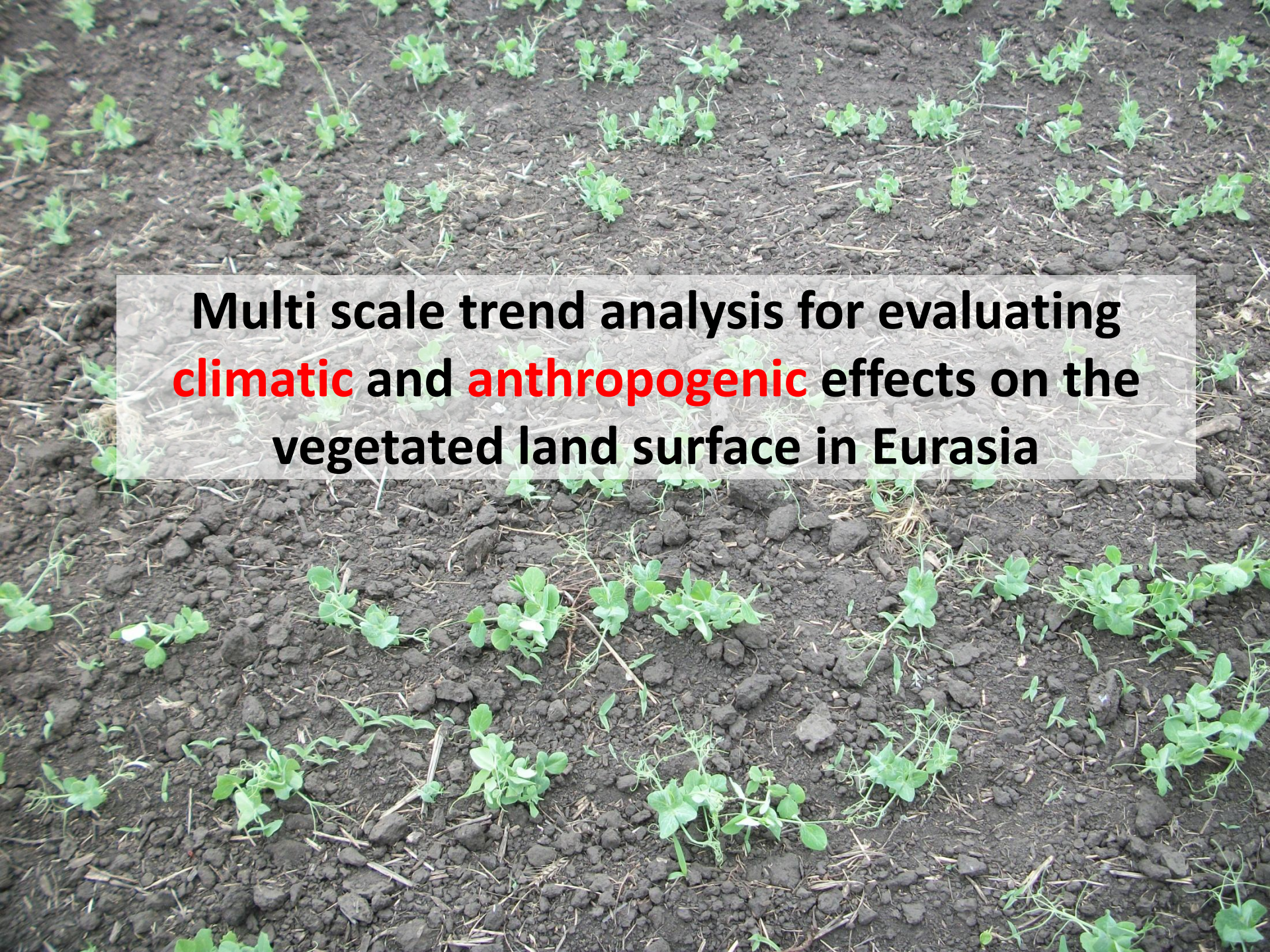
Correlation:
Peak timing x AO index

1985-1988 & 1995 - 1999

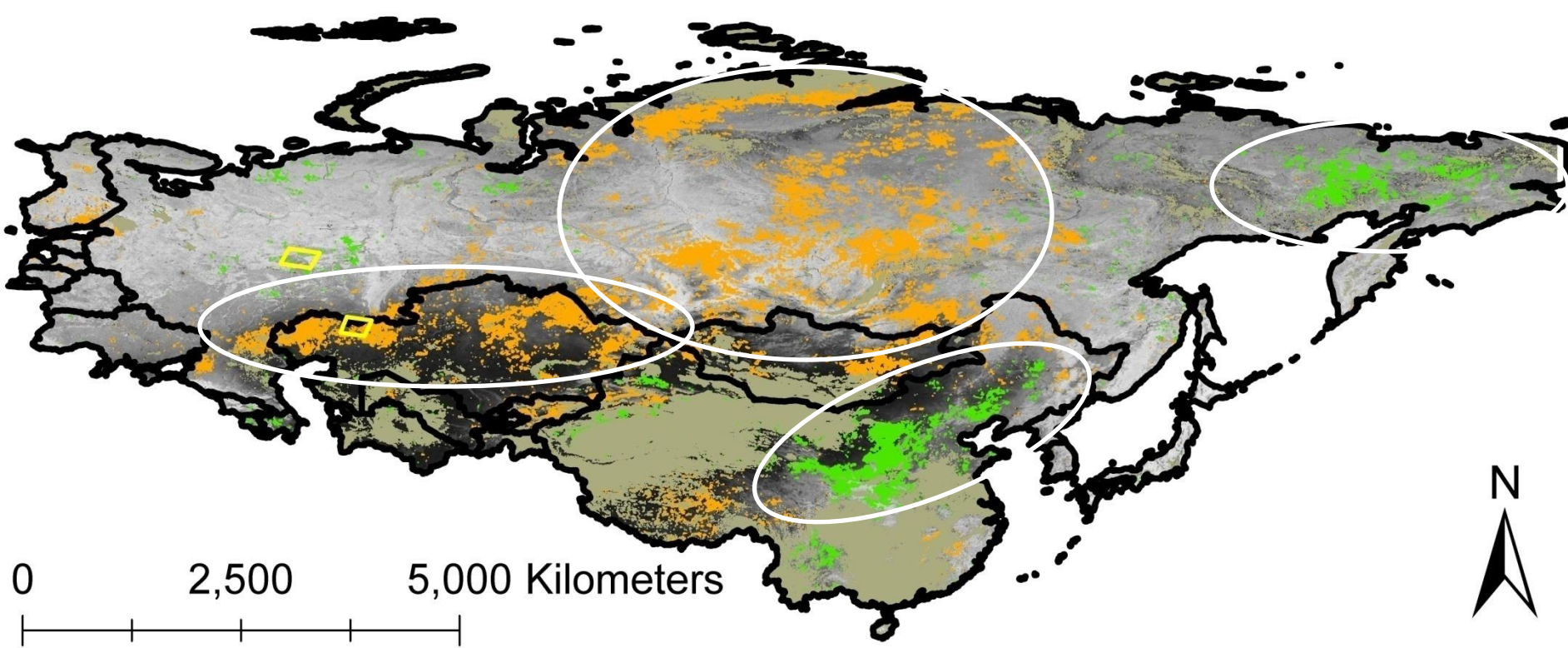


- NDVI data: MODIS BRDF
- AGDD data: created based on MODIS Land Surface Temperature data
- Rank correlation between NDVI peak timing and summer AO.
- Analysis based on MODIS data from 2000 – 2008.
- Encouraging results: despite different datasets and different time periods studied → similar correlation patterns.
- Pattern only deviates in far eastern Russia.

2000 - 2008

A photograph of a field with young green plants growing in dark, tilled soil. The plants are small and leafy, scattered across the field. The soil is dark brown and appears to be recently tilled, with some small clumps and debris visible. The overall scene is a typical agricultural or experimental field setting.

**Multi scale trend analysis for evaluating
climatic and anthropogenic effects on the
vegetated land surface in Eurasia**

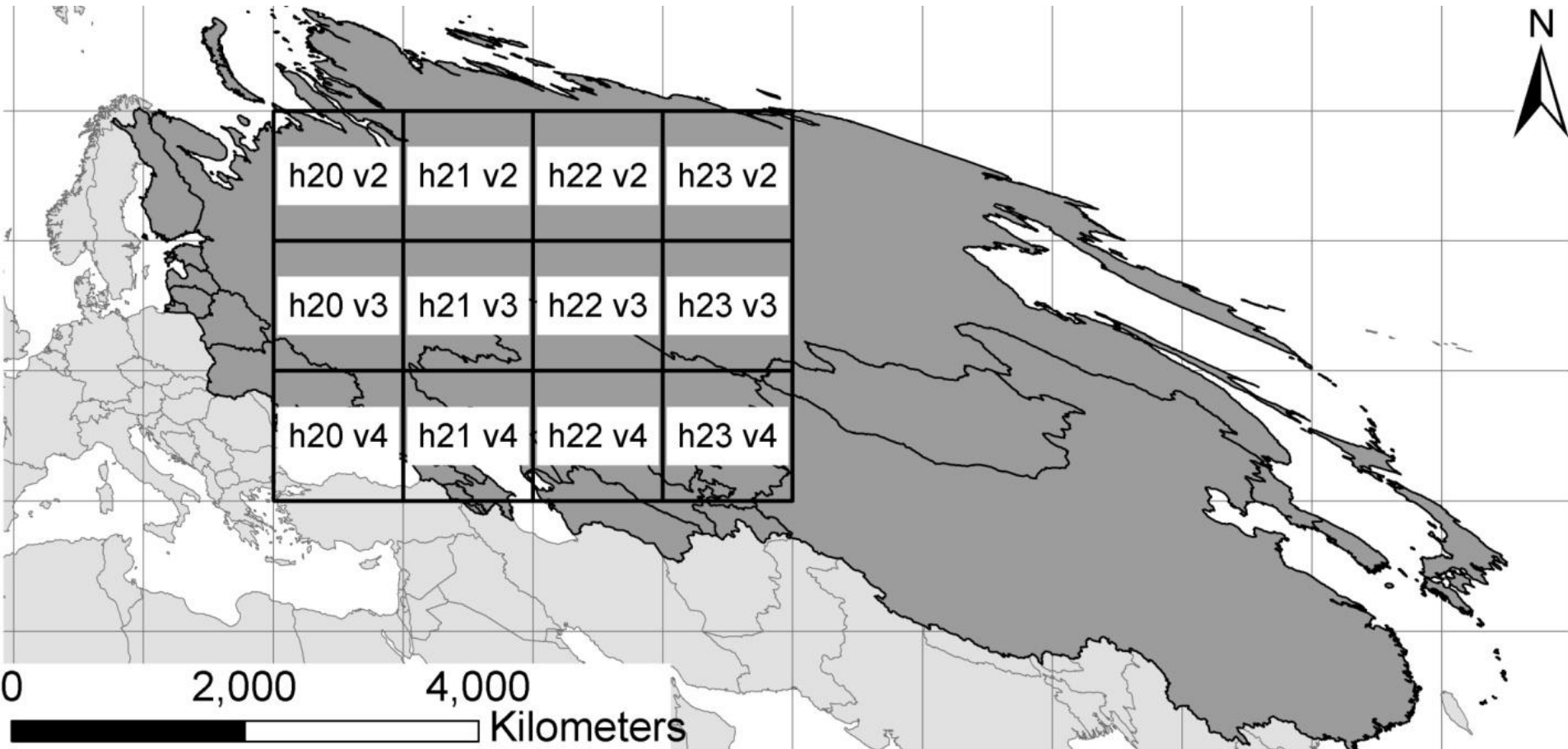


To guard against spurious trends, we present only highly significant trends having a *p-value of less than 0.01*.

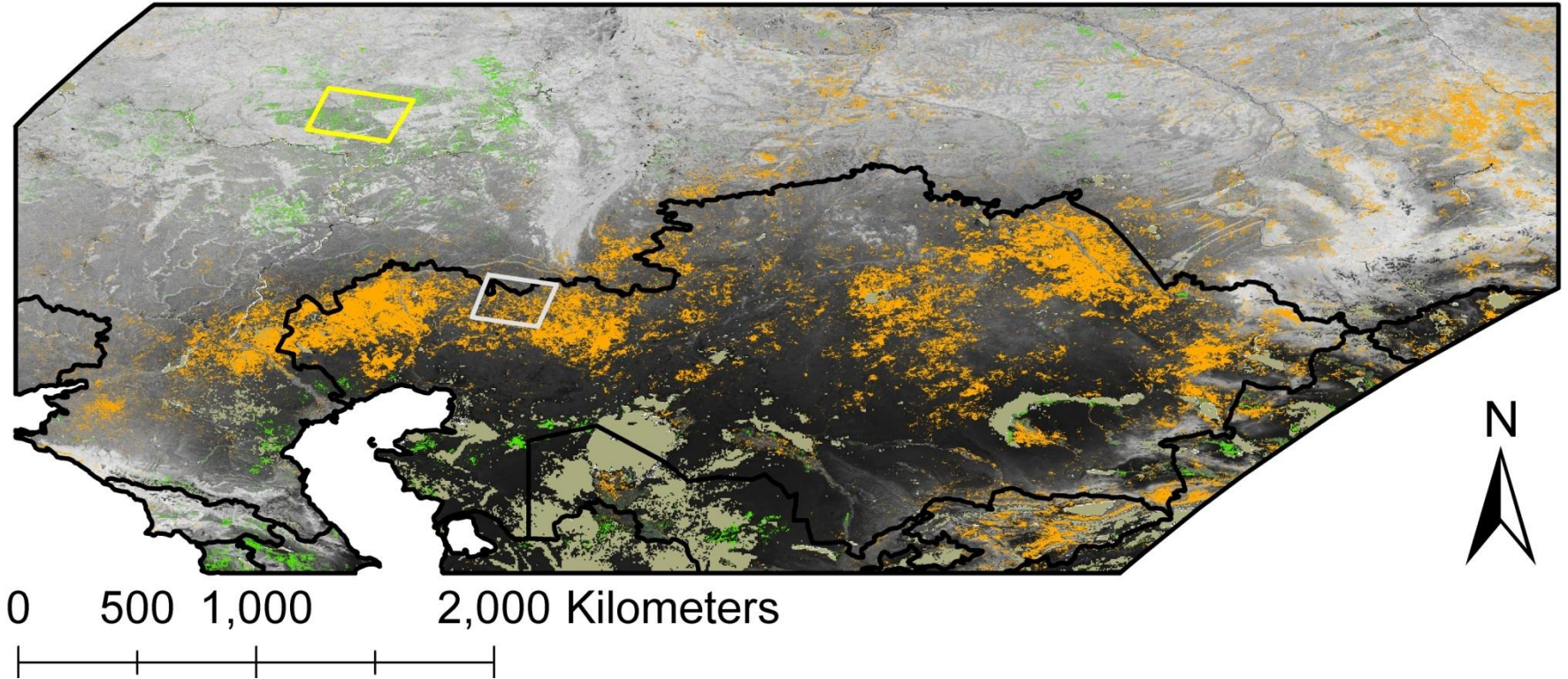
We found significant negative trends in 6.1% of the study region ($2.1 \times 10^6 \text{ km}^2$).

Highly significant positive trends appeared in only 2.4% of the study area ($0.82 \times 10^6 \text{ km}^2$).

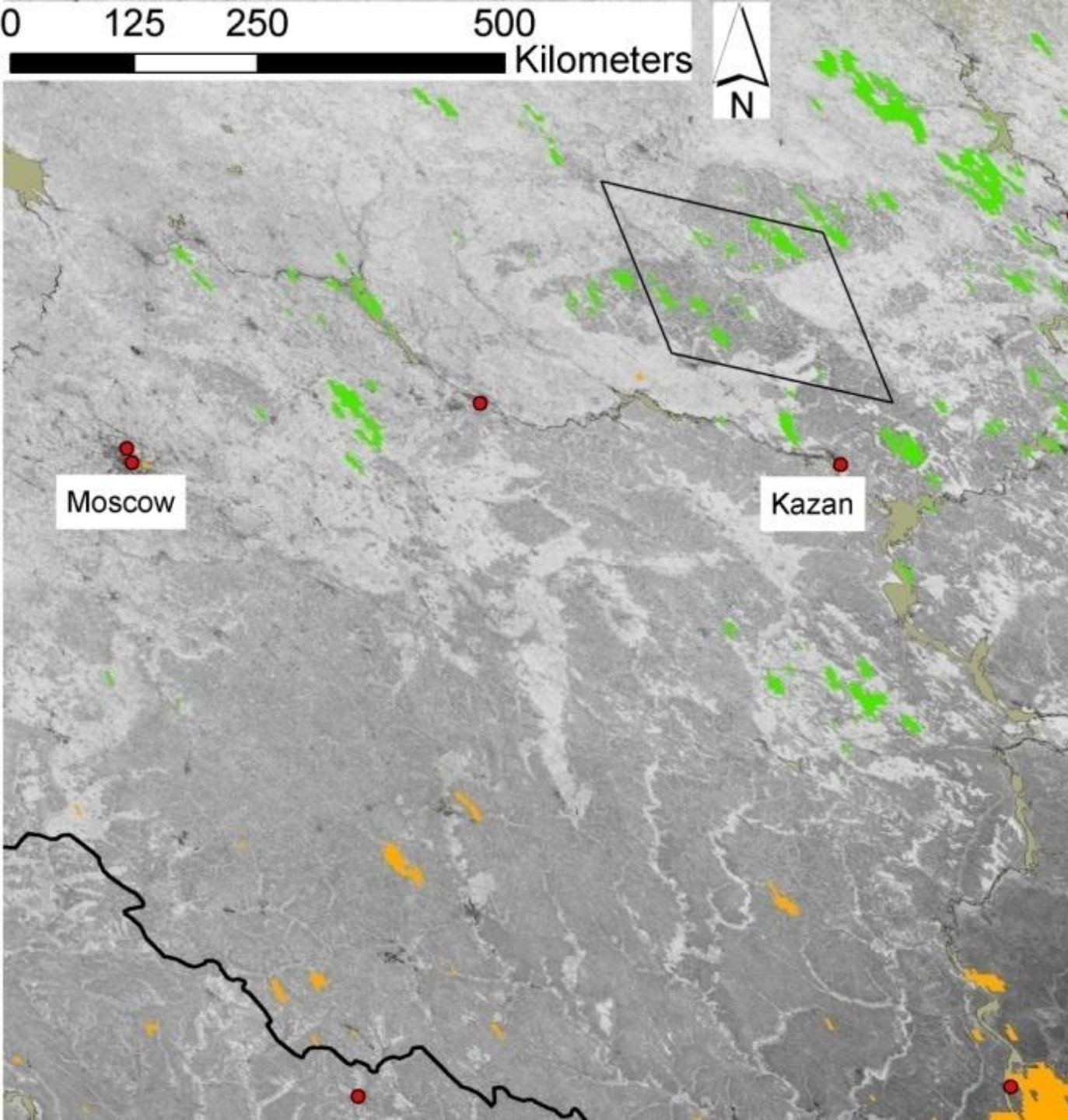
Investigate changes in more detail: 500m MODIS data



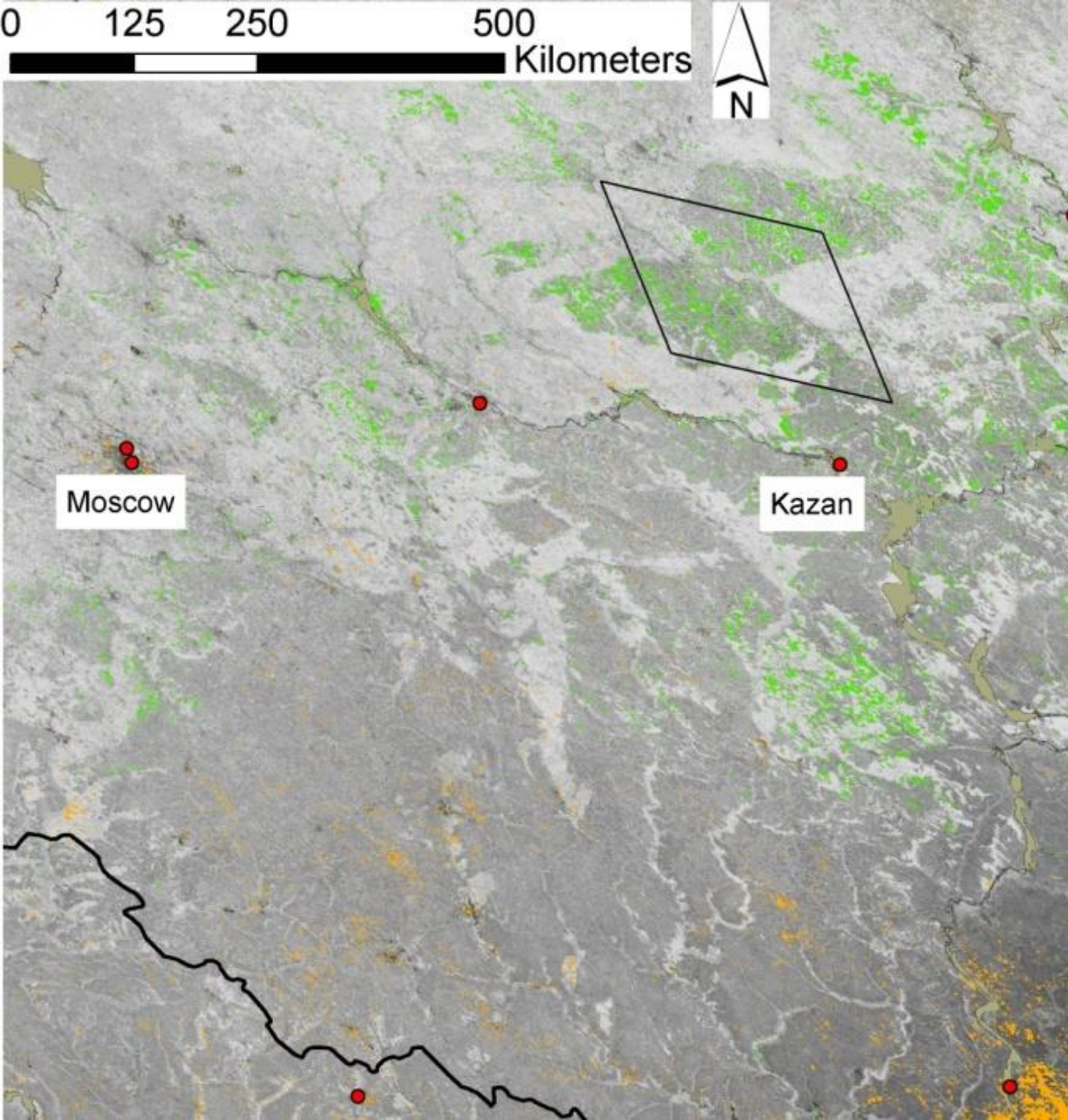
500m Trend Results



- Dusting of positive (green) and negative (orange) trends.

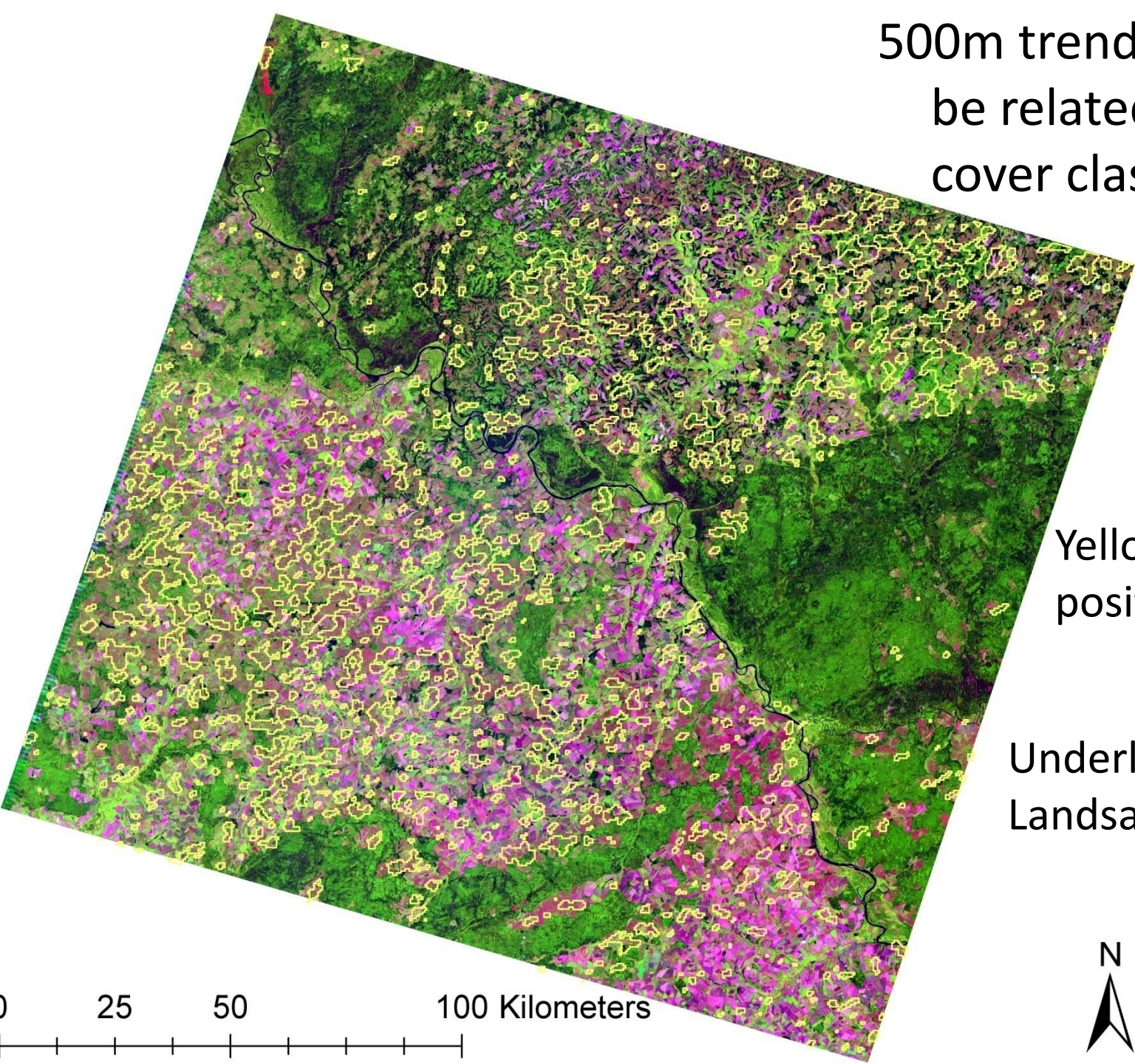


- 5.6 km (0.05°) NDVI trends
- Patches of positive and negative trends are visible



- 500m NDVI trends
- Patches of trends disappear and are replaced by “dustings”.

500m trends can easily be related to land cover classes.

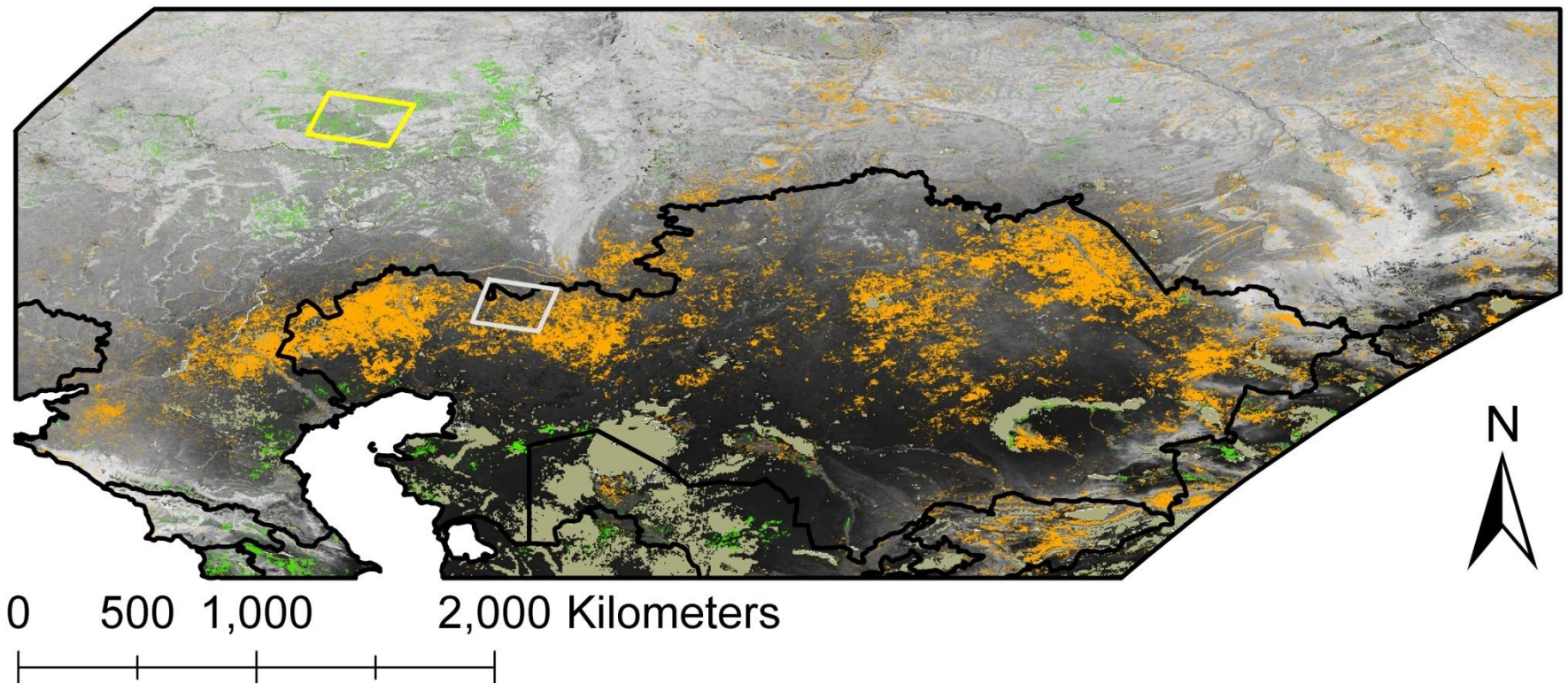


Yellow outlines:
positive trend

Underlying image:
Landsat TM 30m

0 25 50 100 Kilometers

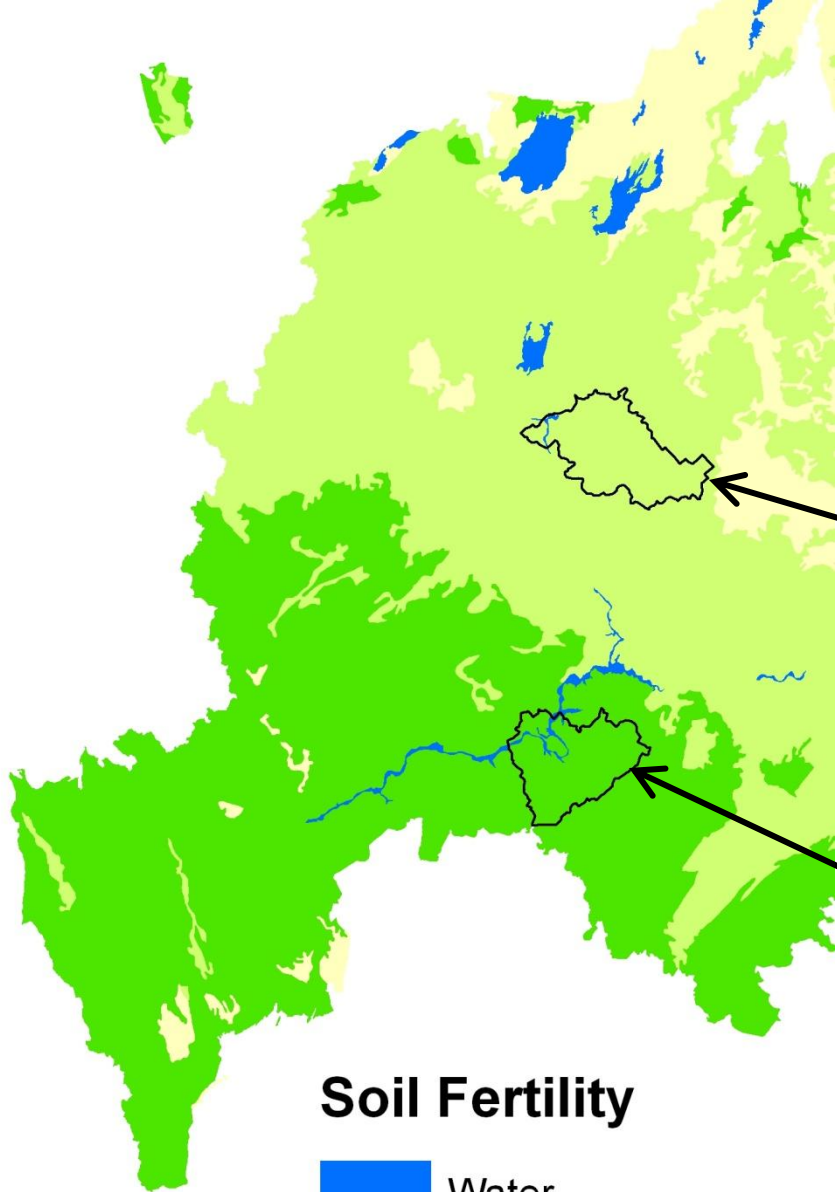





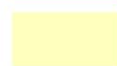
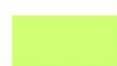

- Widespread negative trends are related to drought conditions.
- We believe that the positive trends are predominantly related to land cover changes: land abandonment

Preliminary Results from field visit May – June 2010





Soil Fertility

-  Water
-  Low
-  Moderate
-  High



Kostroma



Samara

Regional Scale Heterogeneity – Socio-economic analysis

- Agricultural development for Russia since 2000 reveals large heterogeneity.
- Rural populations changes are apparent but not negative everywhere and the change rates differ starkly.
- Changes are not uniform with respect to both crop and livestock developments.

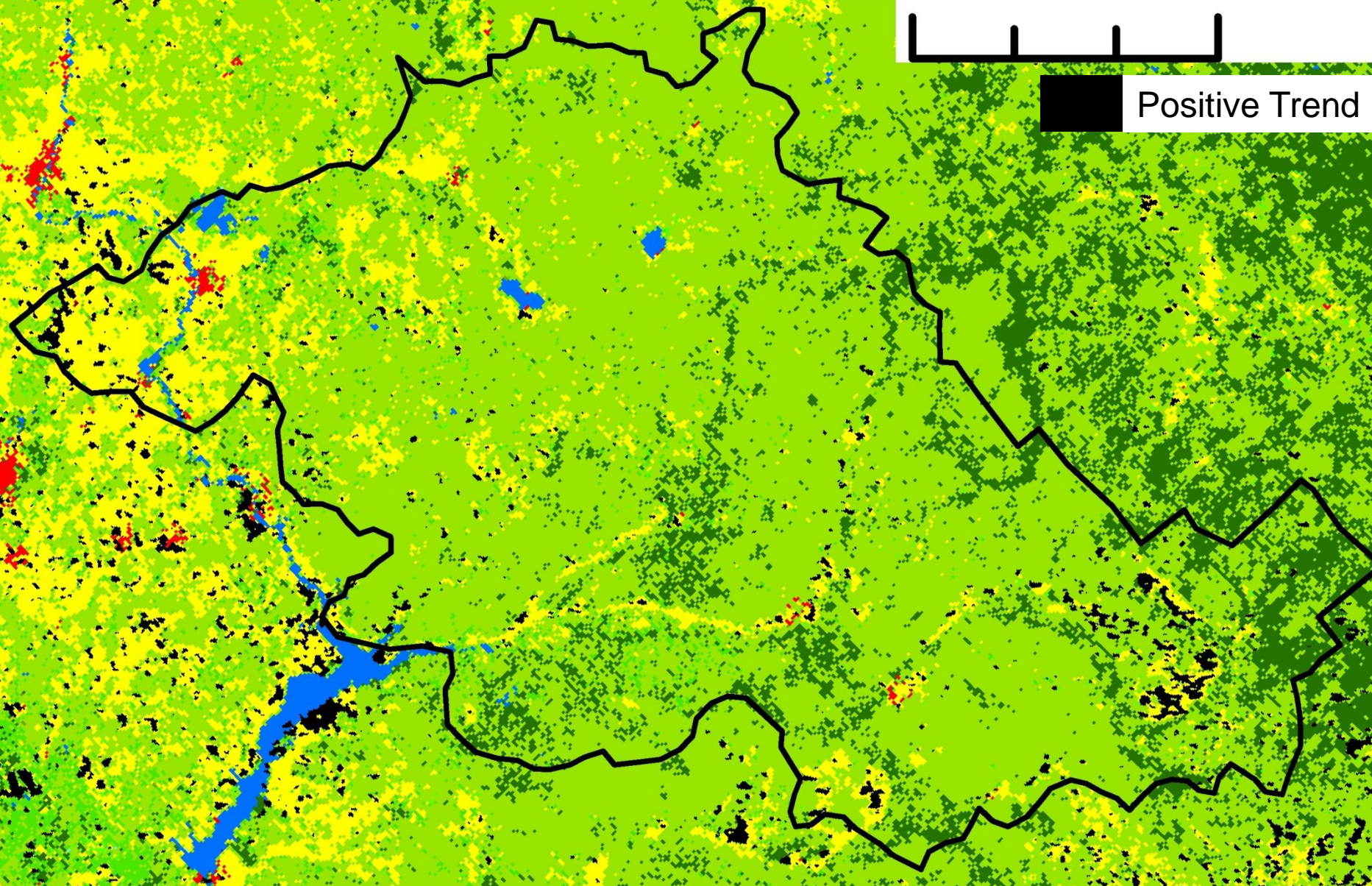
Kostroma



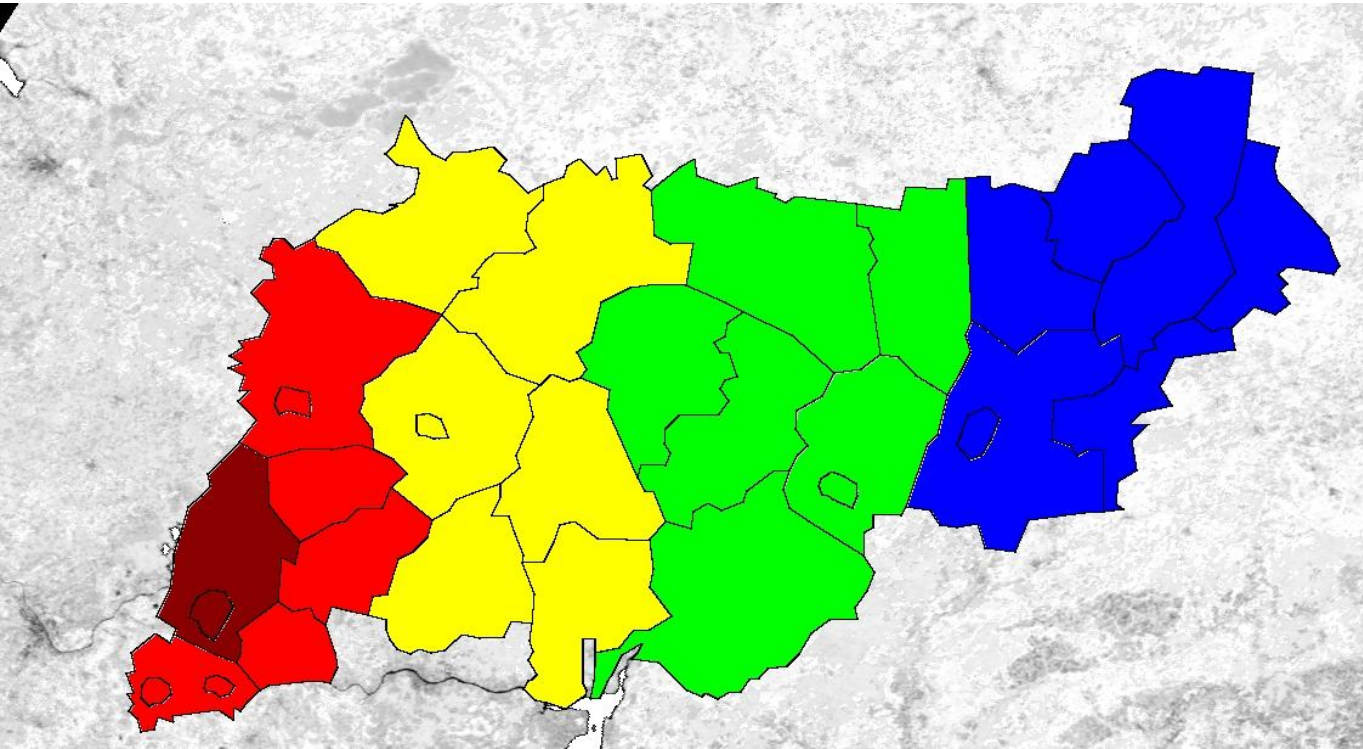
- Lots of abandonment.
- Many villages are abandoned completely.
- Others have only a few elderly people left.

0 50 100 Km

Positive Trend



Kostroma

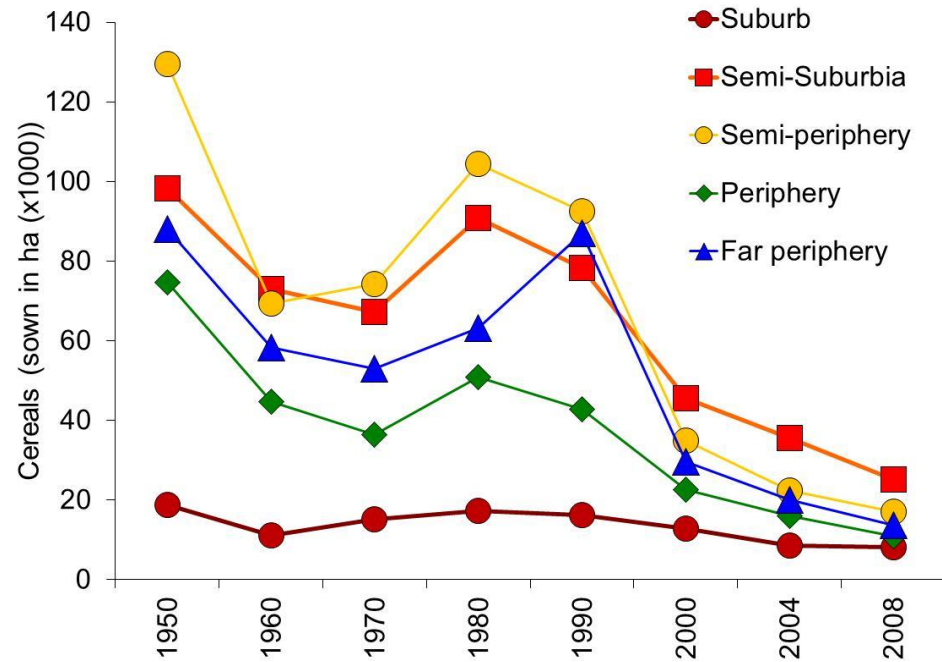
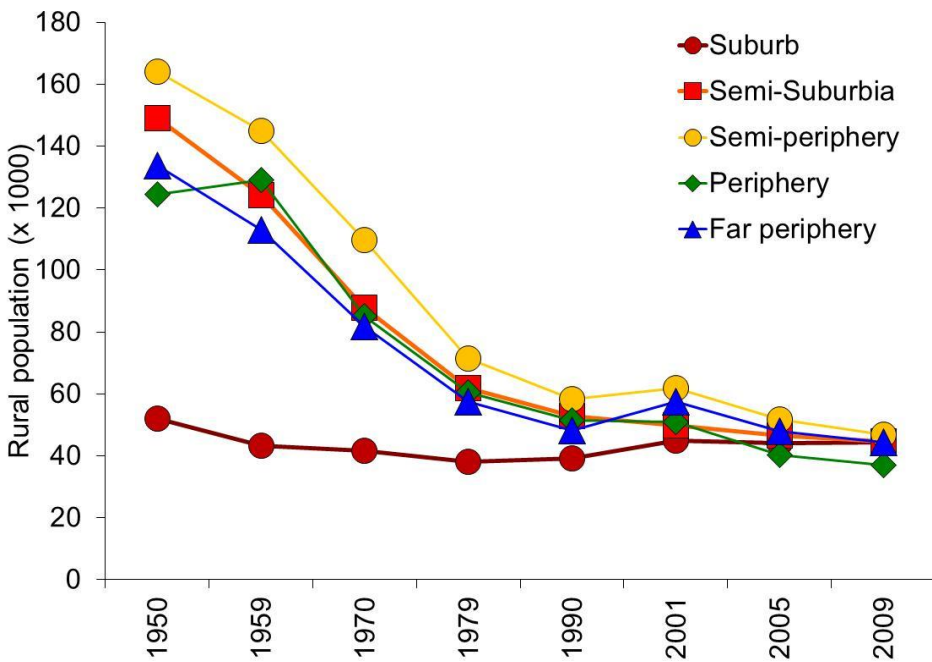


We grouped the administrative districts by distance from the city.

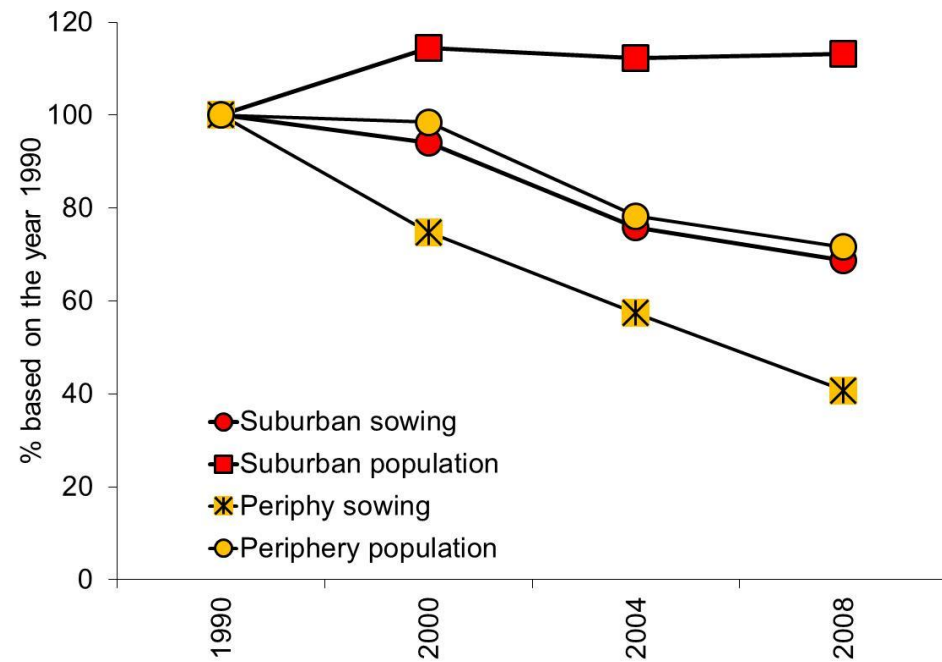
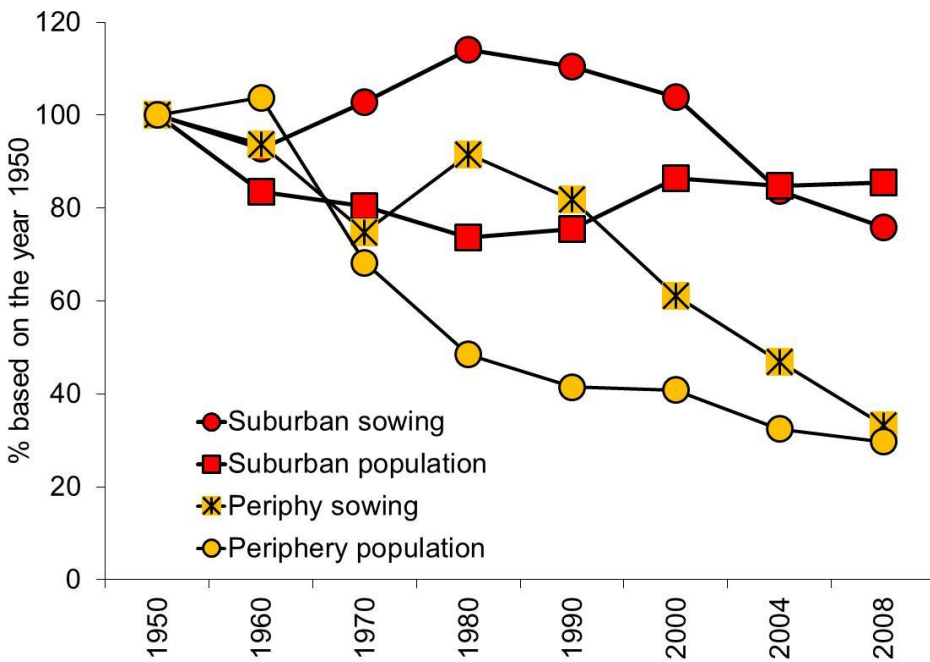
- Suburb
- 2nd order neighbors (semi-suburbia, Russian style).
- 3rd + 4th order neighbors (semi-periphery)
- 5th + 6th order neighbors (periphery)
- 7th – 9th order neighbors (far periphery).

Makarievsky and Kologrivsky rayons (periphery) and Manturovsky rayon (far periphery) were examined in detail in summer 2010.

(Nefedova, 2006).



- In the suburbs the rural population almost did not change since 1950 and in recent years even increased.
- All other areas are characterized by strong declines with maximum steepness between 1960-1980.



1960 – 1980:

- Increasing sown areas despite declining population.
- This only worked well in the suburbs, in the periphery, 100% was never reached.

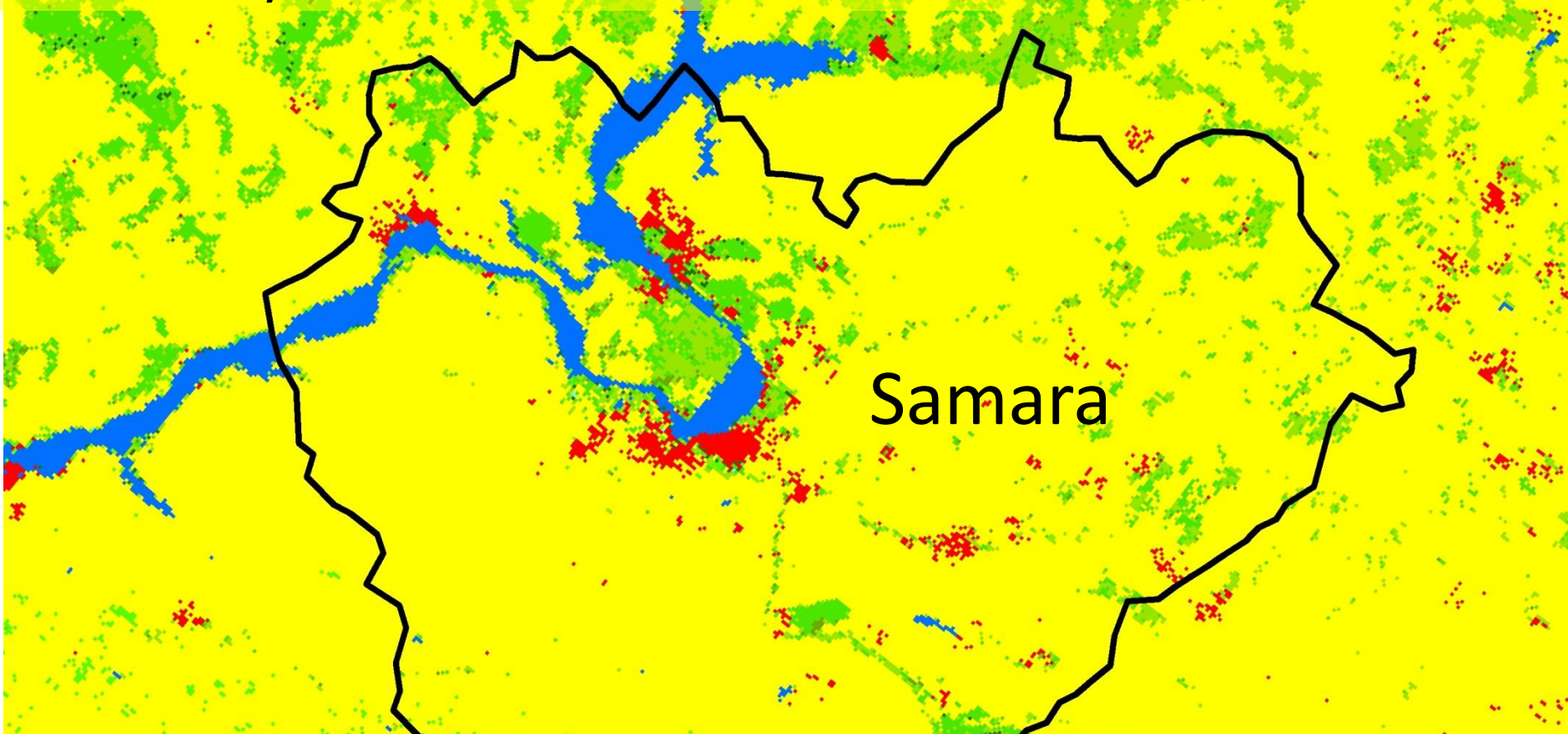
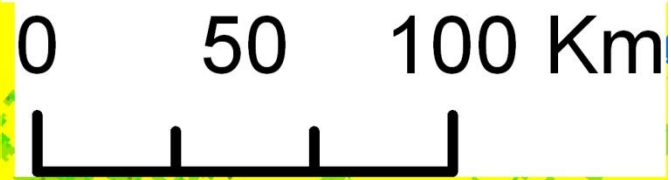
Since 2000:

- Population in the suburbs has stabilized.
- Seed dynamics are negative.
- Periphery population and sowing declined drastically.

Kostroma

- Kostroma city has a population of 270 thousand people and is the only city with a population of more than 100 thousand people.
- **Suburban-peripheral contrasts in population and agricultural economy.**
- Strong differences between the centers (with the zone of influence) and periphery regions
- The zone of influence of cities in rural areas depends on its population size.

- Agricultural lands occupy 67% of the territory and arable lands 51%.



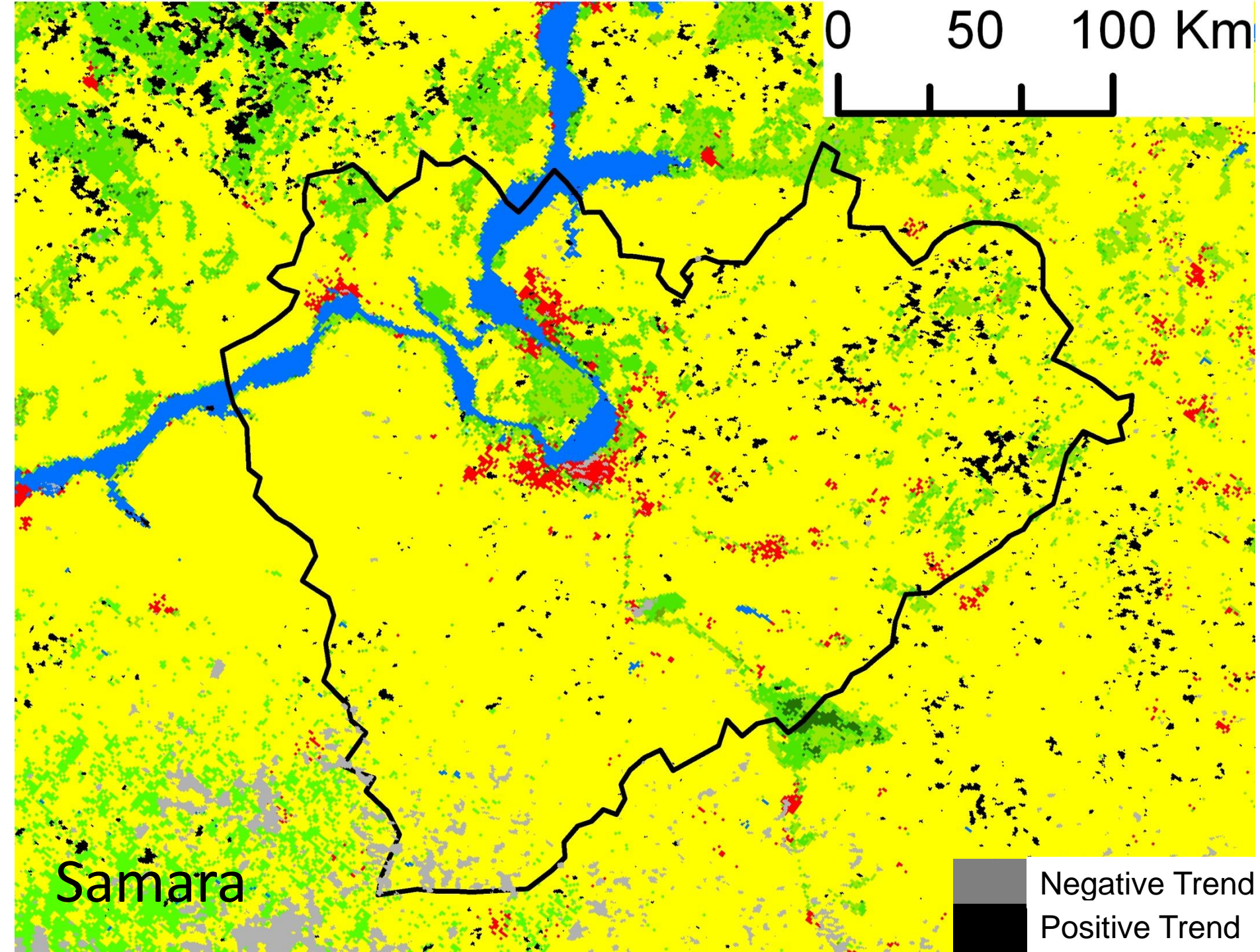
- Agriculture employs roughly 615,000 people.
- Samara is one of the main grain providers.
- Relatively favorable natural conditions, but periodic droughts especially in the southern regions.

Samara population dynamics

- Loss of rural population in the twentieth century was far lower than in other areas.
- By 2009, Samara retained 72% of the rural population of 1959 (Kostroma only retained 40%).
- In the 1990's Samara region was very attractive to migrants. The maximum inflow in the countryside was in 1994-95: net migration was 152 people / 10,000 rural population.
- Migration contributed to the rural population being relatively young, active and easily adapting to changing conditions.

Samara Agriculture

- Since 1997, agriculture is growing (except in 1998).
- Agriculture area is gradually emerging from the crisis, but it is changing its sectoral and territorial structure.
- There was a clear shift from livestock to crop farming:
 - the proportion of crop growing in the Samara region rose from 41% in 1991 to 60% in 2003.
 - cattle loss from 1,012,000 to 212,000



Contrast in ethnic make-up is important:



- In some areas (mainly north-east), the share of the Russian population is less than half.
- Highest percentage of Chuvash population and increased proportions of Mordvin and Tatar.
- In the southern steppes, ethnic Russians predominate, but in some areas there is an increased share of Bashkir and Kazakh.

Samara



- Drought is the main issue.
- Commercial cattle almost completely disappeared (production costs = sales price).
- Crop farming appears to grow (slowly).
- Crops are changing.

Entrepreneurs
are active in
various areas



Conclusions



Global Change is an ongoing multifaceted phenomenon

- Change is evident in a range of different changes across the land surface.
- Over the last two decades, plant responses to climate change appeared somewhat straightforward: increasing temperatures → increasing vegetation productivity and longer growing seasons.
- Recently, reversal of vegetation productivity: increases in disturbance exacerbated by climate change.
- More than 3 times as many negative NDVI changes than positive NDVI changes since 2000.

Dual scale analysis uncovers multiple trends that would be impossible to reveal at a single scale:

- Finer scale analysis reveals trends that are more relevant to human decision-making and regional economics.
- Fine scale changes may disappear at the courser scale resolution as a result of mixed pixels.
- It would NOT be right to argue that these finer scale changes are not relevant or significant.

Russia Land Abandonment

- Russia is often treated as a unified whole, especially with respect to agricultural reform → large regional diversity exists.
- Land abandonment is not occurring randomly or unexpectedly → it is preceded by persistently low crop yields → declining rural population density.



Thank You!

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