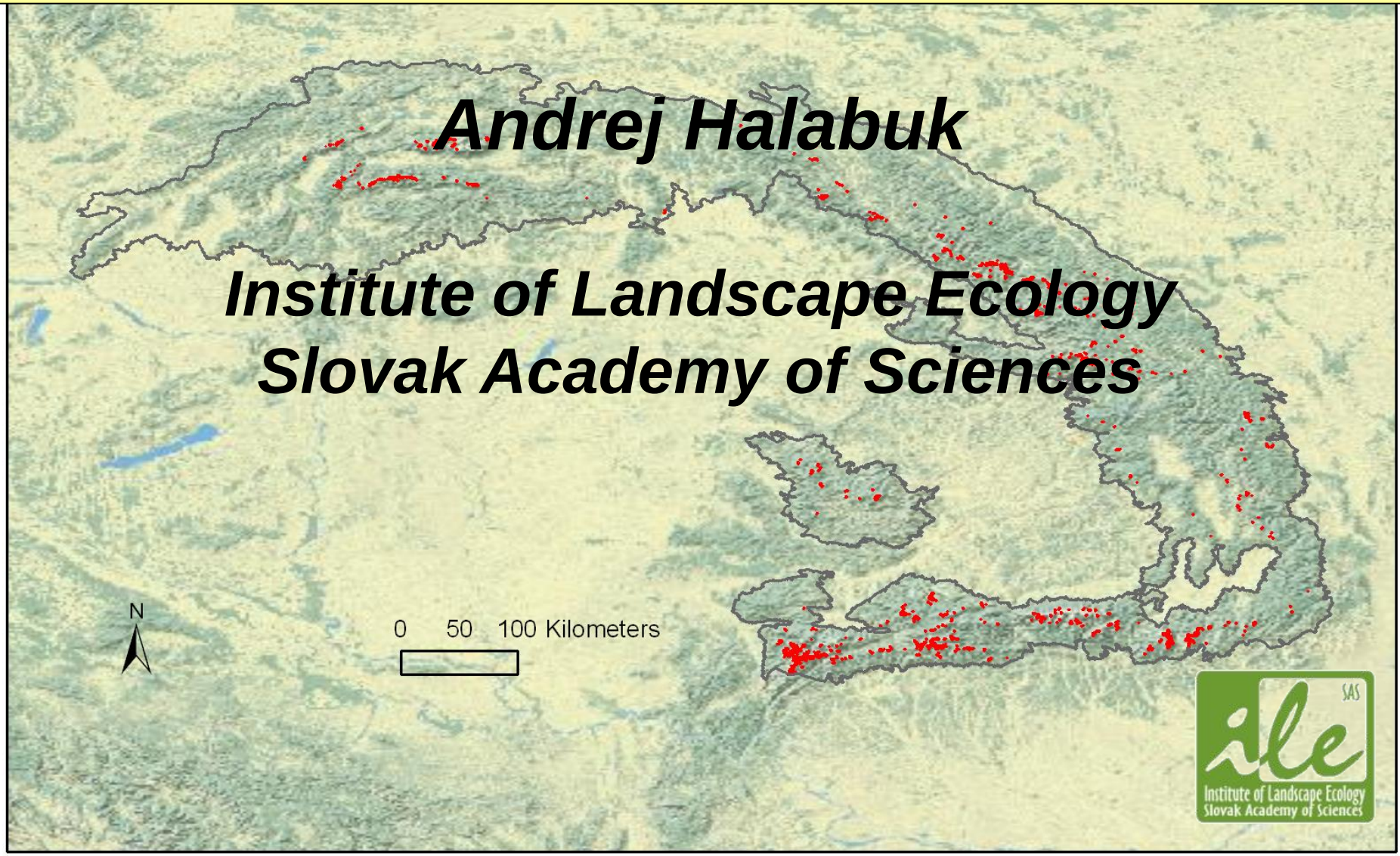
Monitoring of Grasslands by Using MODIS & Landsat



Institute of Landscape Ecology Slovak Academy of Sciences

- **Interdisciplinary scientific institution for basic and applied research in landscape ecology (established in 1965)**
- Total staff: 59 (scientific staff: 39; PhD students: 7)
- ILE SAS covers fields of abiotic, biotic and socio-economic sciences

Research related to Remote Sensing

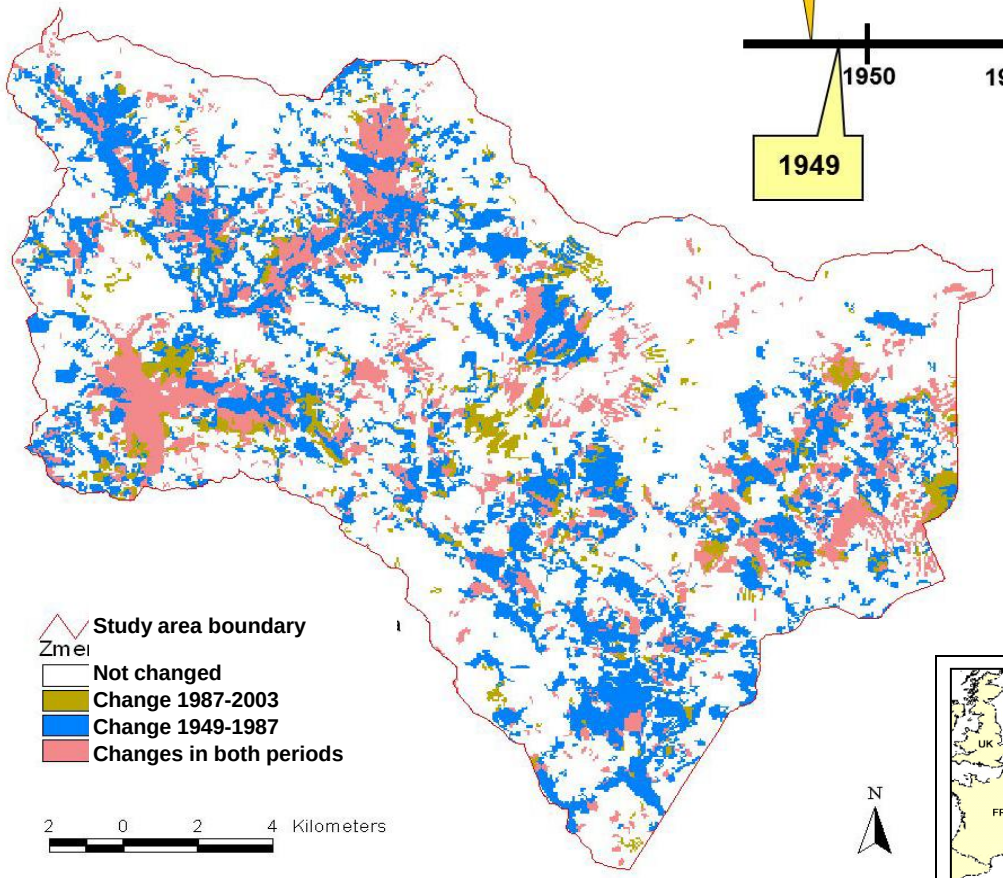
BioScene

Scenarios for reconciling biodiversity conservation with declining agricultural use in the mountains of Europe

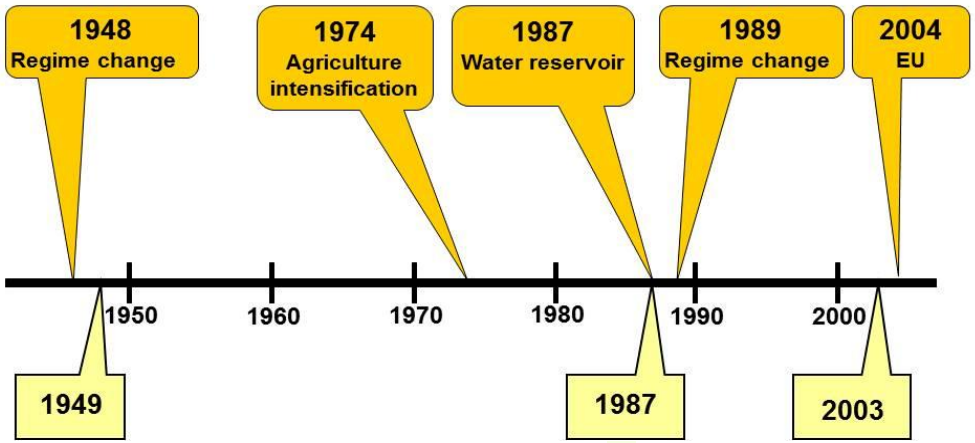
FIFTH FRAMEWORK PROGRAMME

DPSIR concept

Land cover transitions during 1949-1987–2003



Drivers of land use change

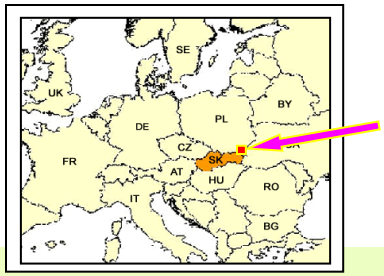


Main changes 1949-1987

from extensive grassland to forest
from mosaics to intensive grassland
from mosaics to extensive grassland
from mosaics to forest
from shrub to forest

Main changes 1987-2003

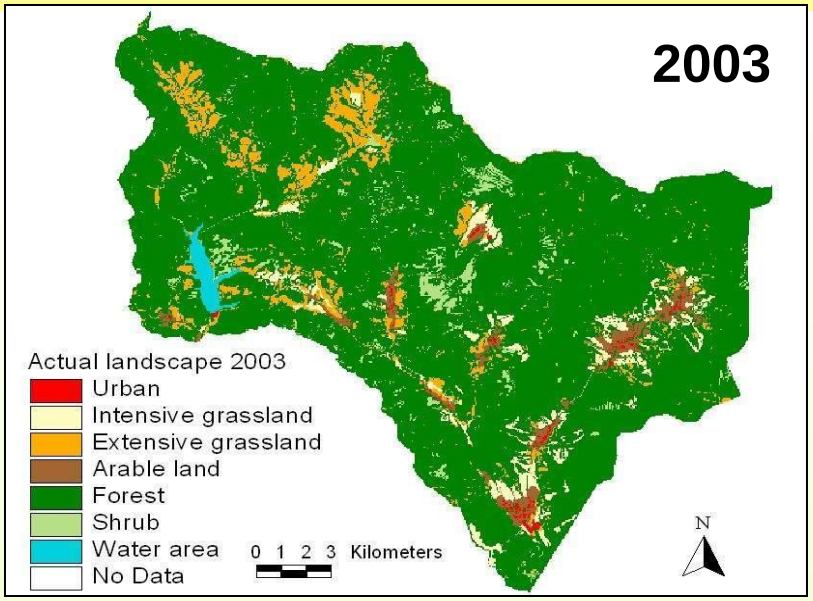
from ex



3.Detailed interdisciplinary field research on 3 selected areas

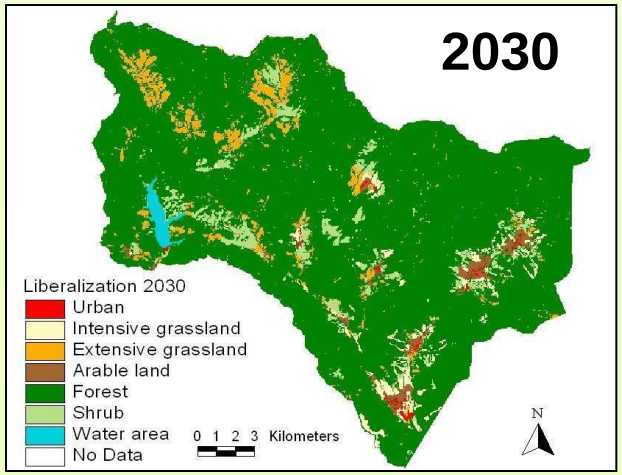
- Land use changes
- Sociological reserach – stakeholders attidude and expetations, history of landuse
- Selected groups of animals (birds, spiders, buterfies, dragonflyes, beetles)
- phytocenological reserach
- Pedological reserach
- Morphometric analyze of georelief
- Elaboration of Strategy for protection and management

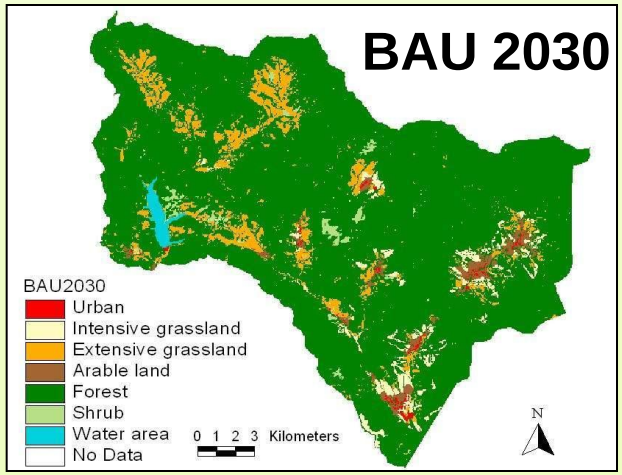
Predictive land cover change modelling

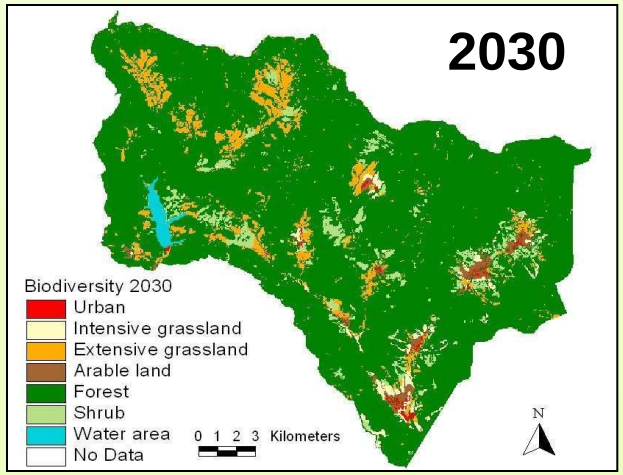


Liberalization

Biodiversity

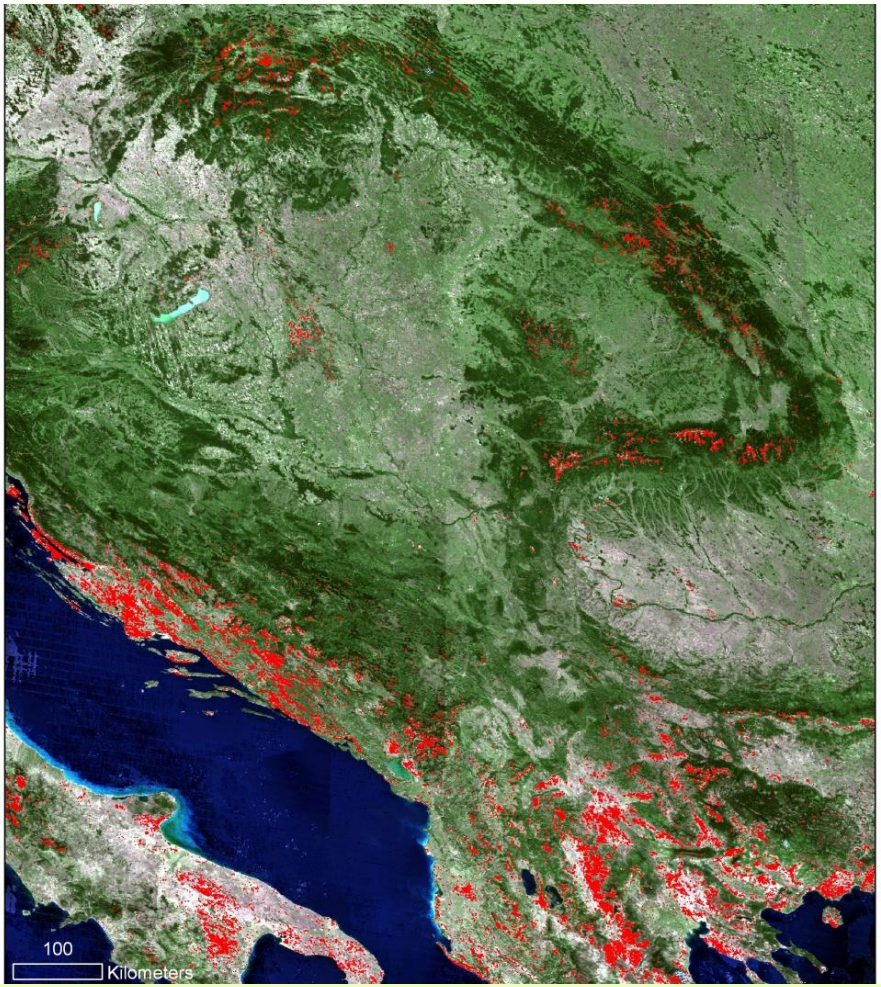






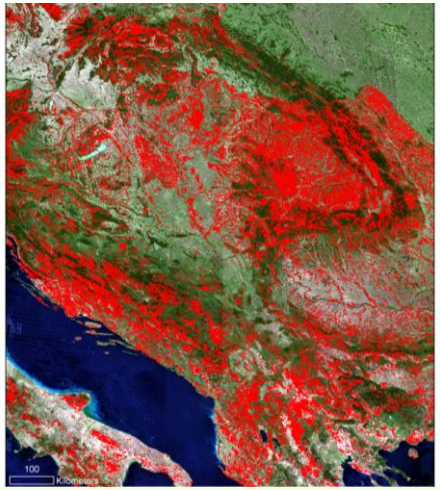
Grassland focus

- Grasslands – important component of landscape and its functioning (production, biodiversity, water retention)
- Lack of consistent spatial data, difficult detection by RS
- **Detection of management practice in grasslands (cutting, grazing, overgrowing, drying, flooding, burning)**

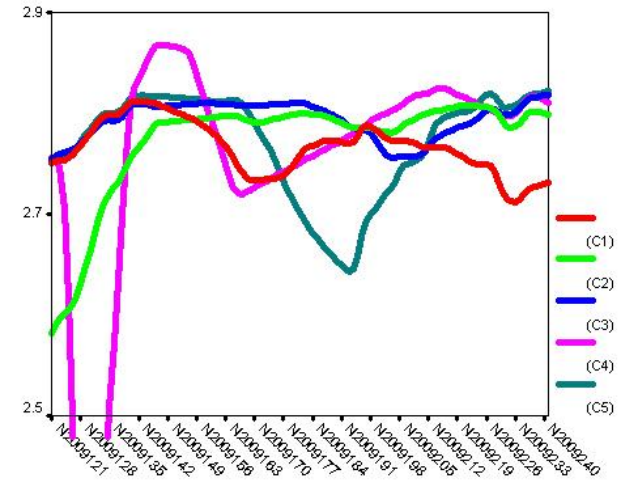


MODIS based analysis of NDVI time series

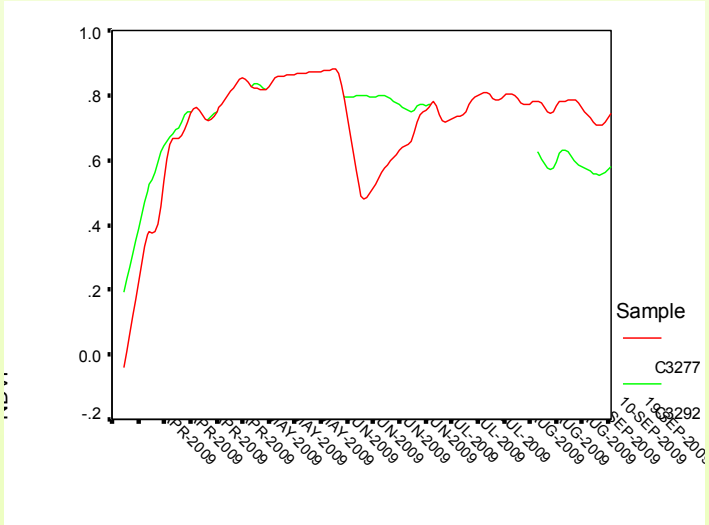
1. Grassland mapping



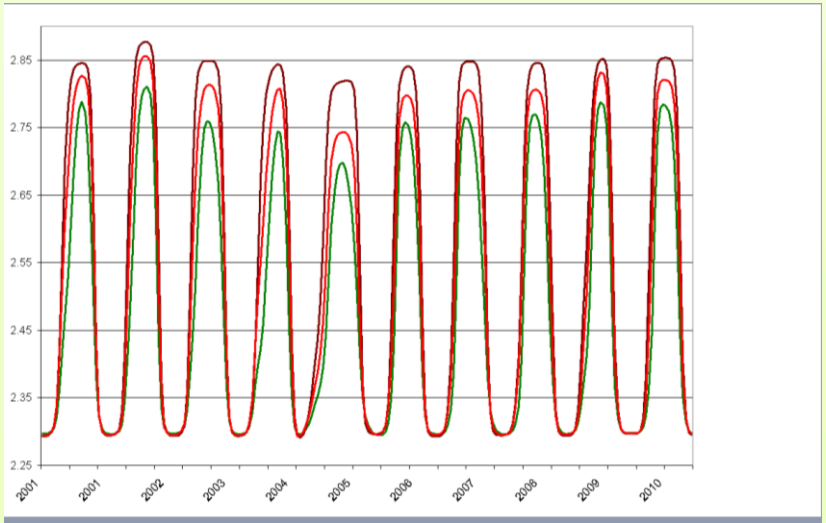
2. Grassland habitat classification



3. Detection of management practices



4. Grassland LSP



1. Grassland mapping

Suppervised approach

Landsat:

- Classification using multi-date multispectral signatures
  - Reflects different color and leaf biochemical composition in specific dates
- Final generalization using image segmentation process

MODIS:

- Multi-temporal classification using NDVI temporal profile
  - Reflects seasonality and management practices
- Pixel based

Both approaches need training sites for signature development, exploring of temporal profiles of crops and validation sites for accuracy and reliability assessment

Unsuppervised approach

. Broader scale

2011/07/17 (LTM5 RGB 30m))

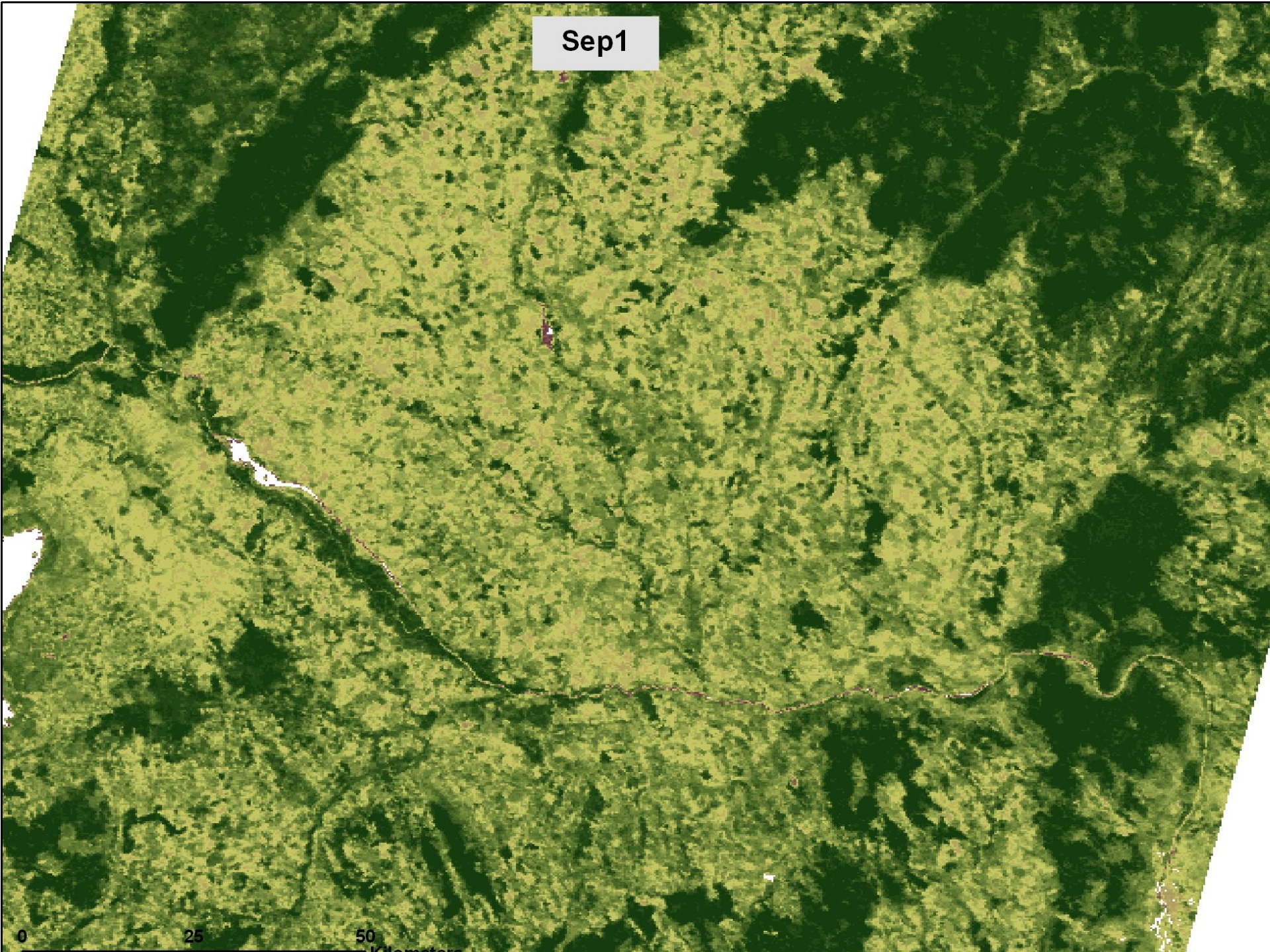
Available satellite images

Landsat TM5:

- 2011/06/15, 2011/07/17, 2011/08/02, 2011/09/03

Landsat ETM+:

- 2011/04/20, 2011/05/06; 2011/05/22; 2011/07/09; 2011/08/26; 2011/09/11; 2011/09/27


Sep1
0
25
50

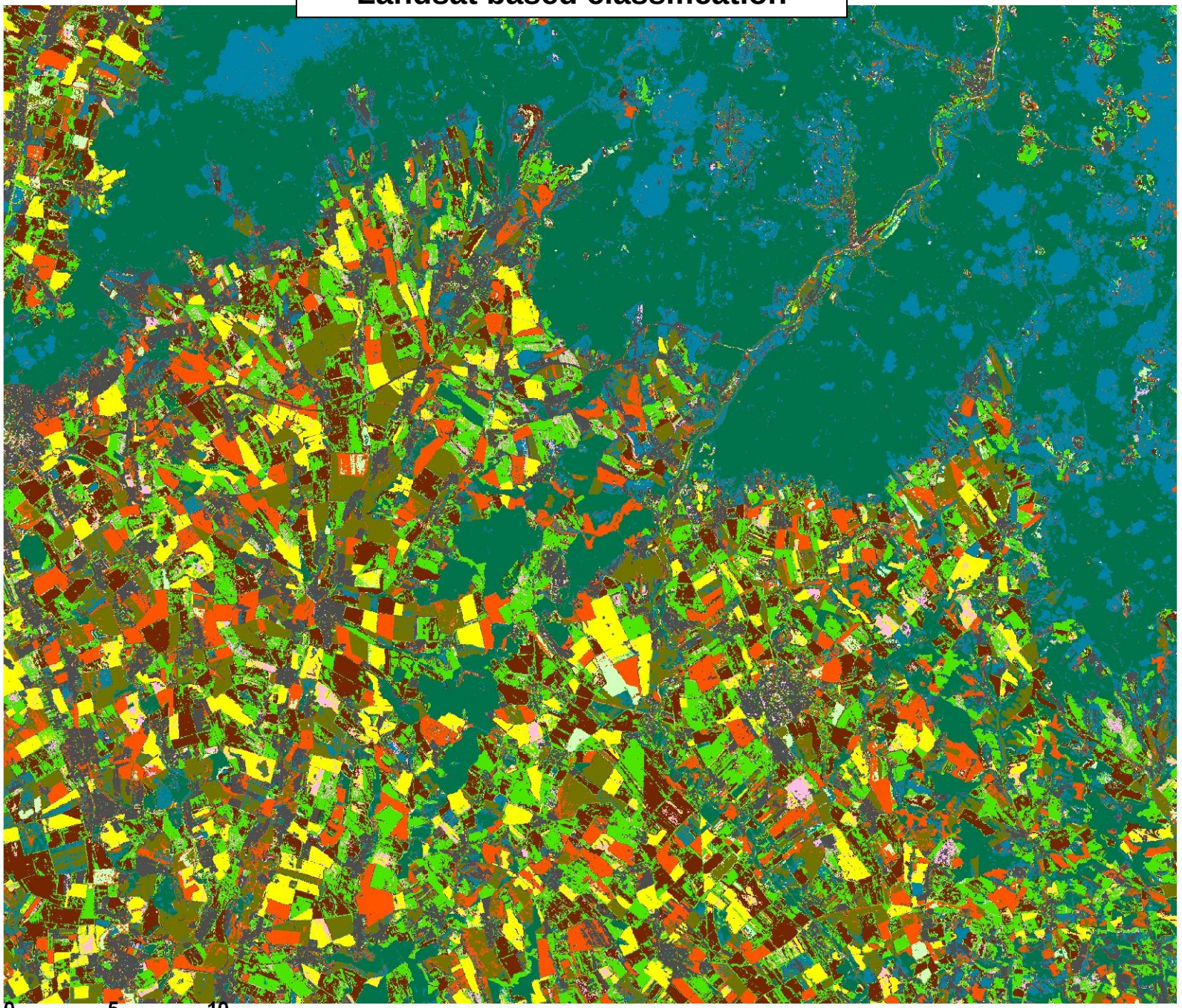
Training sites

- **Field research**
- **Desktop analyses**

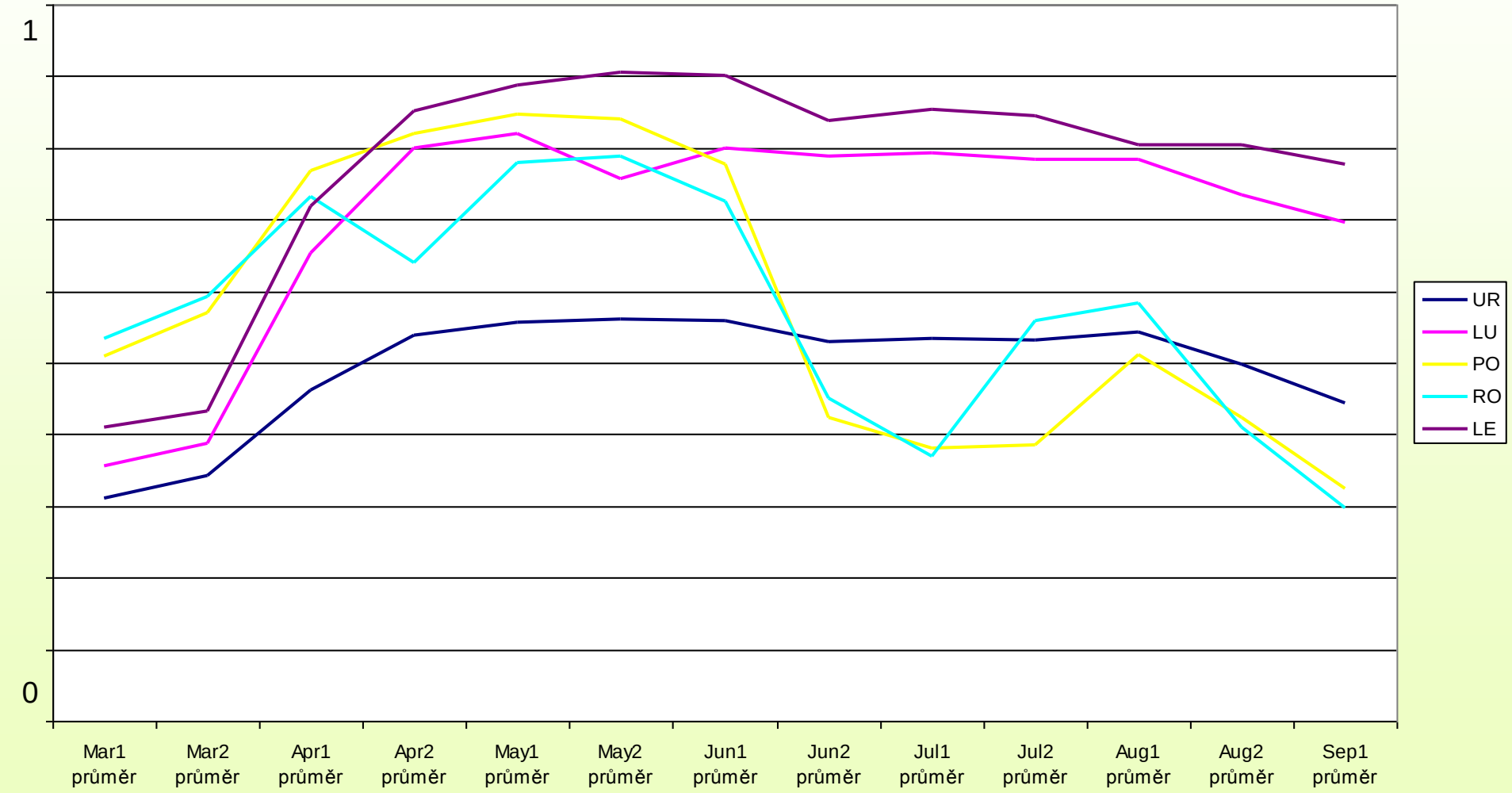
- Radiometric correction and calibration of input Landsat data
- Identification of main crop types
- Spectral libraries of main crops using
- Multitemporal signatures
- Visual interpretation of HR satellite images

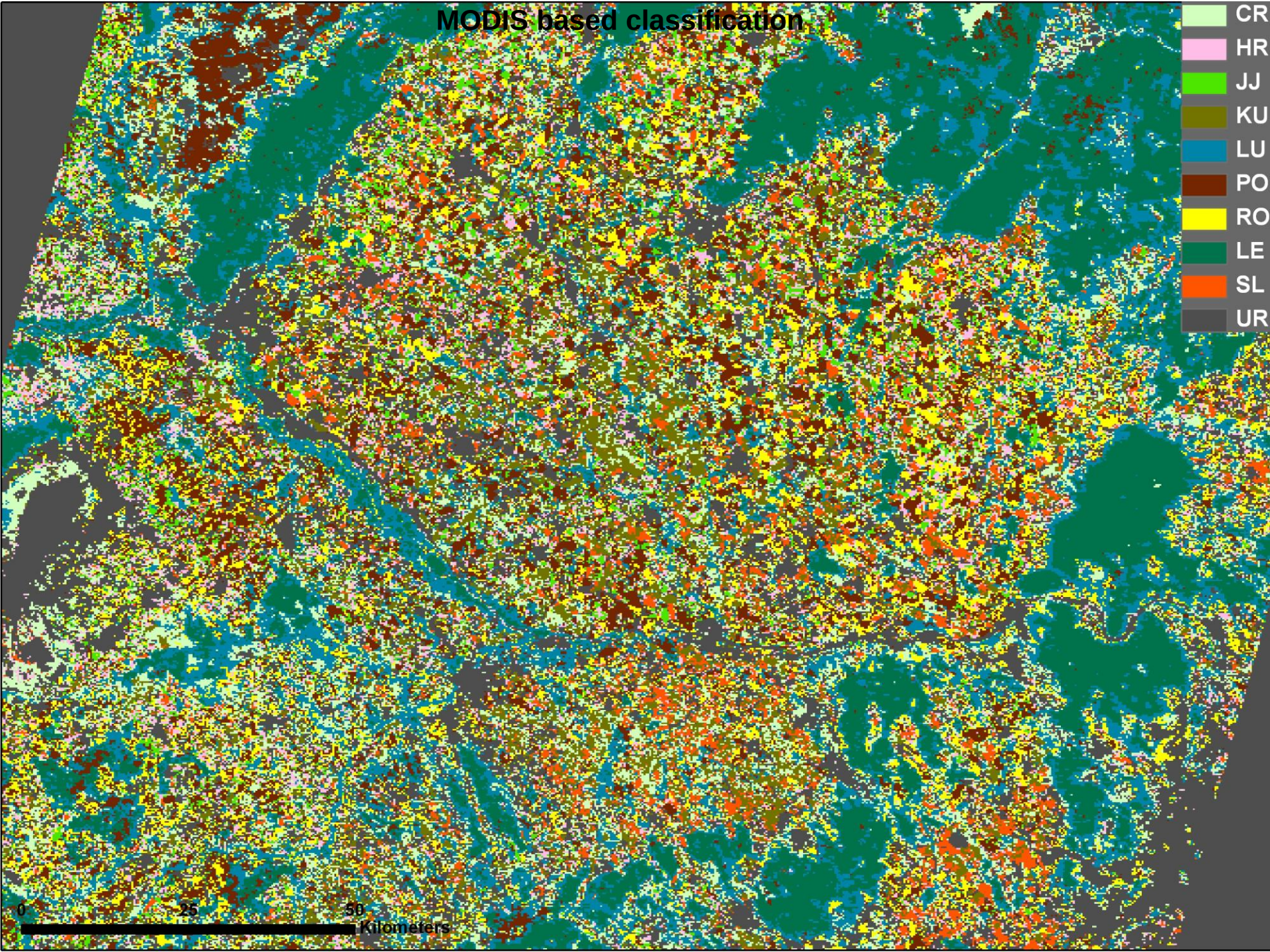

Totally: 720 sites
0
5
10
Kilometers

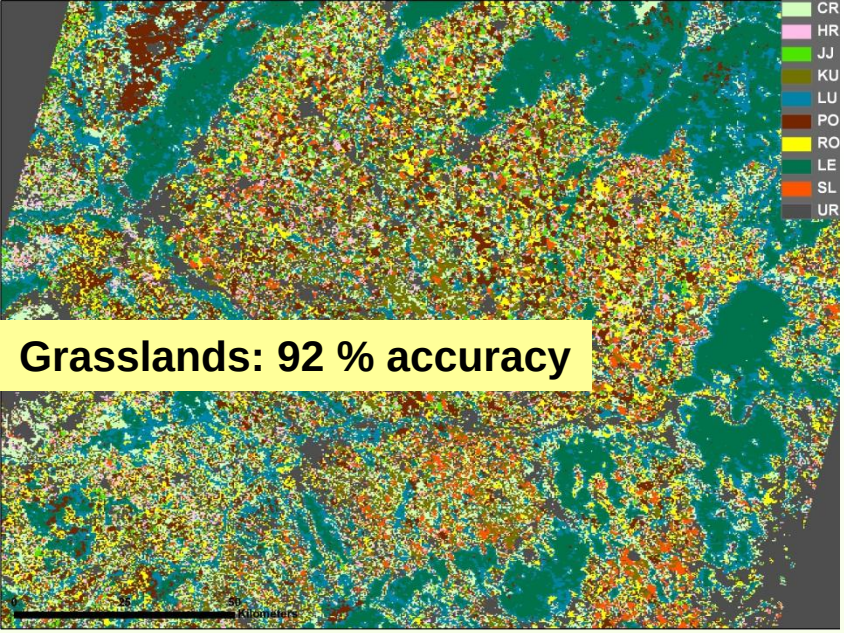
Landsat based classification

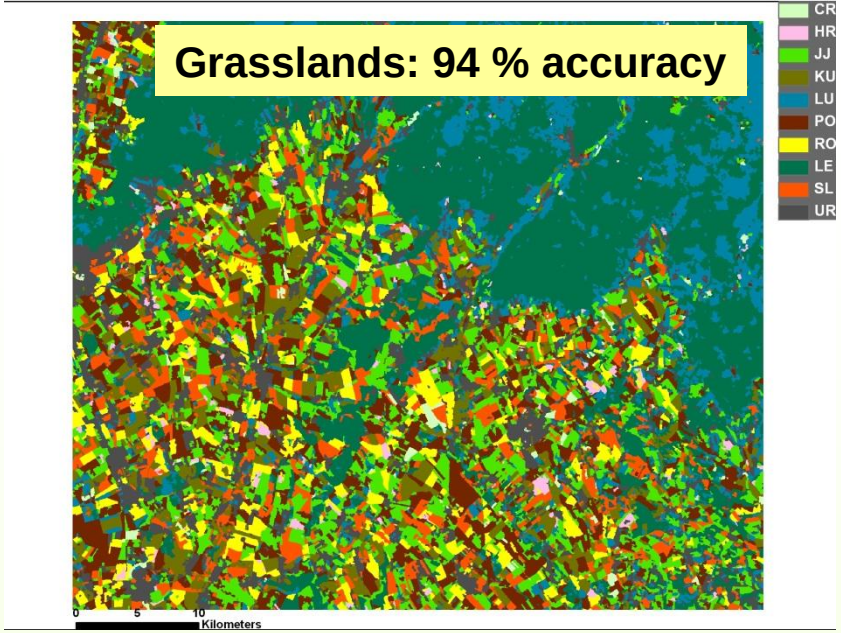


MODIS based approach NDVI profile



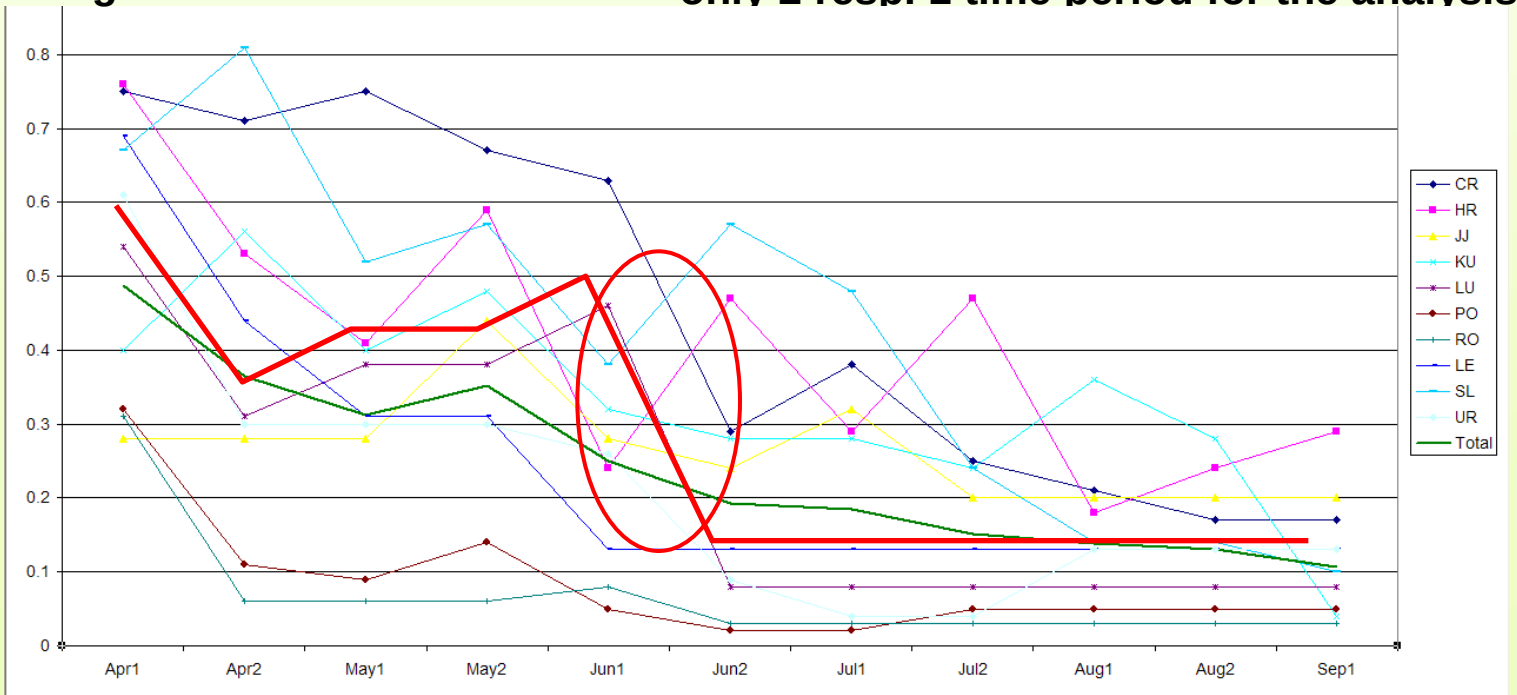

MODIS based classification
CR
HR
JJ
KU
LU
PO
RO
LE
SL
UR
0
25
50
Kilometers



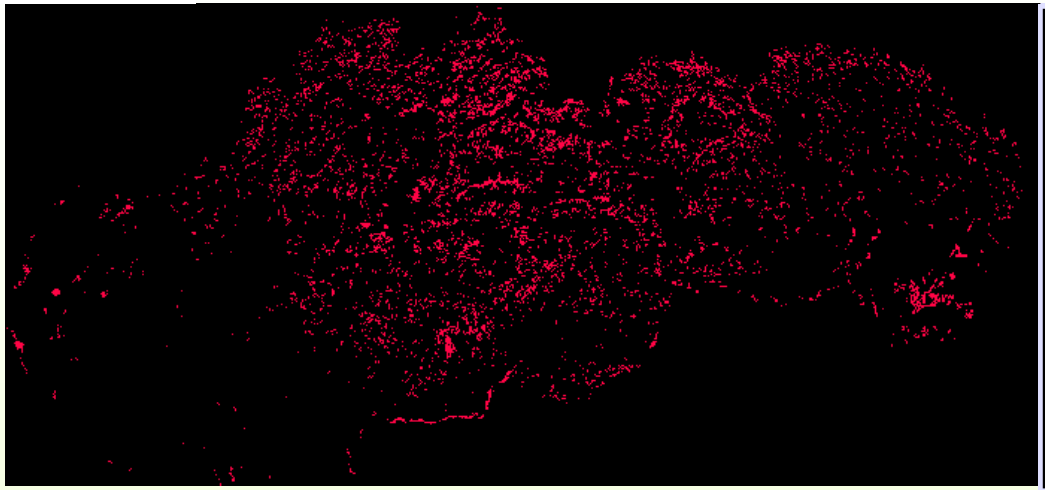


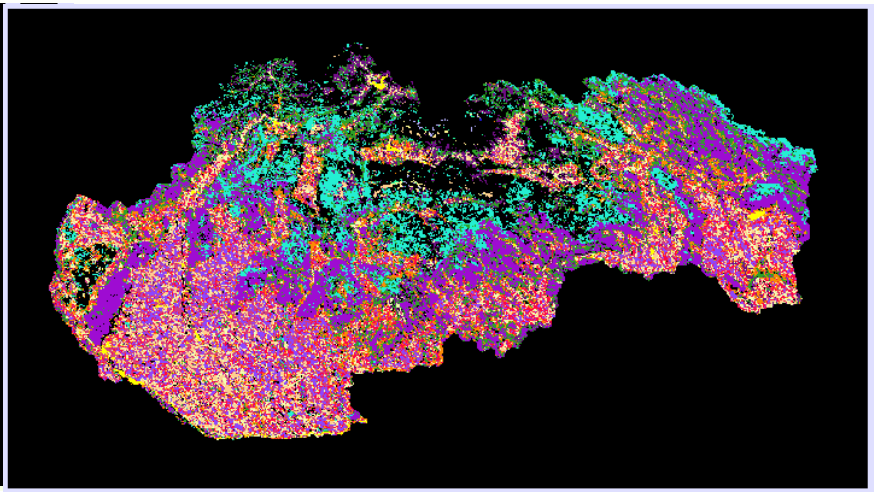
Errors decreased dramatically after the crop harvesting in late June

Accuracy decreased to 85% and 78% when using only 2 resp. 1 time period for the analysis



Grassland mapping in Slovakia

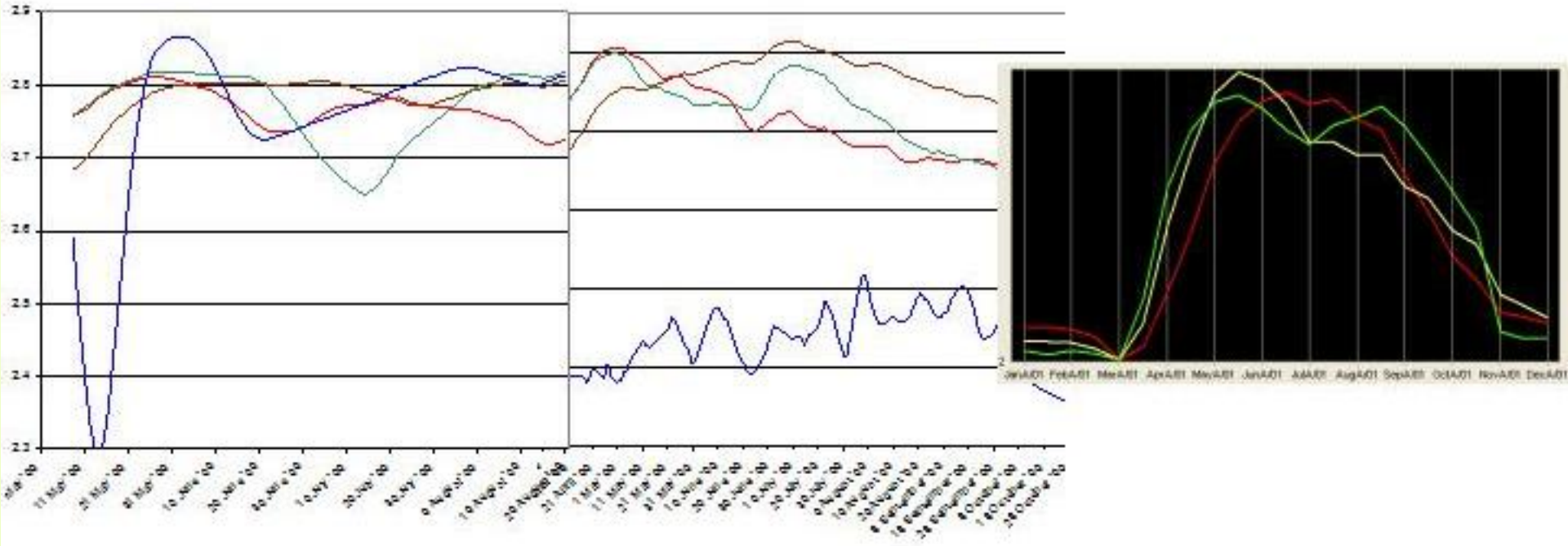




Valid. set		CLC	8d NDVI	16d NDVI
Heterogenous	Prod. acur.	38%	30%	30%
	Users acur.	58%	58%	51%
Homogenous	Prod. acur.	39%	68%	53%
	Users acur.	77,5%	61%	60%

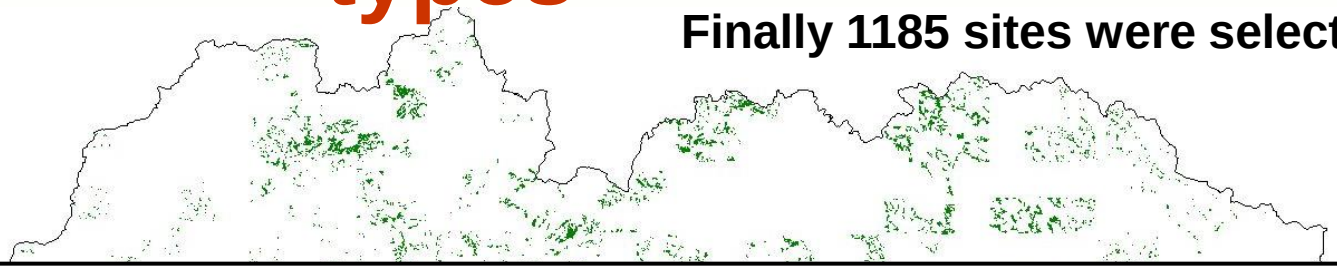
2. Classification of grasslands based on annual profile of NDVI

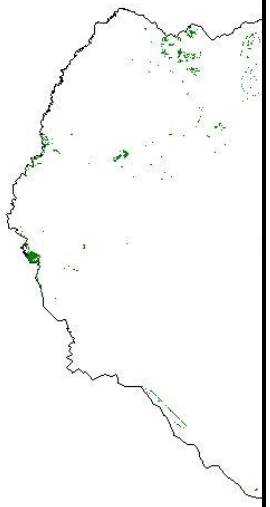
1. **Slovak grassland sites** (pure 3758 pixels) – based on GE inspection and LPIS
2. **Hungarian lowlands** (N2000 grasslands - approx. 32000 pure pixels – GE inspection)
3. **Slovak grasslands** – approx. 90 000 heterog. pixels whithout no check



2. Classification of grassland habitat types

Finally 1185 sites were selected

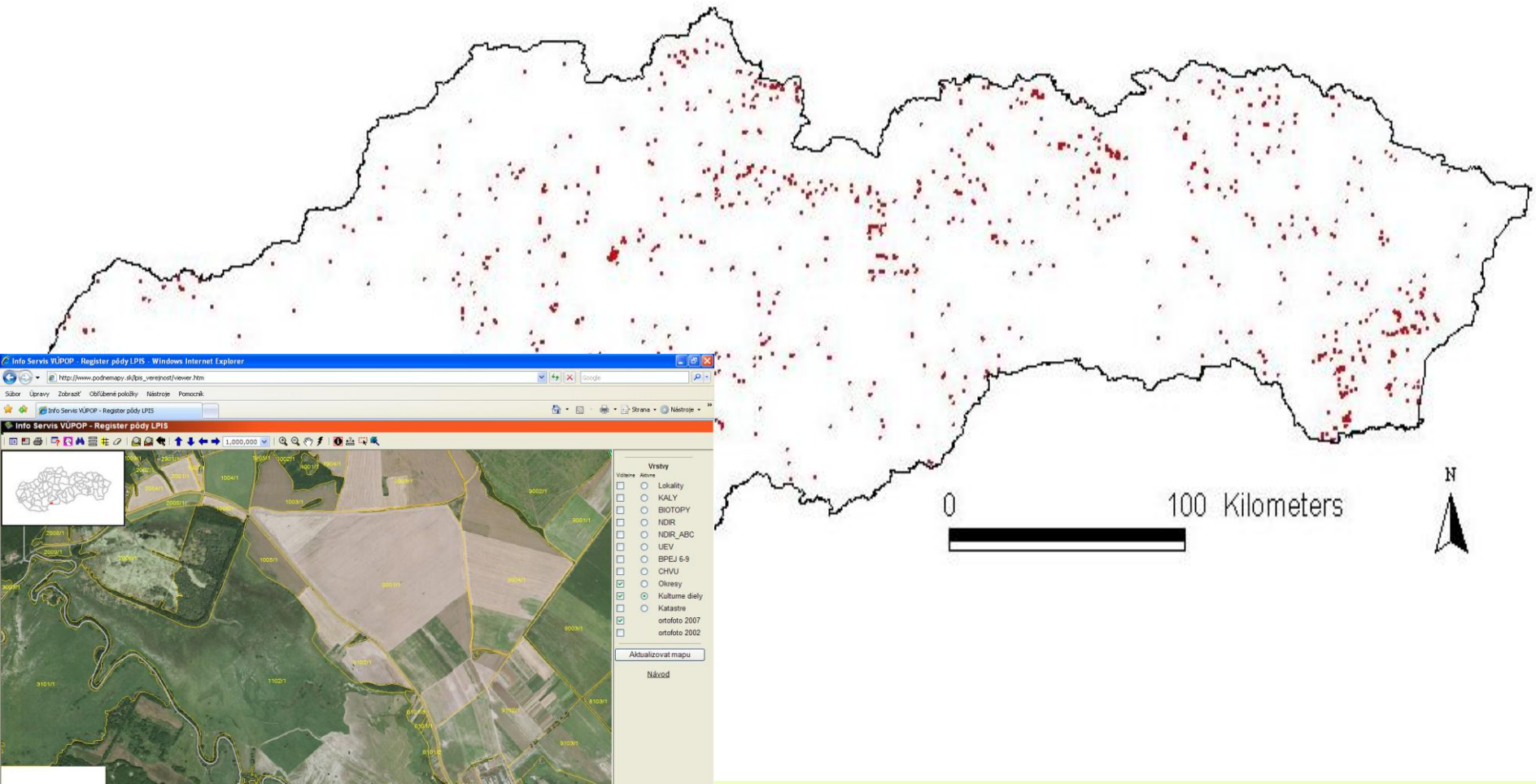




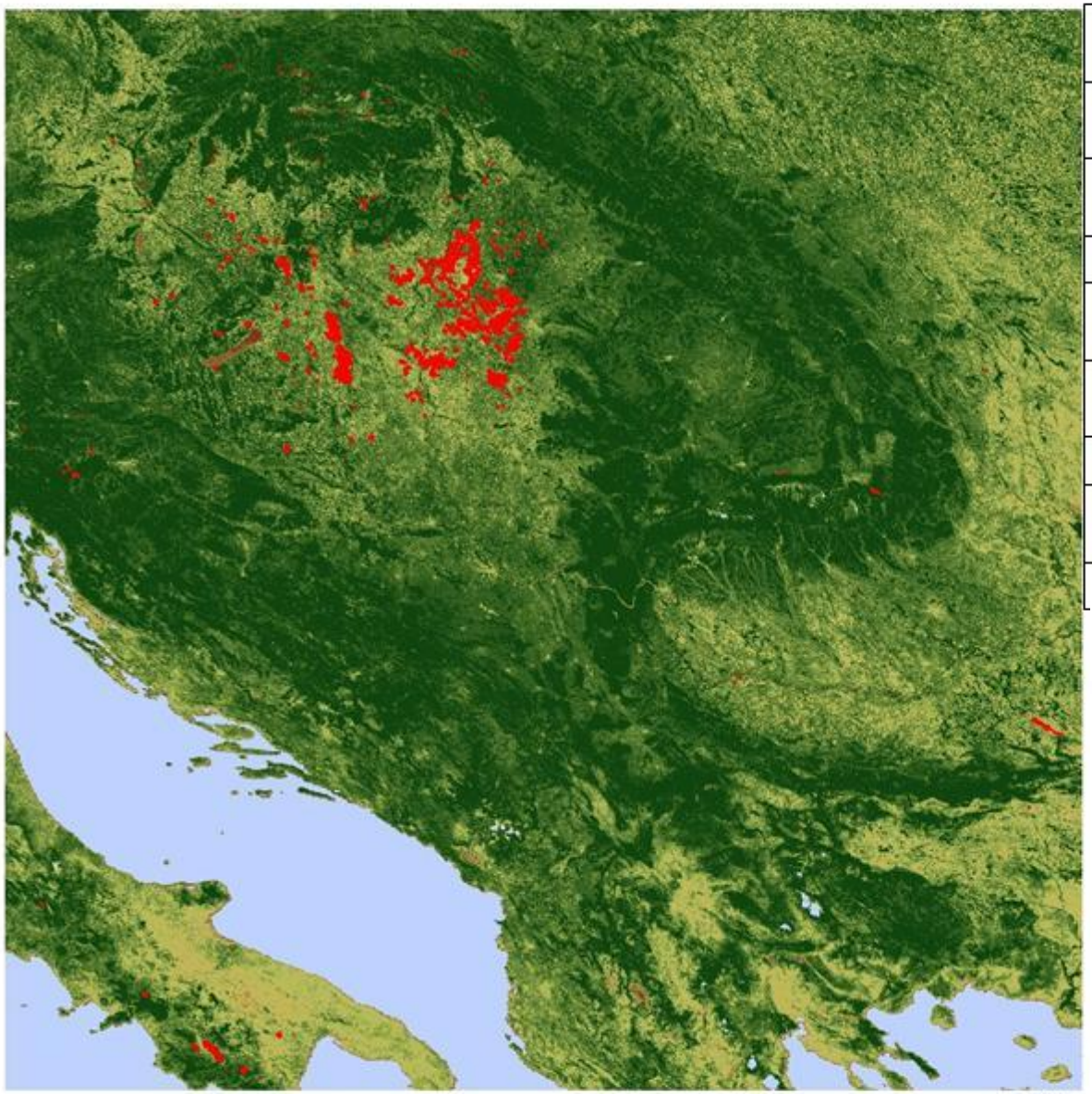
Grassland NATUR

6150 Siliceous alpine and boreal grasslands	**698.23**
6170 Alpine and subalpine calcareous grasslands	**986.05**
6230 * Species-rich Nardus grasslands, on silicious substrates in mountain areas (and submountain areas in Continental Europe)	**794.17**
6410 Molinia meadows on calcareous, peaty or clayey-silt-laden soils (Molinion caeruleae)	**15.99**
6430 Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels	**703.56**
6440 Alluvial meadows of river valleys of the Cnidion dubi	**154.57**
6510 Lowland hay meadows (Alopecurus pratensis, Sanguisorba officinalis)	**2291.9**
6520 Mountain hay meadows	**69.29**

3758 pure pixels were selected



Study area: MODIS tile grid h19v4



EEA data set

Habitat code	Description	Count
N11	Alpine and sub-Alpine grassland	1
N07	Bogs, Marshes, Water fringed vegetation, Fens	22
N09	Dry grassland, Steppes	79
N25	Grassland and scrub habitats (general)	2
N10	Humid grassland, Mesophile grassland	8
N14	Improved grassland	6
N03	Salt marshes, Salt pastures, Salt steppes	75

Total N2000 sites 193
Total 250*250m pixels 32200

- More than 80% of grassland habitats in N2000 site
- Random sampling
- 2830 selected for the study
- Wetlands and grasslands

PCA

-searching for the most informative periods in time series
-selection of the components of particular interest (mapping approaches)

Rotated Component Matrix[a]

	Component				
	1	2	3	4	5
D071117	9.032E-02	7.474E-02	.225	4.694E-02	.806
D071203	-2.57E-02	.336	-.206	.116	.681
D071219	.117	.539	-4.99E-02	9.671E-02	.424
D080101	.273	.156	.195	-1.16E-02	.113
D080117	8.969E-02	.214	4.089E-02	2.065E-03	4.919E-02
D080202	-4.55E-02	.481	-.213	.115	.415
D080218	.222	.788	.143	8.155E-02	.181
D080305	.306	.790	.274	.120	3.146E-02
D080321	.147	.850	.228	.155	1.950E-02
D080405	-7.88E-02	.862	.126	.250	6.386E-02
D080422	-.193	.673	3.880E-02	.421	.188
D080508	1.635E-02	.397	.137	.750	.141
D080524	.181	.242	6.676E-02	.833	.107
D080609	.404	.177	.202	.760	-1.23E-02
D080625	.945	4.391E-02	7.841E-02	-3.50E-02	9.651E-03
D080711	.899	8.416E-03	8.659E-02	.105	2.713E-04
D080721	.945	4.391E-02	7.841E-02	-3.50E-02	9.651E-03
D080812	.718	8.270E-02	5.720E-02	.414	-6.66E-02
D080828	.900	9.634E-02	.150	2.410E-02	6.679E-02
D080913	.883	9.081E-02	.224	9.953E-02	2.616E-02
D080929	.782	5.289E-02	.290	.164	4.134E-02
D081015	.738	8.263E-02	.410	.235	.108
D081031	.561	.131	.635	.223	9.138E-02
D081116	.322	.222	.853	.125	-1.68E-02
D081202	.322	.222	.853	.125	-1.68E-02

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 9 iterations.

Harmonic analysis

-decomposes a time dependent periodic phenomenon into a series of sinusoidal functions,
defined by unique amplitude and phase values
-Permits a complex curve to be expressed as the sum of a series of cosine waves (terms)
and additive terms
-Amplitude – half the height of the wave
-Phase – offset between the origin and the peak
-Per pixel basis

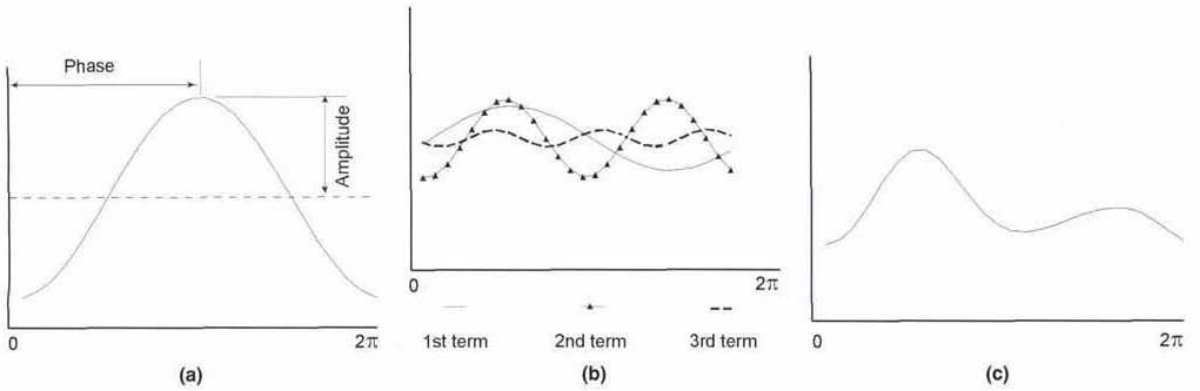
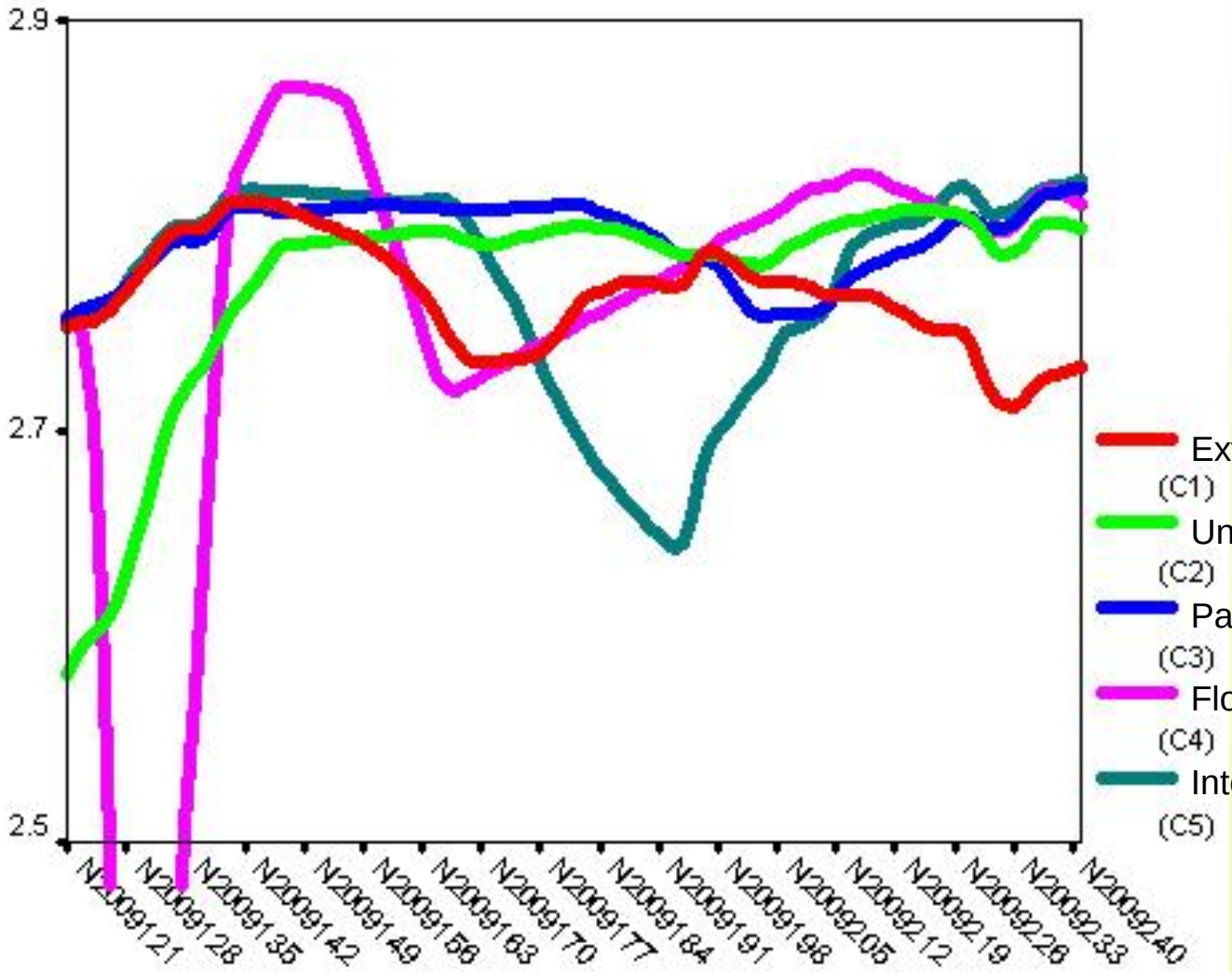


Figure 1. (a) Simple cosine curve representative of the first harmonic. (b) Curves for harmonic terms 1, 2, and 3. (c) Curve produced from addition of curves in Figure 1b.

Jakubauskas et al., 2001

Classification of BHC grasslands

- Based on within season variability and course of NDVI profile



Intensive grasslands

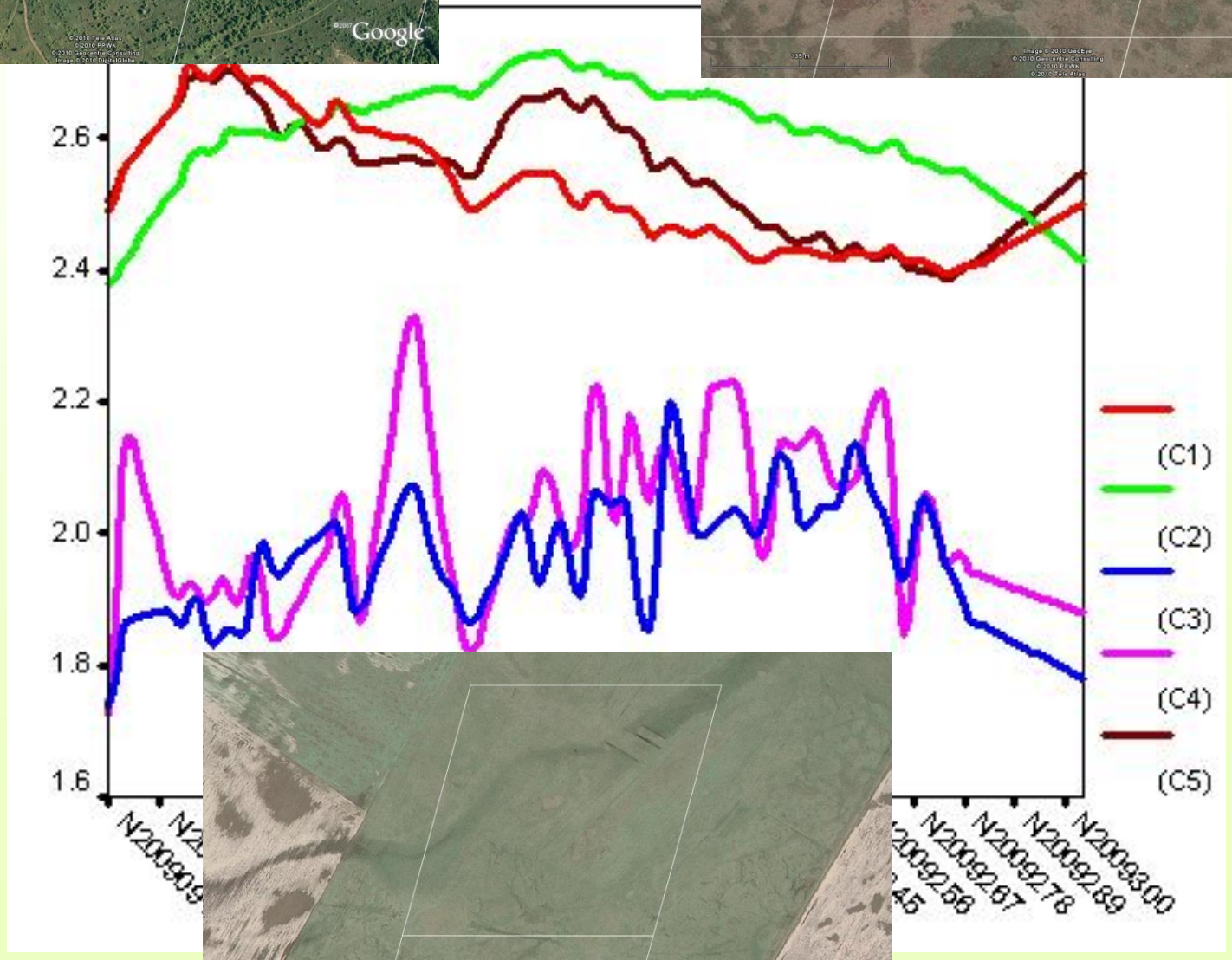
unmanaged - abandoned

flooded grasslands

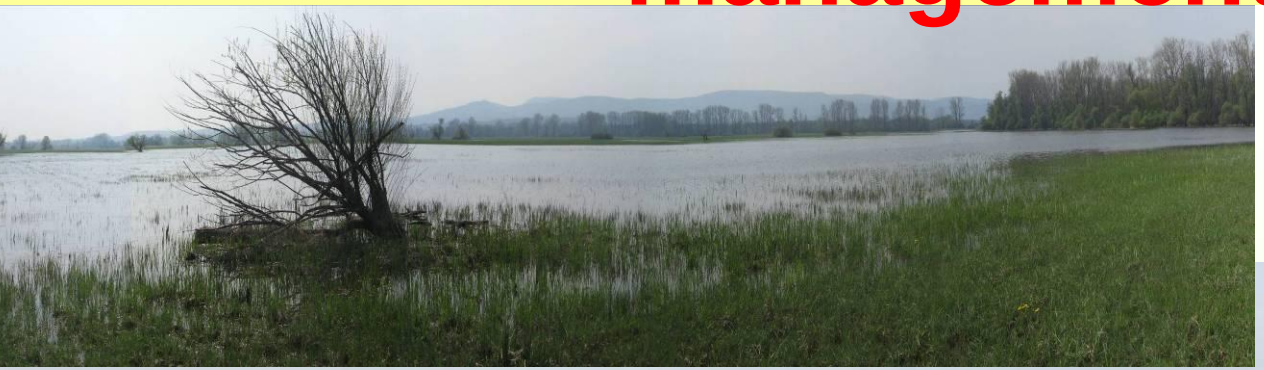
# of Panno


Google

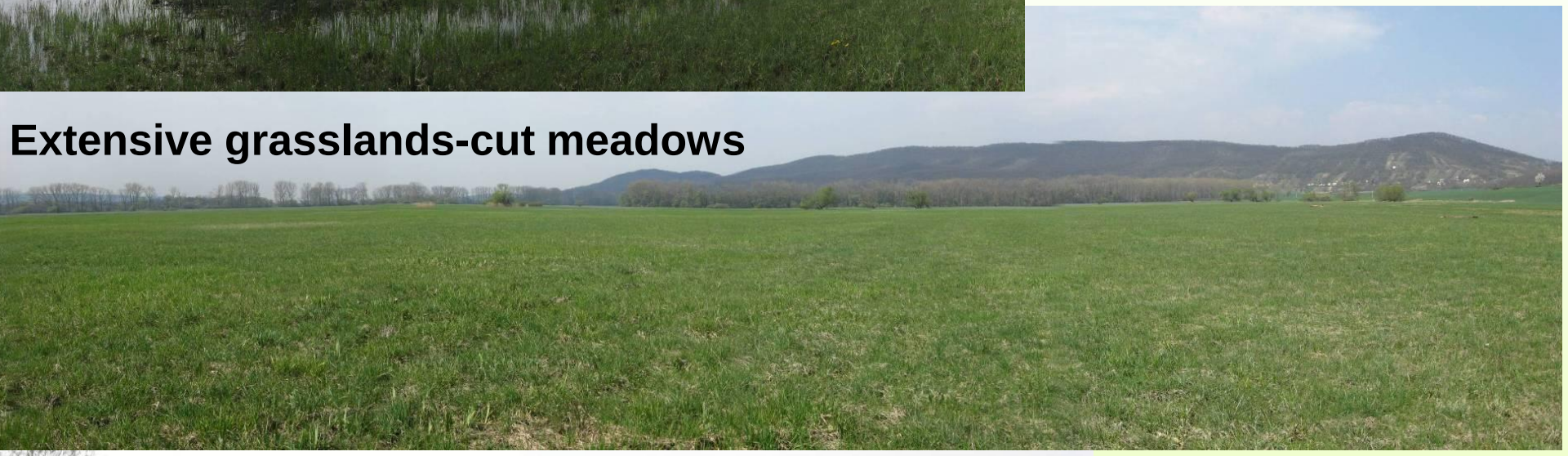

Google


2.6
2.4
2.2
2.0
1.8
1.6
(C1)
(C2)
(C3)
(C4)
(C5)
N2009278
N2009289
N2009300

3. Detection of grassland management



Alluvial flooded meadows

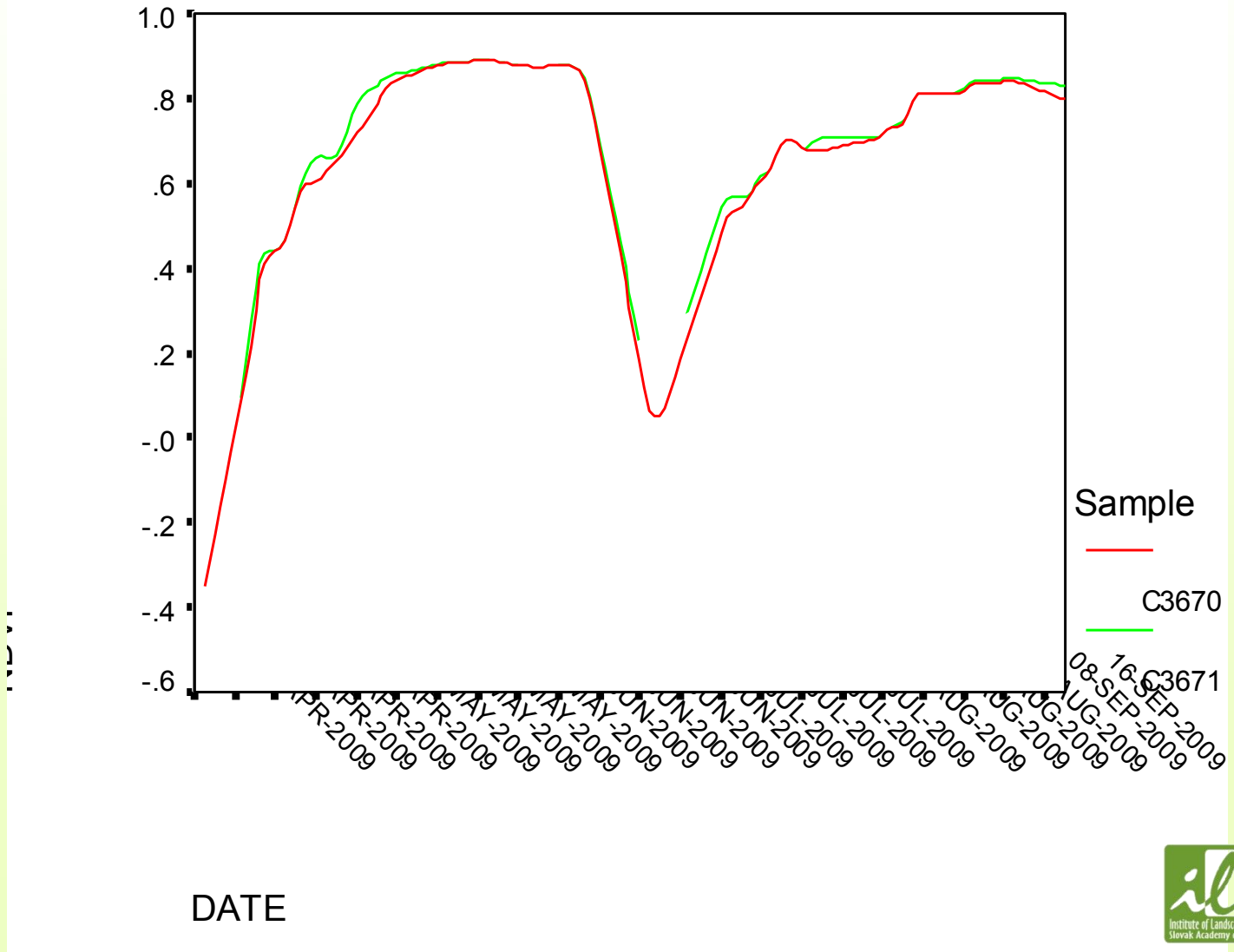


Extensive grasslands-cut meadows

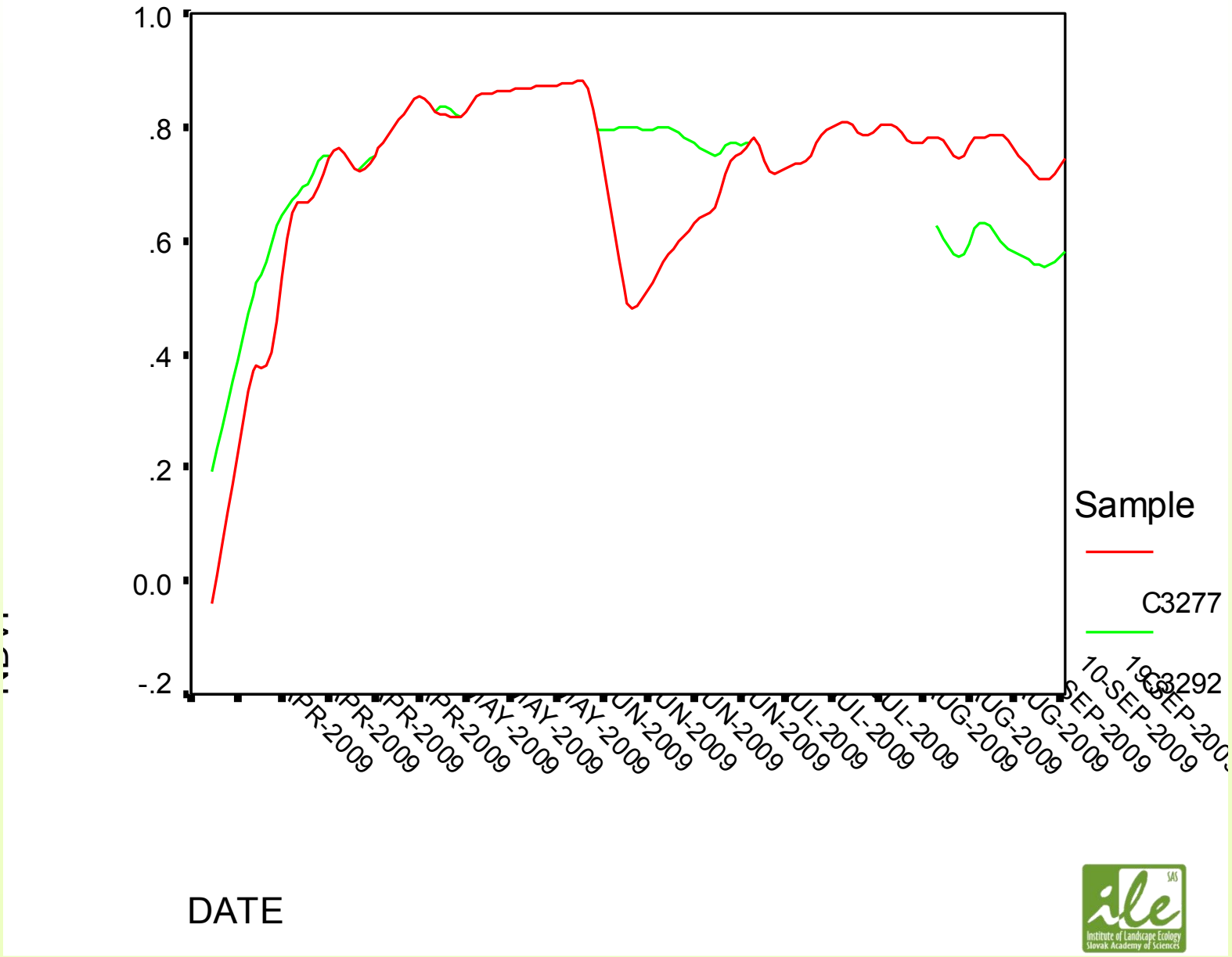
Intensive grasslands-pastures

Unmanaged grasslands

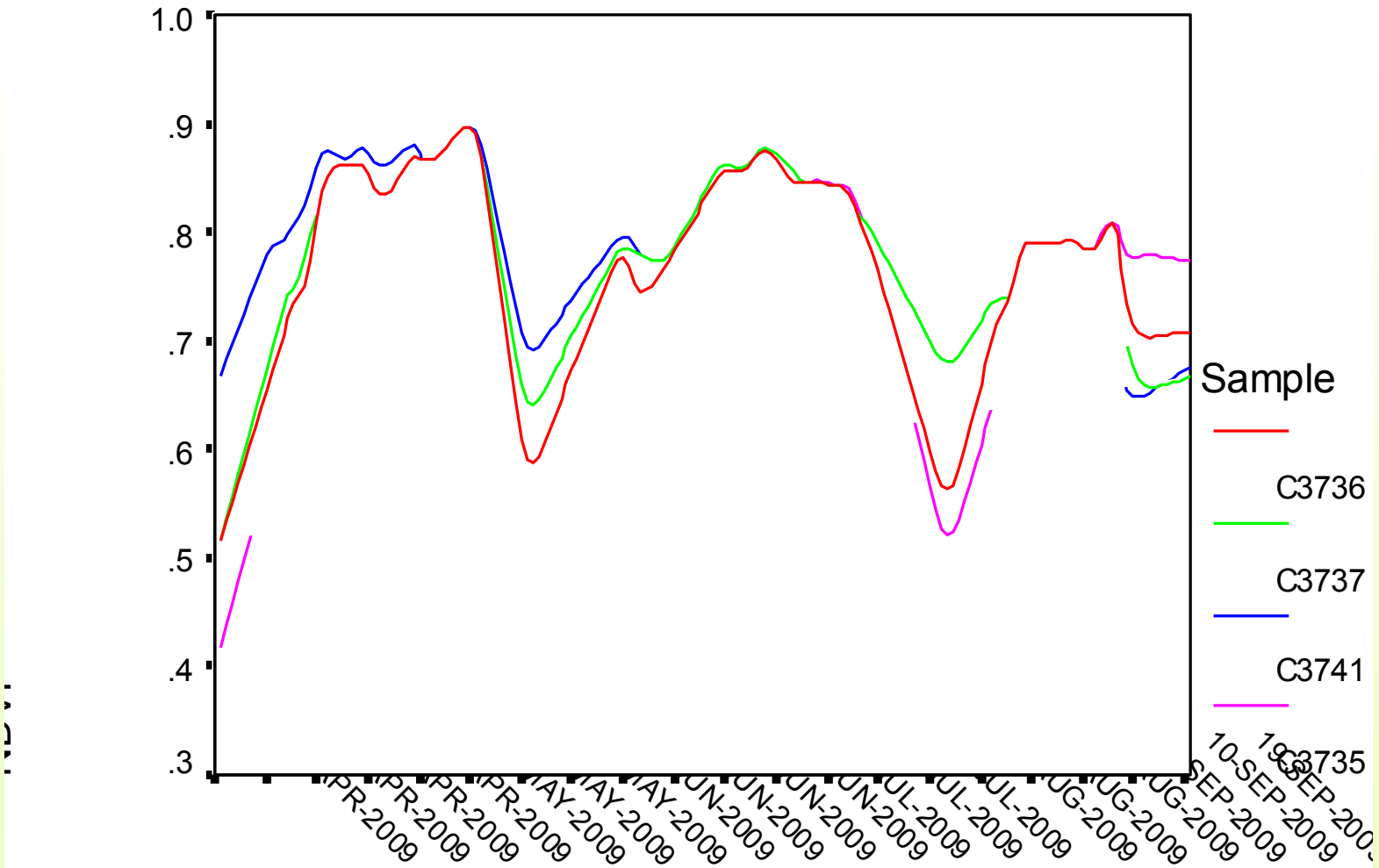
Morava river – flood meadows



Latorica river – cut vs. uncut meadows

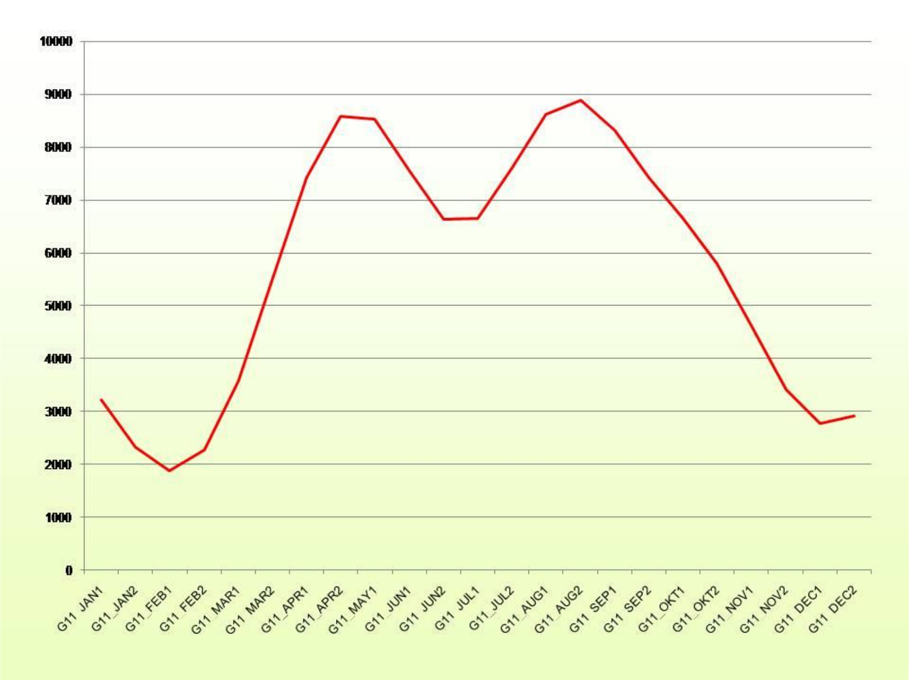


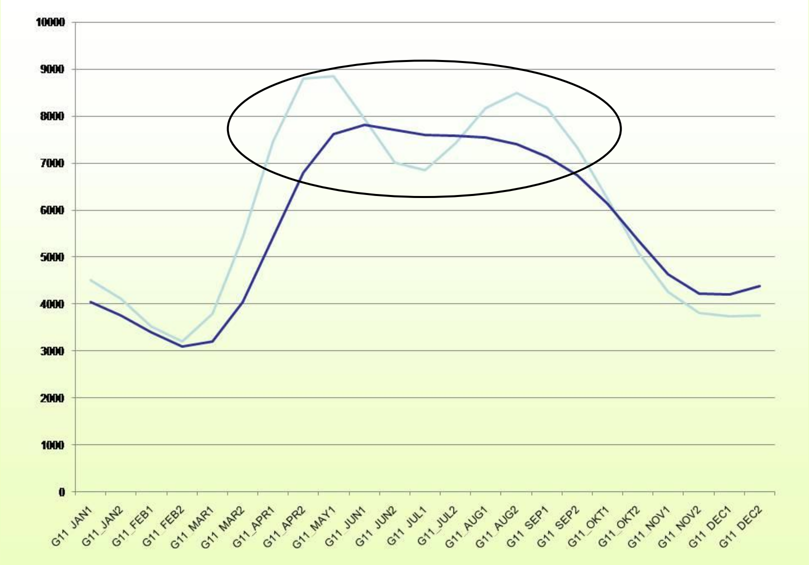
Intensive meadows

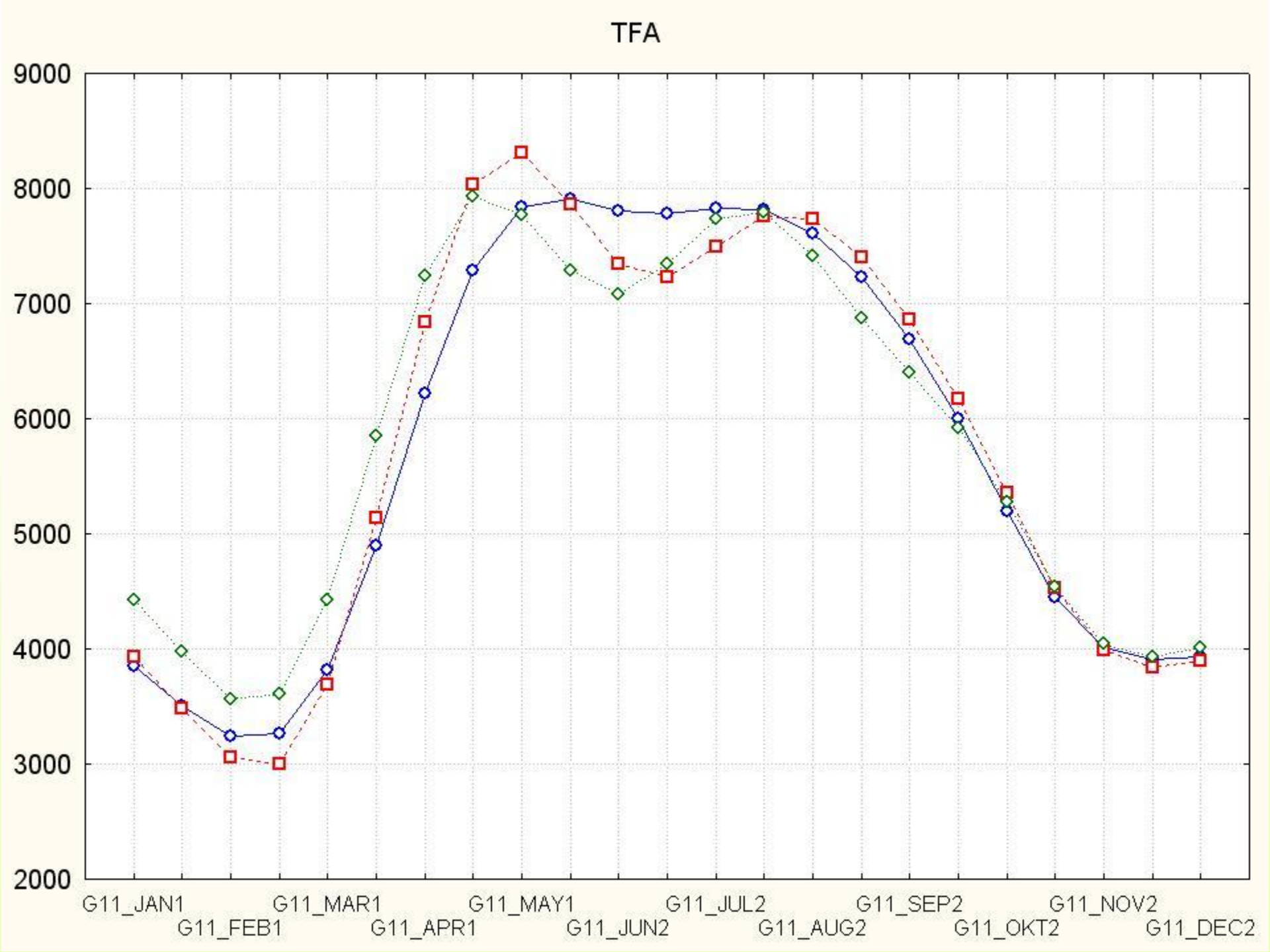


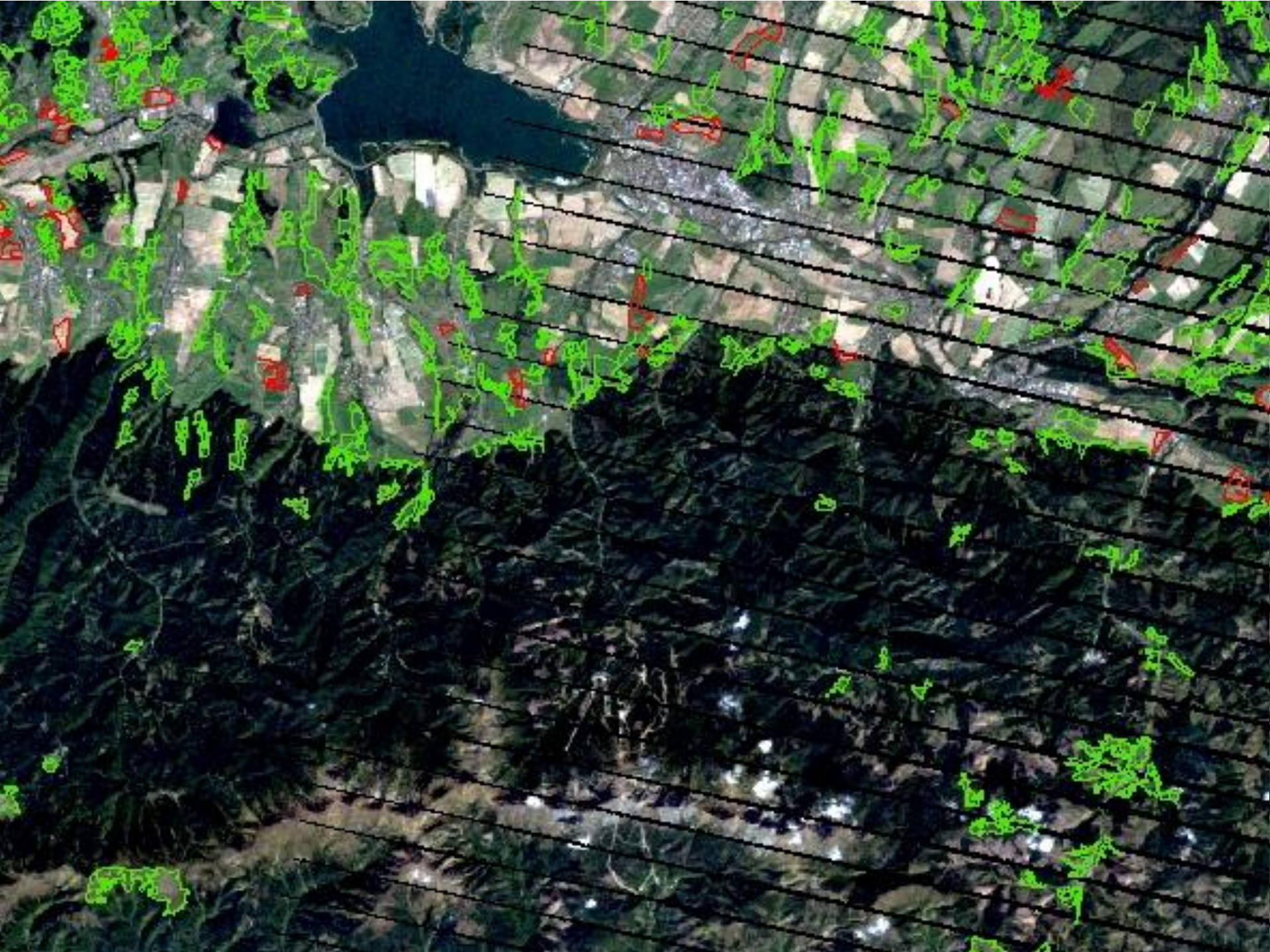
Telgárt – managed vs. abandoned

Cutting of hay meadows

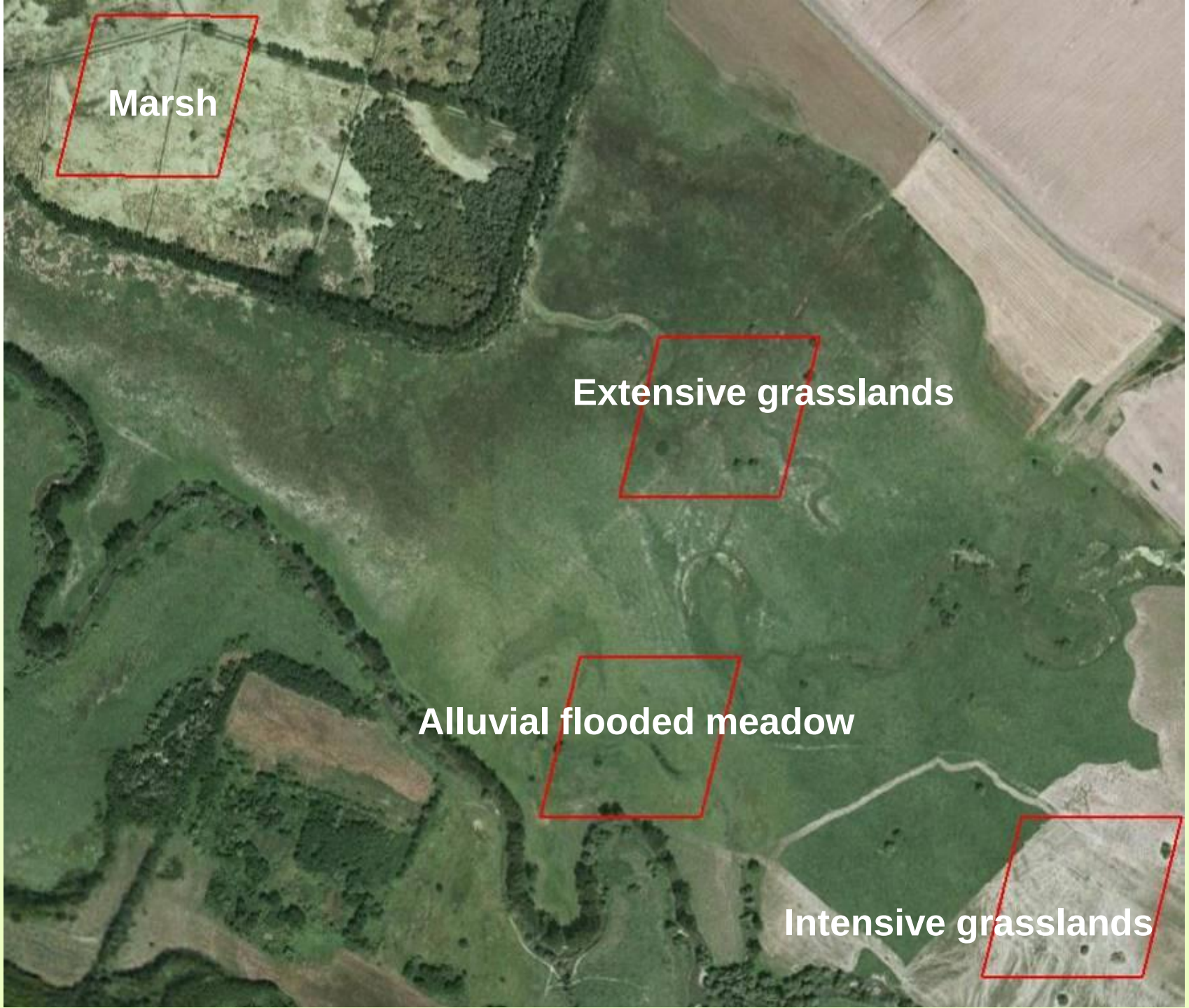




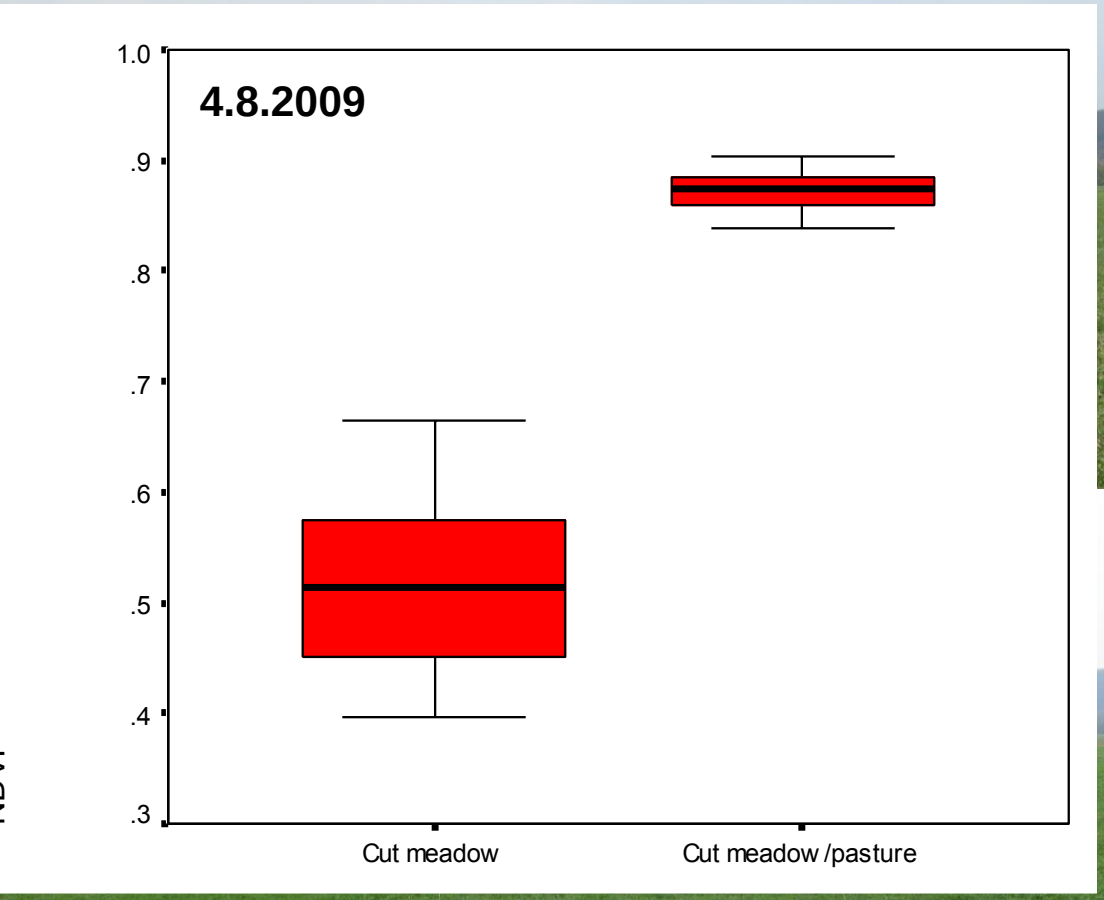

TFA
9000
8000
7000
6000
5000
4000
3000
2000
G11_JAN1
G11_FEB1
G11_MAR1
G11_APR1
G11_MAY1
G11_JUN2
G11_JUL2
G11_AUG2
G11_SEP2
G11_OKT2
G11_NOV2
G11_DEC2




0 25 50 100 Kilometers

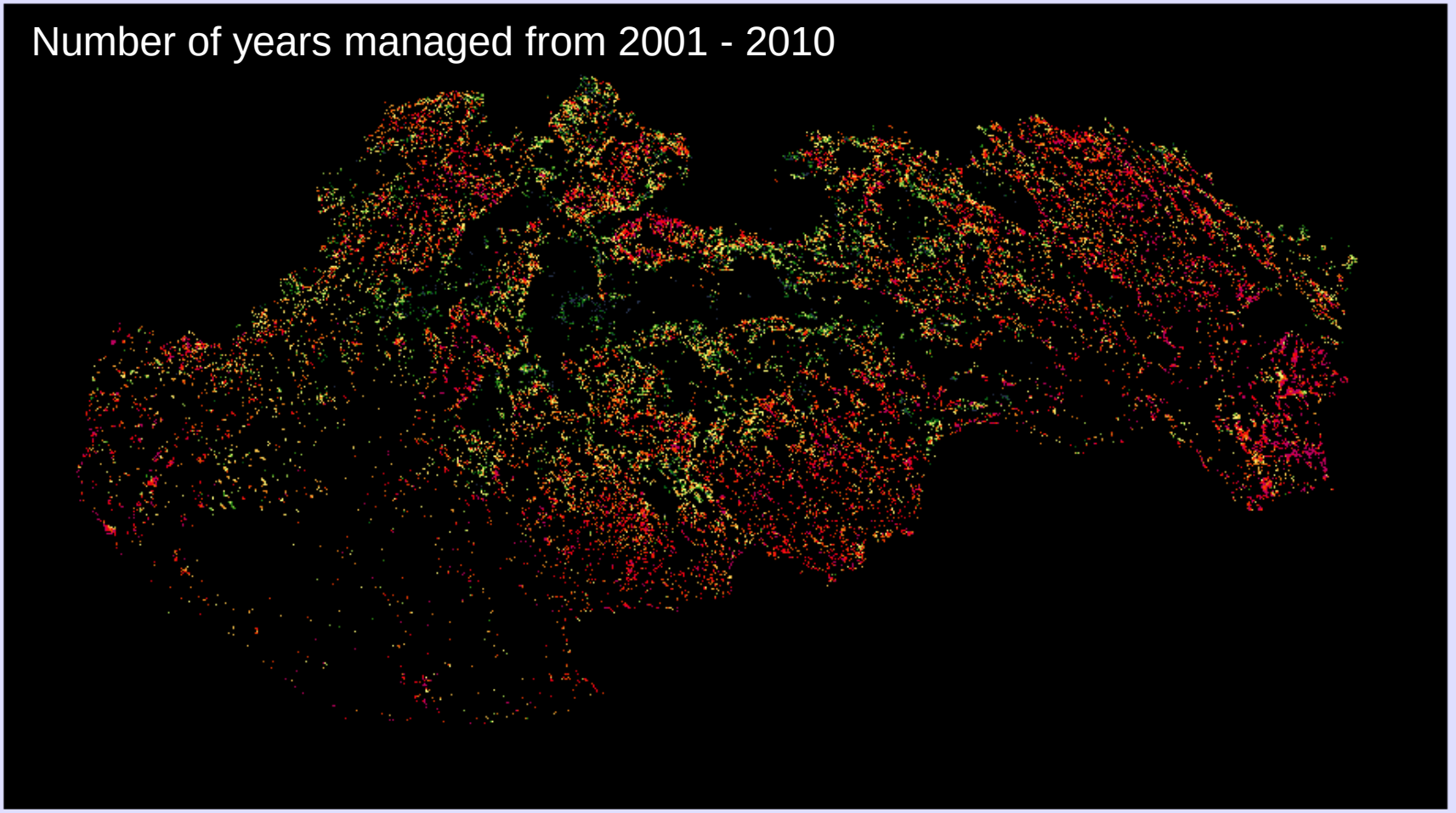

Marsh
Extensive grasslands
Alluvial flooded meadow
Intensive grasslands

Study site Ipel valey



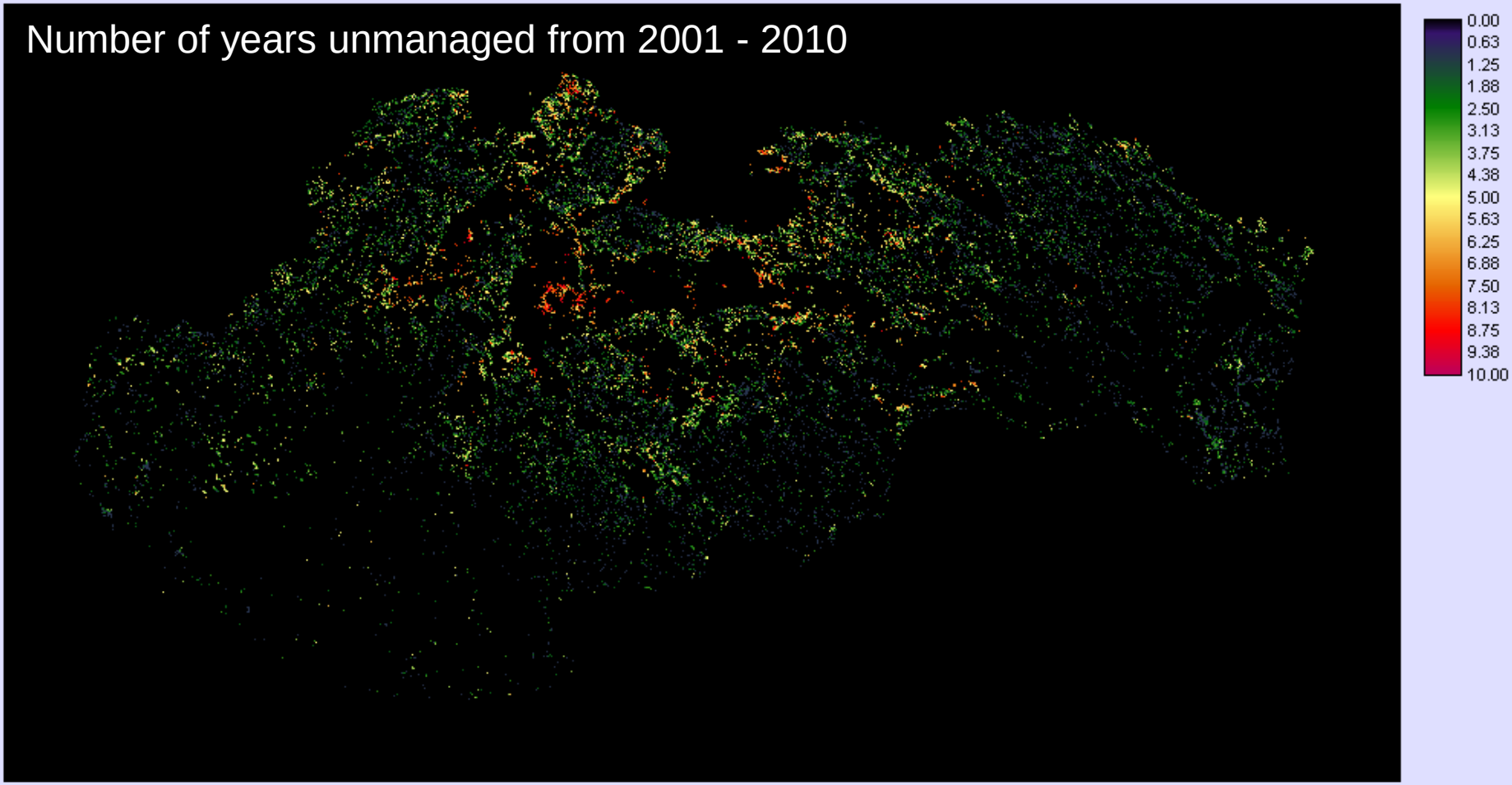
Cutting of hay meadows

- Mainly remote and mountainious areas
- Further analysis needed including socioeonomic data
- Possible consequences – predictive modelling

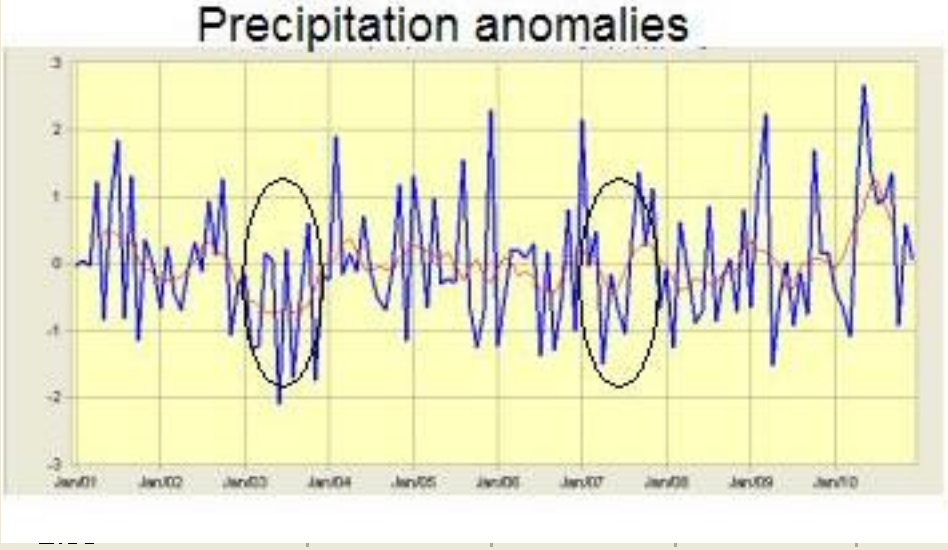


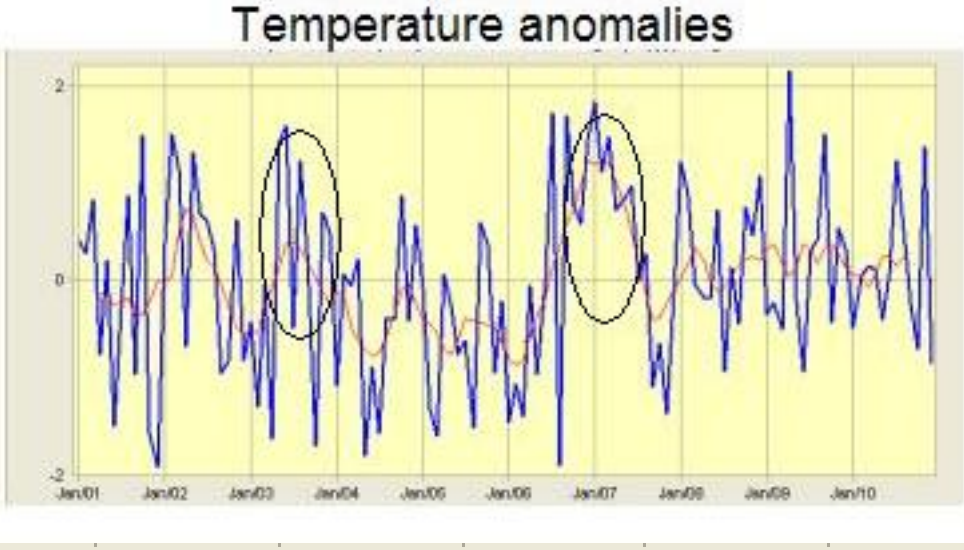
Cutting of hay meadows

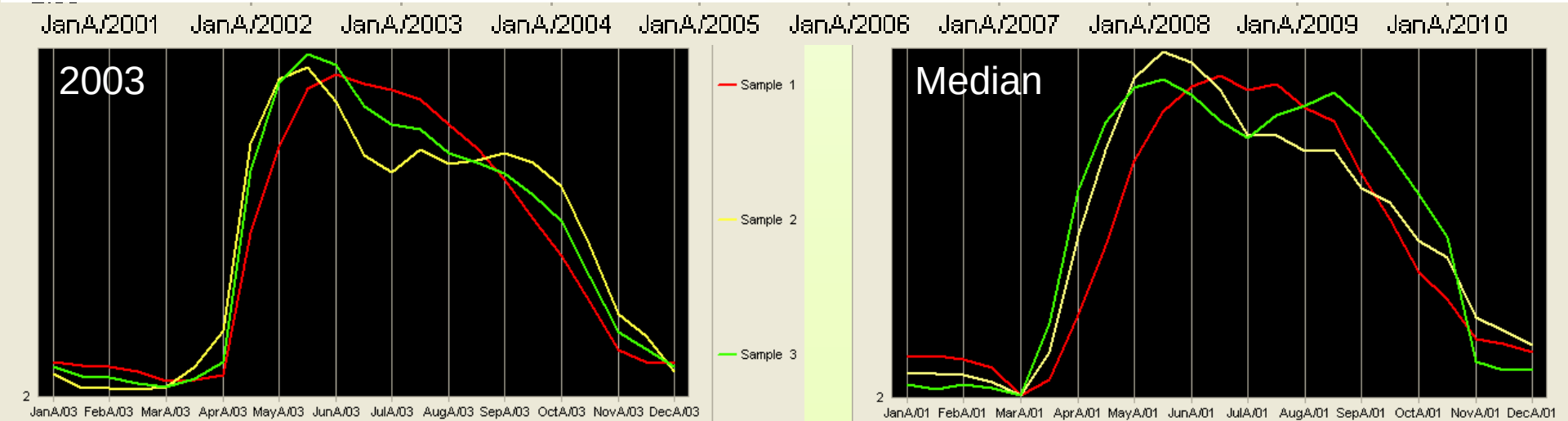
- Mainly remote and mountainious areas
- Further analysis including socioeonomic data is needed
- Possible consequences – predictive modelling

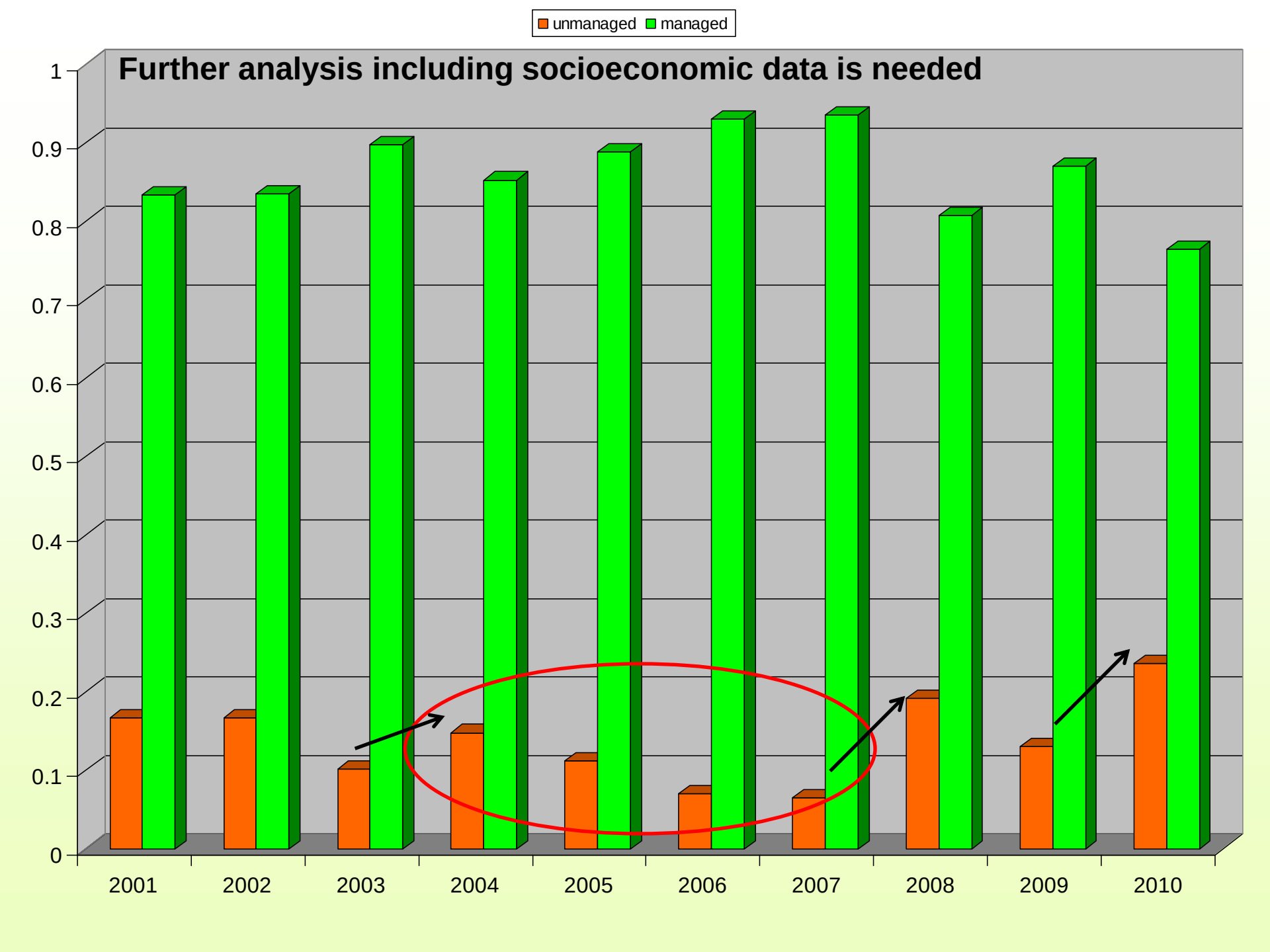


Interaction with climate variabilty








unmanaged
managed
Further analysis including socioeconomic data is needed
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010

Current and future research focus

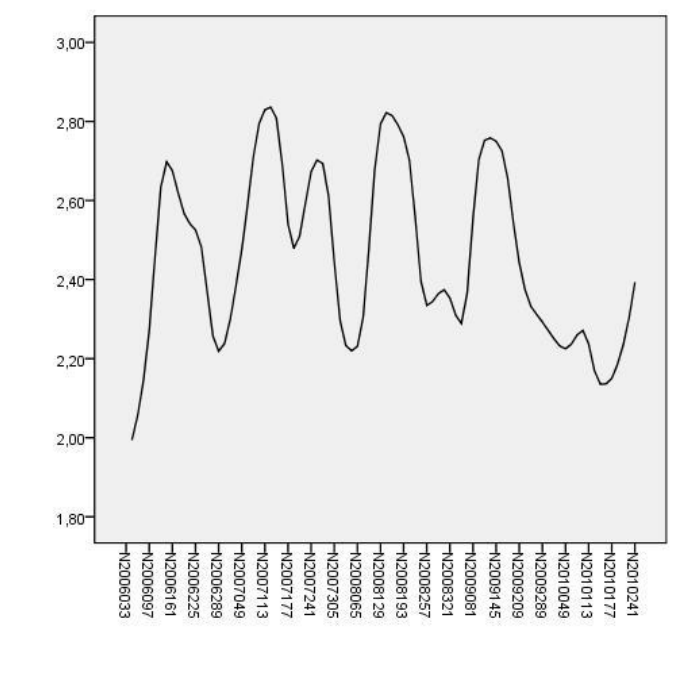
- Optimal filtering of MODIS series for grassland studies
- How to gather the samples for training and validation (Landsat,…)
- Set up of broad habitat grassland categories
- Regional dependent signatures of grasslands

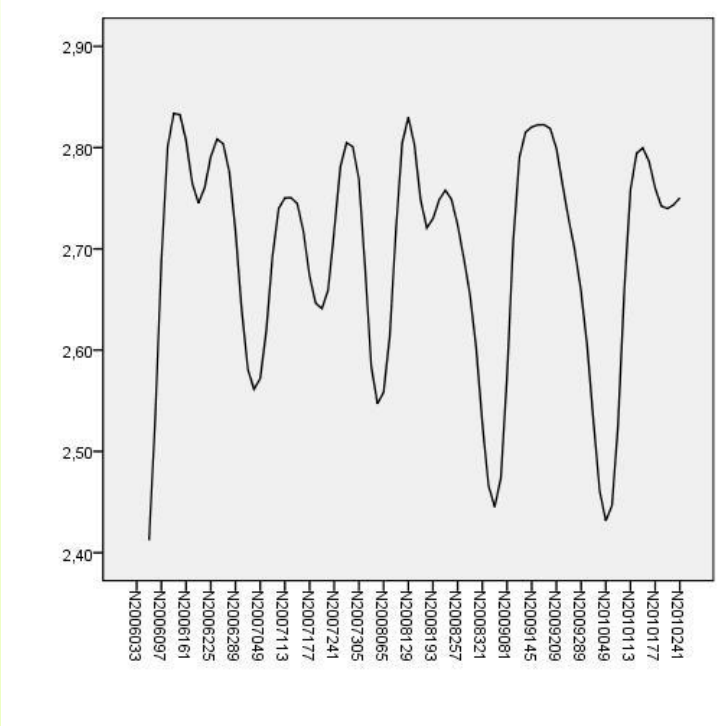
Current and future research focus

- Classification in different landscapes with different agricultural practices (Austria, Hungary, Czech rep.)
- Early season estimates
- Testing of consistent classification methods allowing quarterly crop monitoring
- Optimalization and minimalization of field training
- Optimal dates for classification (Landsat)
- Data fusion (prediction of Landsat NDVI series)

4. Analysis of changes

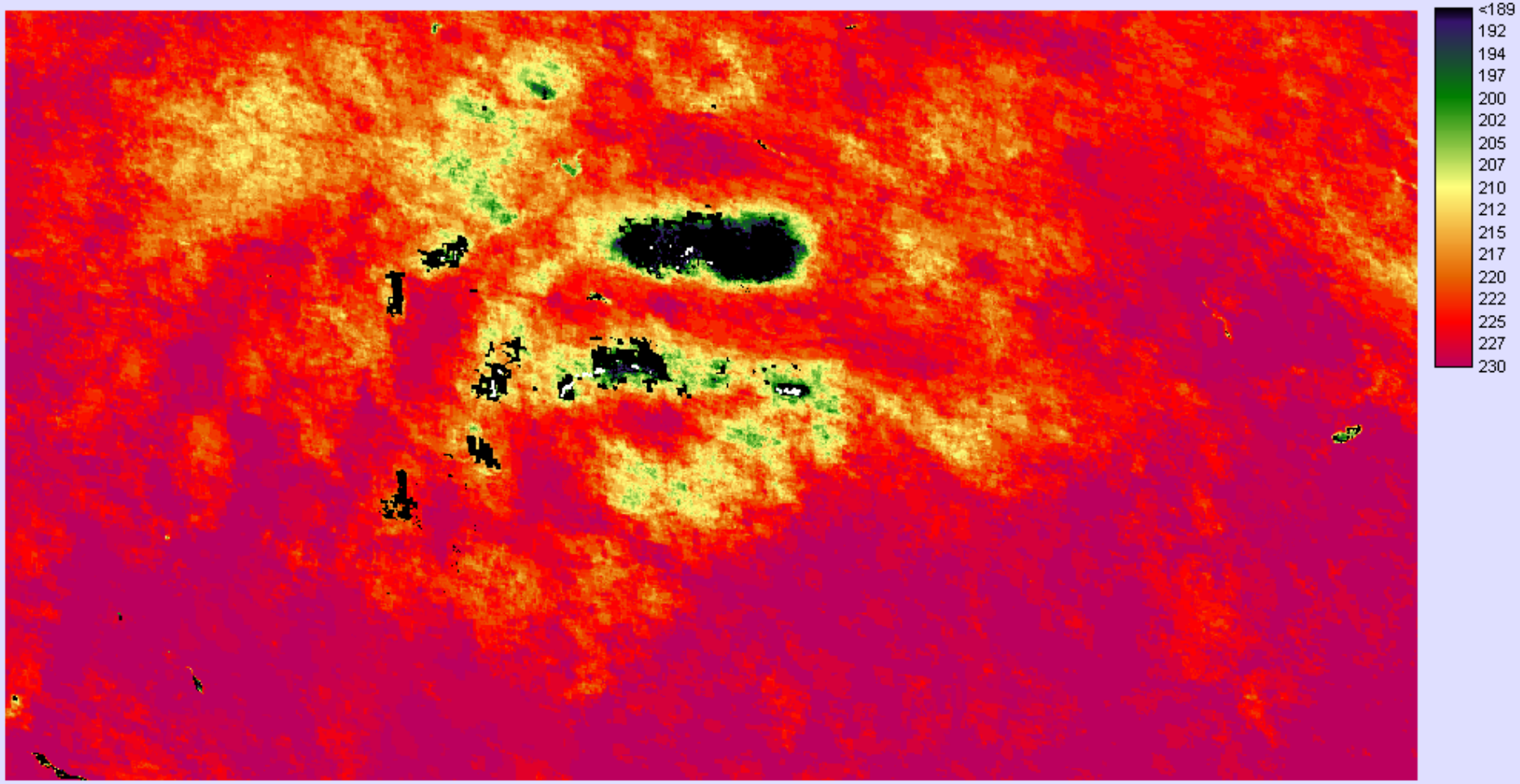
-Change detection
-Assessments of trends
-Within season and interseason variability
-LSP



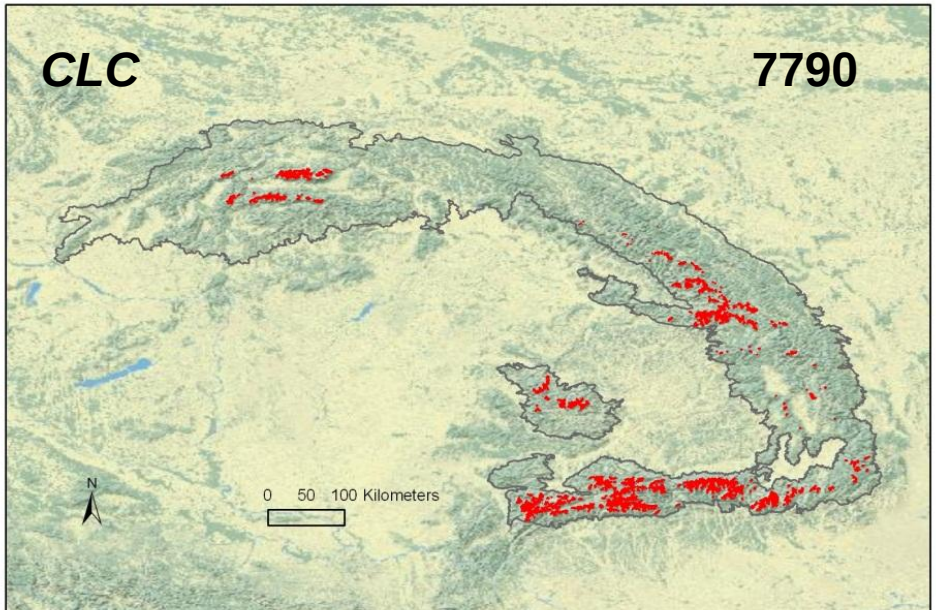


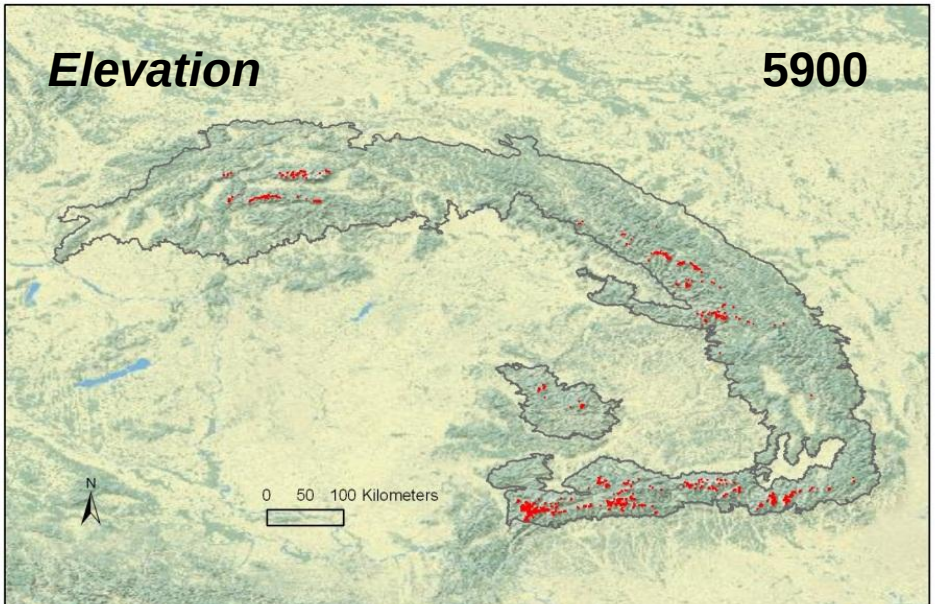
Limitations for mountains

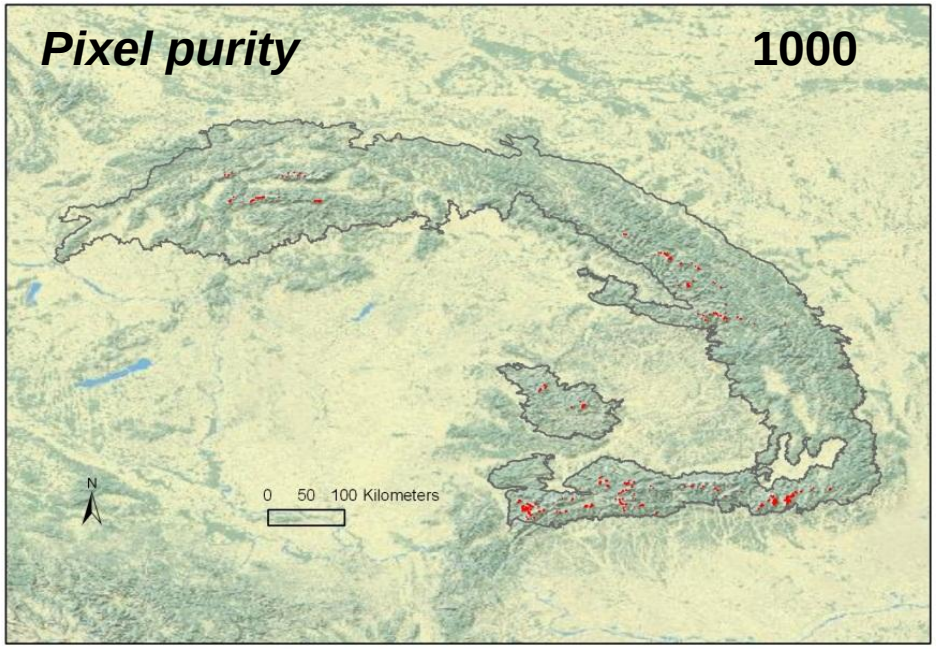
-sharp relief (missing data for sun-target geometry)
-heterogeneity (pixel purity)
-clouds, and shadows (missing data)
-local microclimate vs. regional data available

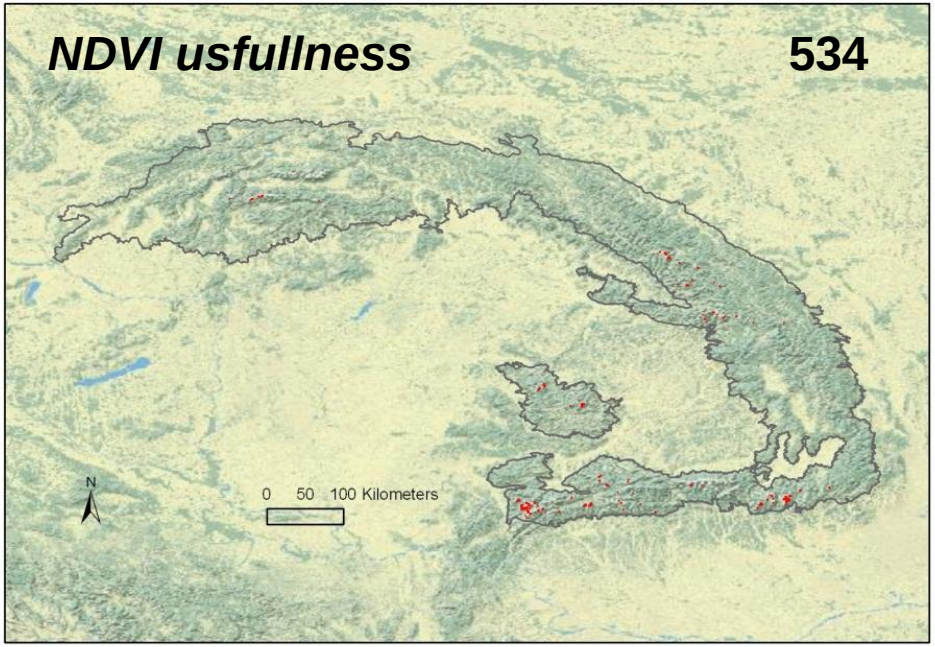


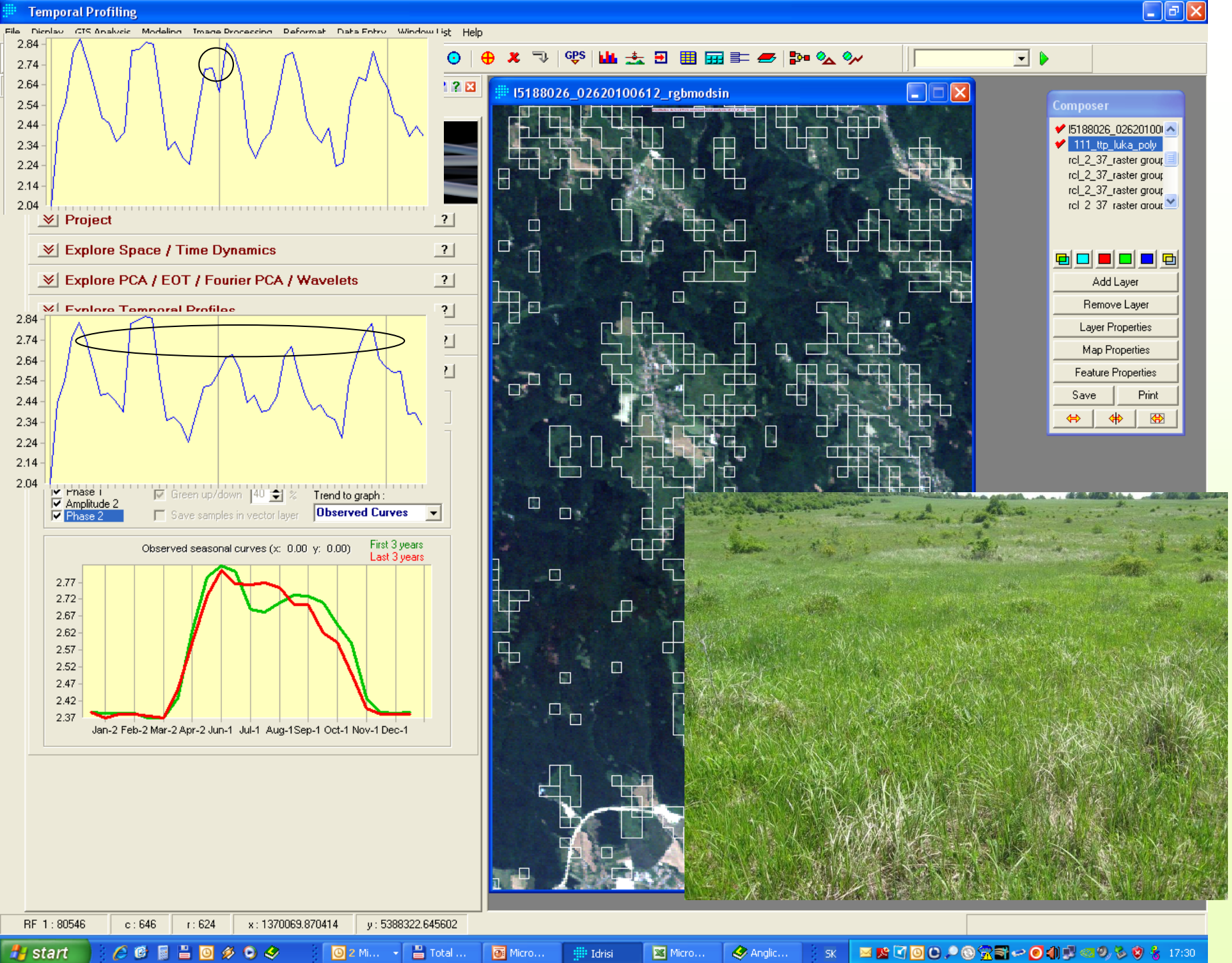
Selection of mountain grasslands










Temporal Profiling
File Display GIS Analysis Modeling Image Processing Reformat Data Entry Window List Help
Project
Explore Space / Time Dynamics
Explore PCA / EOT / Fourier PCA / Wavelets
Explore Temporal Profiles
Phase 1
Amplitude 2
Phase 2
Green up/down
Save samples in vector layer
Trend to graph :
Observed Curves
Observed seasonal curves (x: 0.00 y: 0.00)
First 3 years
Last 3 years
Jan-2 Feb-2 Mar-2 Apr-2 Jun-1 Jul-1 Aug-1 Sep-1 Oct-1 Nov-1 Dec-1
l5188026_02620100612_rgbmodsin
Composer
111_ttp_luka_poly
Add Layer
Remove Layer
Layer Properties
Map Properties
Feature Properties
Save
Print
RF 1 : 80546
c : 646
r : 624
x : 1370069.870414
y : 5388322.645602
start
17:30

Future development: From land cover change to land cover dynamics

Land cover dynamics

•characterized by seasonal and inter-seasonal variability of vegetation greeness

•reflected in dynamic change of SI signal

- Response to increasing availability of SI
- Increasing temporal resolution (LDCM, Sentinel2,...)

Result:

- multitemporal and time series based land cover classification and land cover dynamics analysis
- time series analysis of vegetation greenness (NDVI)