

LAND SYSTEM CHANGE IN EURASIA



Critical Regional Issues Affecting
SOCIETIES IN TRANSITION FACING
GLOBAL ENVIRONMENTAL
CHANGES



OUTLINE

- LAND USE CHANGE CONTEXT
- GRAZING SYSTEM CHANGES
- ECOSYSTEM EFFECTS

IGBP Land Cover Classification Russia and Central Asia



International Geosphere Biosphere Programme Land Cover Classification (Belward, 1996)

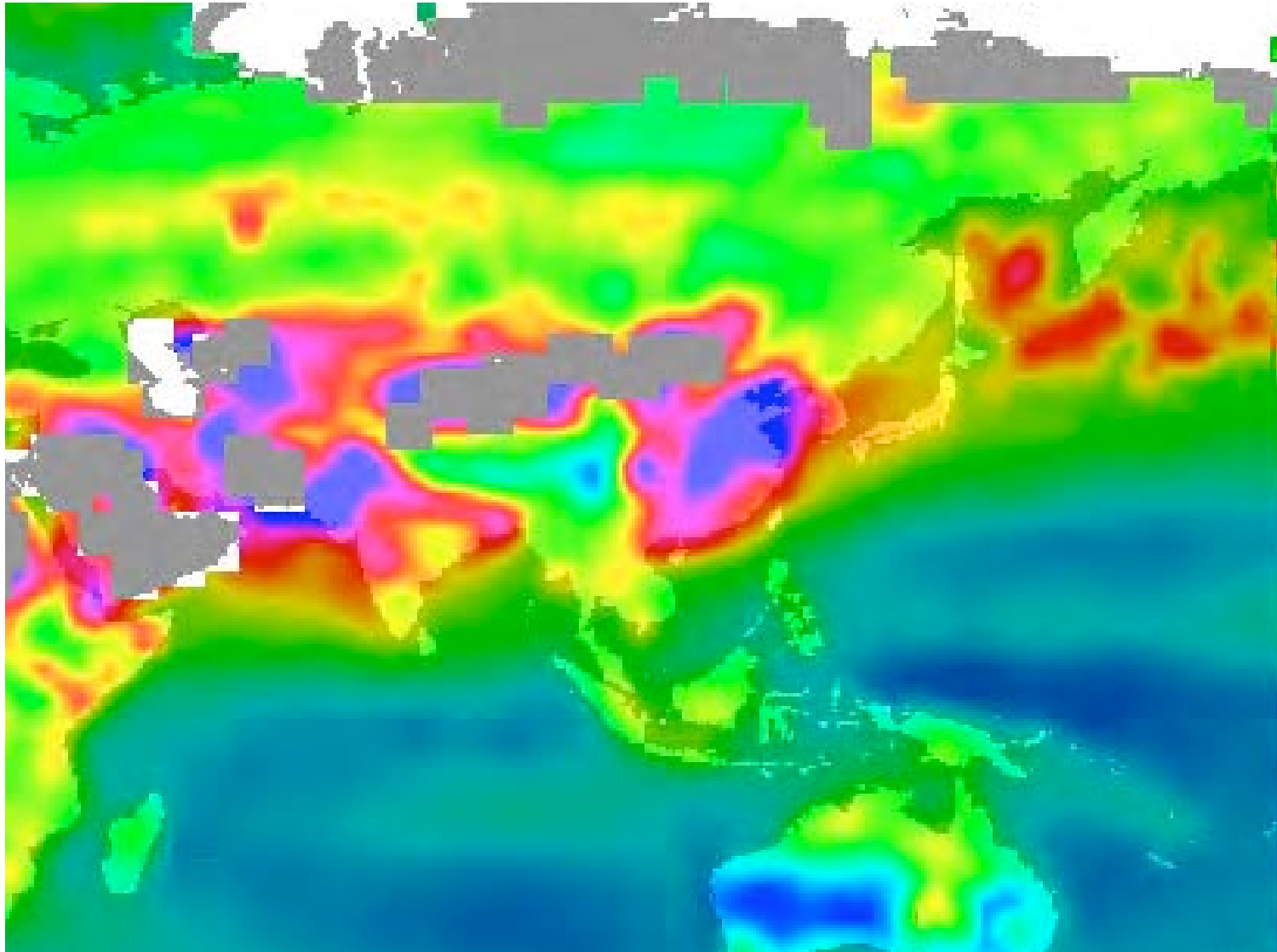
Evergreen Needleleaf Forest	Woody Savannas	Cropland/Natural Vegetation Mosaic
Deciduous Needleleaf Forest	Savannas	Snow and Ice
Deciduous Broadleaf Forest	Grasslands	Barren or Sparsely Vegetated
Mixed Forest	Permanent Wetlands	Water Bodies
Closed Shrublands	Croplands	
Open Shrublands	Urban and Built-Up	



0 750 1,500 2,250 3,000 Kilometers

1 - Kilometer Resolution

MODIS Optical Density (Average 2001)



Social and Biogeographical Context

- Thousands of years of pastoral and cropland development
- Gateway of trade and cultural exchange between East and West
- Rich Natural Resources
- Variable Climate

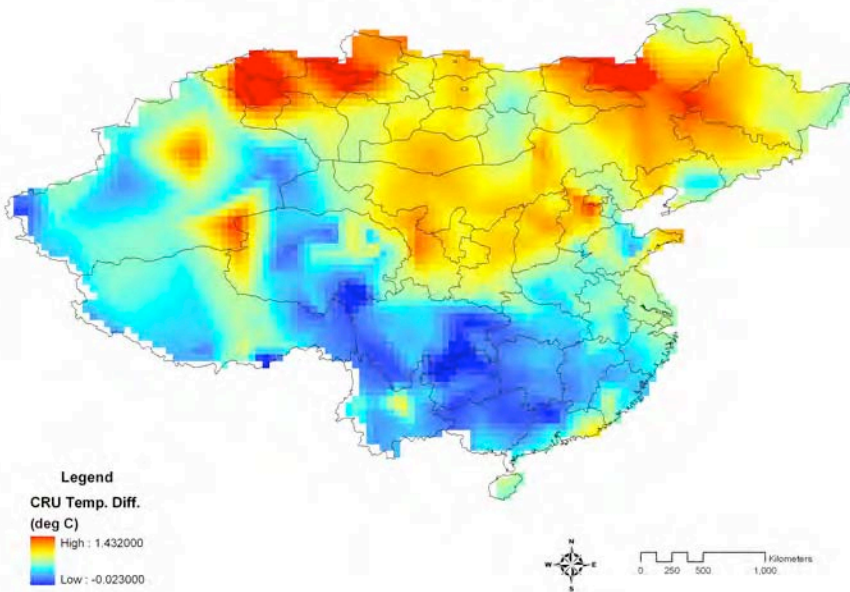
LAND USE IN TRANSITIONAL ECONOMIES

MULTIPLE FACTORS AFFECTING LAND SYSTEMS

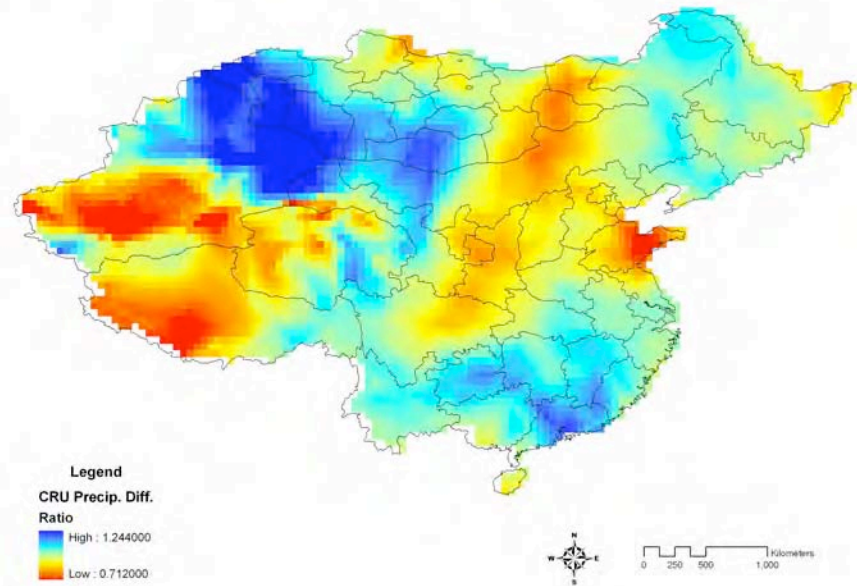
- ECONOMIC LIBERALIZATION
- POLITICAL CHANGE
- DEMOGRAPHIC SHIFTS
- ENVIRONMENTAL POLICY
- CLIMATE CHANGE

CLIMATE TRENDS OF THE 1990'S

CRU Difference in Average Temperature (deg C)
1991 to 2000 vs. 1961 to 1990



CRU Difference in Average Precipitation -- 1991 to 2000 : 1961 to 1990



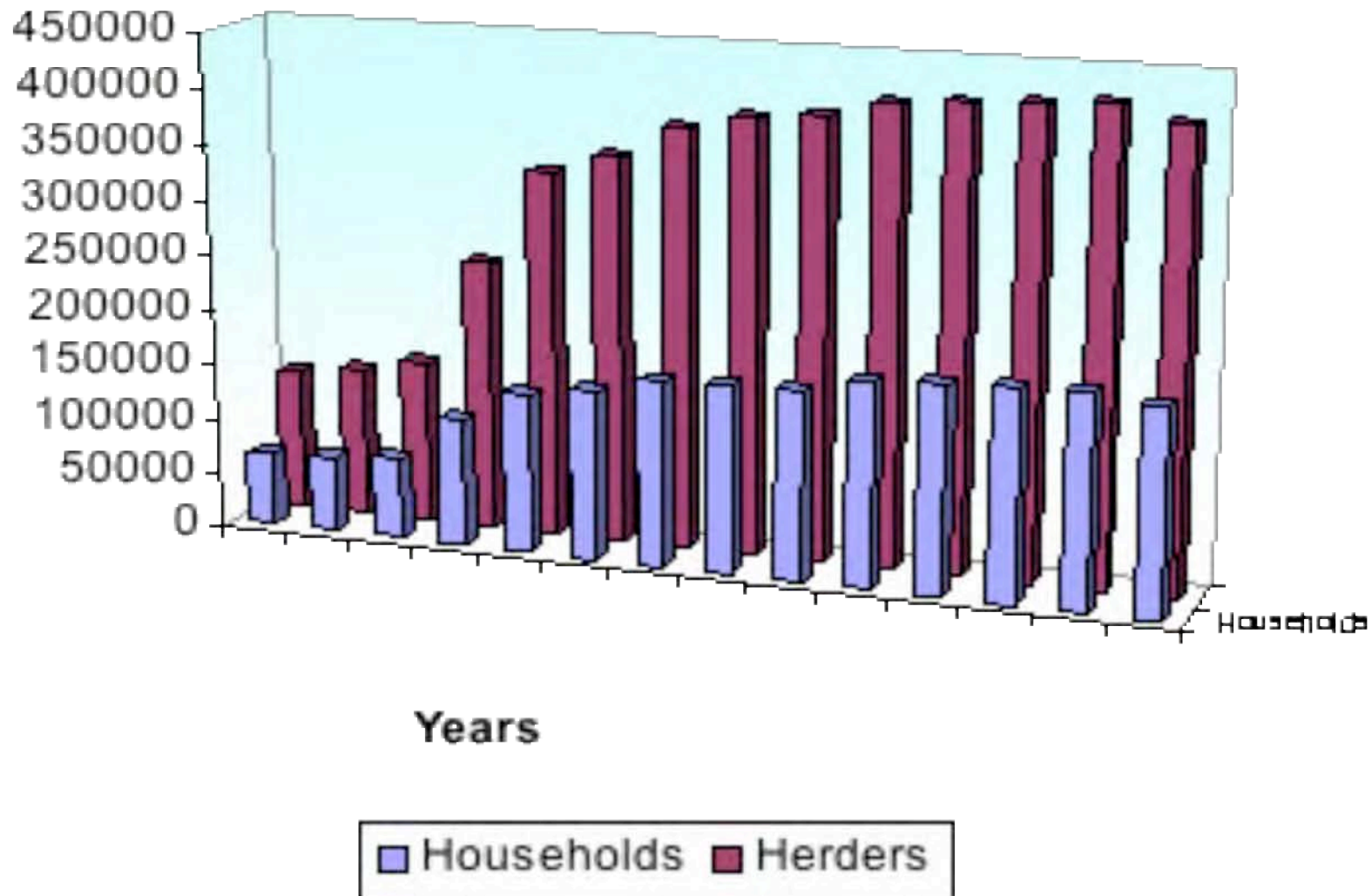
Temperatures of the 1990's tended to be as high as $.5^{\circ}\text{C}$ warmer
Precipitation tended to be drier by 30% of the 30 year average

Pasture usage (ha) per unit livestock unit (LU)

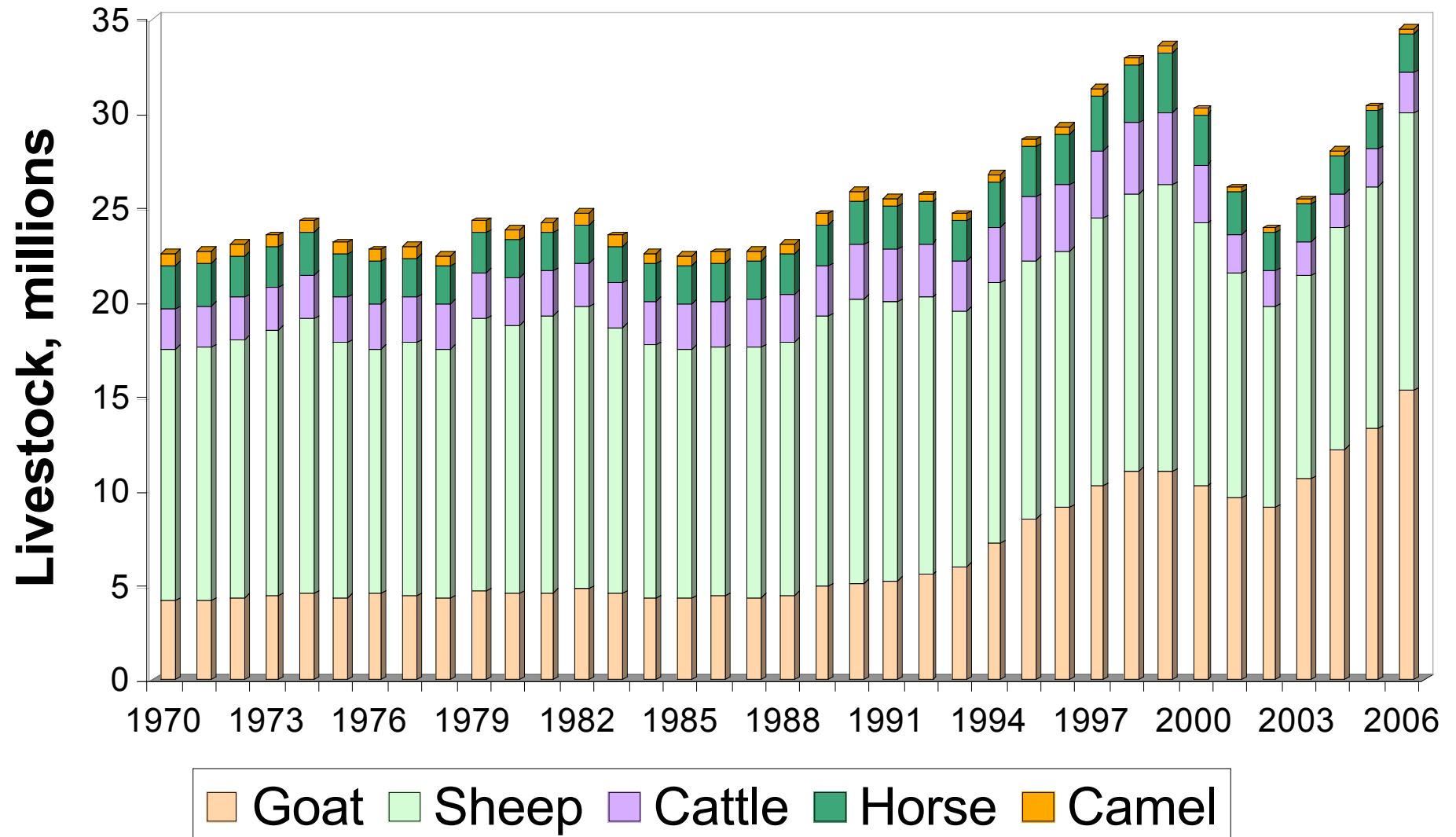
(Data source is FAOSTAT, 2004)

Location	1990	1995	2000
Kazakhstan	10.1	12.4	26.8
Kyrgyzstan	2.6	4.1	4.5
Mongolia	14.2	12.2	12.2
Tajikistan	NA	1.9	2.3
Turkmenistan	NA	12.3	14.9
Uzbekistan	NA	3.0	3.2

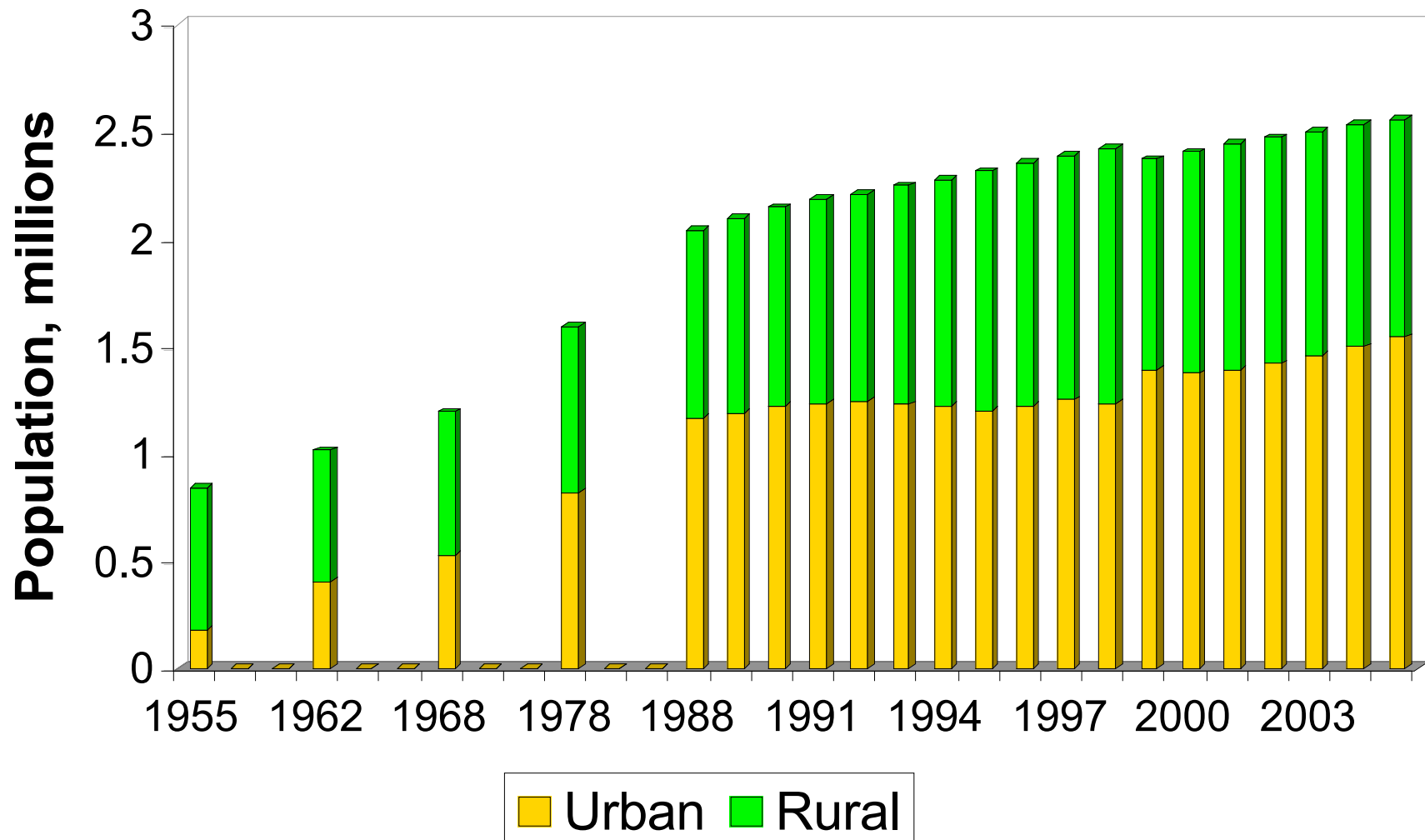
Herders and Household numbers in Mongolia

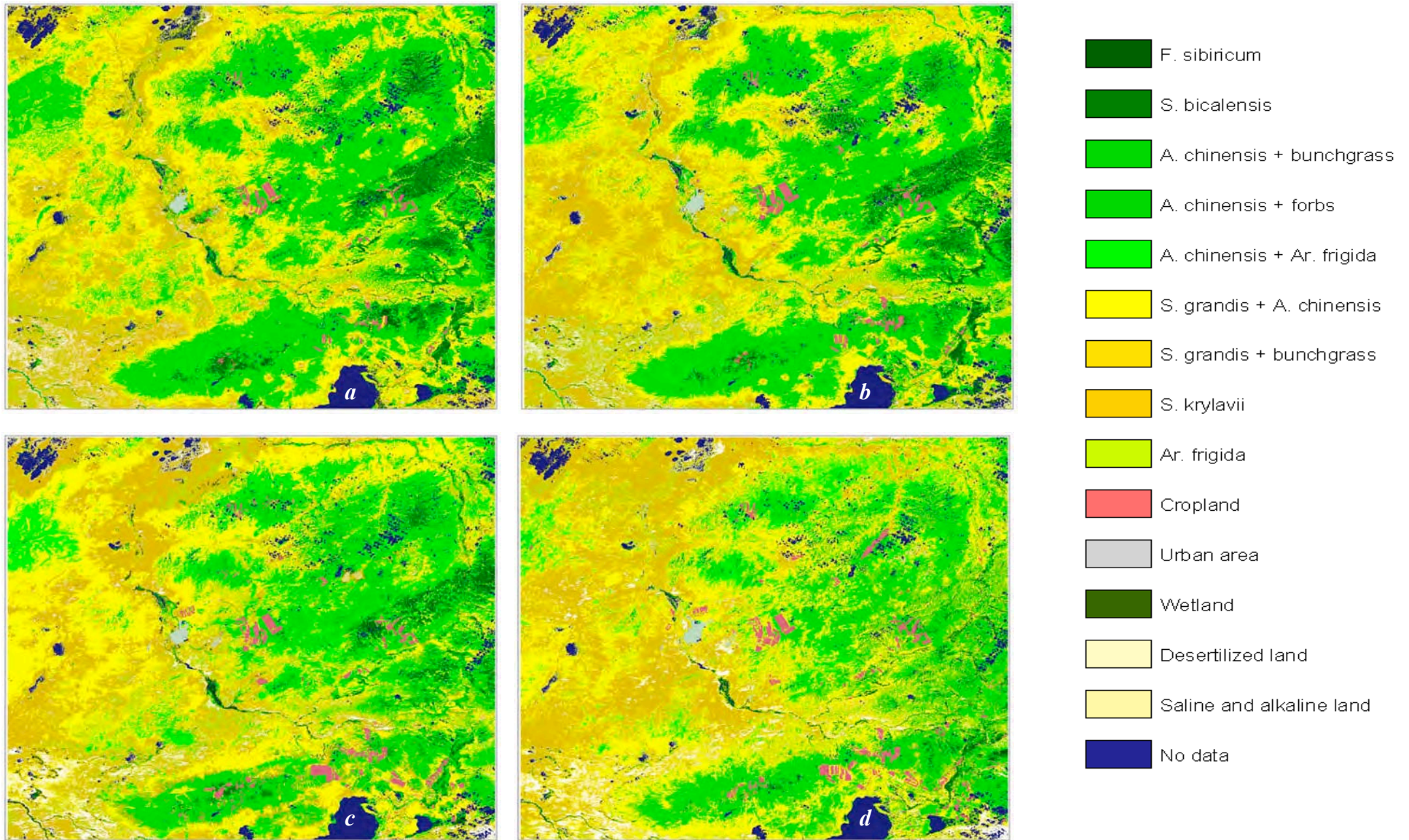


Livestock dynamics in Mongolia



Population dynamics in Mongolia

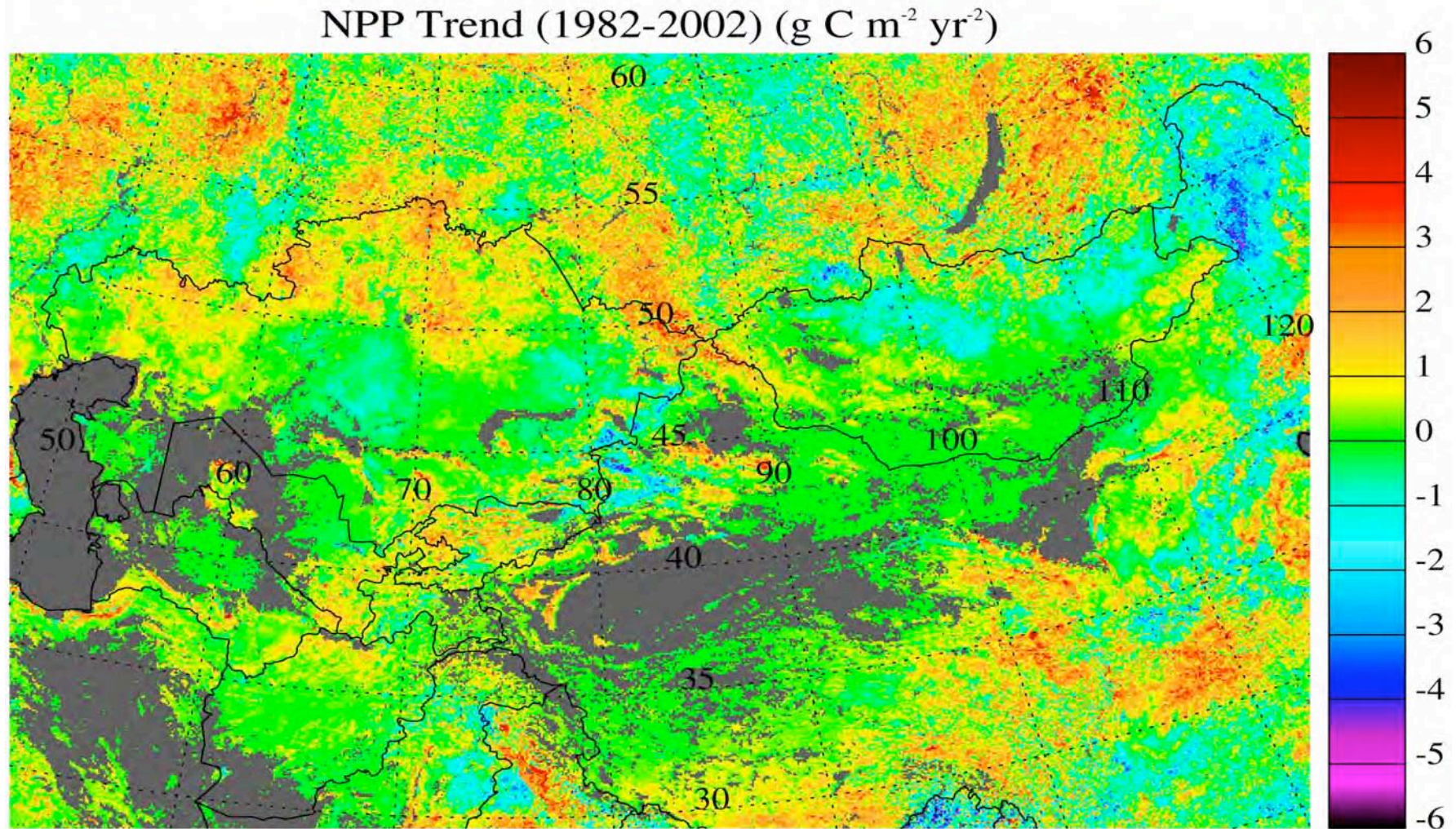




Optimized Land use/land cover classification (14 classes) of Xilin River Basin (Data source: Landsat TM/ETM+ sensor data, band 1, 2, 3, 4, 5, and 7. *a.* Jul 31, 1987; *b.* Aug 11, 1991; *c.* Sep 27, 1997; *d.* May 23, 2000

Land use/cover type	1987	1991	1997	2000	1987-2000	
					Change in area (km ²)	Change rate (%)
<i>F. Sibiricum</i> steppe	713.6	561.1	273.7	188.1	-525.5	-73.6
<i>S. baicalensis</i> steppe	388.9	370.0	253.5	187.4	-201.5	-51.8
<i>A. chinensis</i> + forbs steppe	5281.2	4604.3	3191.2	2942.6	-2338.6	-44.3
<i>A. chinensis</i> + bunchgrass steppe	2631.8	2373.5	2035.5	1805.7	-826.1	-31.4
<i>A. chinensis</i> + <i>Ar. frigida</i> steppe	463.2	714.6	1874.4	1436.5	973.3	210.1
<i>S. grandis</i> + <i>A. chinensis</i> steppe	4065.5	4076.3	4068.9	4309.1	243.6	6.0
<i>S. grandis</i> + bunchgrass steppe	2330.5	2136.3	2210.9	2238.1	-92.4	-4.0
<i>S. krylavii</i> steppe	3196.4	3813.4	4109.6	4479.1	1282.7	40.1
<i>Ar. frigida</i> steppe	952.1	1317.5	1597.7	1997.7	1045.6	109.8
Cropland	114.3	154.3	296.1	332.1	217.8	190.5
Urban and residential area	25.2	29.2	33.6	43.6	18.4	72.6
Wetland	177.5	154.9	205.2	60.5	-117.0	-65.9
Desertilized land	246.0	282.3	447.1	554.9	308.9	125.6
Saline and alkaline land	139.4	138.0	128.3	150.3	10.9	7.9

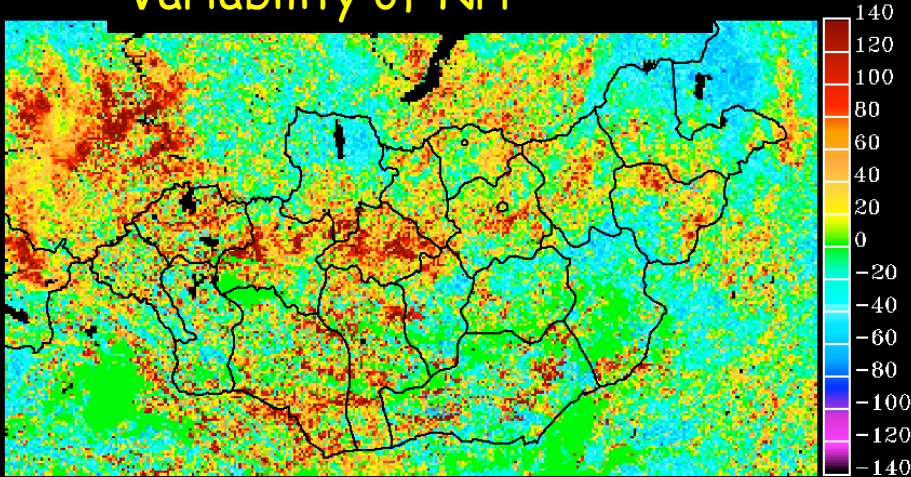
NPP Trends based on Satellite Analysis (8km AVHRR data product)



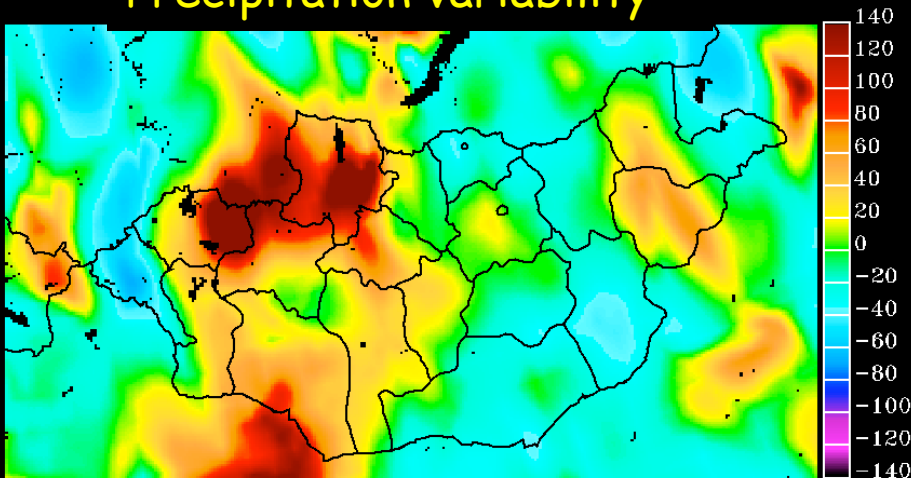
Analysis of Hicke and Tucker

NPP became more variable in the 1990s

Variability of NPP



Precipitation variability

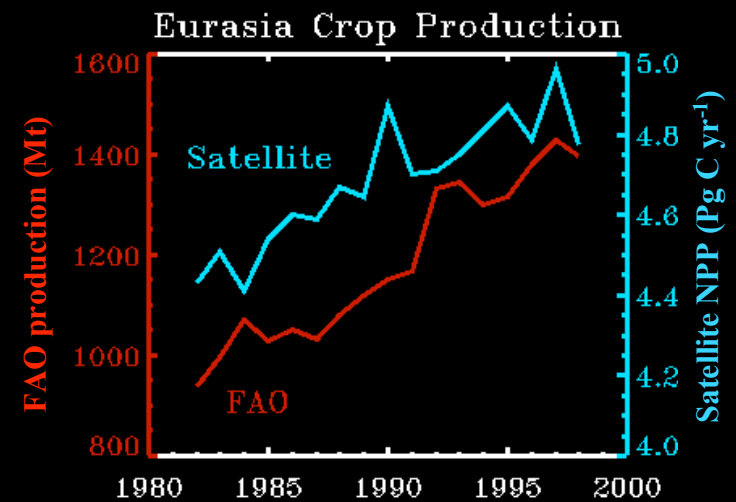
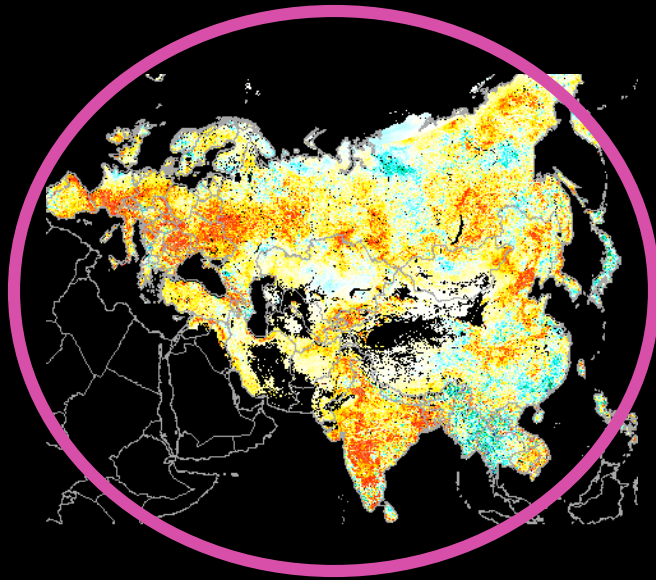


$$\frac{\text{StDev}(90\text{s}) - \text{StDev}(80\text{s})}{\text{StDev}(80\text{s})} \times 100$$

Precipitation behavior likely to influence NPP in some regions, but not all...

...other climate variables?
shifts to croplands/different crops? grazing? other land-use changes?

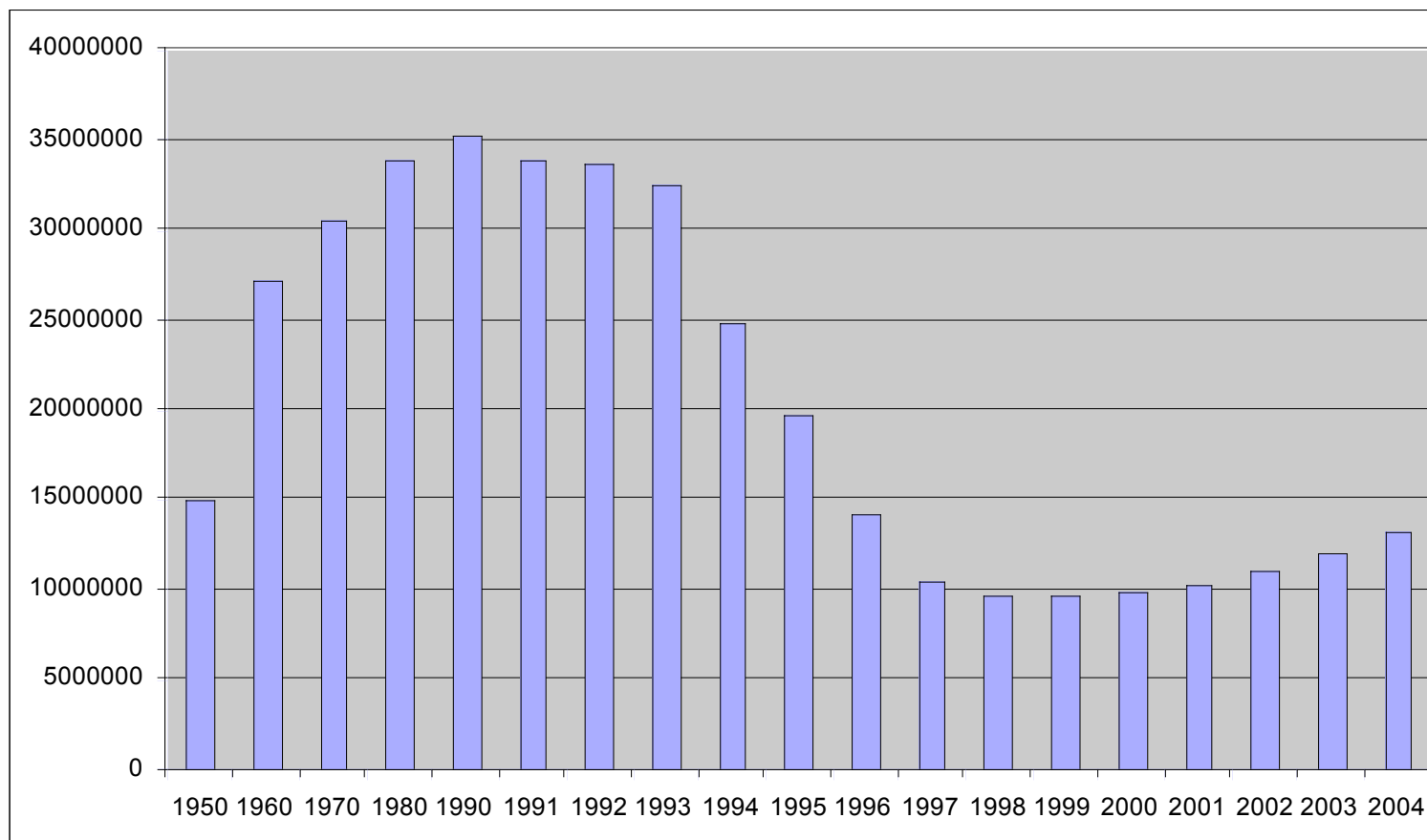
Similarity of agricultural statistics, satellite-derived production highlight importance of crops



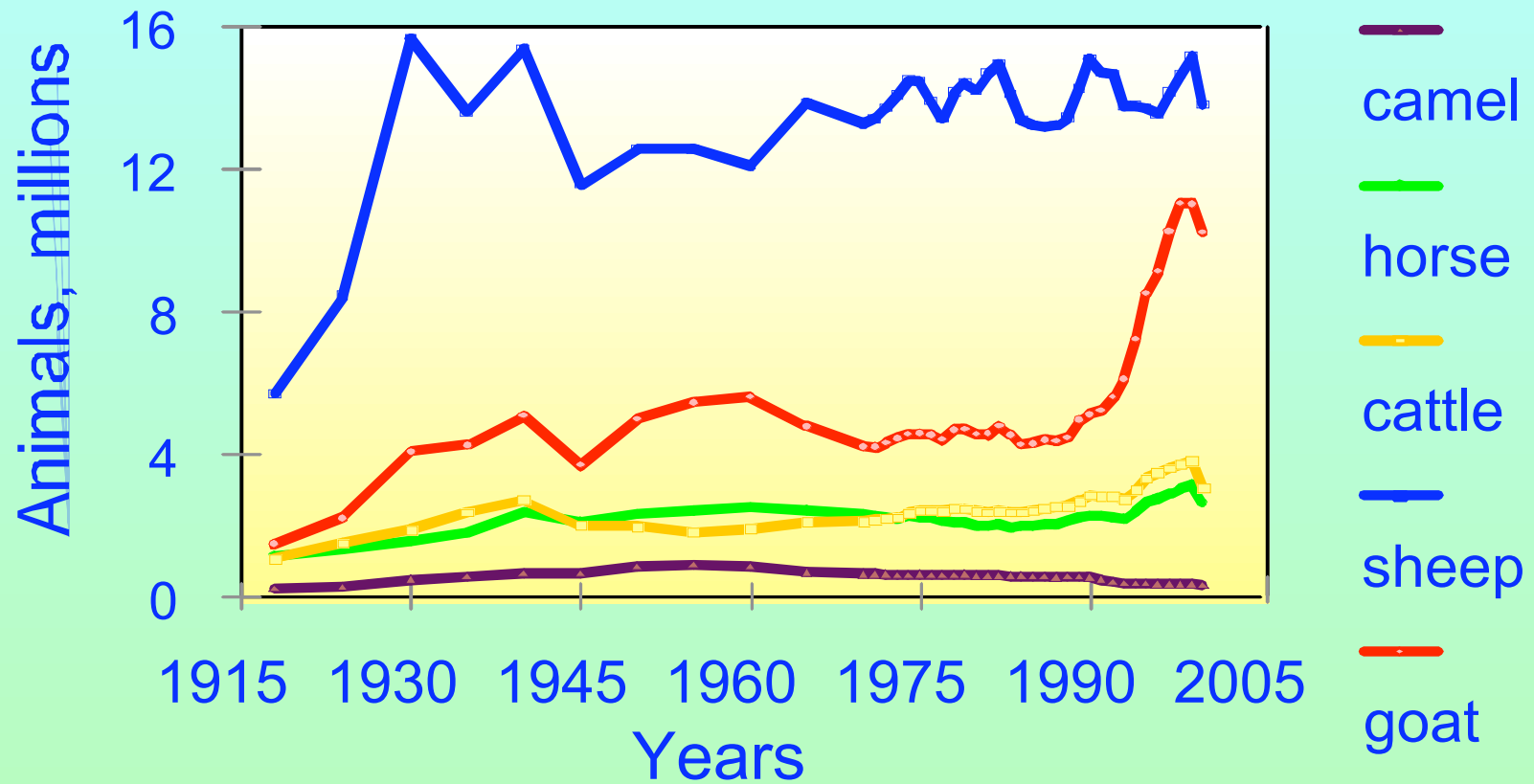
LAND USE PRESSURES



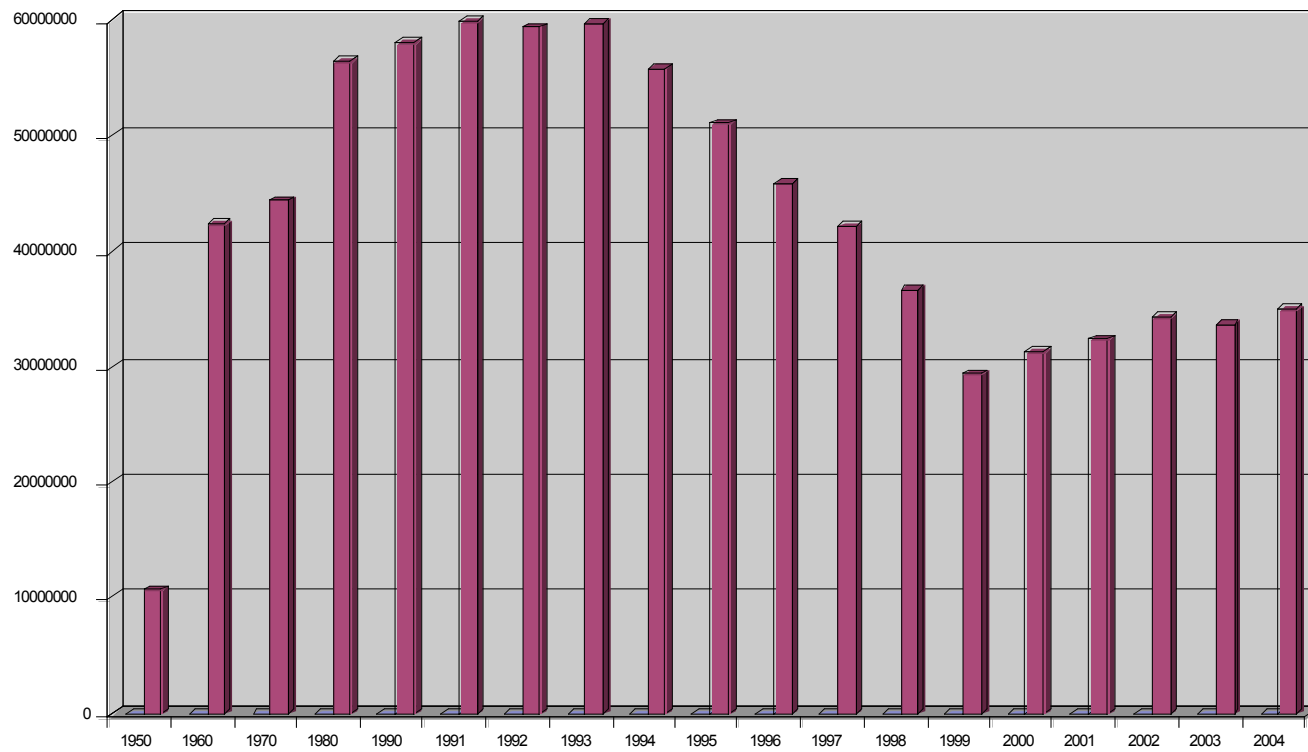
Dynamics of the amount of sheep and goat in Kazakhstan 1950 – 2004 (mln. head)

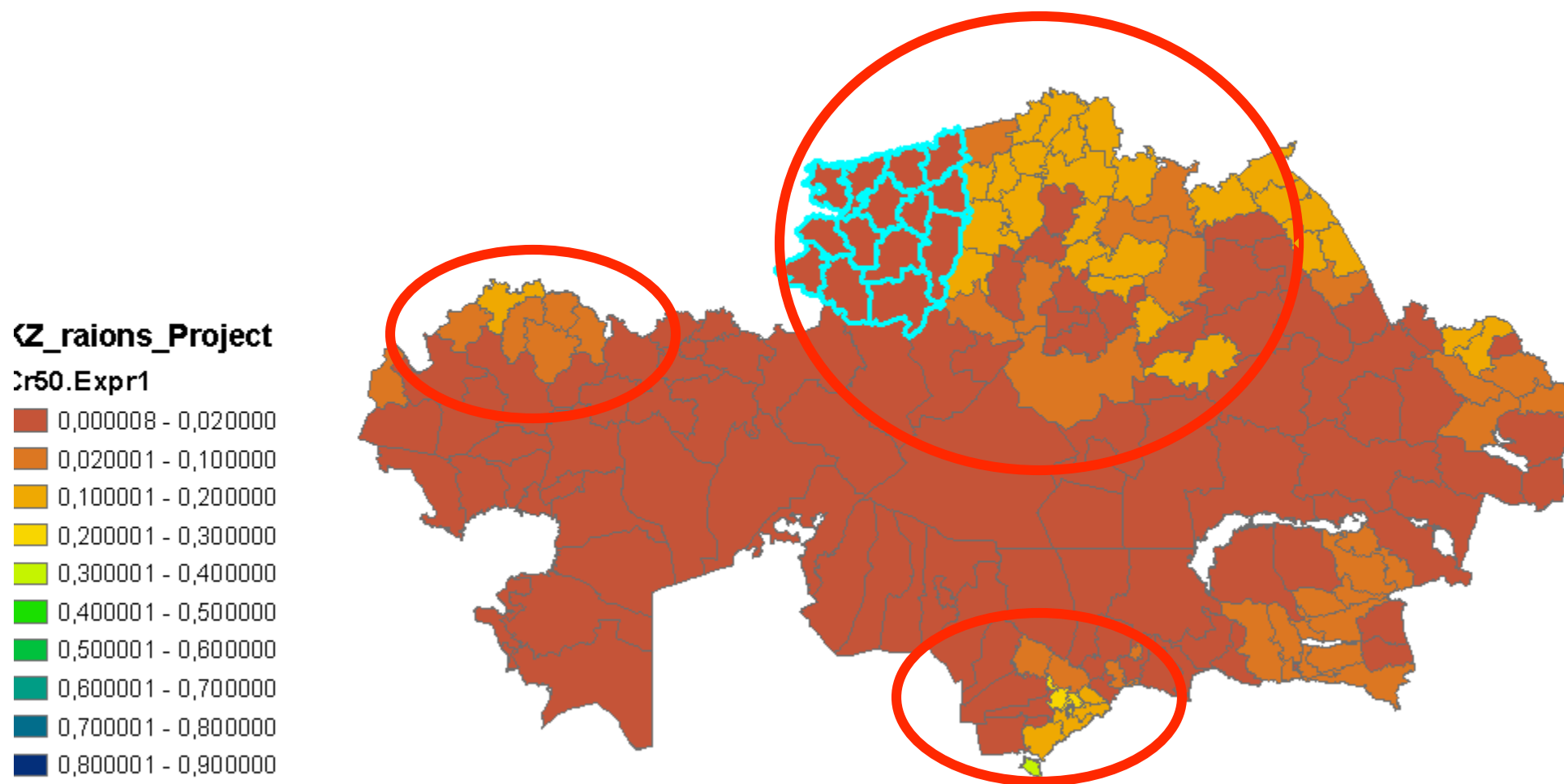


Livestock dynamics in Mongolia



Dynamics of the arable land in Kazakhstan 1950 – 2004 (ha)

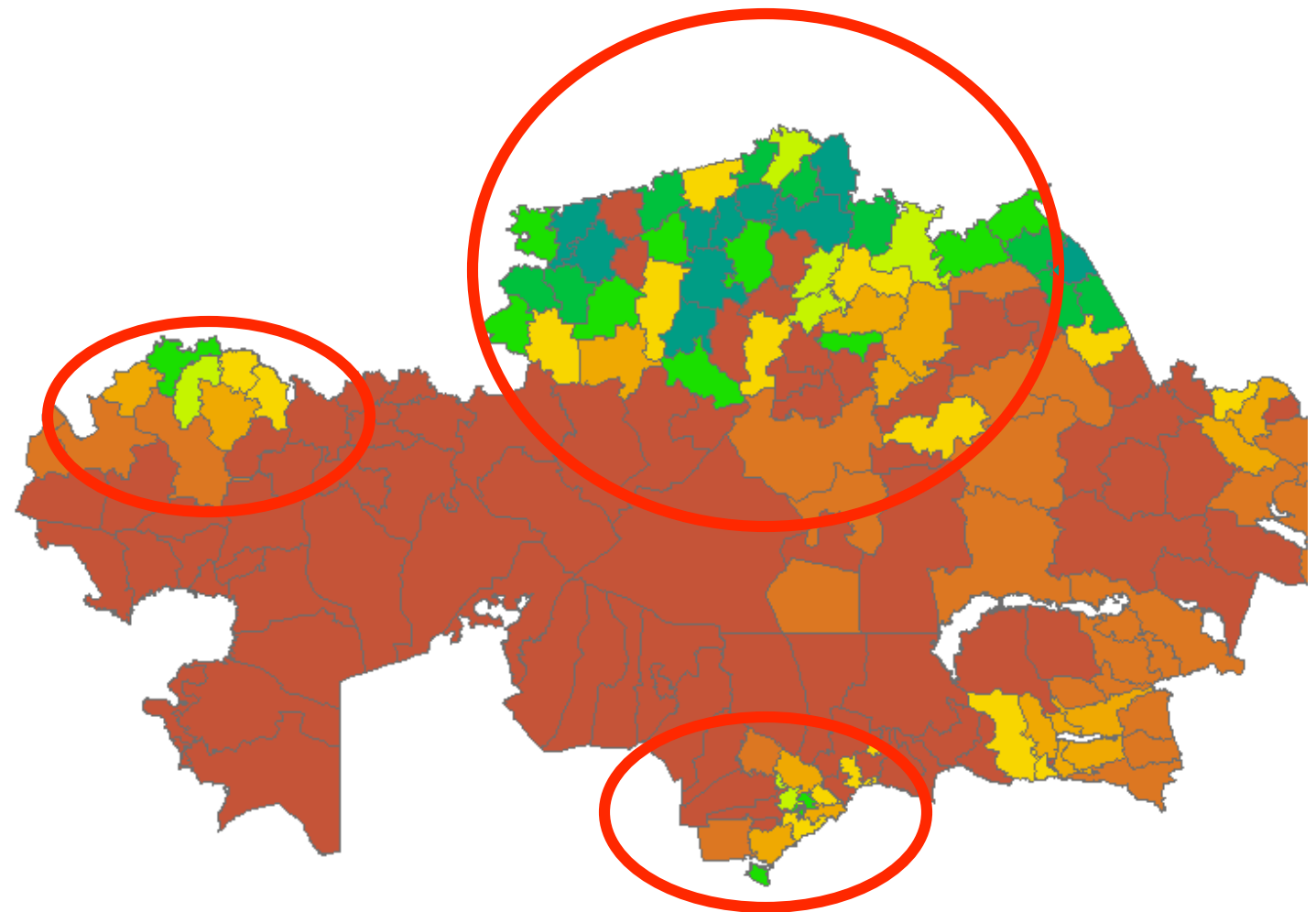
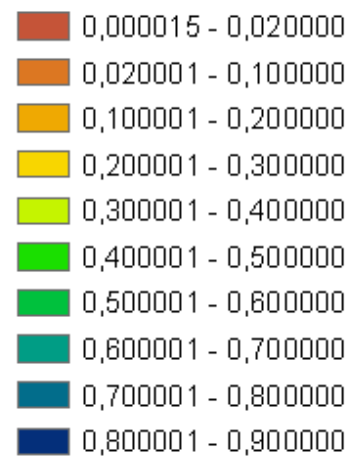




Fraction of arable land in raions of Kazakhstan, 1950

KZ_raions_Project

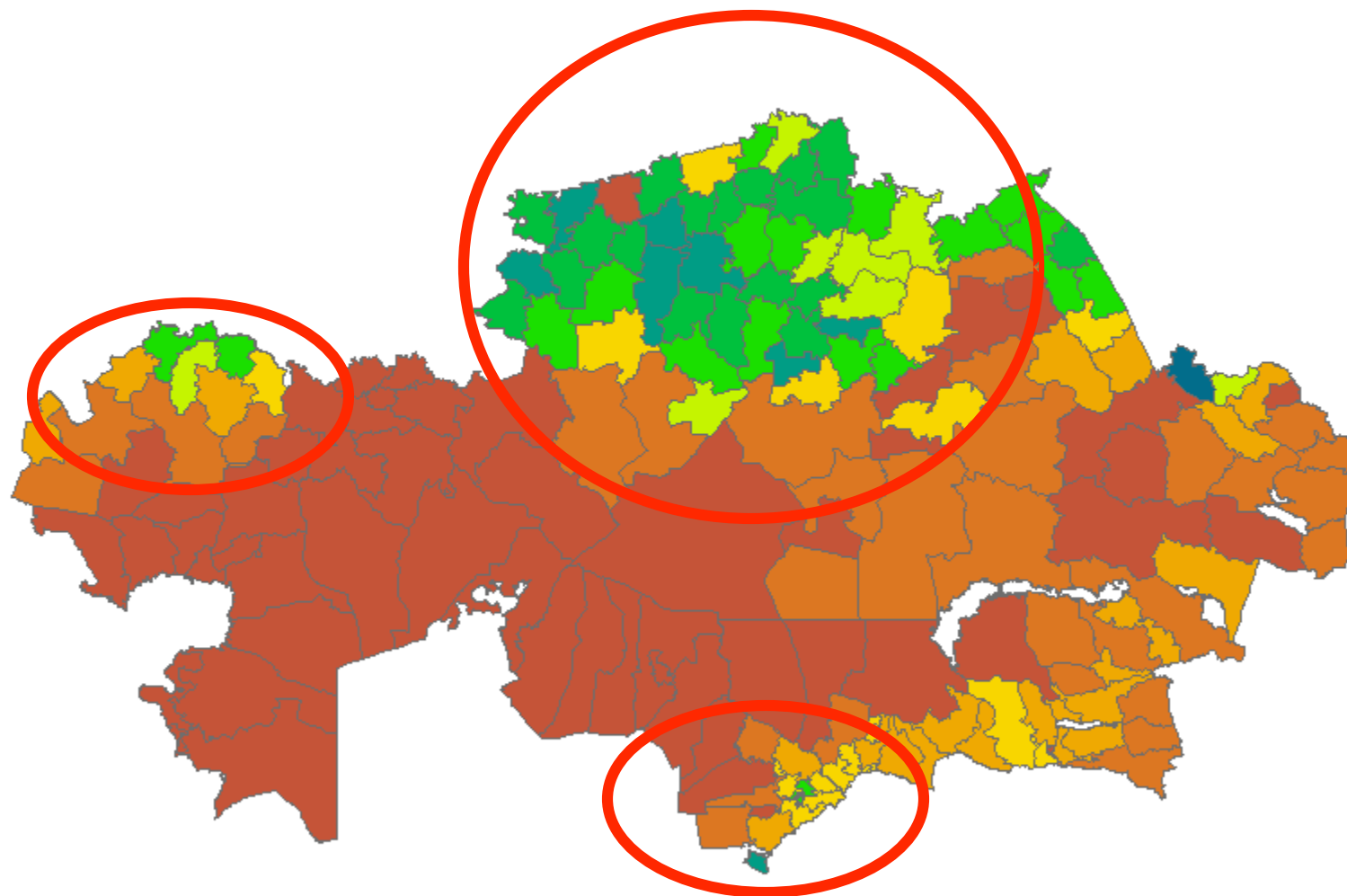
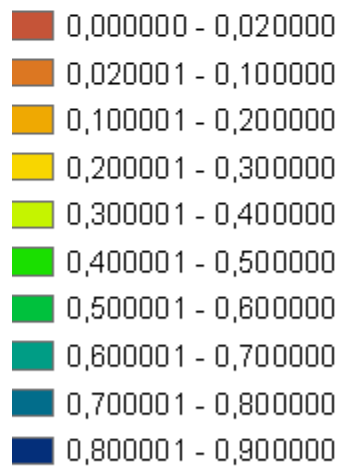
Cr60.Expr1



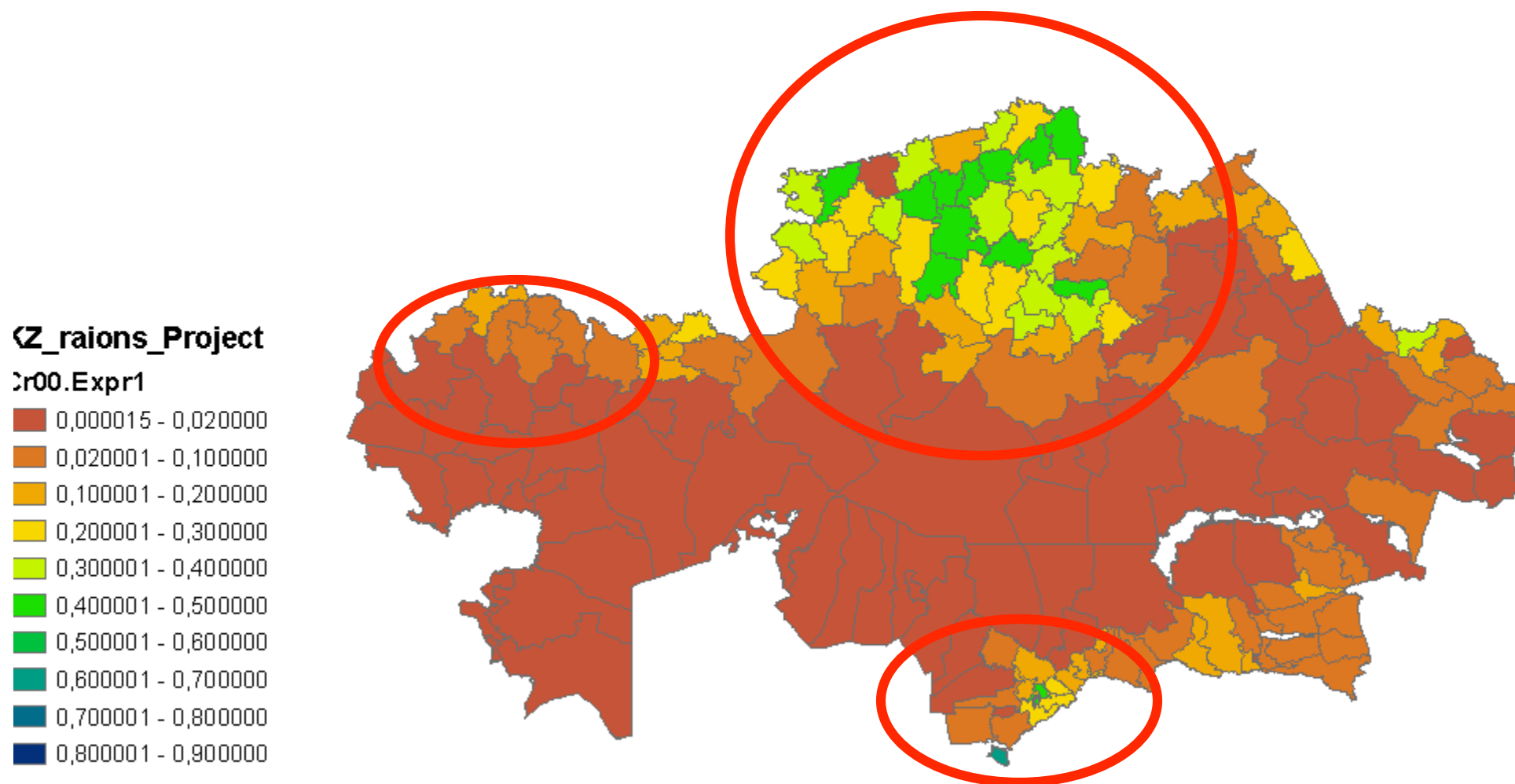
Fraction of arable land in raions of Kazakhstan, 1960

QZ_raions_Project

2r92.Expr1

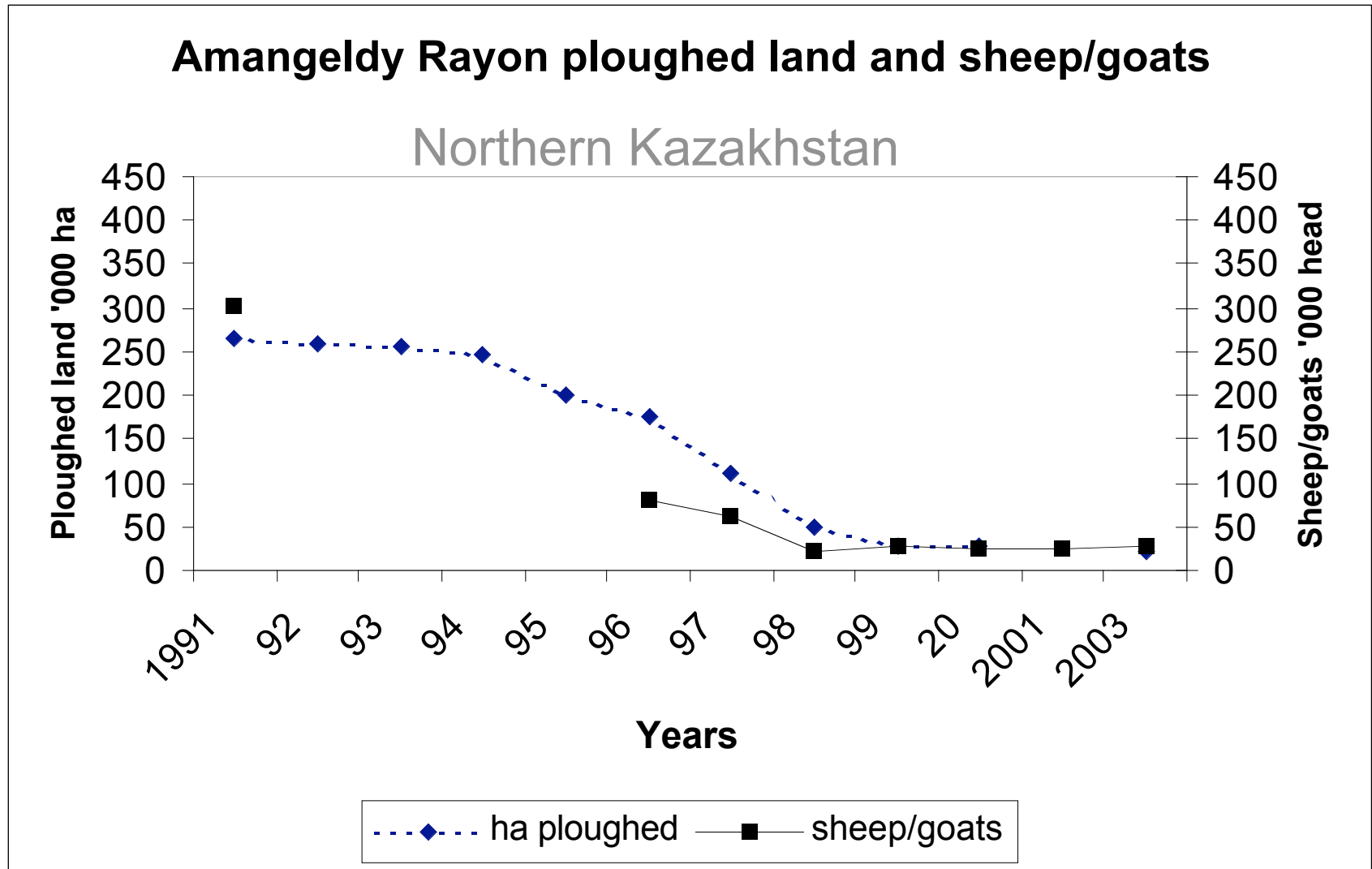


Fraction of arable land in raions of Kazakhstan, 1992



Fraction of arable land in raions of Kazakhstan, 2000

LOSS OF LAND PRODUCTIVITY

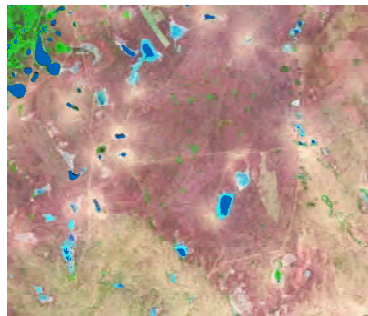


Smailov, Bragin, Temirbekov, Kerven

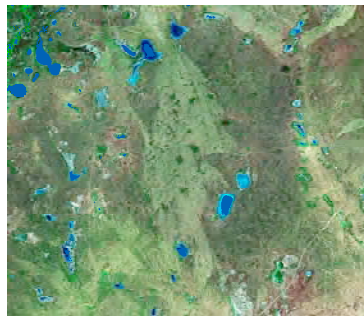


Change detection in rangelands

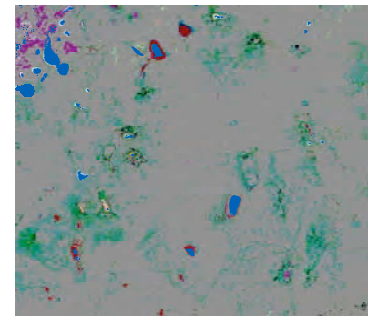
Southern part of the oblast was a major livestock rearing region in Northern Kazakhstan. After 1993-1994 privatization in agricultural sector of Kazakhstan this region shows recovery of vegetation around barns at distant pastures and around some settlements (green color on composite of band difference images). This agrees quite well with the data from other maps shown below which suggest that this district has good grazing lands and in the period 1990-2000 livestock amount dropped significantly.



Landsat TM image
Circa 1990



Landsat ETM image
Circa 2000



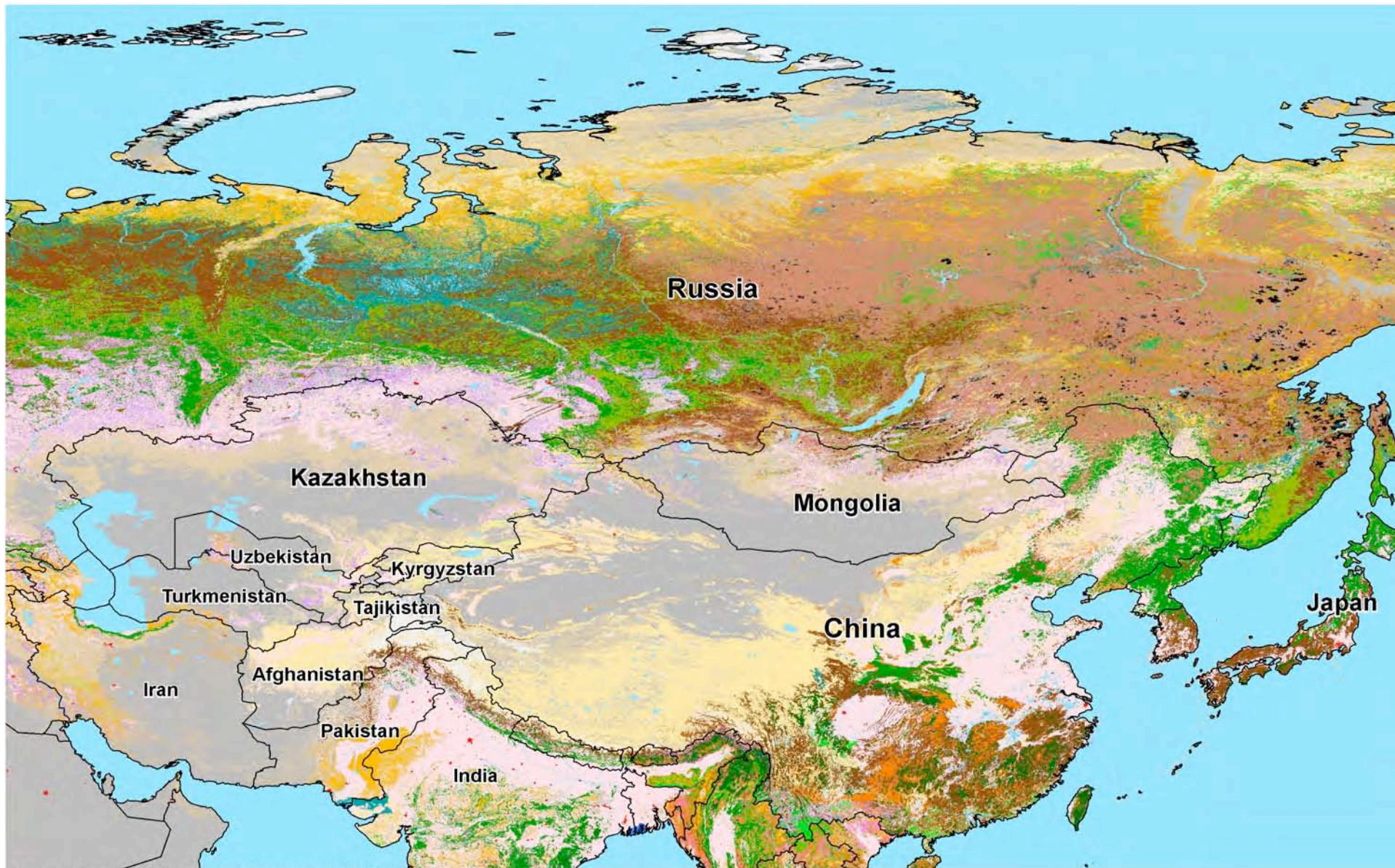
Composite of band
difference images

Data from livestock database on Dzhangildinskii district

1. Amount of sheep decreased by 318,000 head.
2. Amount of cattle decreased by 28,000 head.

Rangeland types by Vegetation Map

1. Bunch grass-sagebrush rangelands on chestnut soils with 10% solonetz. Used as spring-summer-fall pastures for all livestock.
2. Agropyron-forb-sagebrush rangelands on sands in places encroached by bushes and in places overgrazed. Used as spring-summer-fall pastures for sheep, horses and camel; can be partly used as winter pastures.

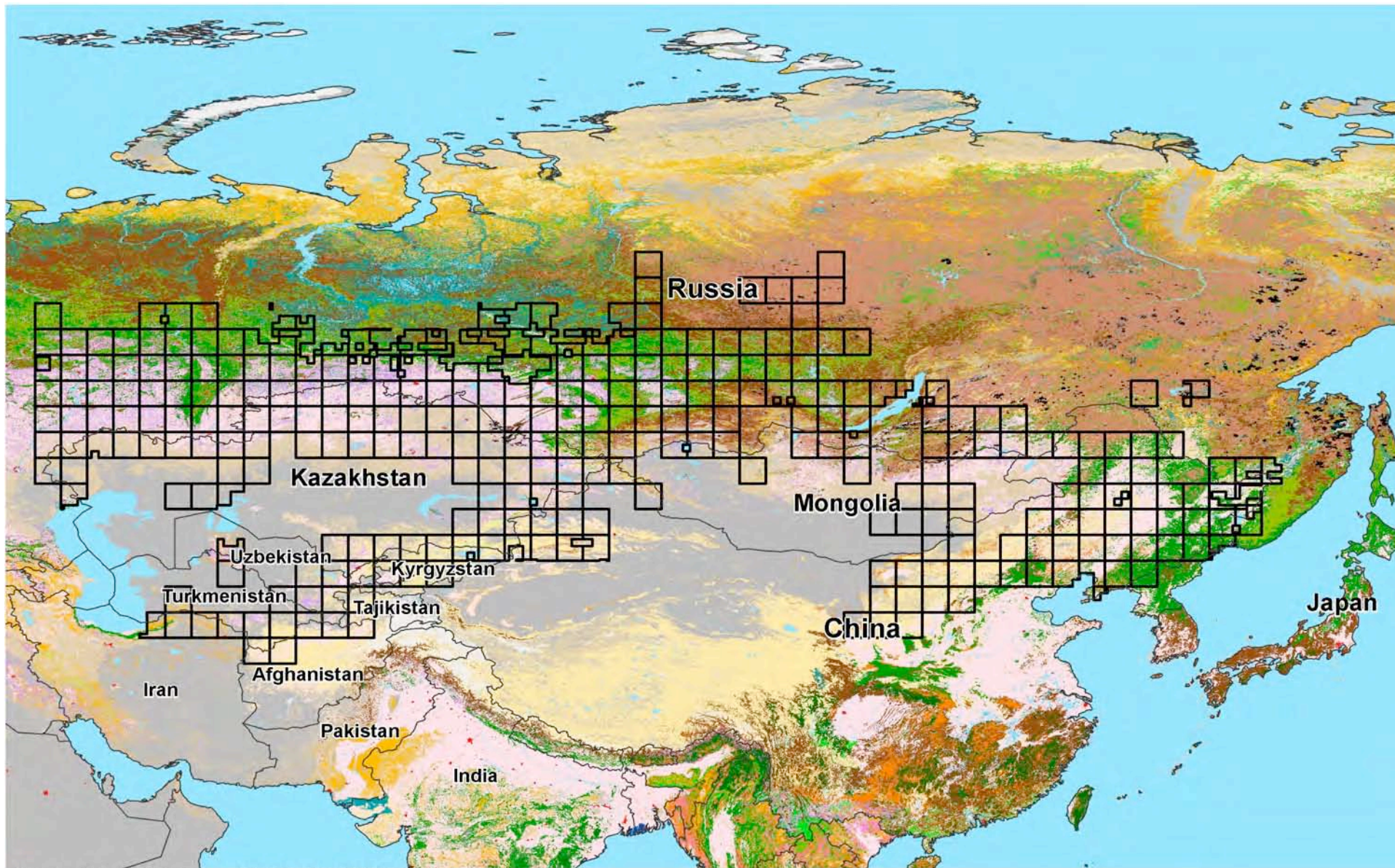


Current Land Cover -- Global Land Cover 2000



0 500 1,000 1,500 2,000 Kilometers

1-Kilometer Resolution



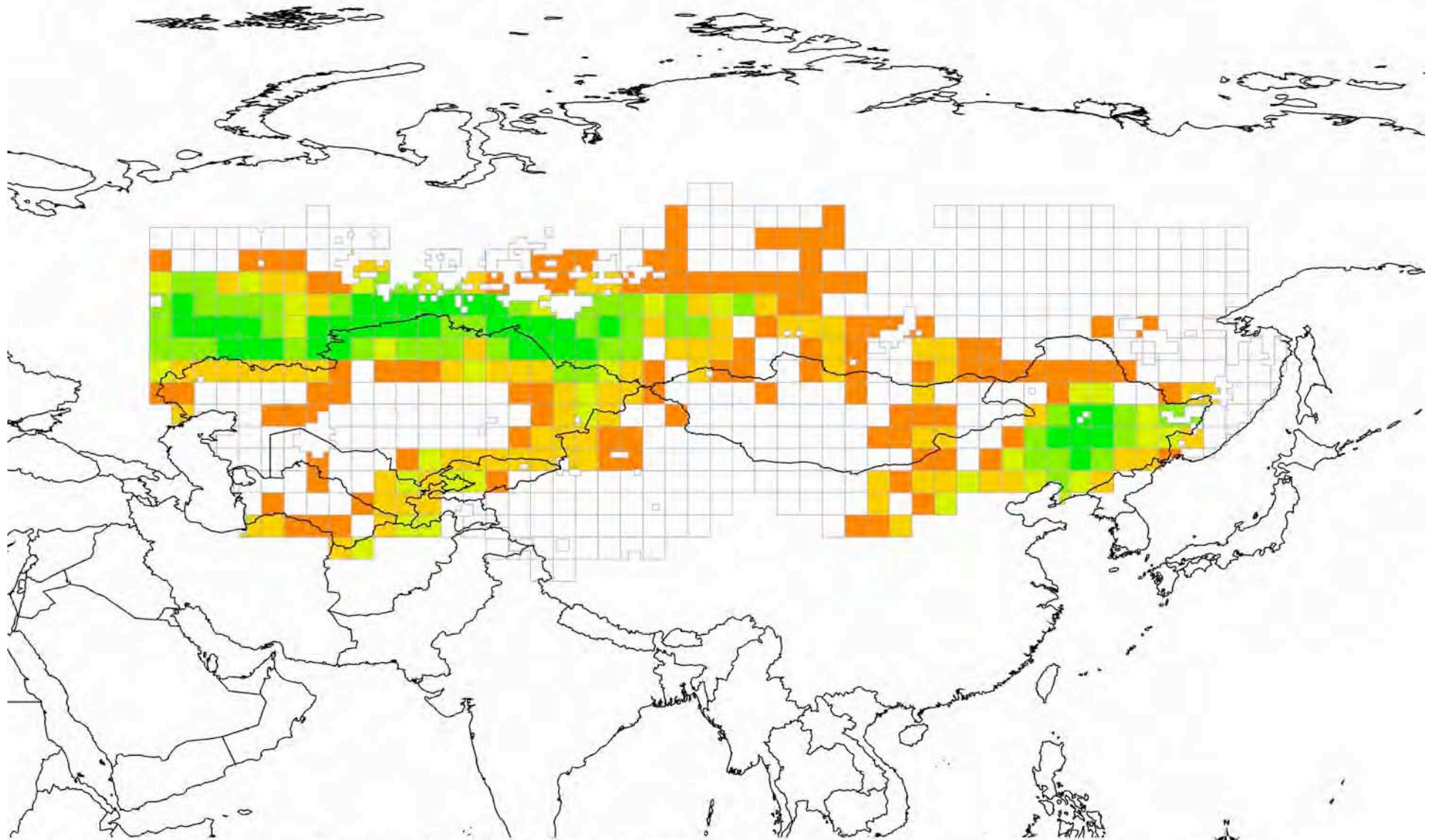
Current Land Cover -- Global Land Cover 2000



0 500 1,000 1,500 2,000 Kilometers

1-Kilometer Resolution

Percent Cropped Area by NCEP Cell



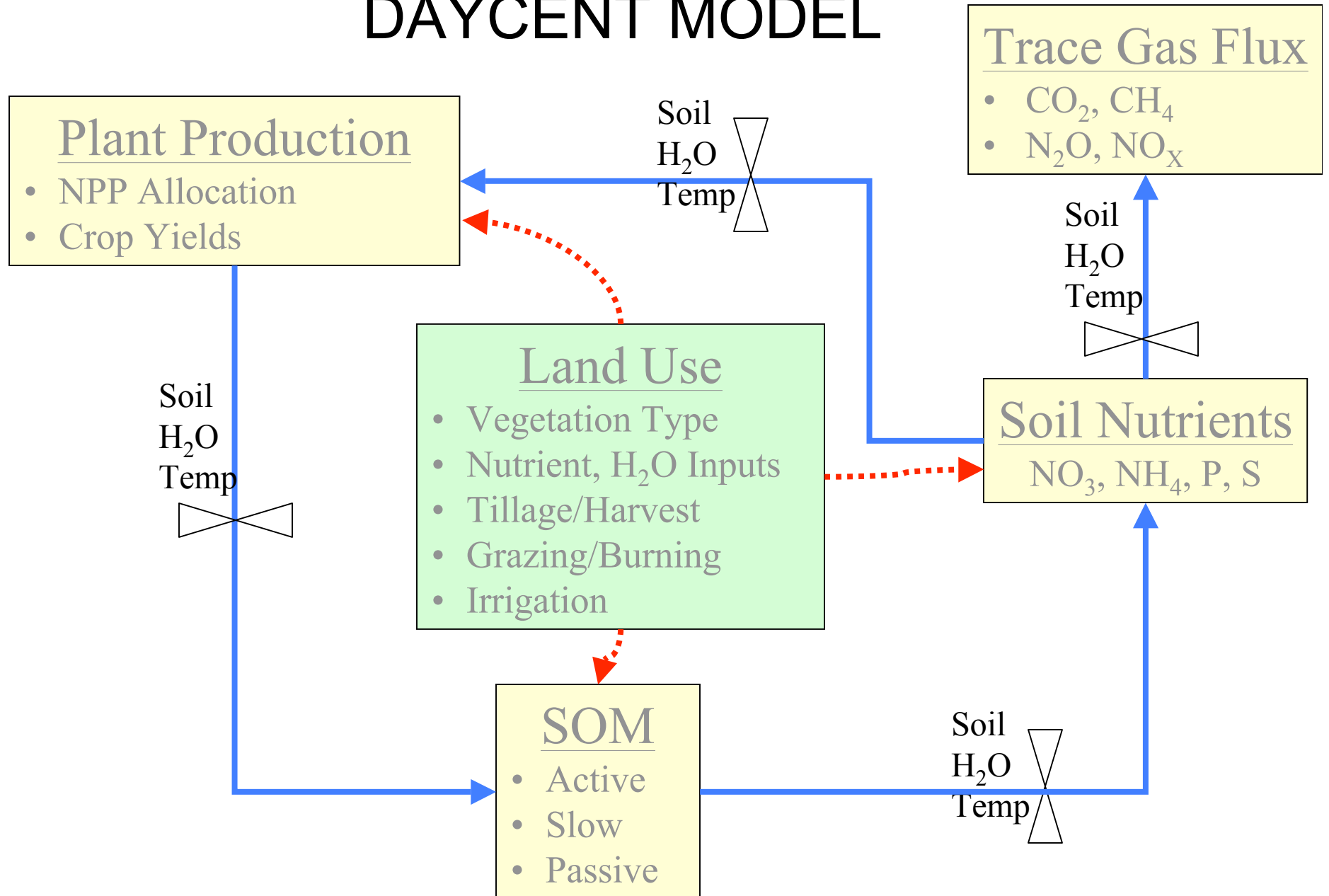
1992 Croplands Dataset, Ramankutty, N. and Foley, J. (1988)

Percentage

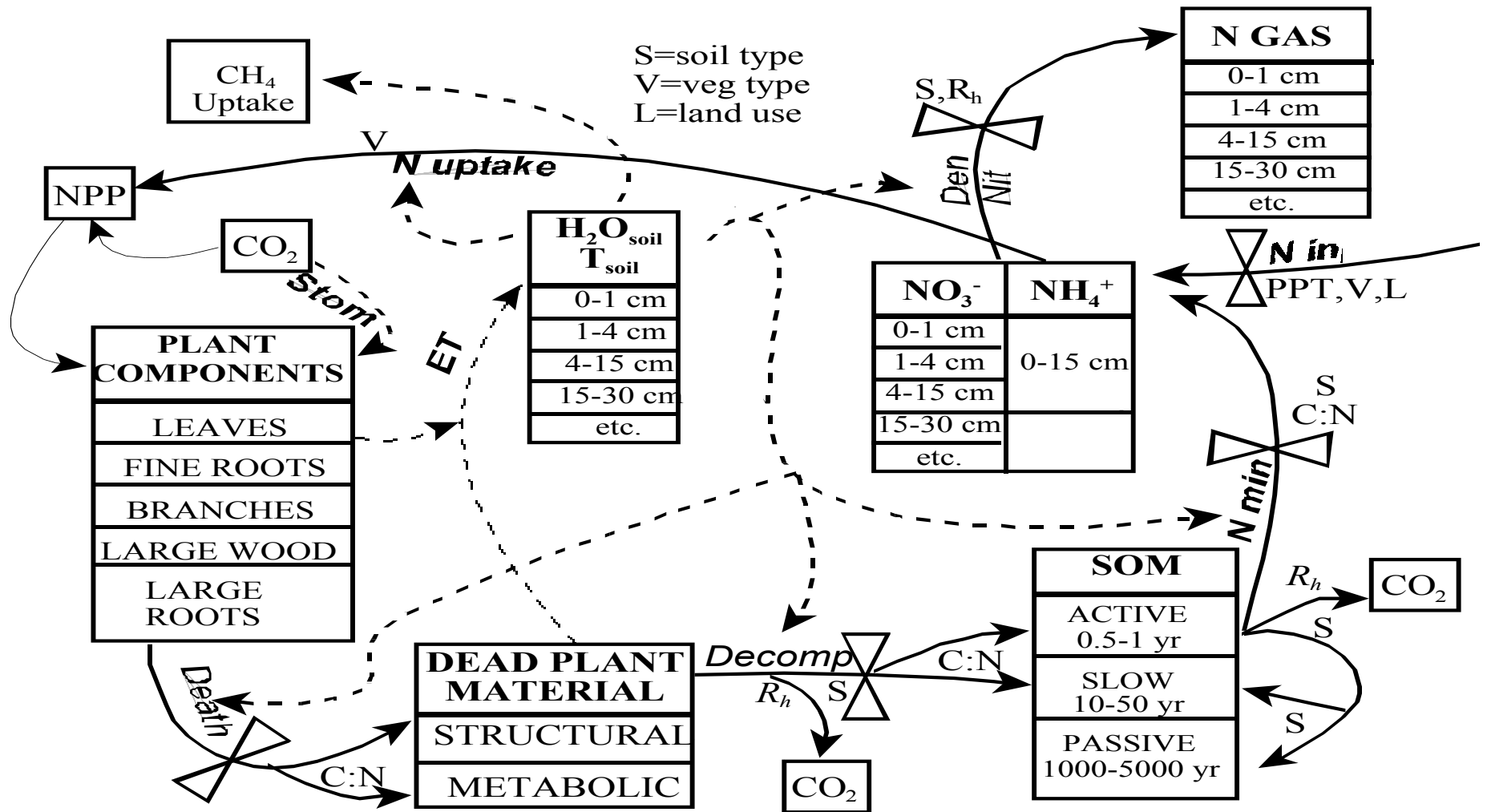


0 500 1,000 1,500 2,000 Kilometers
1-Kilometer Resolution

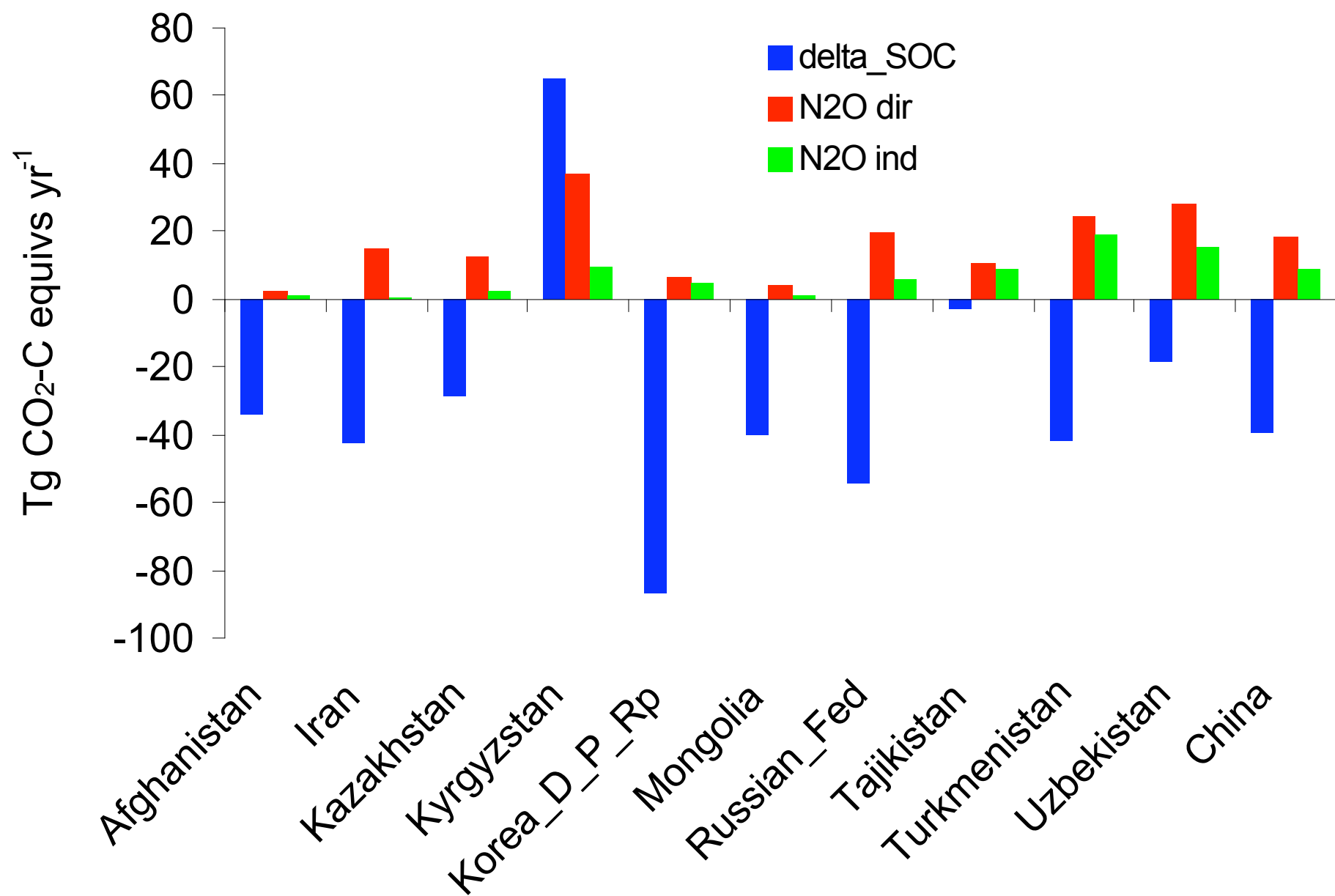
DAYCENT MODEL



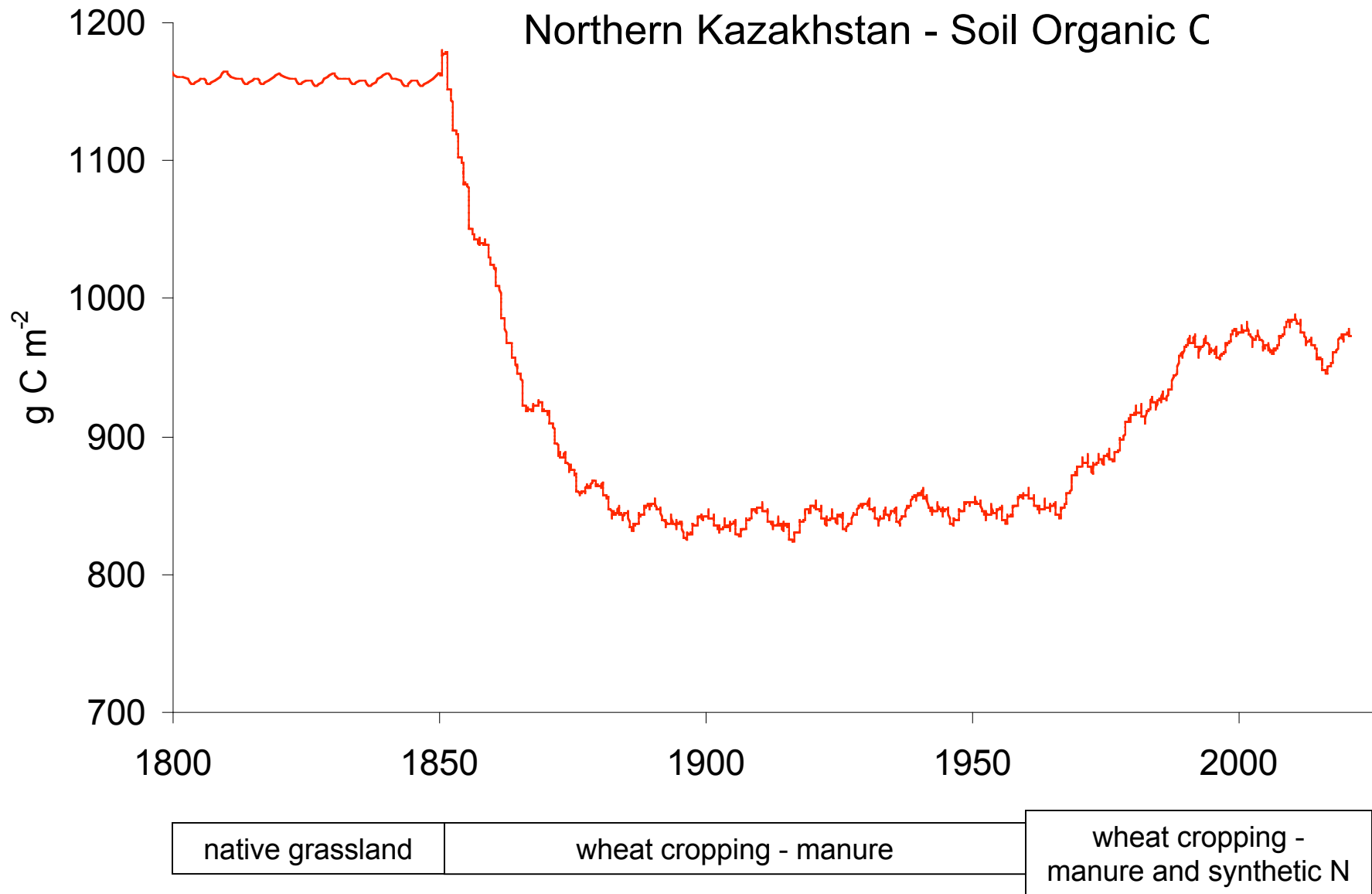
DAYCENT MODEL

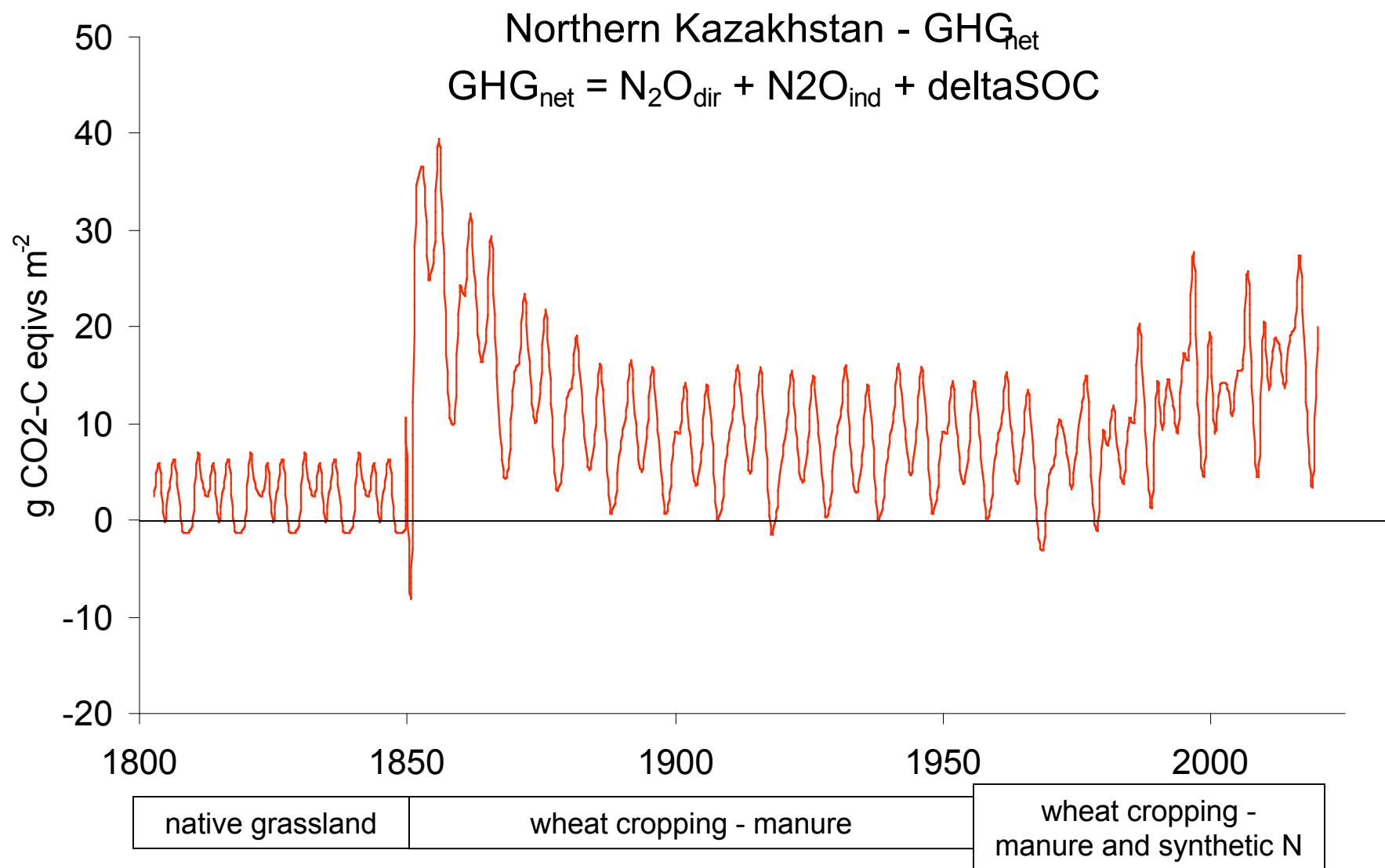


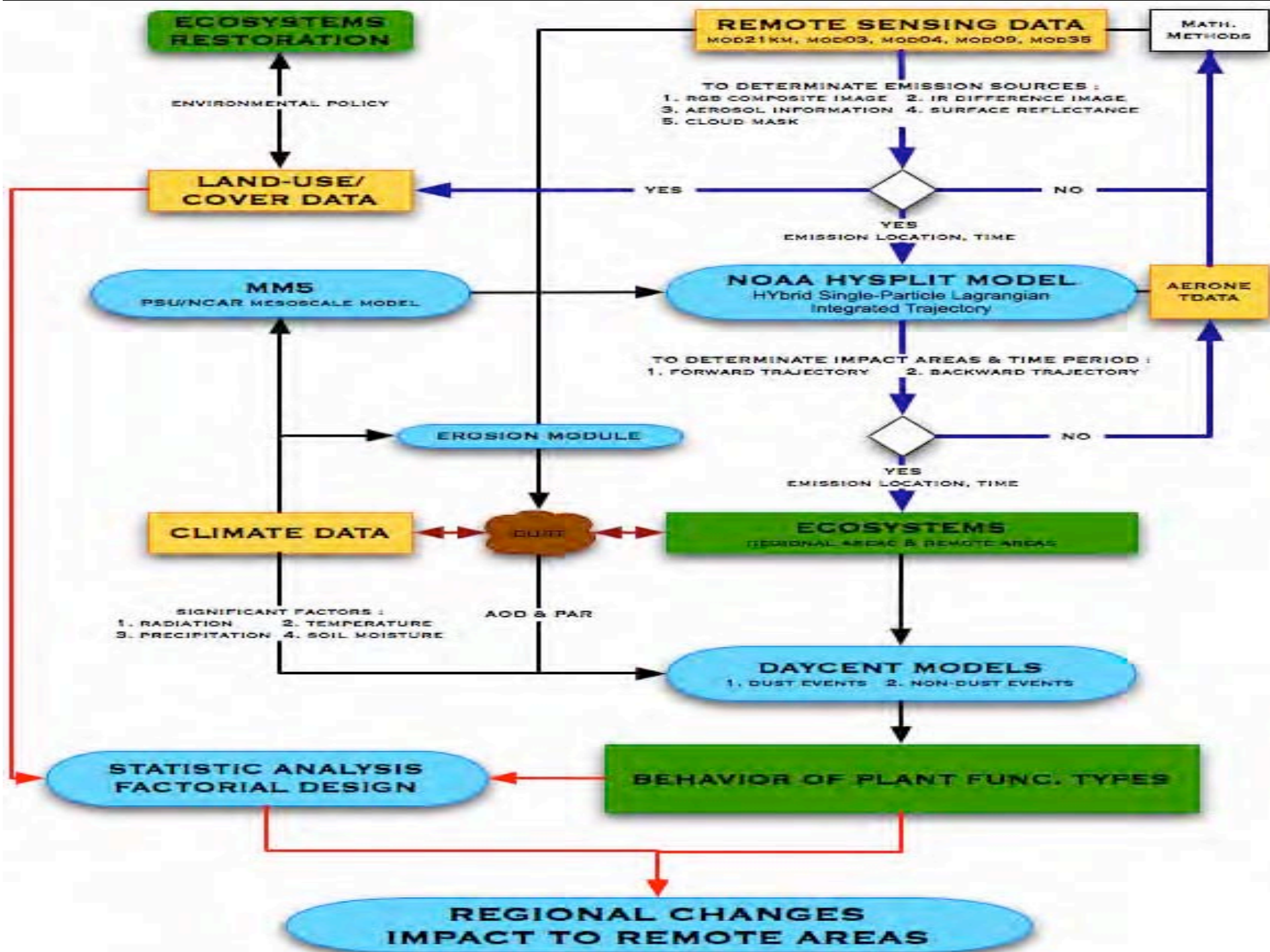
Parton et al. 1998
 Kelly et al. 2000
 Del Grosso et al. 2001



Northern Kazakhstan - Soil Organic C







Future Questions

- Land use effects on biophysical and biogeochemical processes
- Climate effects on land and water management practices
- Socio-economic drivers of future land use dynamics
- Coping and adaptation strategy to deal with climate and land use effects



THANK YOU

