Influence of LULC change on the Landslide Susceptibility

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POHOS project:

People movements on the border of urban and suburban areas of Olomouc region

http://pohos.upol.cz/

Outline

- Introduction
- Case study
- LULC
- Landslide Susceptibility
- Assessment of the LULC influence
- Conclusion & Directives

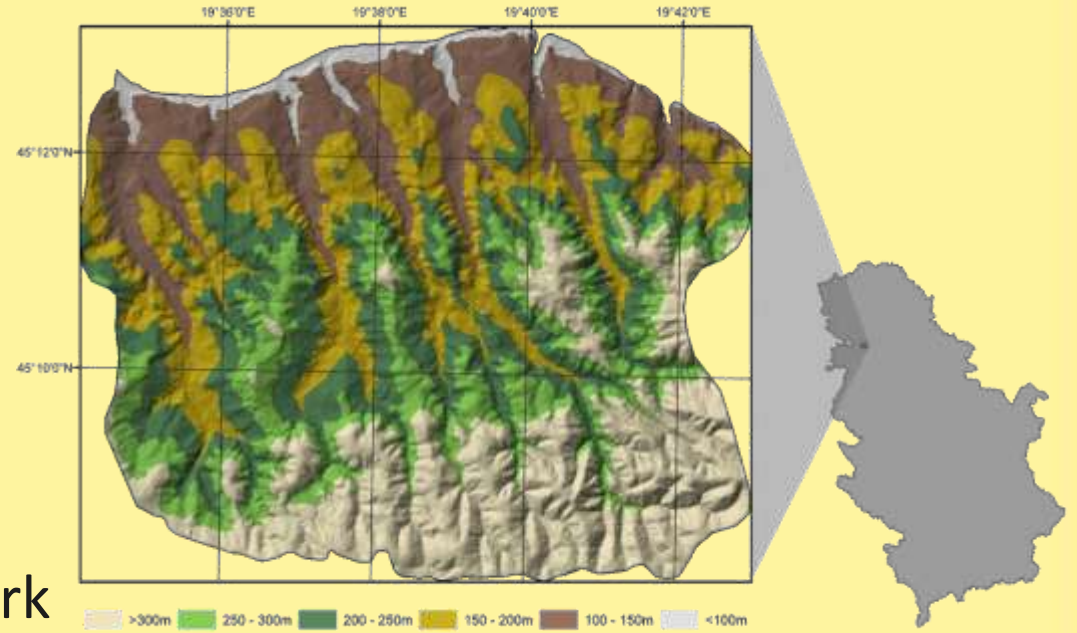
Introduction

- Landslide Susceptibility and Global Awareness
- Influence factors:
  - Triggering factors
  - Natural terrain properties
  - Human influence
- LULC modeling
  - Short-term and long-term changes?!
  - Scale/resolution issues?!

Case study

Fruška Gora Mountain, Serbia

- Features (and relation to landslides)
  - Geology
  - Geomorphology
  - Hydrology
- Trends of change
  - Protected areas of the national park
  - Rural and urban areas



LULC

Classification – USGS level 1:

- Water bodies & wetlands
- Barren areas
- Urban & built-up areas
- Agricultural areas
- Forests

Mid-scale (30m resolution)

LULC sources and materials

- LANDSAT TM (free data from Earth Land Cover Facility and USGS Earth Explorer), bands 1-5and 7, 1991. summer images.
- LANDSAT ETM (free data from Earth Land Cover Facility and USGS Earth Explorer), bands 1-5 and 7, 2006. summer images.
- Spectral references: spectral curves
- IDRISI Taiga processing kit

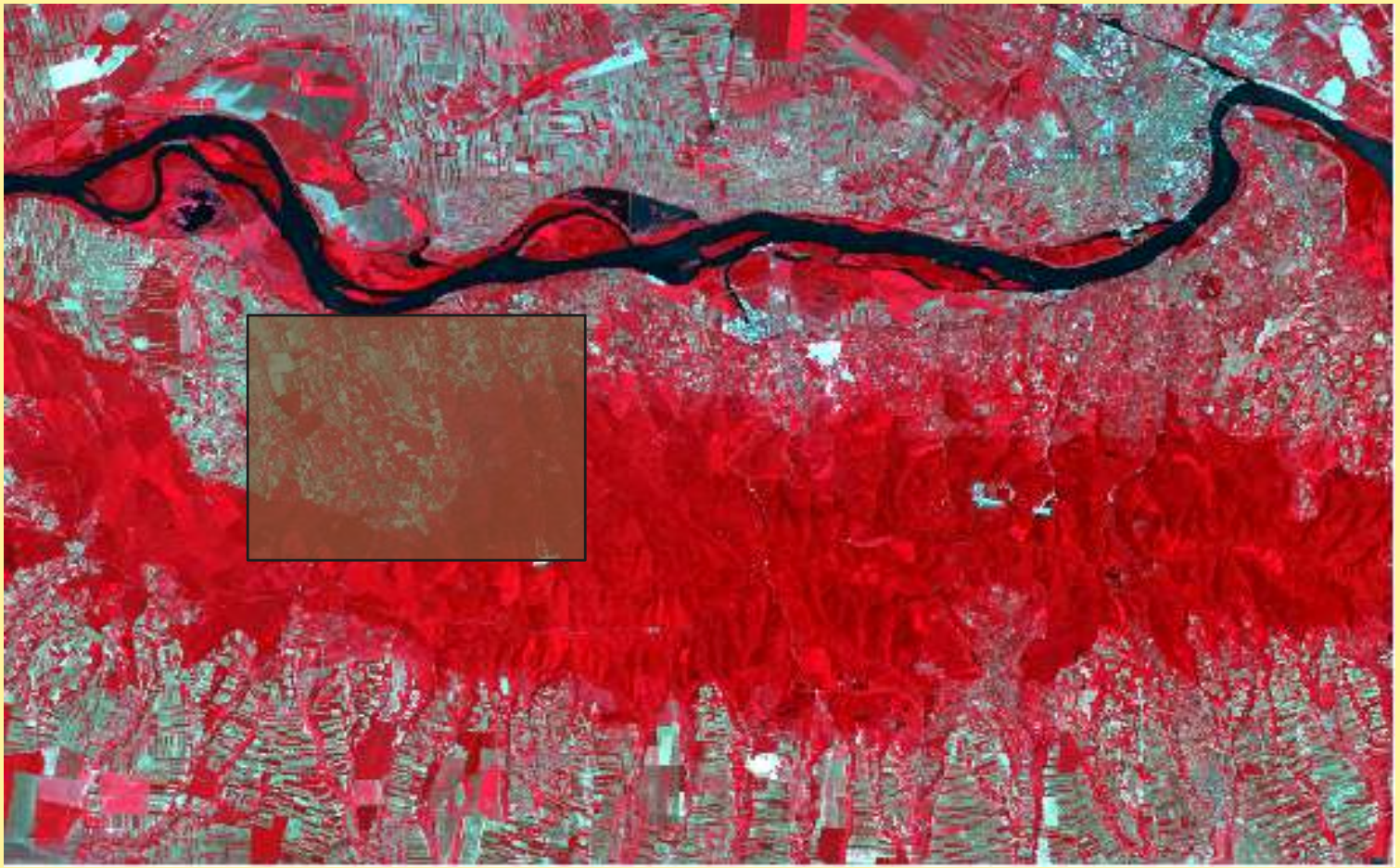
LULC mapping

Pixel-based LULC mapping procedure:

- ✓Pre-processing
- Pre-classification processing
- Classification
- ✓Assessment of accuracy (same errors)

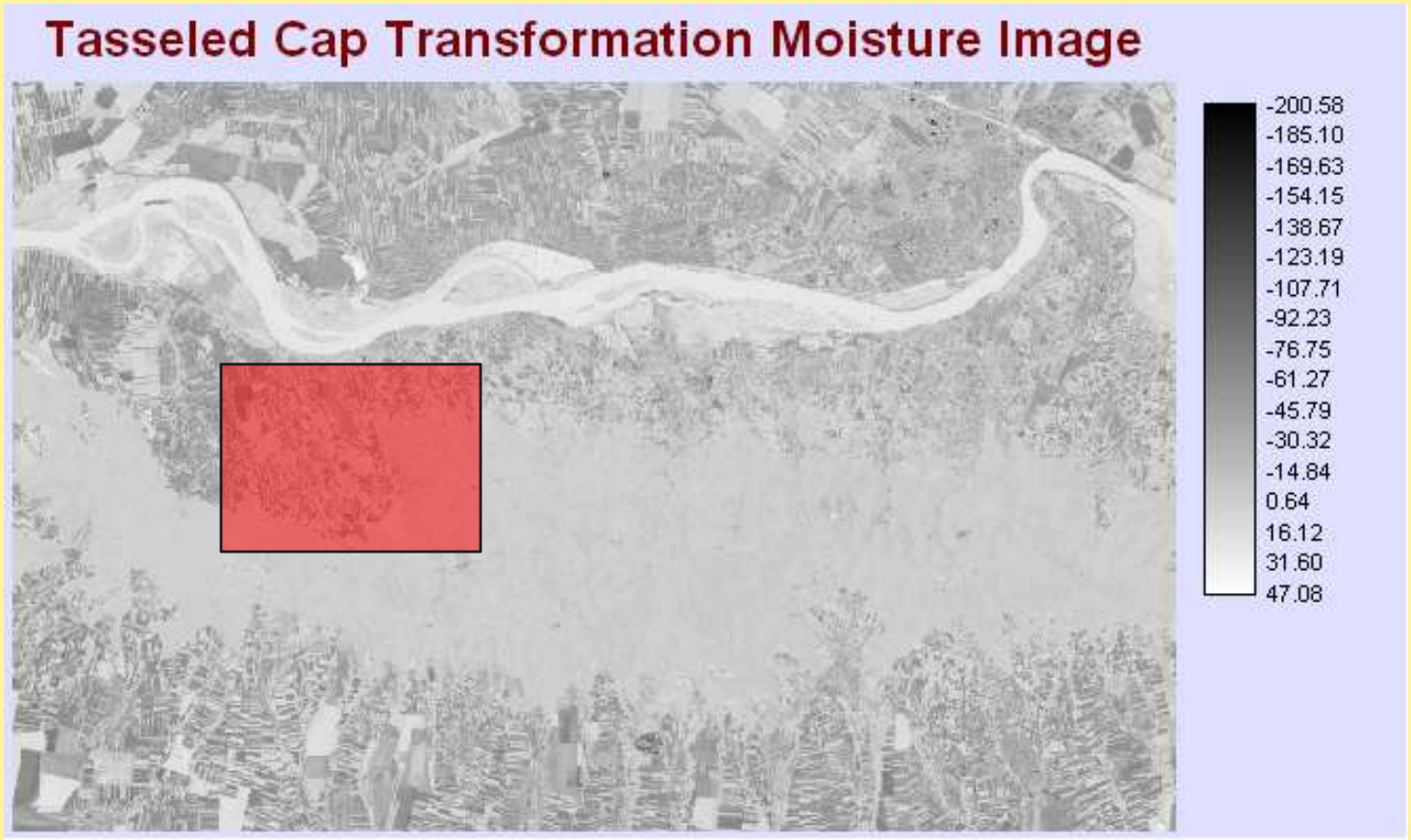
LULC pre-classification processing

- Visualizing with false color composite (RGB=432)

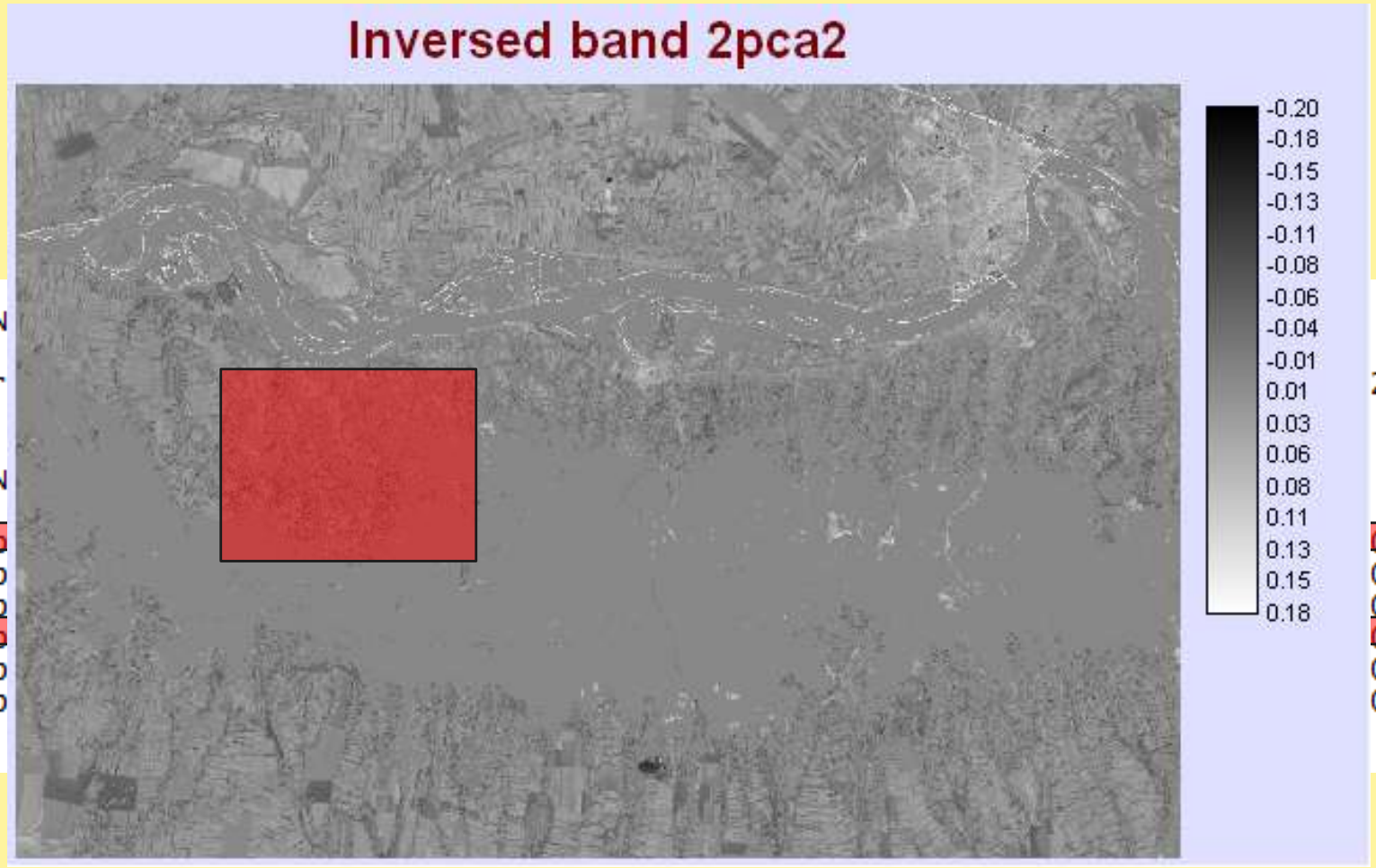


LULC pre-classification processing

- Visualizing with false color composite (RGB=432)
- Tassel Cap transformation (moist, vigor, brightness)



LULC pre-classification processing



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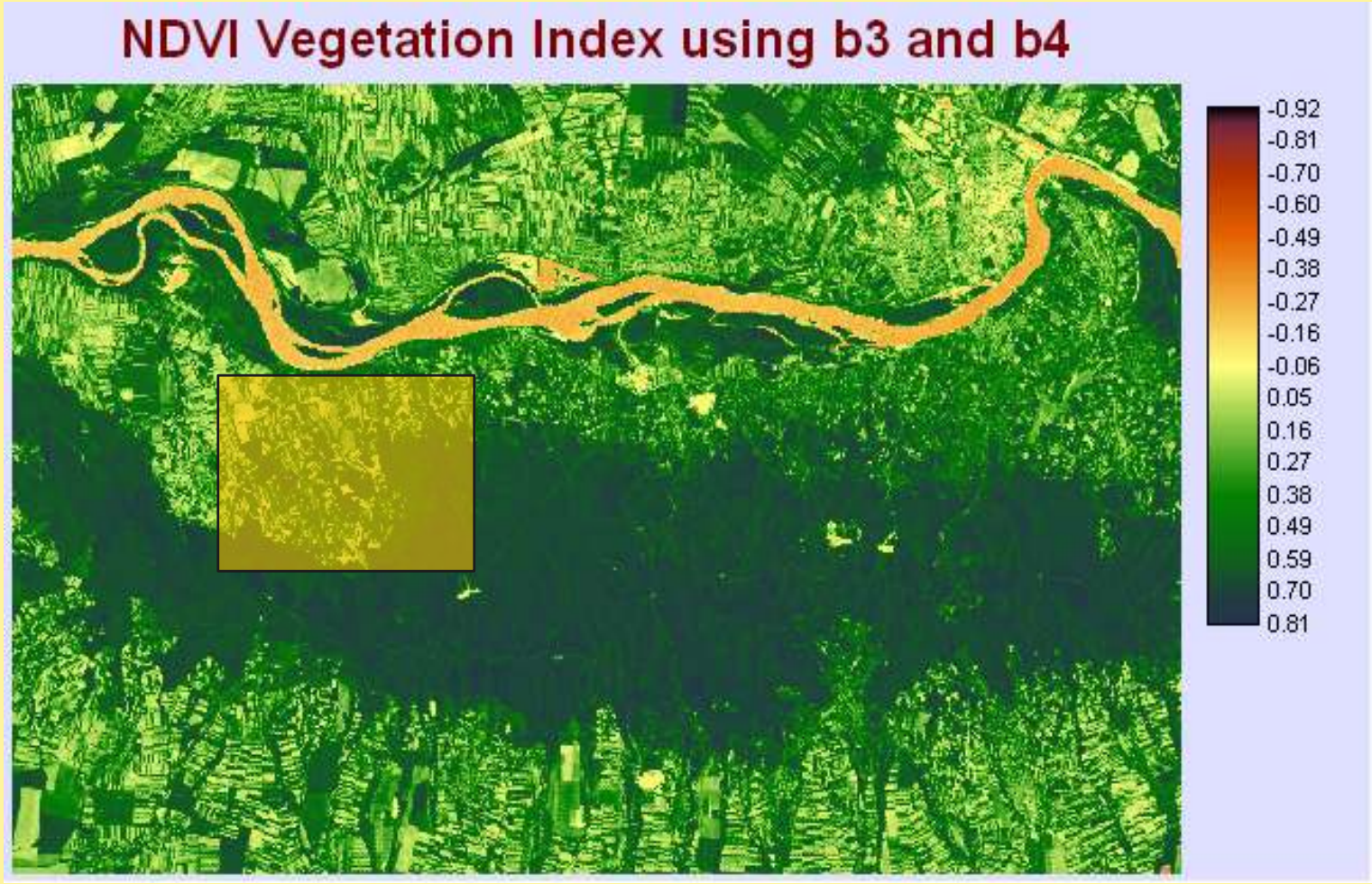
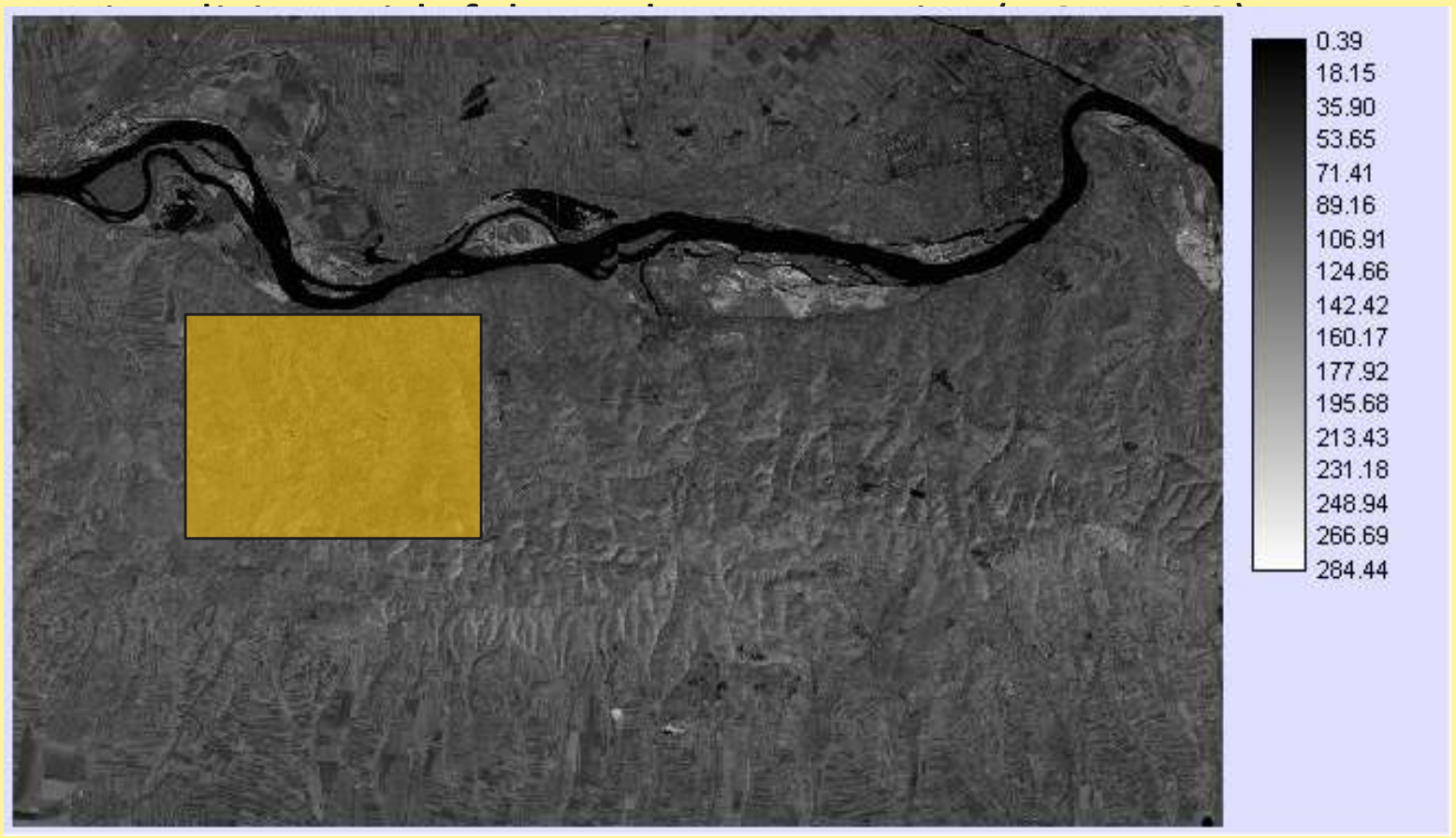
LULC pre-classification processing



LULC pre-classification processing



LULC pre-classification processing

- Visualizing with false color composite (RGB=432)
- Tassel Cap transformation (moist, vigor, brightness)
- Principal Component Transformation (PCA 1-5)
- Vegetation Index (NDVI)

$$(b4-b3)/(b4+b3)$$

- Ratio image combination

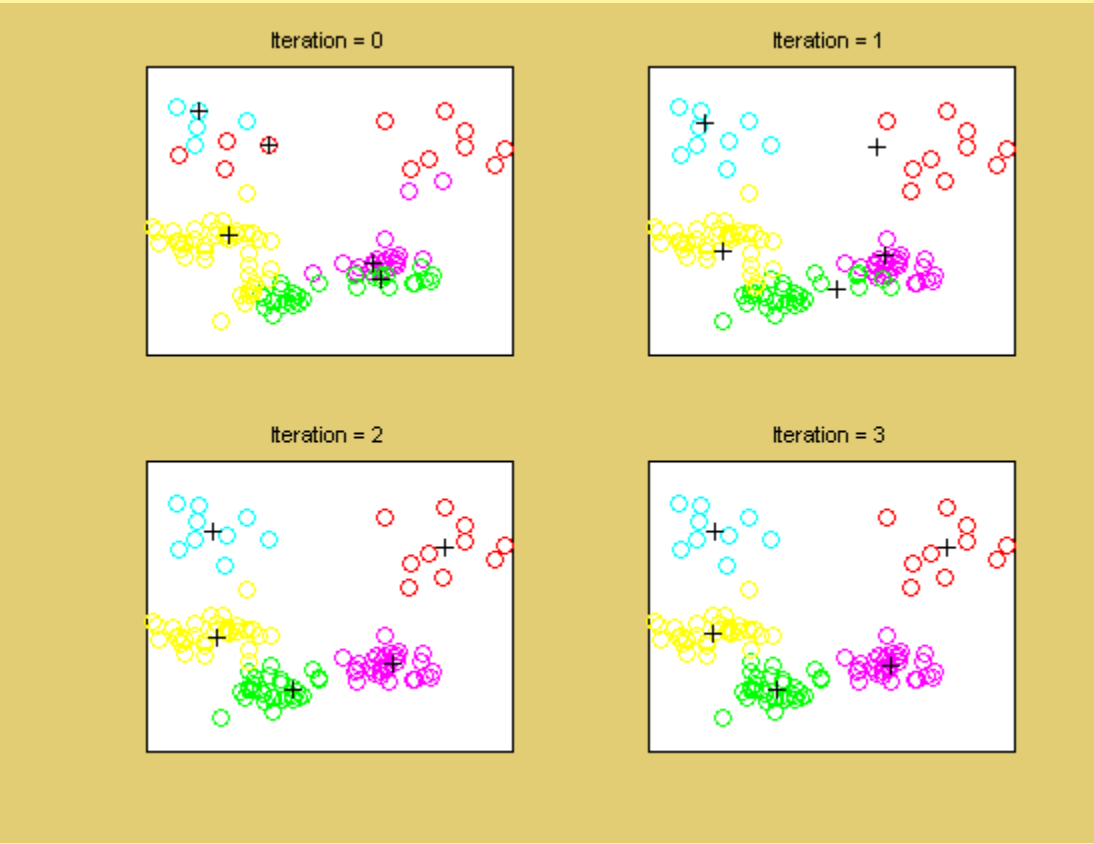
$$\frac{(b4+b5+b7)/3}{b4/b1}$$

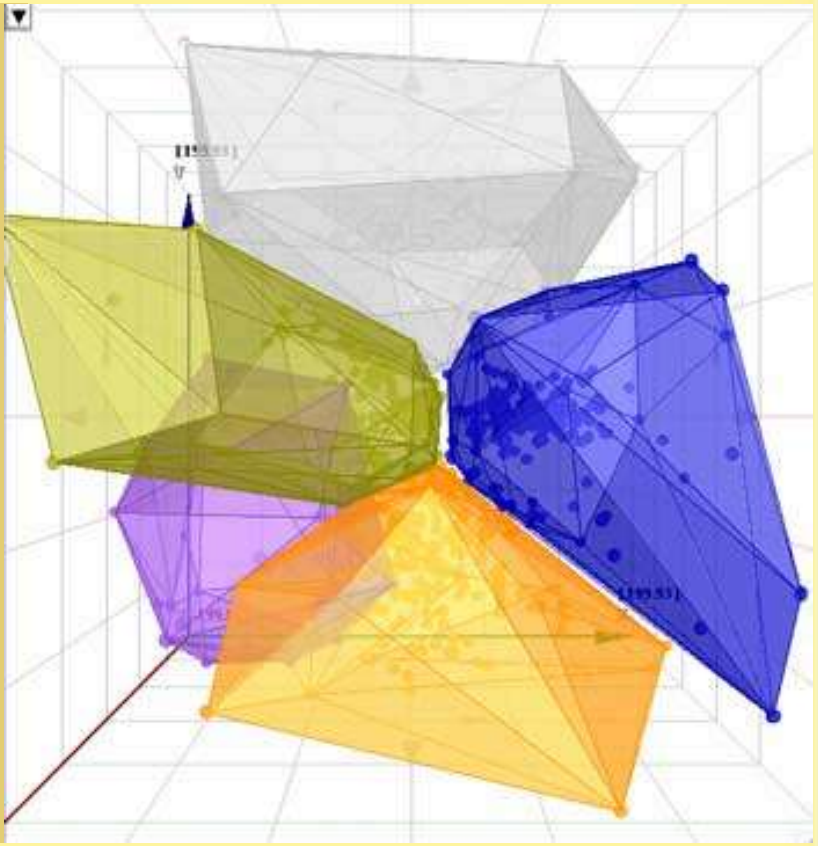
- Masking images
  - Water mask from Tassel Cap Moist
  - Forest mask from NDVI

LULC classification

K-MEANS algorithm

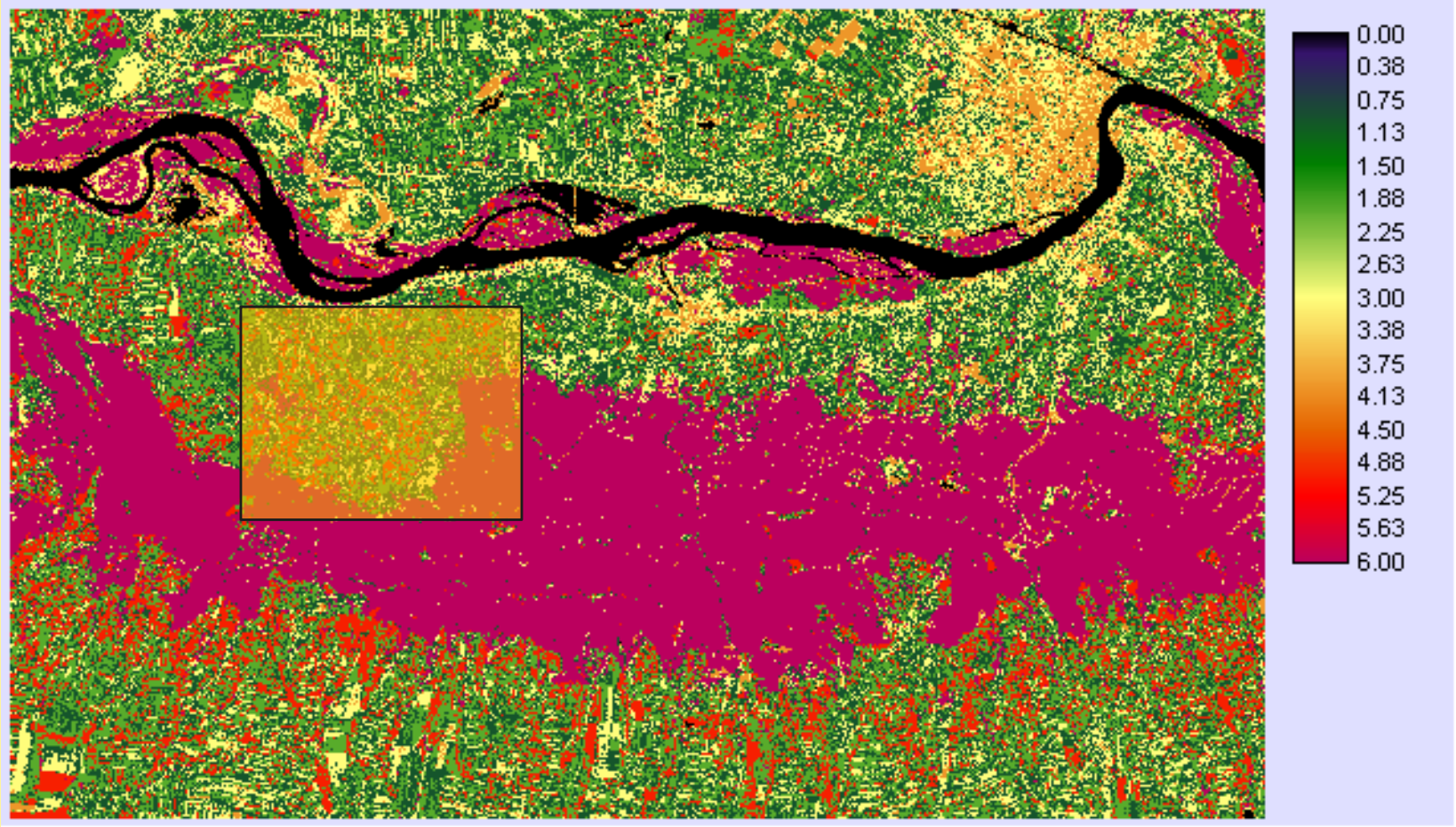
- Semi-supervised classification



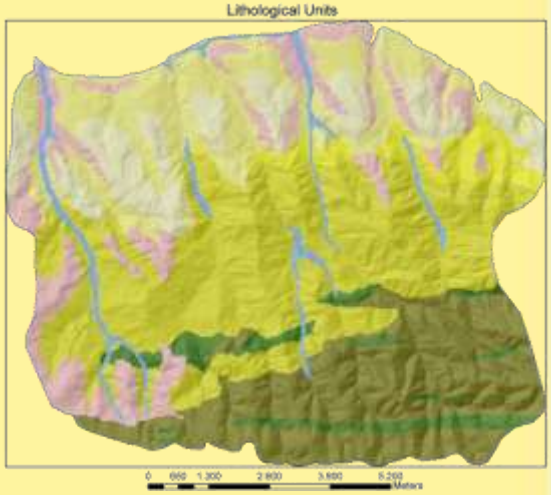


LULC classification

K-MEANS algorithm



Landslide Susceptibility



Input factors:

- Slope angle (DEM)
- Elevation (DEM)
- Buffer of drainage network (DEM)
- Topographic Wetness Index (DEM)
- Lithology (digital geological map)
- LULC (two time splits 1991, 2006)

Reference map

- RS-based geomorphological map

Landslide Susceptibility

Method – additive modeling:

- ArcGIS environment (map algebra)
- Normalization and ranging (selecting class intervals)
- Weights of Evidence

$$W_i^+ = \ln \frac{P\{F|L\}}{P\{F|\overline{L}\}} \qquad W_i^- = \ln \frac{P\{\overline{F}|L\}}{P\{\overline{F}|\overline{L}\}}$$

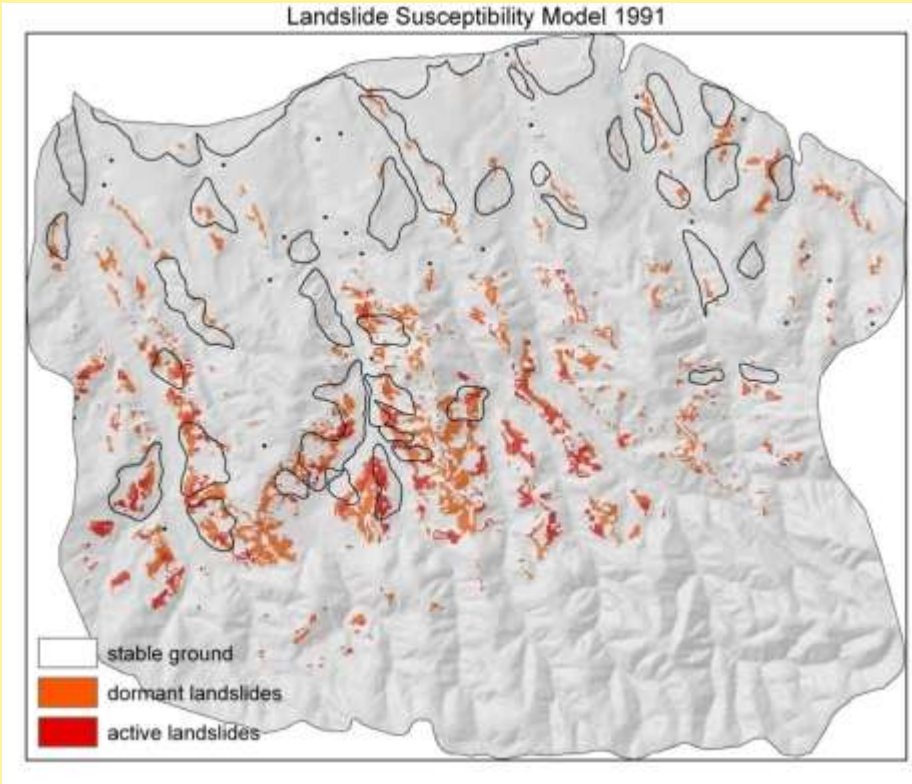
- Additive model

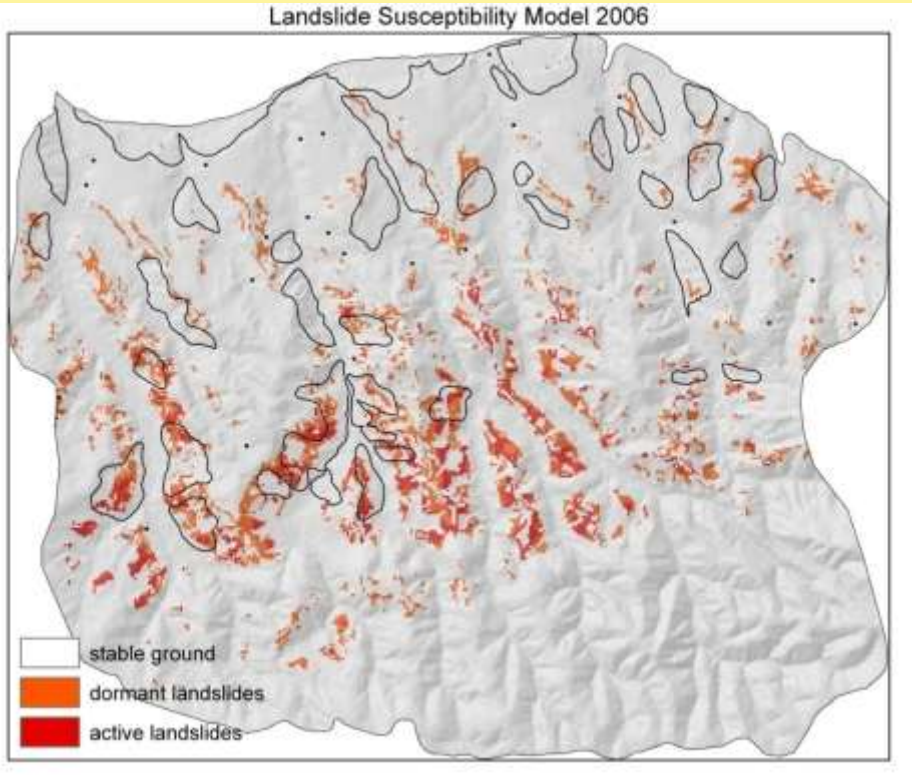
$$F_j = \sum_{i=1}^{n} F_i \cdot (W_i^+ + W_i^-) \Rightarrow S = \sum_{j=1}^{k} F_j$$

Landslide Susceptibility

LULC class	Total Weight of 1991 LULC	Total Weight of 2006 LULC
Water & wetland	2,096539	2,163602
Urban & Built-up areas	4,17536	3,737984
Forests	-7,49547	-7,35421
Agricultural land	-1,75755	-1,13473
Barren land	2,544887	0,399872

Landslide Susceptibility





Assessment of LULC influence

Kappa statistics (measure of agreement)

K-index	Susceptibility 1991 LULC	Susceptibility 2006 LULC	Referent landslide map
Susceptibility 1991 LULC	1	0,65	0,07
Susceptibility 2006 LULC		1	0,05
Referent landslide map			1

Conclusions & Directives

- Poor correlation with the reference model probably due to the simplicity of the approach
- ✓Changes of LULC itself do not influence the outcome in this case study
- Changes of LULC are present especially in the class of Barren land

- Better imagery (hyperspectral or higher resolution)
- Supervised classification for LULC mapping
- Object-based approach for LULC mapping

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Thank you for your attention & criticism!

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