AGRICULTURAL CHANGES IN EUROPEAN RUSSIA

Implications for Food Security

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CHANGES TO RUSSIA'S AGRICULTURAL SYSTEM

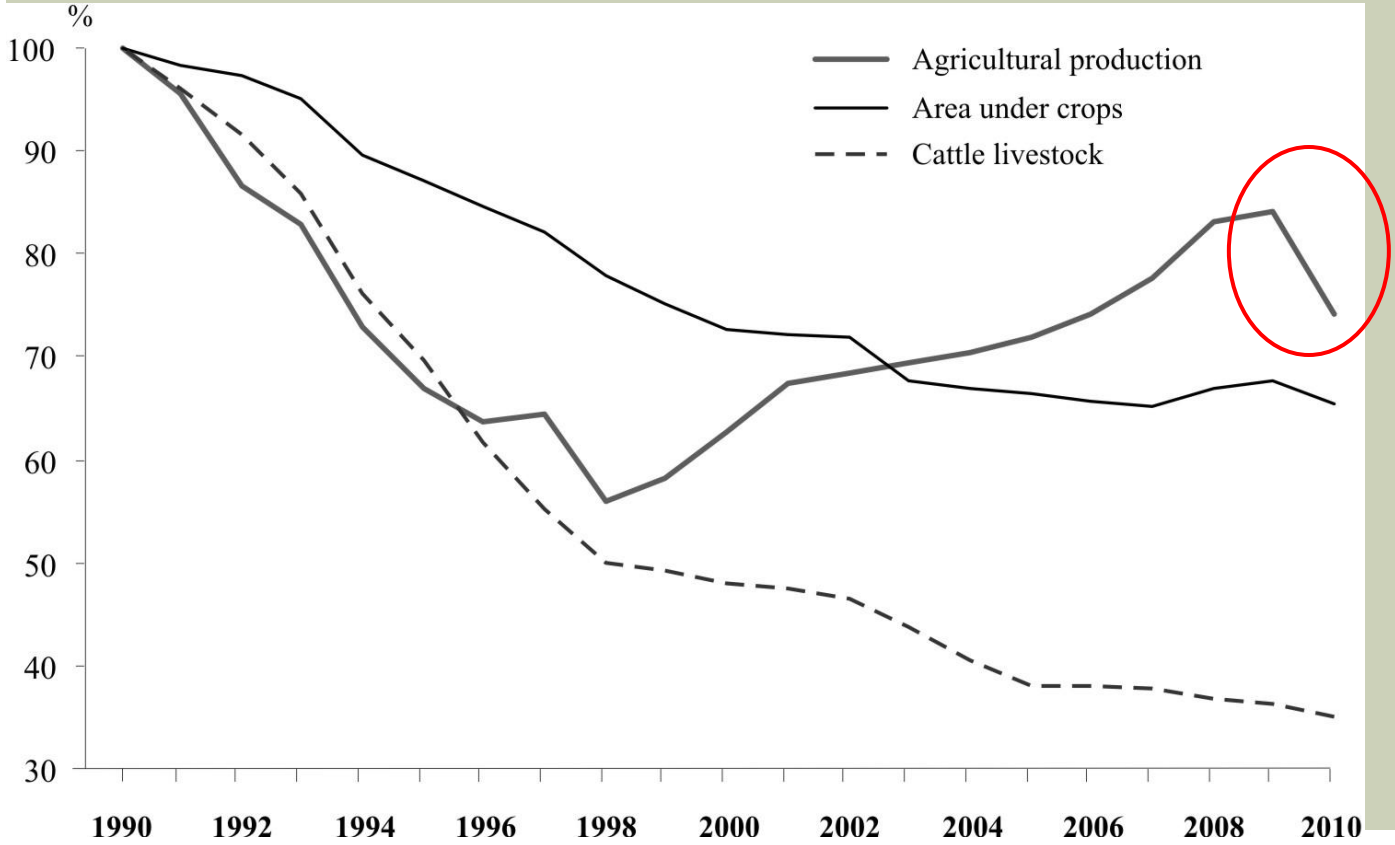
- In recent years three concurrent trends have occurred within Russia's agricultural system:

1. A significant rebound in production (grains)
2. The emergence of food security as a guiding principle of agricultural policy.
3. An increase in Russia's food exports (specifically grains) making Russia a major player in global food trade.

Wegner, 2013.

AGRICULTURAL DYNAMICS IN RUSSIA

- Agricultural production has rebounded from the lows of the 1990s.



2010 drought in Russia led to significant grain losses

Harvest was ~ 30% below original projections

Ioffe et al. 2013

RUSSIA'S AGRICULTURE AND GLOBAL FOOD SECURITY

Winter 2010 and 2011 →

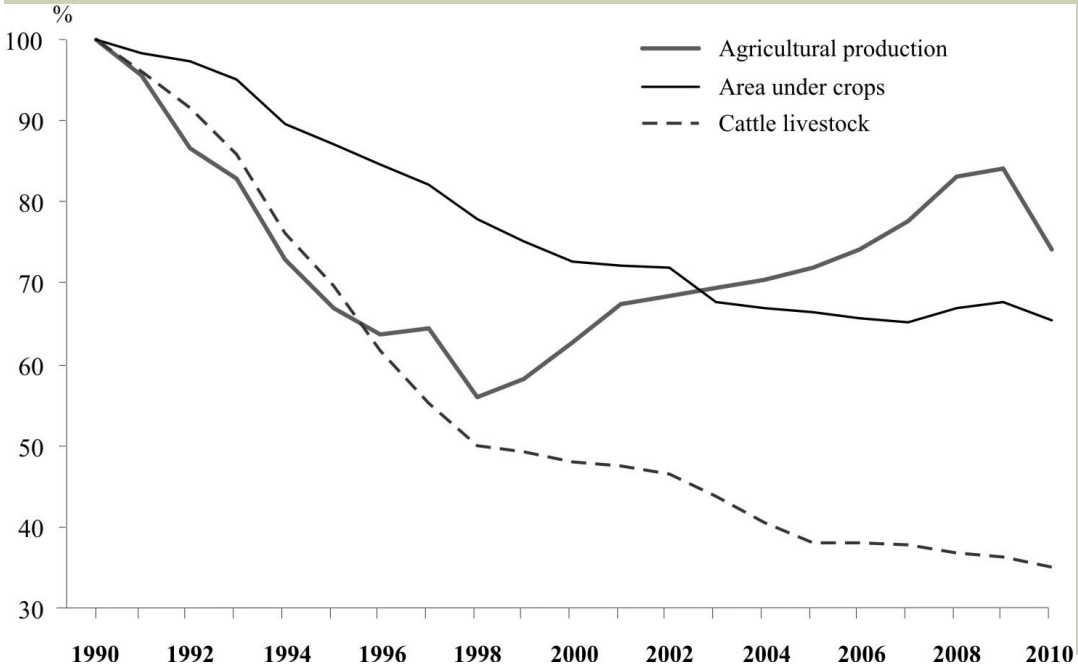
- China was struck by a "once-in-a-century" drought.
- Wheat production in Russia, Ukraine fell dramatically due to drought and wildfires
- Wheat production in Canada fell due to a abnormal cold.
- Global wheat supplies constricted → the Egyptian government failed to balance subsidies and market prices with public needs.

At the time of the uprisings in early 2011, food prices had increased by 20 %, and ~ half of the population (40m)– were receiving food rations.

Johnstone and Mazo, 2013

FOOD SECURITY AND CLIMATE CHANGE

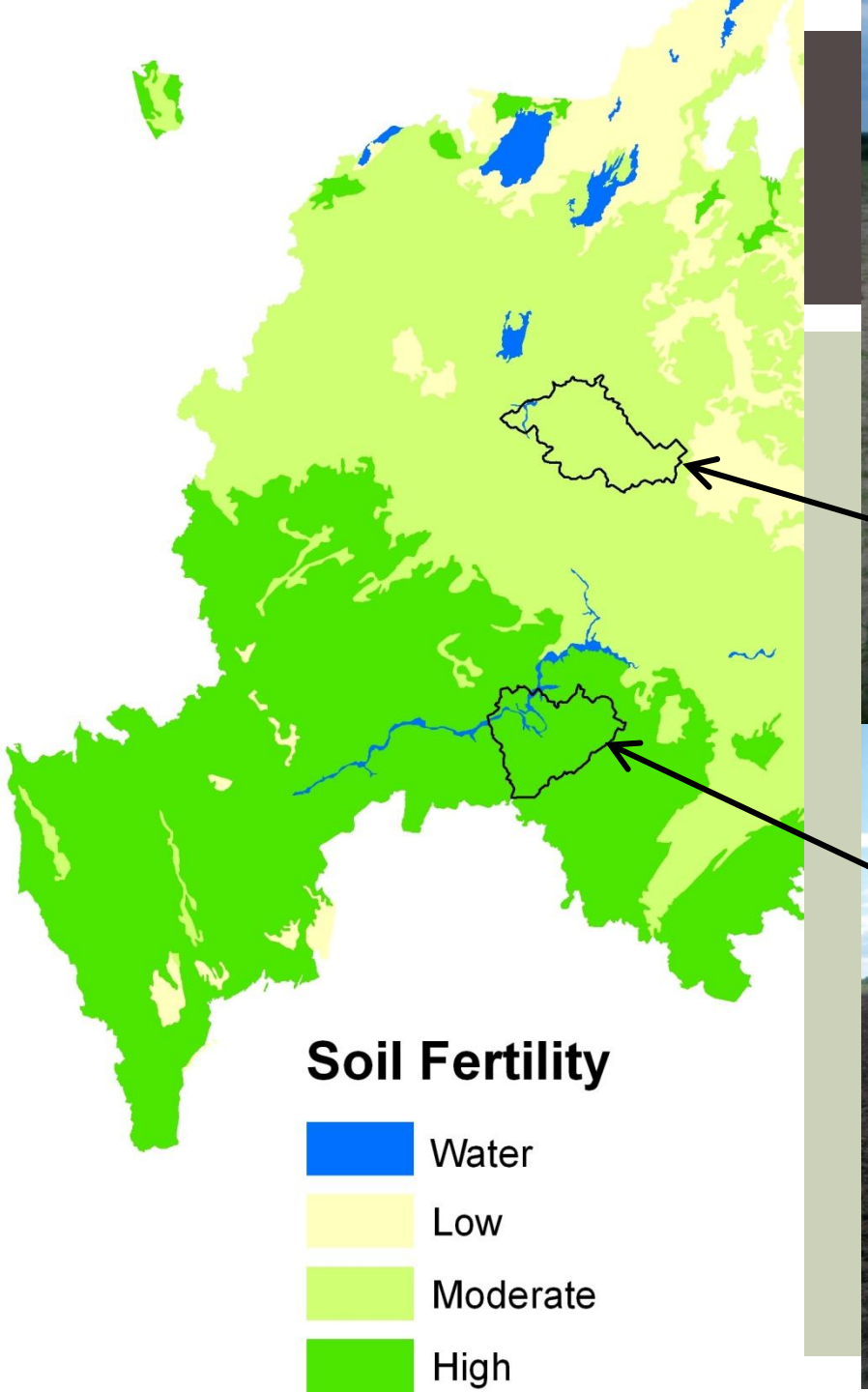
- … under climate change, the biggest losses in suitable cropland are likely to be in Africa, whereas the largest expansion of suitable cropland is in the Russian Federation and Central Asia **Schmidhuber and Tubiello, PNAS (2007).**



- Is this correct?
- Russia is large → what are the spatial variations?
- Can we understand what has changed since 2000?

Ioffe et al. 2013


Study Region:
Rural European Russia
with regional focus areas
Kostroma
Chuvash
Samara
Stavropol
Poland
Turkey
Turkmenistan
Iran

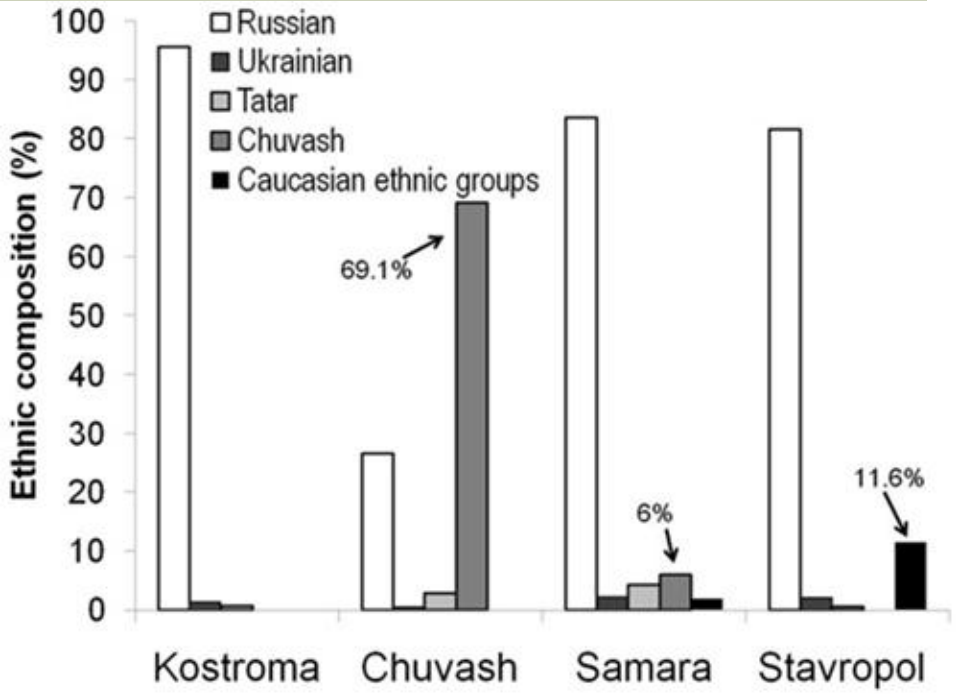

Soil Fertility
Water
Low
Moderate
High


Kostroma

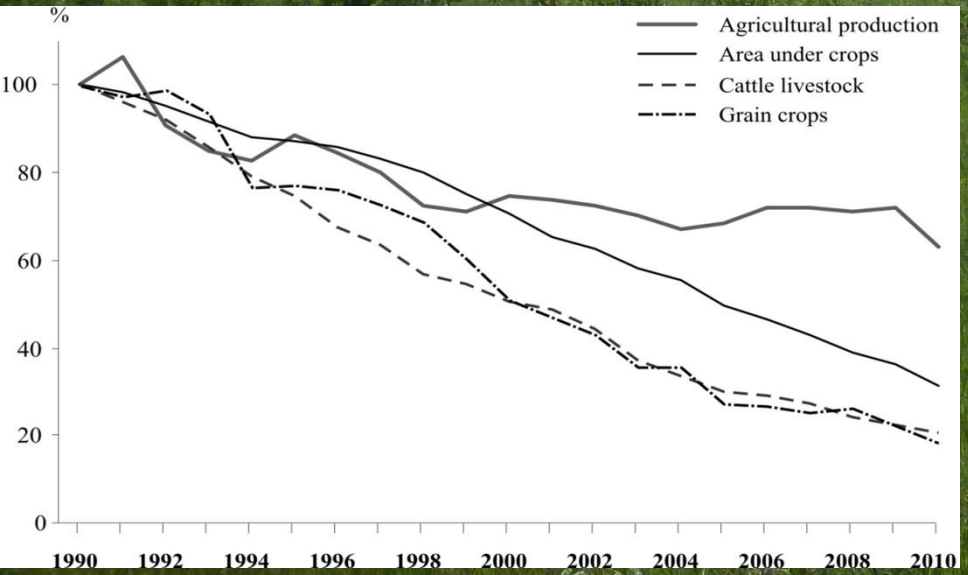

Samara

RUSSIA'S POPULATION DECLINE

- Russia's population is projected to shrink by 29% by 2050.
- There are different dynamics among rural populations which are correlated with ethnicity.
- Population dynamics constitute a key driver in the spatial disintegration of rural Russia.

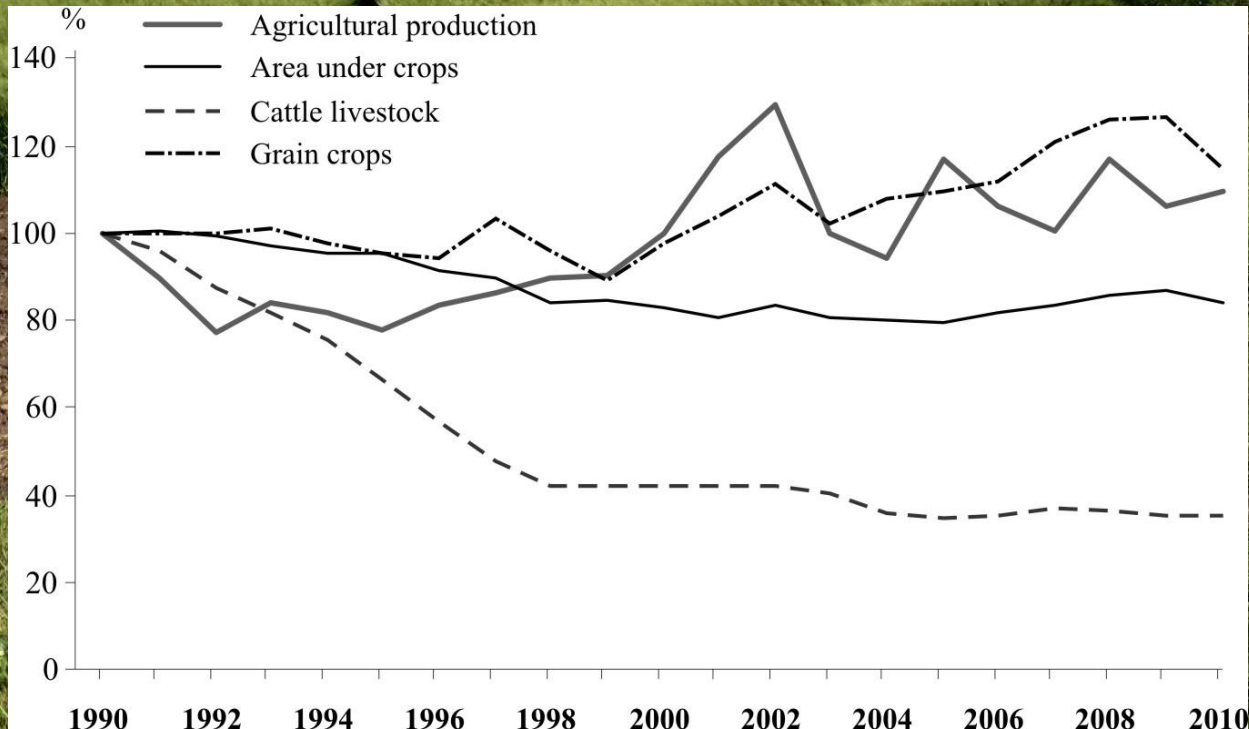


AGRICULTURAL DYNAMICS IN KOSTROMA



Ioffe et al. 2013

AGRICULTURAL DYNAMICS IN STAVROPOL



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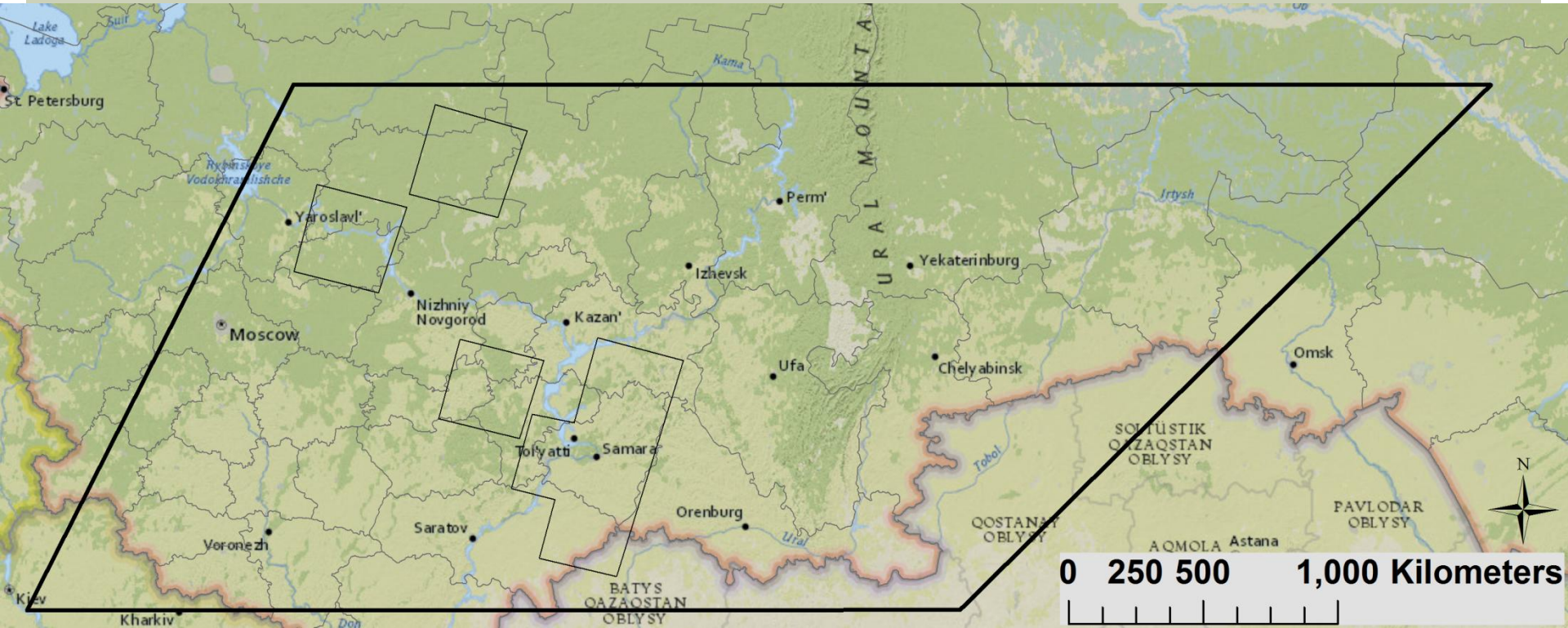
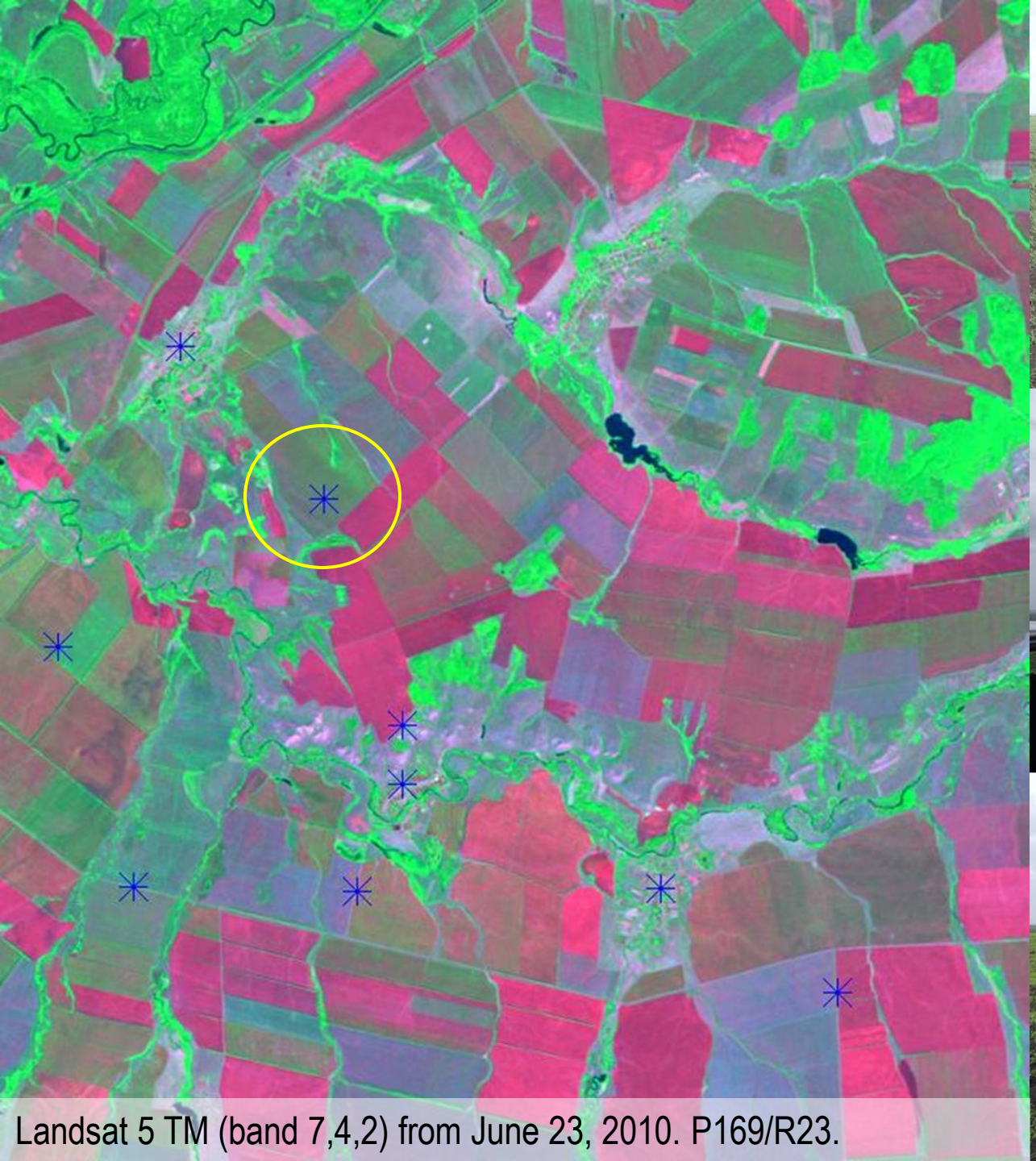
SATELLITE IMAGERY

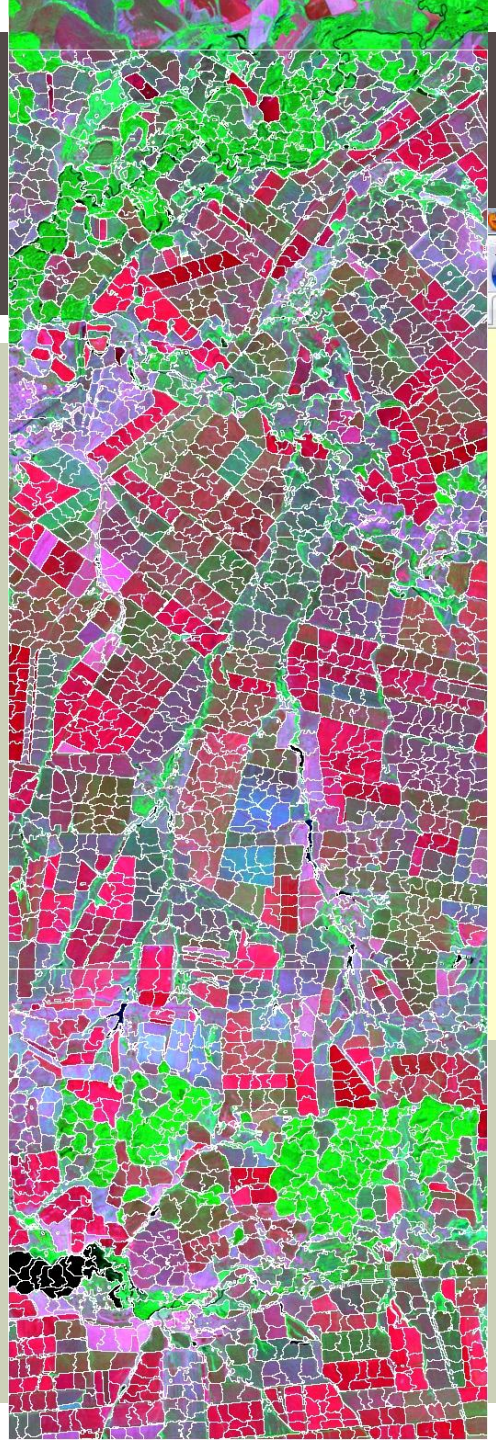
- MODIS Land Surface Temperature
- MODIS BRDF Adjusted Reflectance data
- Landsat land surface reflectance

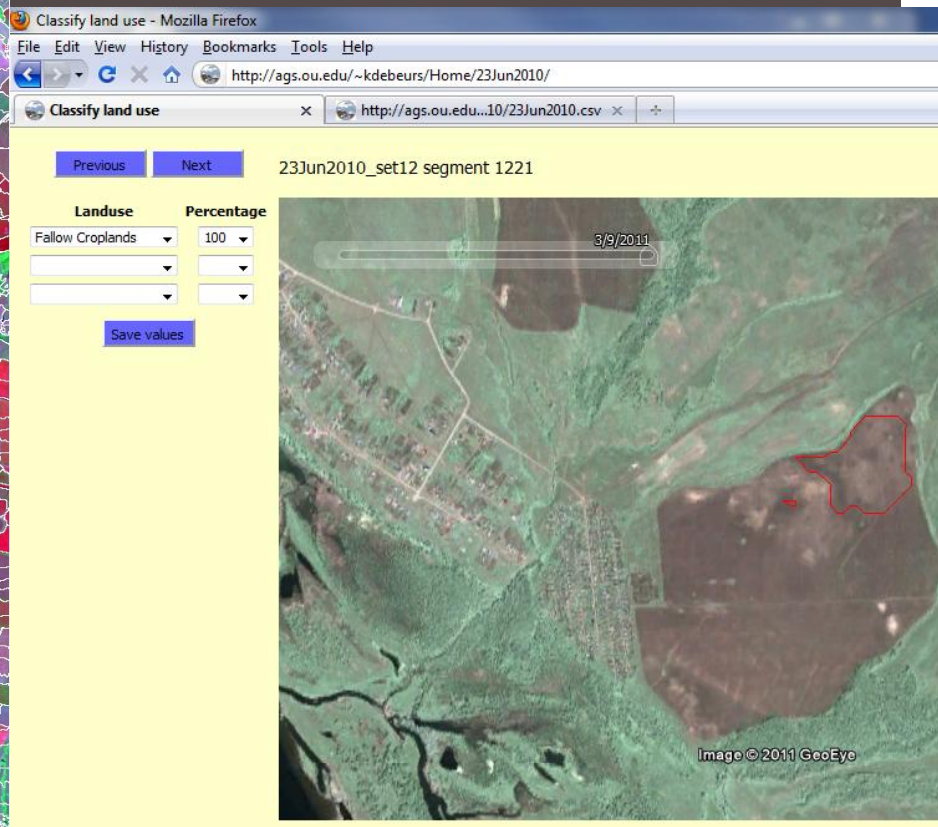




Landsat 5 TM (band 7,4,2) from June 23, 2010. P169/R23.

May 25th, 2010



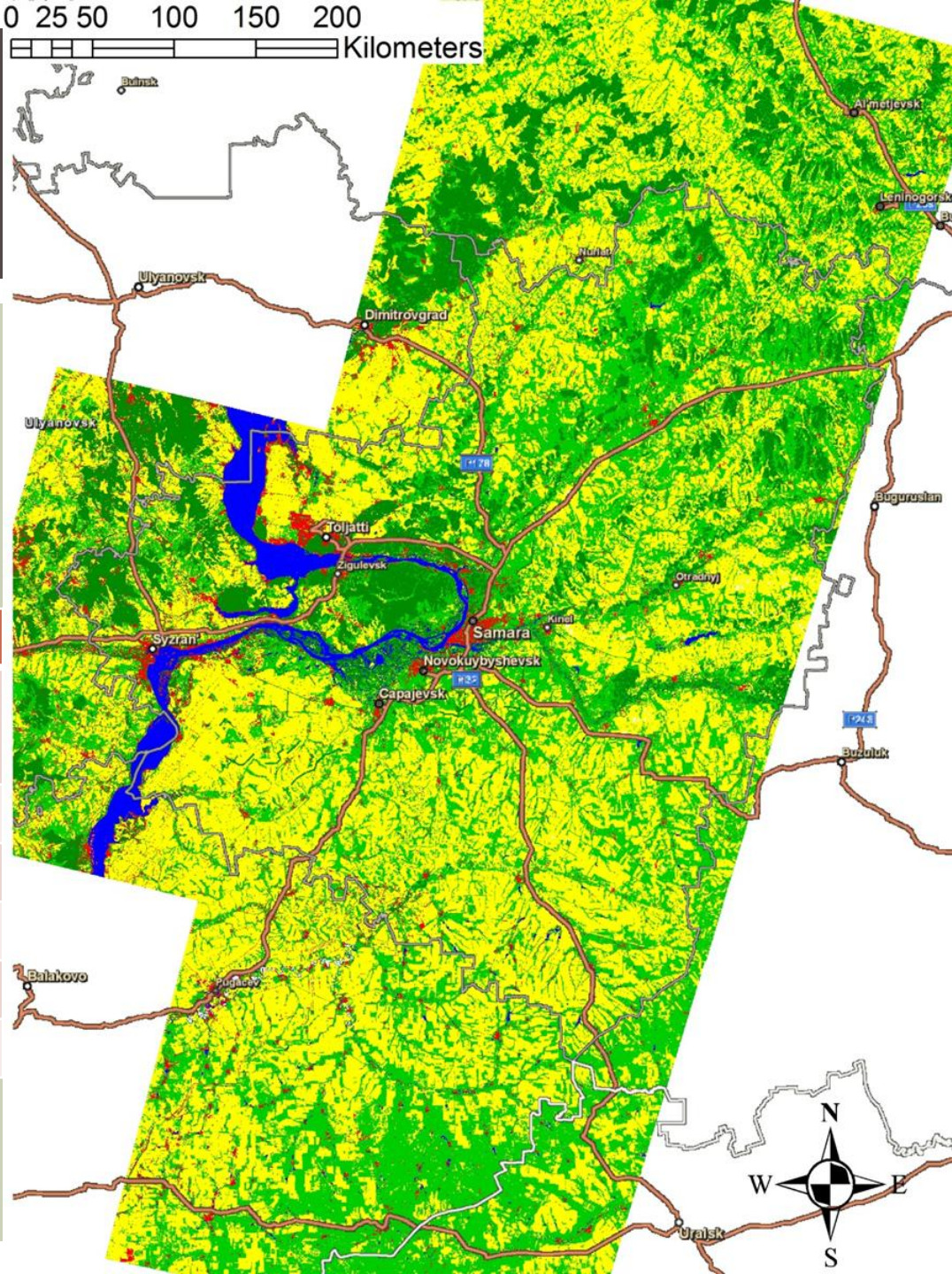


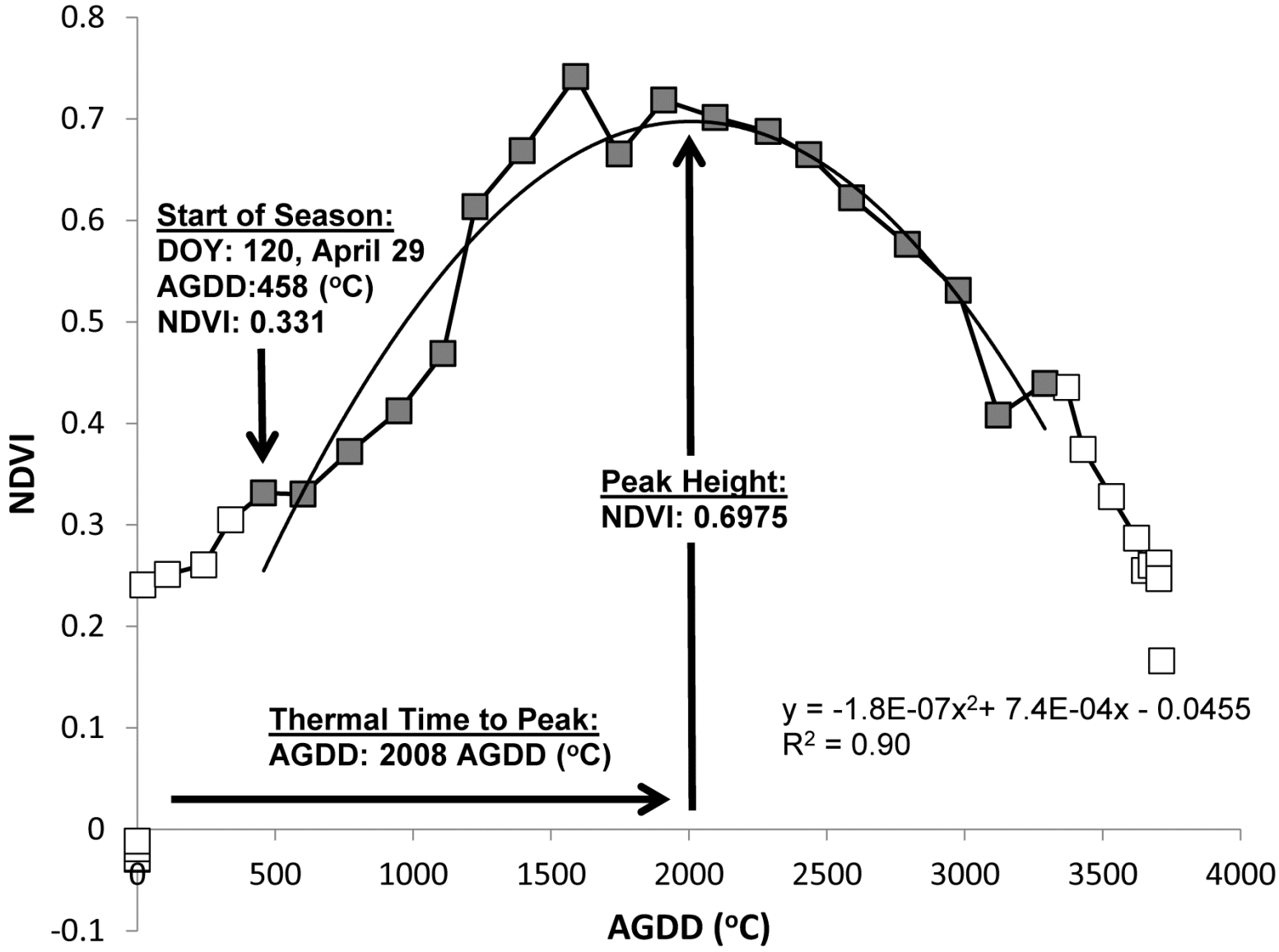
Segment 1221,fallow cropland, 100%, image date = 2009-06-09

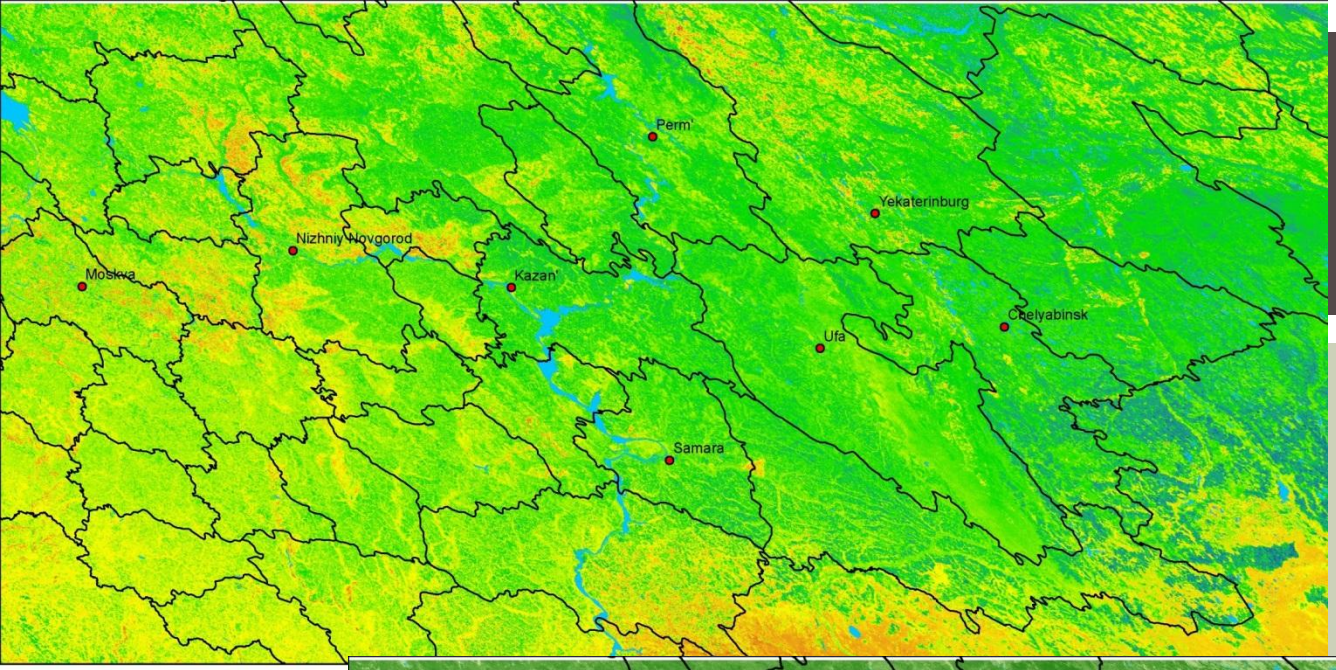
LAND COVER

	Reference Data	
		User Accuracy
Classified	Water	0.948
	Forest	0.967
	Grassland	0.553
	Cropland	0.920
	Urban	0.769

Overall Accuracy: 0.877
Kappa Coefficient: 0.821



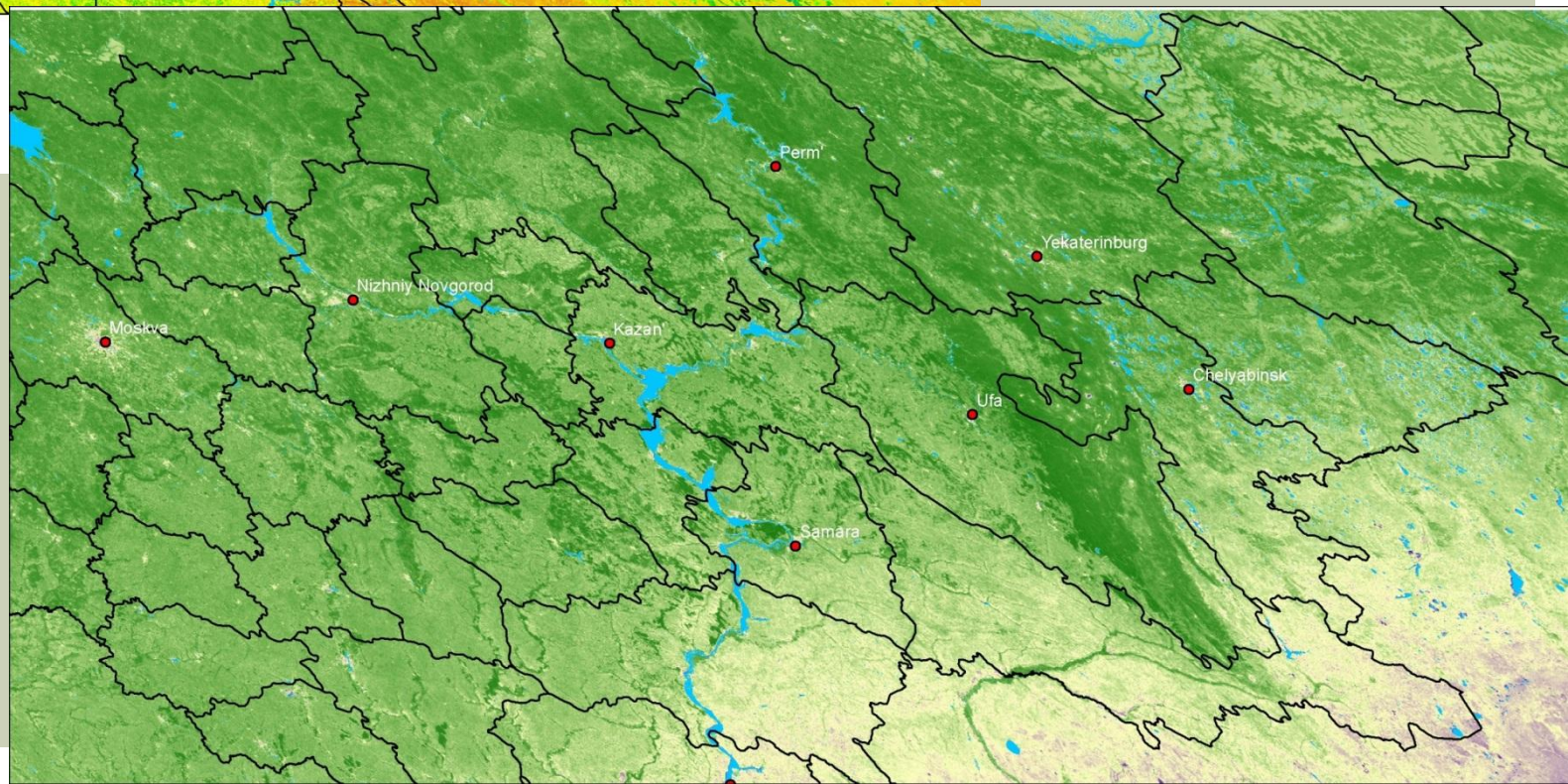

0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
NDVI
Start of Season:
DOY: 120, April 29
AGDD:458 (°C)
NDVI: 0.331
Peak Height:
NDVI: 0.6975
Thermal Time to Peak:
AGDD: 2008 AGDD (°C)
y = -1.8E-07x2+ 7.4E-04x - 0.0455
R2 = 0.90
0
500
1000
1500
2000
2500
3000
3500
4000
AGDD (°C)

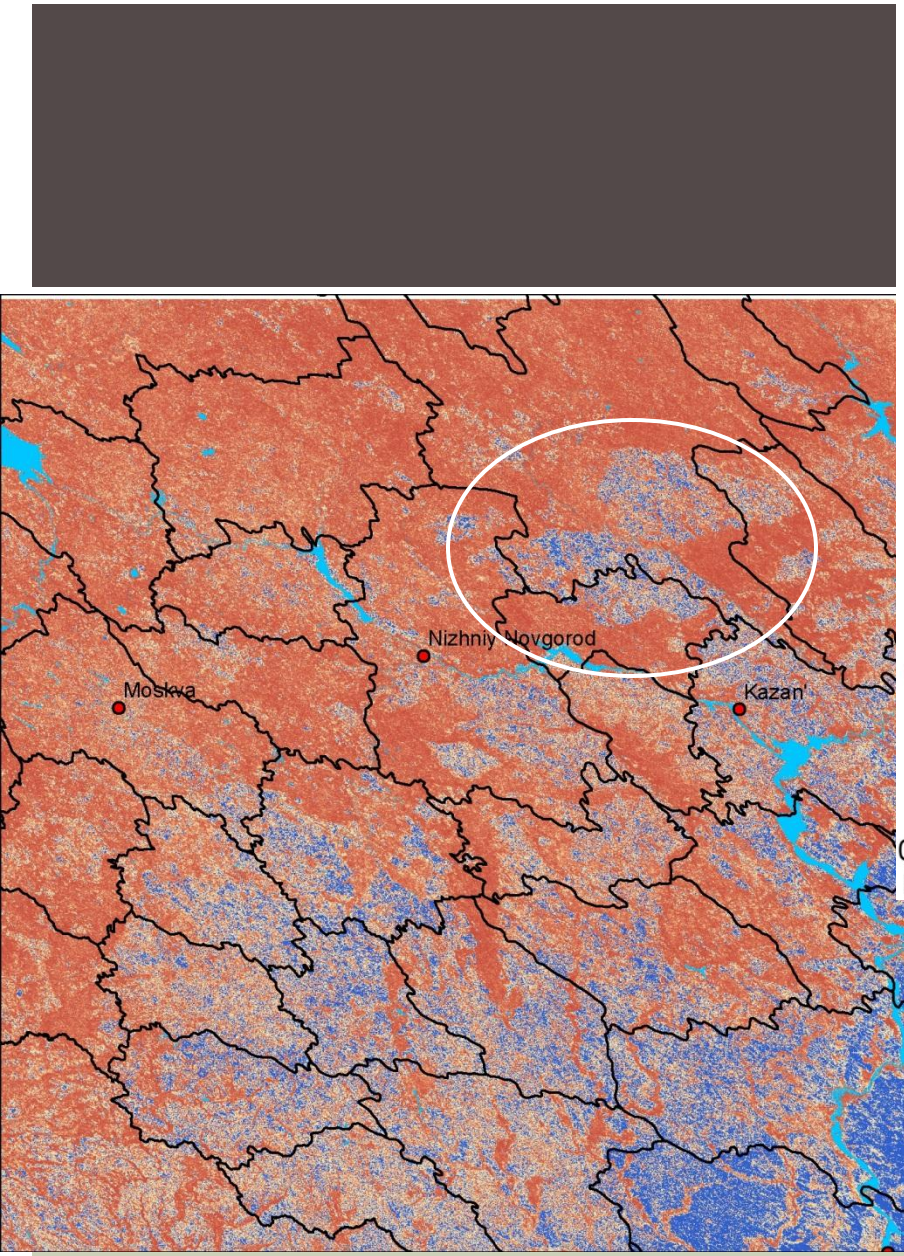


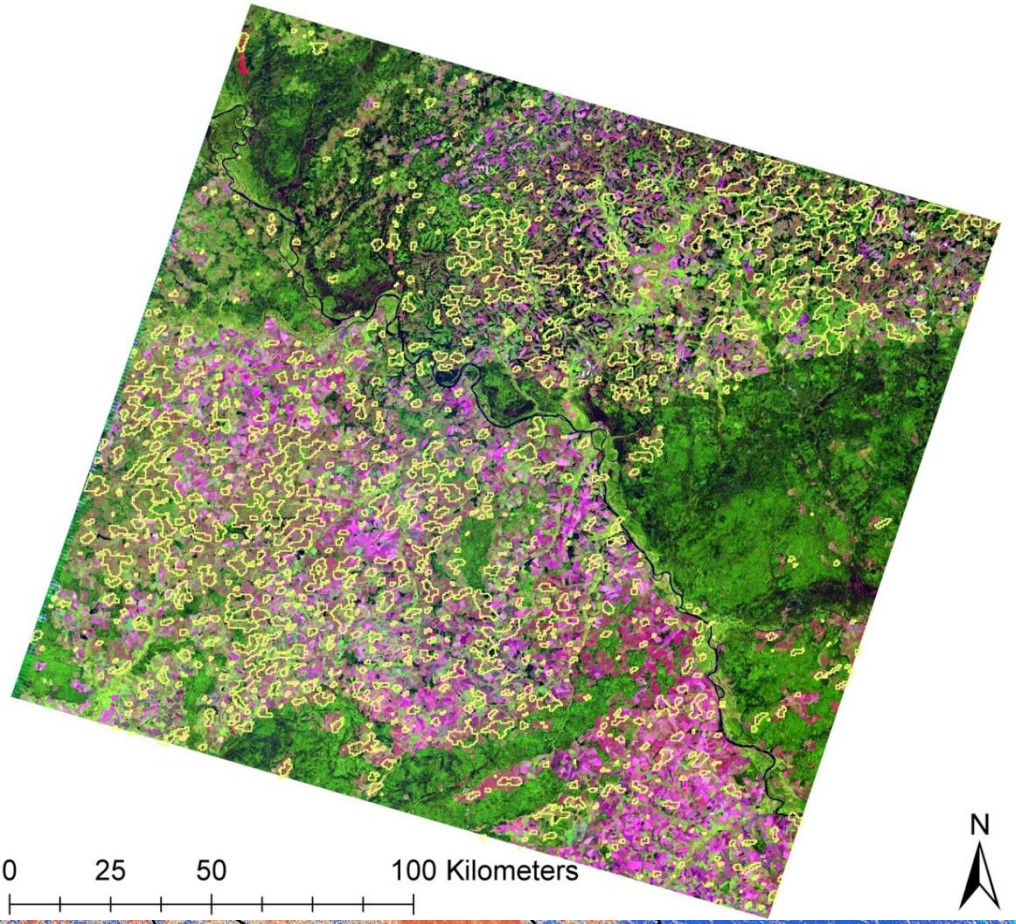
Start of Season

First week of June

Last week of February



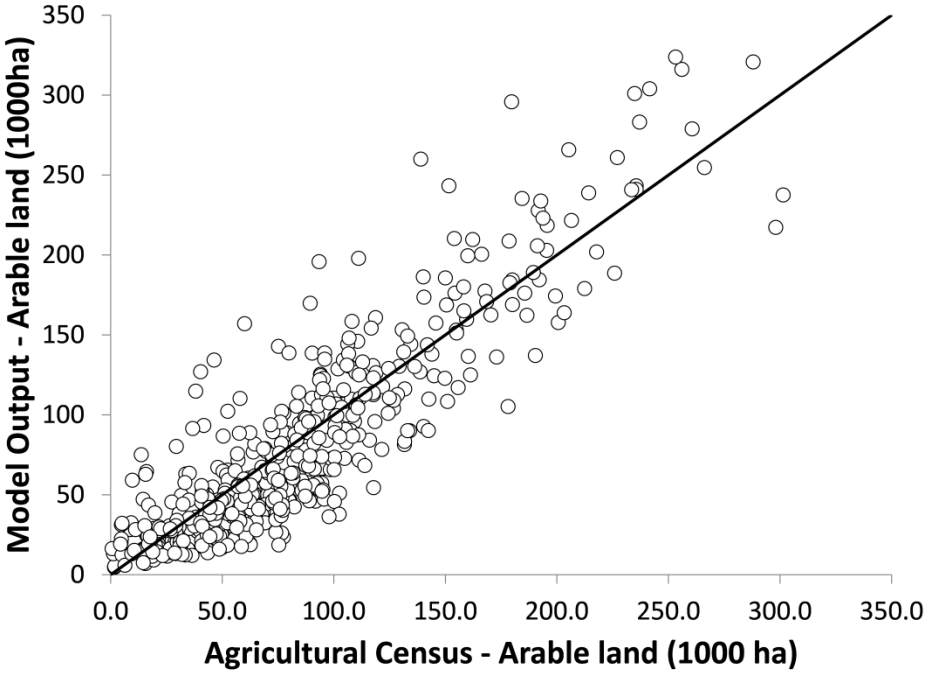


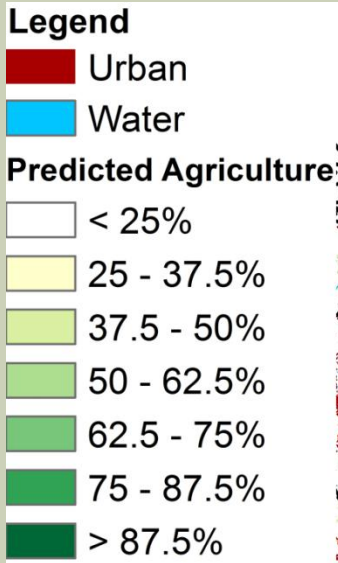


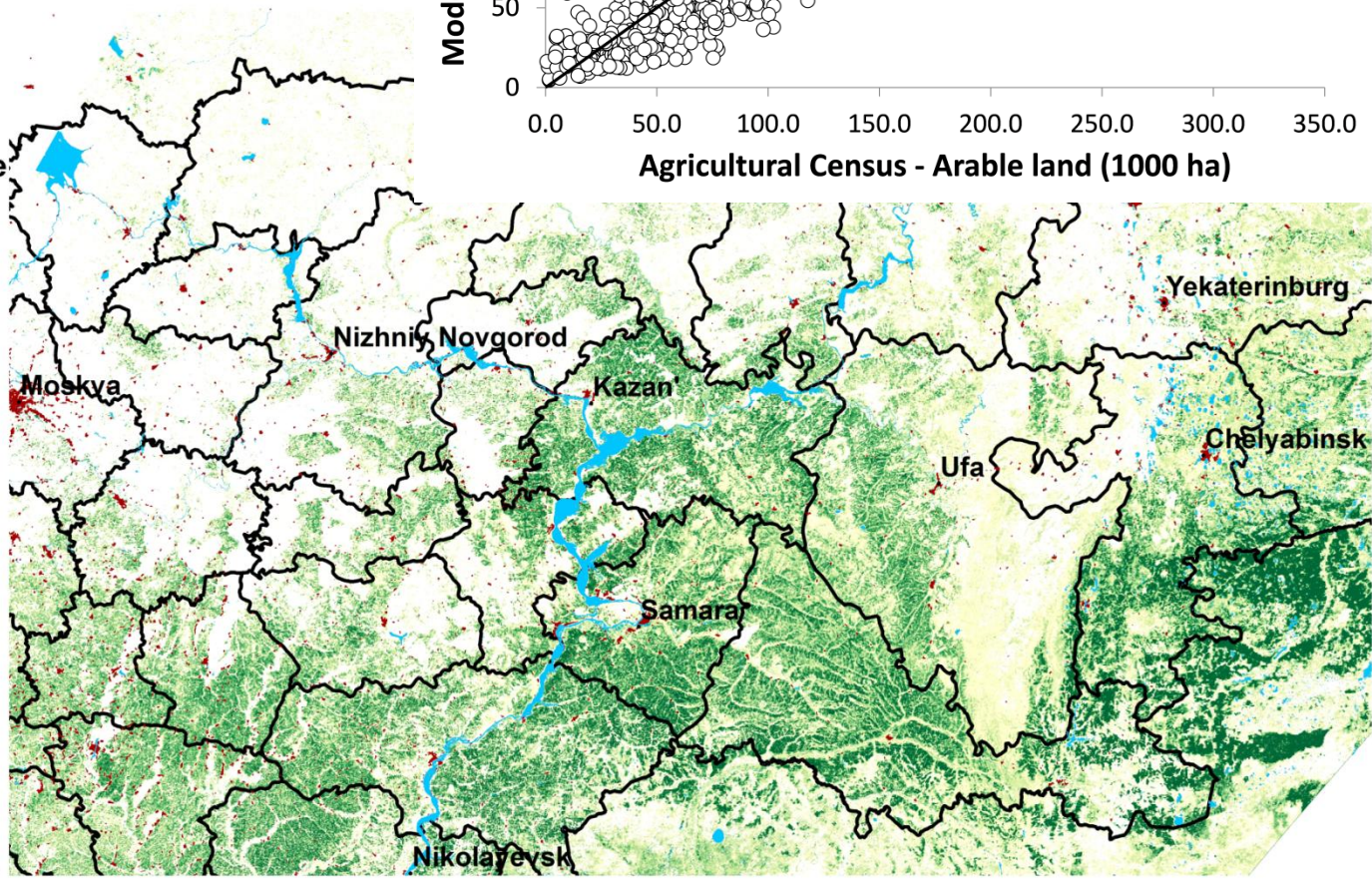
Blue: High variability in peak height over multiple years → crops?

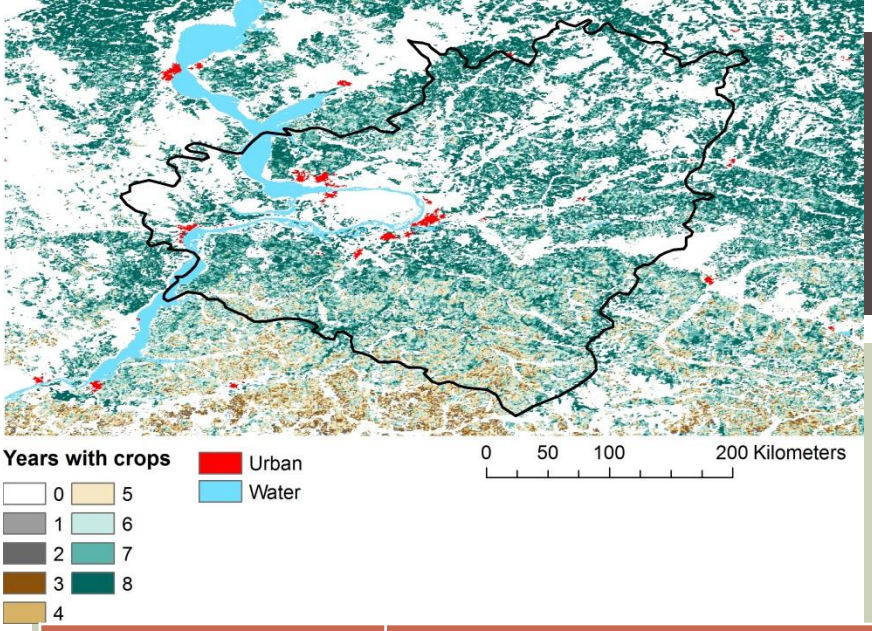
Red: Low variability in peak height over multiple years → forest?

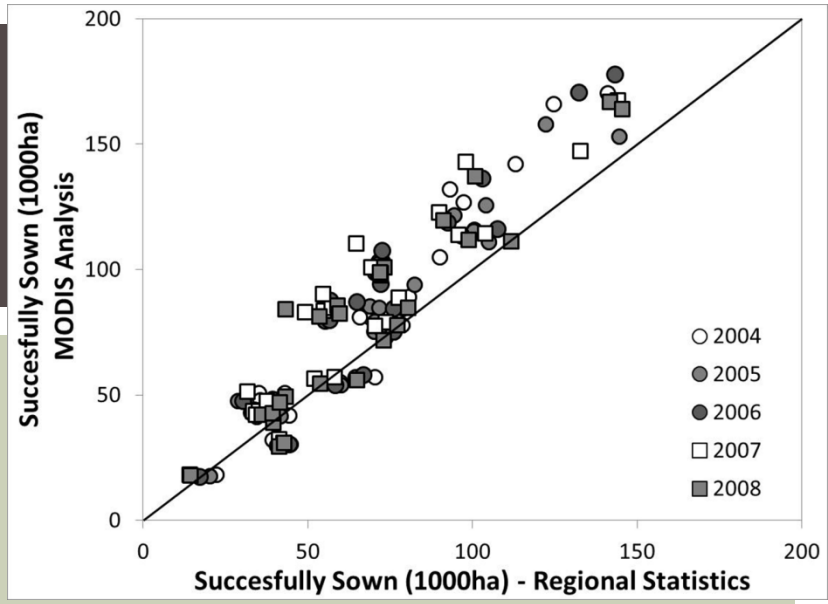
- Model to link land surface phenology (MODIS) with Landsat land cover estimates.
- Use phenology measurements to understand if cropland is actually cropped for a particular year.







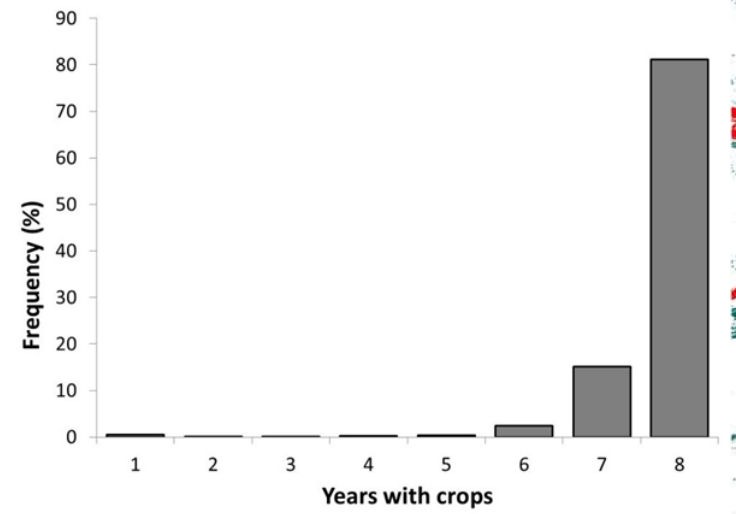


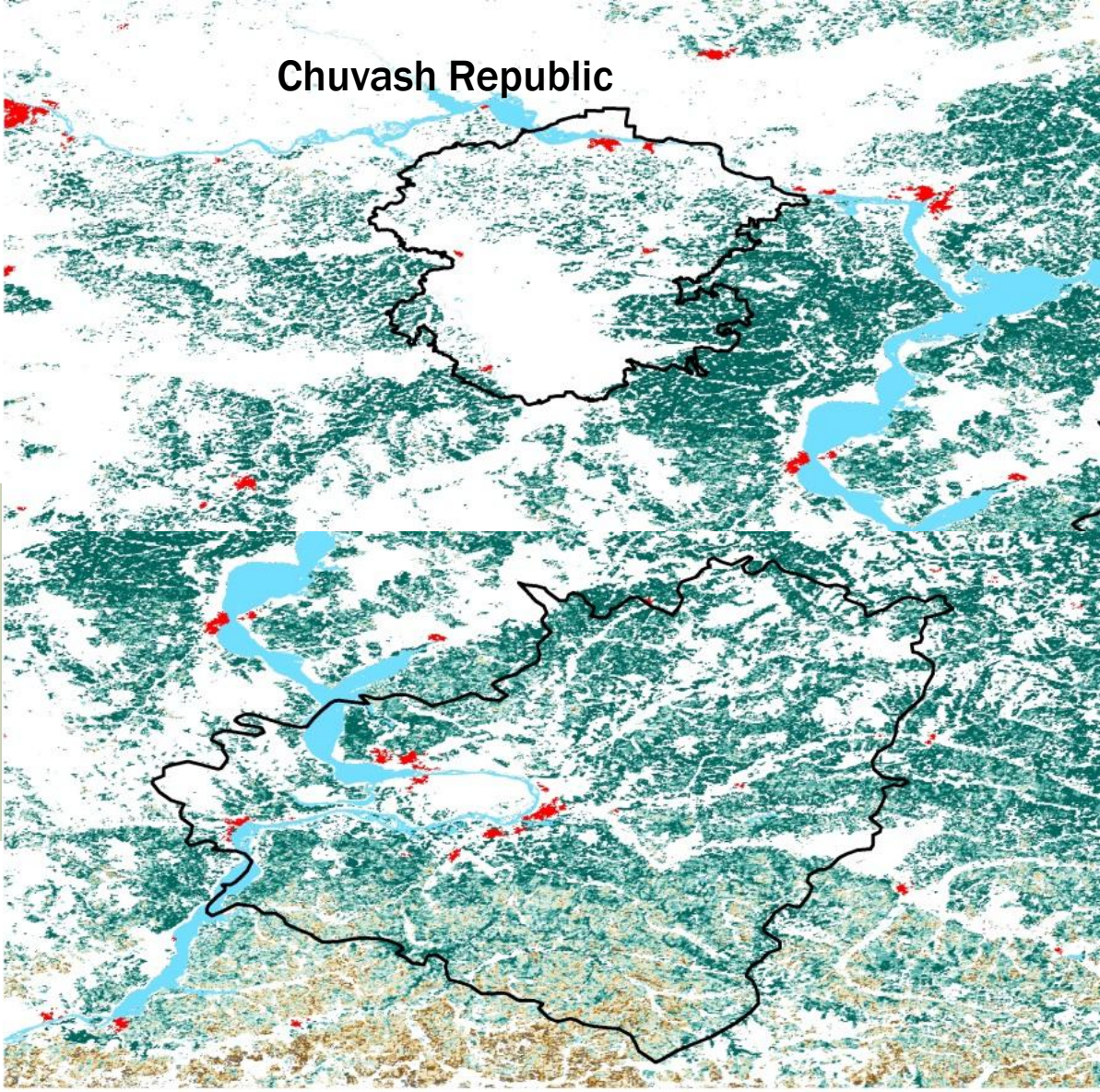


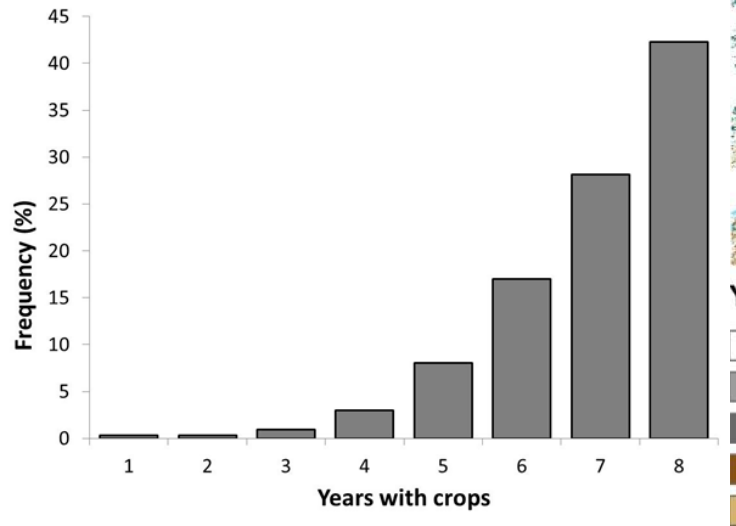
	Successfully Sown Land			
	Intercept (1000 ha)	Slope	R^2_{adj}	RMSE (1000 ha)
2004	-11.451*	1.331	0.915	12.215
2005	-3.856*	1.189	0.906	11.732
2006	-3.944*	1.271	0.899	13.423
2007	6.984*	1.156**	0.857	14.979
2008	1.646*	1.160**	0.864	14.916
Overall	-1.457*	1.213	0.884	13.578

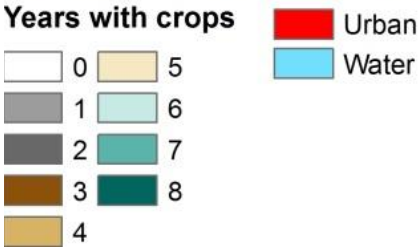
*: not significant different from 0 ($p = 0.05$).

**: not significantly different from 1 ($p = 0.05$).









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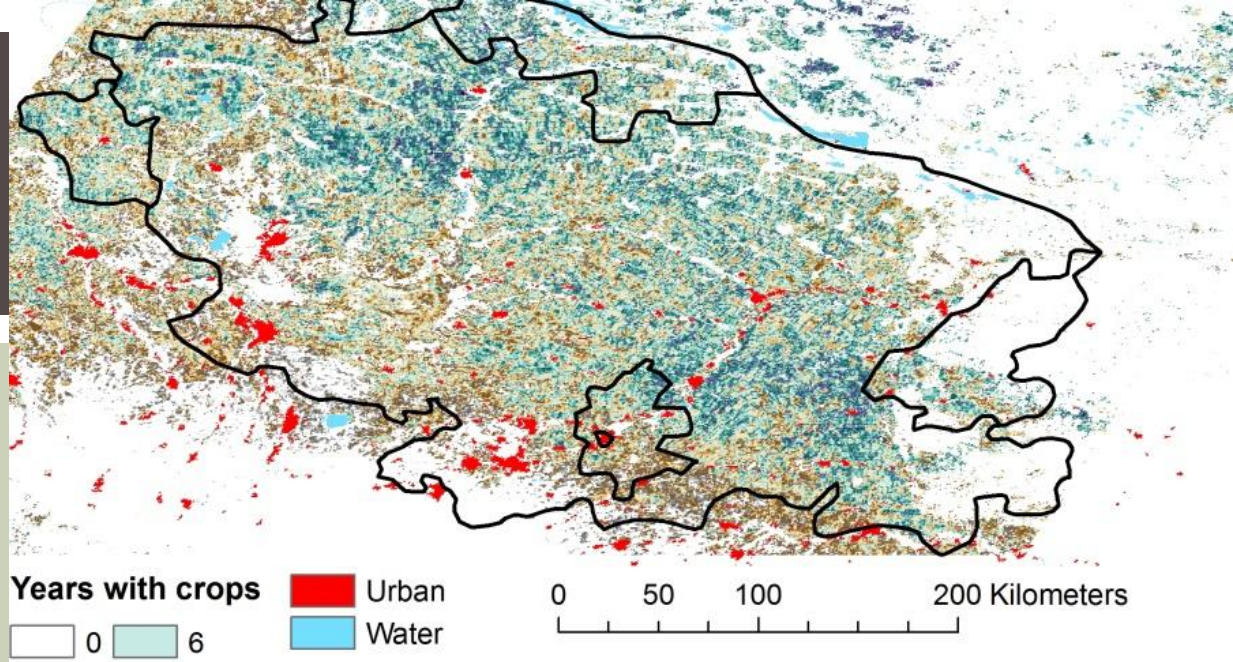
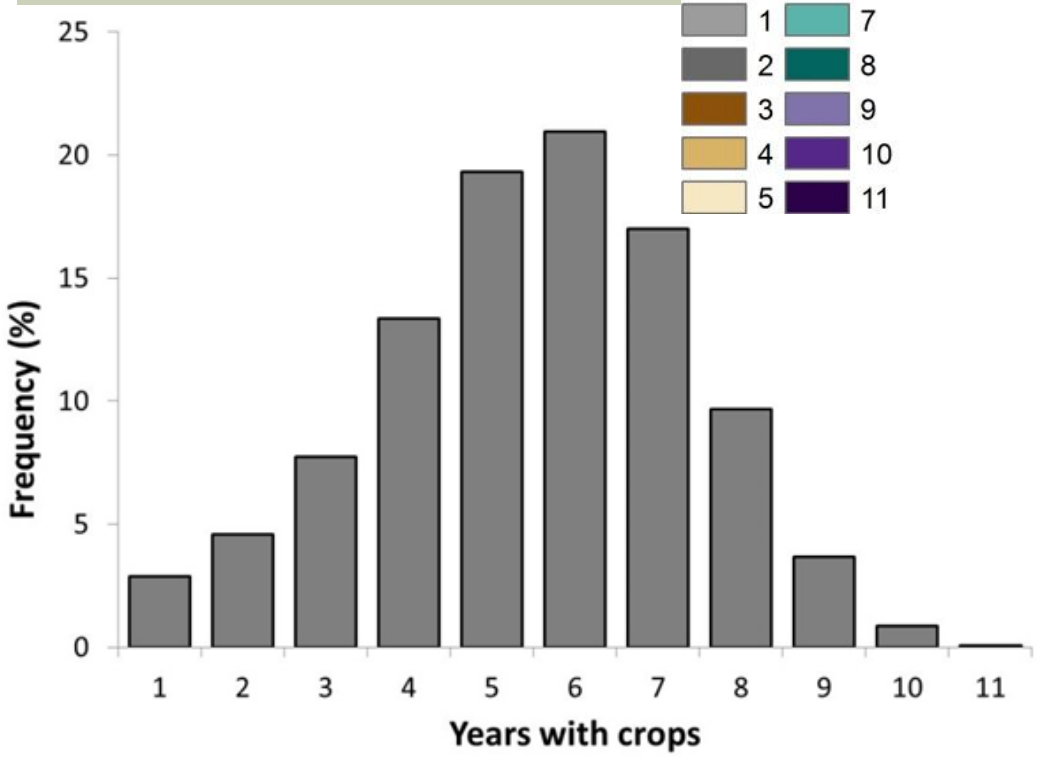
STAVROPOL



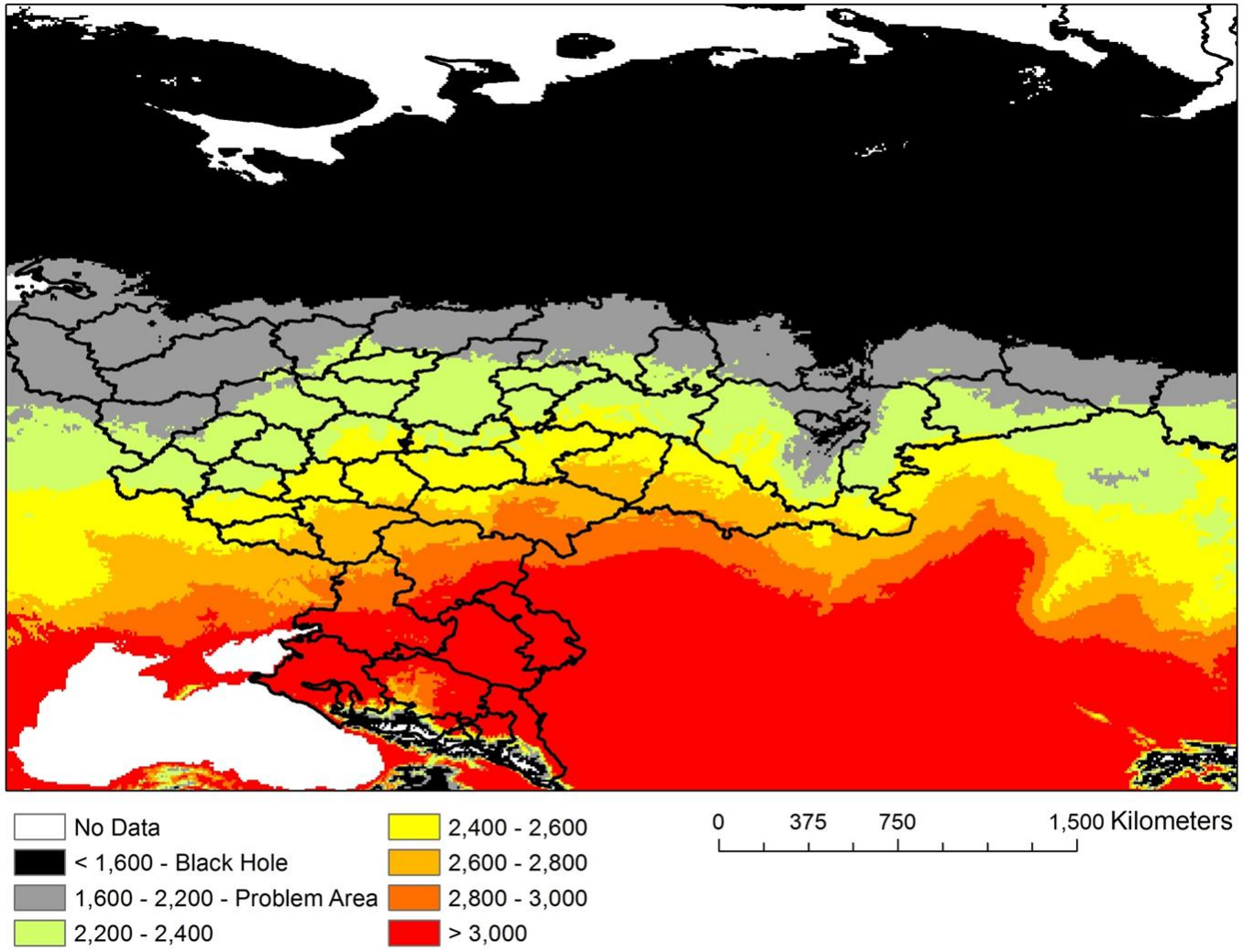


- Southern areas reveal much more temporal variability → crops are not grown on all fields every year.
- Management decisions, droughts.

ACCUMULATED GROWING DEGREE DAYS > 10°C

MarkSim Downscaled Climate Data → Minimum and Maximum Temperature data

Current

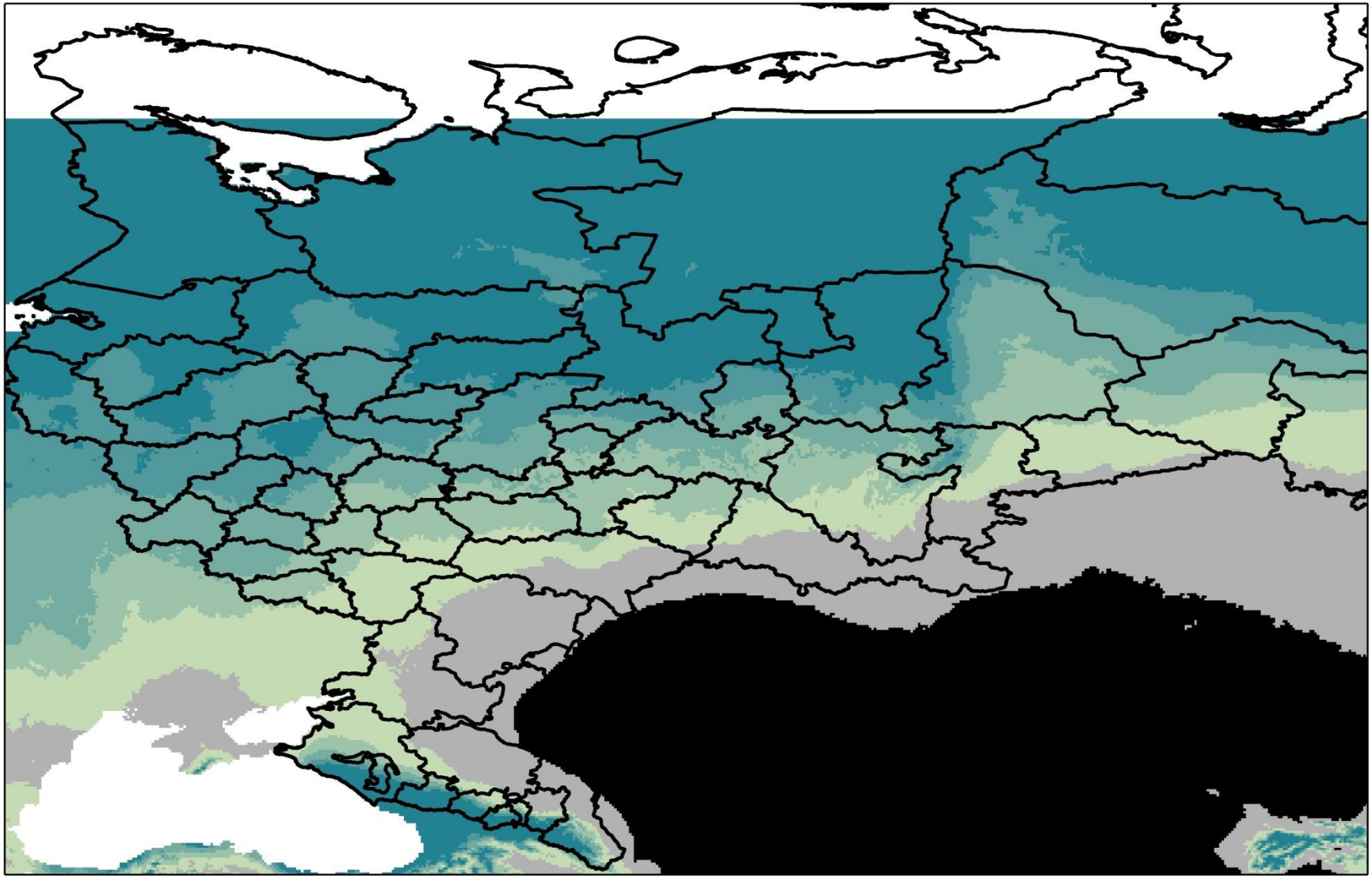


ANNUAL ARIDITY INDEX

- Aridity index: annual precipitation / annual potential evapotranspiration
- Annual potential evapotranspiration (PET) is generated by summing up monthly PET derived from the Hargreaves model.

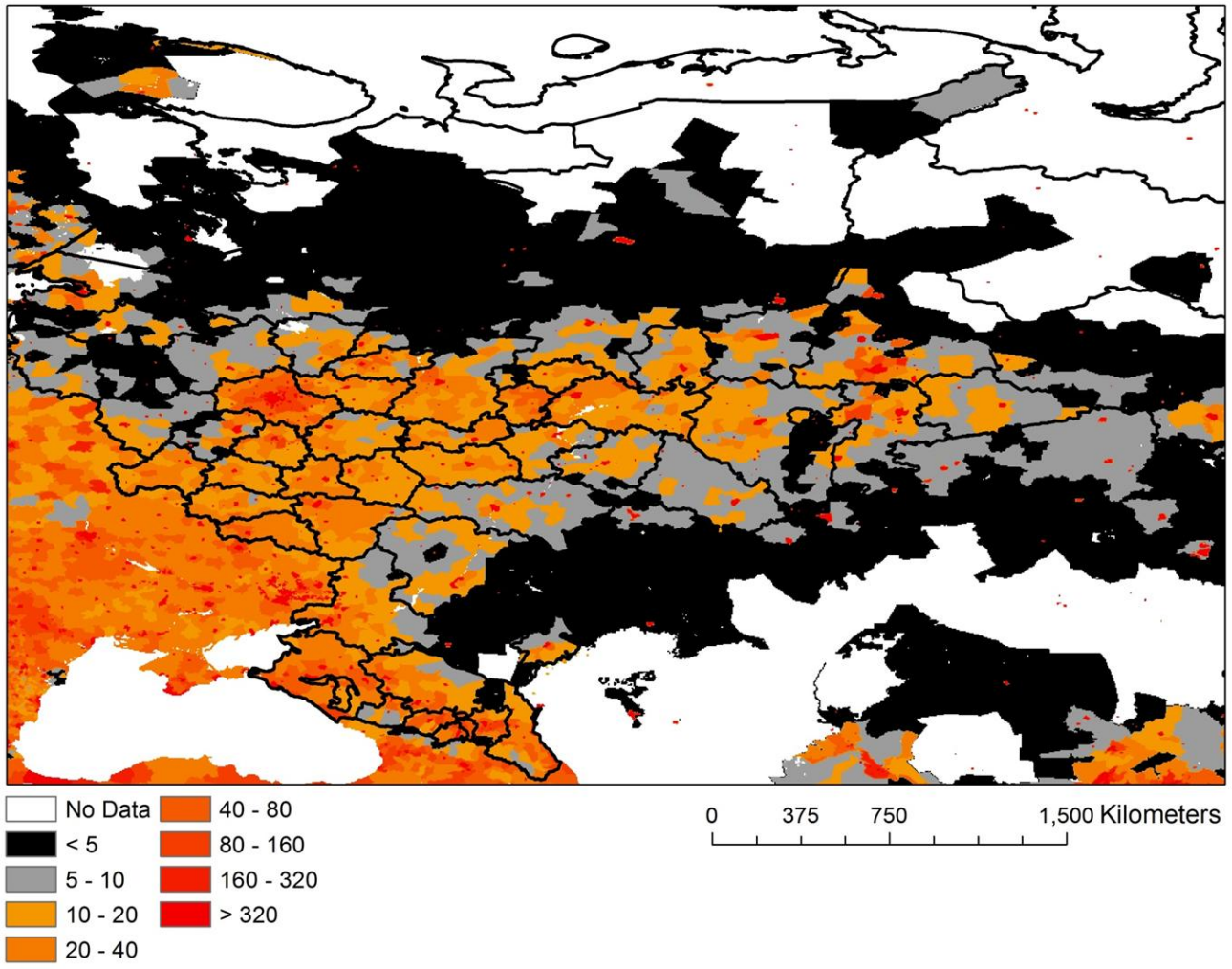
  Based on:

  - Extraterrestrial radiation on the 15th day of the month ($MJm^{-2}day^{-1}$)
  - Projected monthly mean maximum / minimum temperature (°C)
  - Number of days in the month


No Data
< 0.3 - Black Hole
0.3 - 0.55 - Problem Area
0.55 - 0.7
0.7 - 0.8
0.8 - 0.9
0.9 - 1
> 1.0
0
375
750
1,500 Kilometers

RURAL POPULATION DENSITY

CIESIN/Columbia University, and CIAT. 2005. Gridded Population of the World, Version 3 (GPWv3): Population Density Grid, Future Estimates.



CONCLUSIONS

- Russia's agricultural developments are important for global food security.
- Temperature and precipitation are not the only drivers for agricultural production.
- Rural population density also plays a significant role.
- Regional variability gives an idea about ongoing change and future potential.

THANK YOU!

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