LAND COVER CHANGES IN BELA CATCHMENT USING EO DATA

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Abstract. The main objective was to analyze land cover changes in relation to landscape rainfall-runoff processes. Multitemporal satellite imageries were used for the purpose (LANDSAT, SPOT, ERS). The paper presents LANDSAT processing outcomes and ERS-2 visual changes interpretation. Due to previous studies there were observed 3 main land-cover classes: Urbanization, Agricultural areas, Forest and semi-natural areas. Special attention was paid to vegetation density and wetness (vegetation indices). Reflectance value differences in red and near infrared intervals were monitored.

Keywords: LC changes, vegetation indices, LANDSAT ETM+

1 Introduction

Land cover change detection using EO data is limited with spatial, spectral, thematic, and temporal characteristics. There are many diverse methods, which can be used for such analyses, thus choosing sufficient processing steps is not easy. Nowadays, there are at least 7 categories of techniques carried out for satellite multitemporal data processing (Lu et al, 2004). Considering their basic principle, they are: algebra, transformation, classification, advanced models, GIS approach, visual analysis, and other approaches.

Within the project the algebra (vegetation indices) and transformation (PCA) techniques were carried out.

Land cover and its changes together with hydro-synoptic situation influence landscape rainfall-runoff processes. According to Langhammer et al (2004), the fundamental land cover changes, which have impact on rainfall-runoff process, are:

- Deforestation (especially in spring source areas where vegetation interception play essential role). Nevertheless, it is important to know that degradation of soil profile goes together with deforestation process, soil profile influence runoff with stronger intensity than vegetation interception;
- Intensive agriculture (e.g. meadow, pasture, and forest change into agricultural areas), especially into wide-spread homogenous areas play significant role;
- Landscape urbanization (paved surfaces weakens retention capacity of an area, so the surface runoff has predominant influence;
- Industrialization (changes of natural primal hydrographical network in the area, causes water accumulation, chemical and thermal pollution).

Thus we considered forest areas, urban areas, and agricultural areas as important observation aspect studying land cover changes in relation to landscape rainfall-runoff processes.

2 Area of Interest

Bela catchment were chosen for its appearances in previous studies and because this project supports author dissertation thesis. The River Bela catchment is situated in north-west part of Moravia (Czech Republic) – Jeseniky Montains, close to the border with Poland (to the north), and flows into Nysa River (a tributary of Odra). It is 55.2 km long with basin area 395.9 km2 (270.9 km2 and 125.0 km2) and discharges between 1.35 m3/s in dry summer periods and more than 70m3/s in wet autumn or spring periods. Its upstream mountain basin ends close to Czech-Polish border when the river reaches the plain area. The Bela/Biala river represents a typical torrential character river characterized by episodes of a high flood risk followed by periods of low precipitations and small discharges. The absolutely maximal discharged observed during the 1997 flood event reached 490 m3/s.

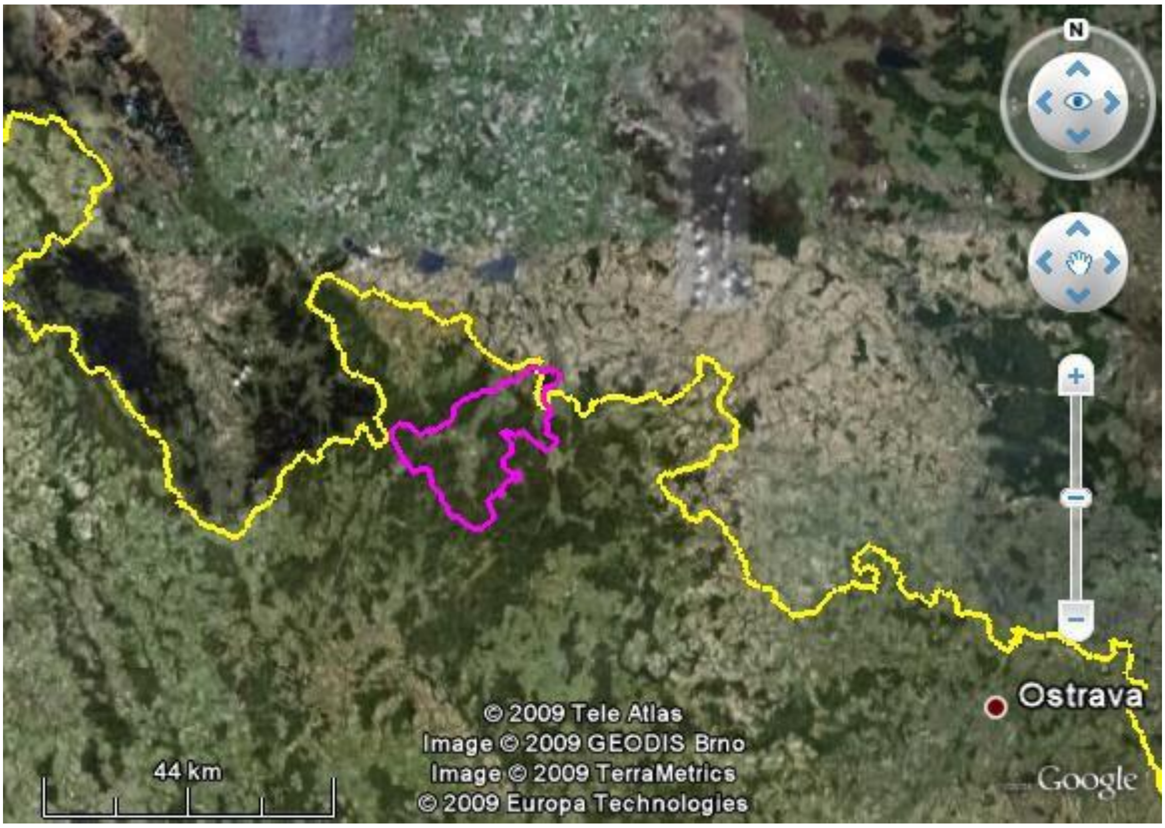


Fig. 1. Area of Interest - The River Bela catchment.

3 Data

EO data represented LANDSAT ETM+ and ERS-2 data. ETM+ multitemporal data set contained time series a year apart, (14 May 2000, 24 May 2001, and 4 May 2002). Data represented Frame 25 and Track 189, 190 (year 2001). ERS-2 data used only for multitemporal compositions creation were obtained from ČVUT.

4 Vegetation Indices

NDVI (Normalized Difference Vegetation Index) provides monitoring of phenological patterns of the earth's vegetative surface, and of assessing the length of the growing season and dry-down periods. (Huete and Liu, 1994 in Jensen, 2005)
NDVI is calculated using near infrared a red bands considering vegetation cover spectral characteristics in these intervals. The output values are within interval -1 up to 1 and very good describe vegetation density and vegetation health conditions.

$$NDVI = \frac{(NIR - RED)}{(NIR + RED)} \quad (1)$$

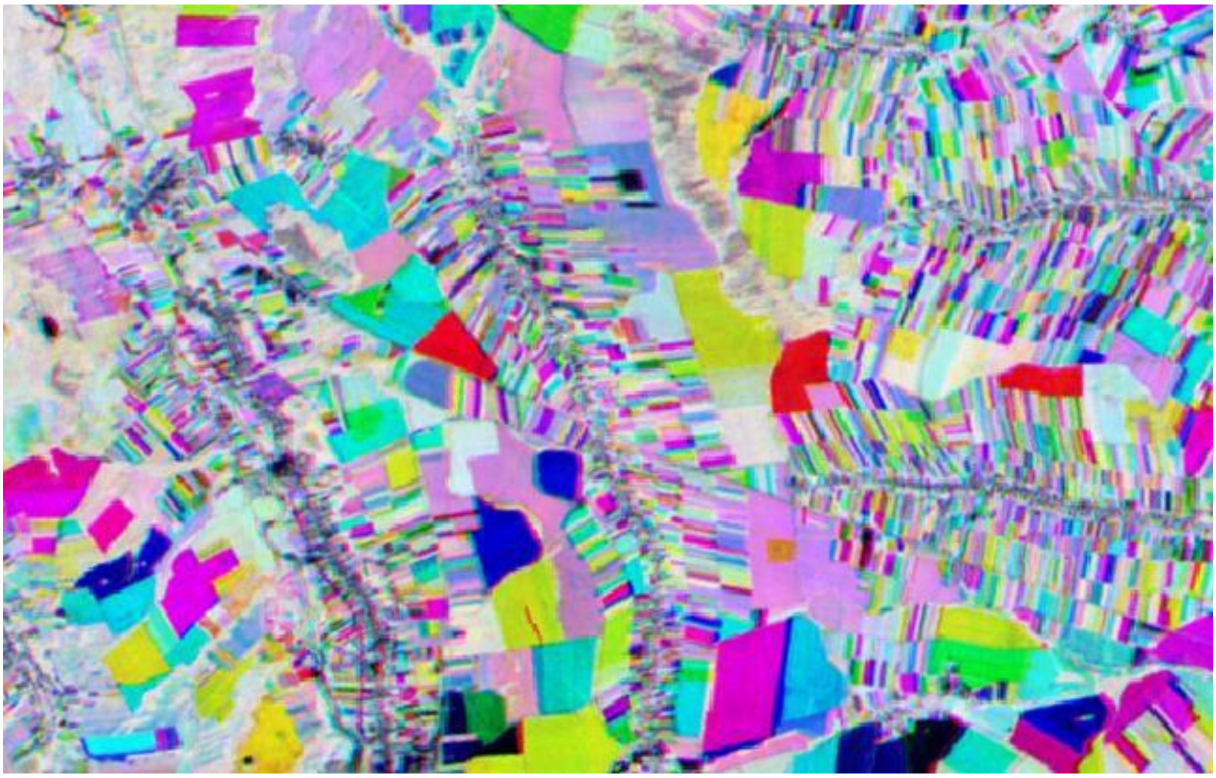
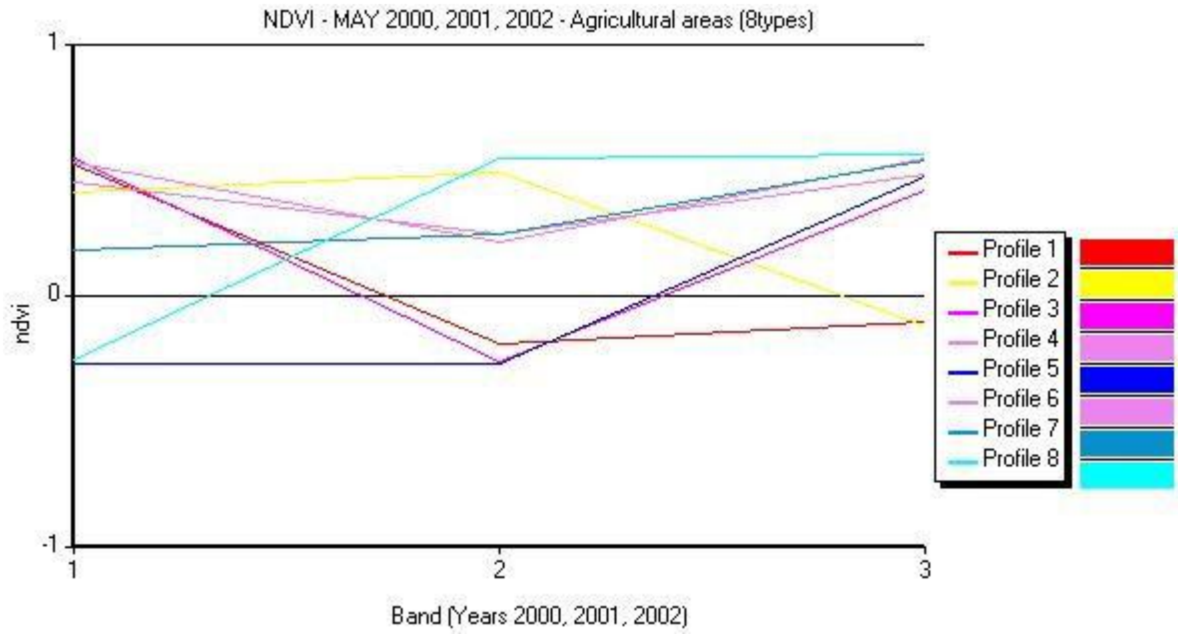


Fig. 2. NDVI 2000, 2001, 2002 RGB composition. Landsat ETM+ data. Agricultural areas.



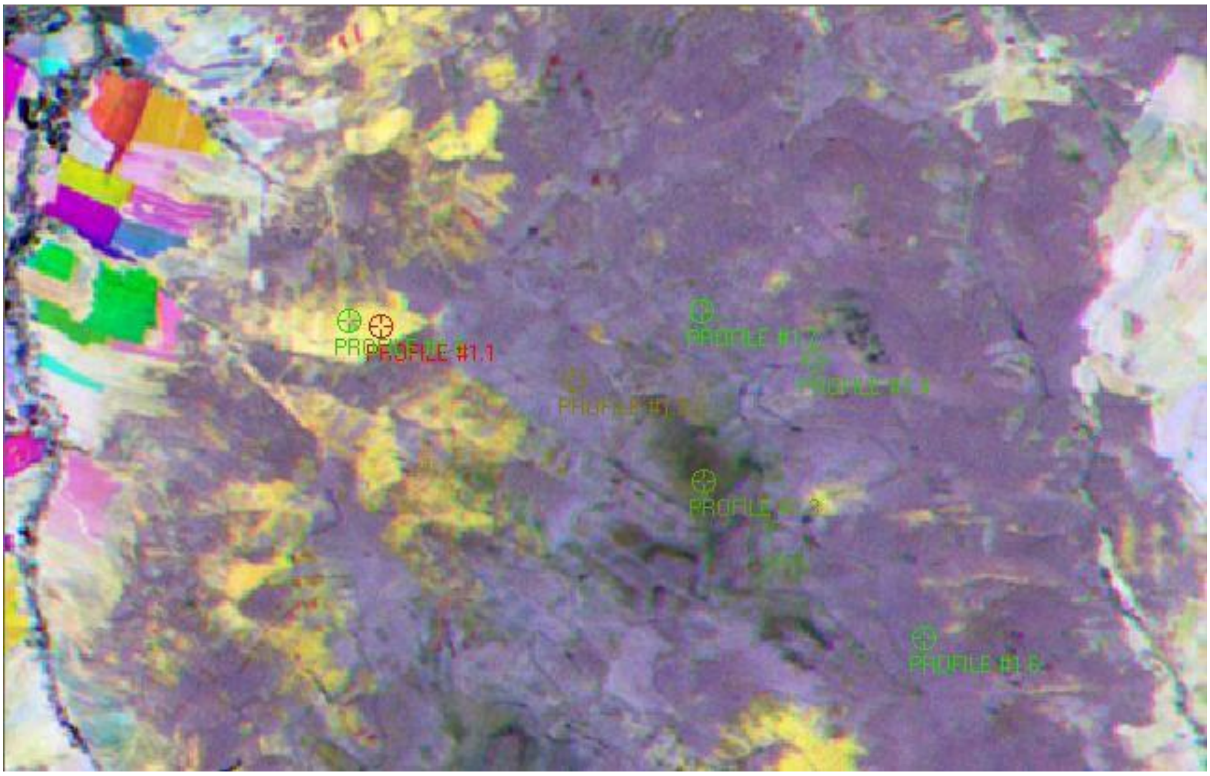
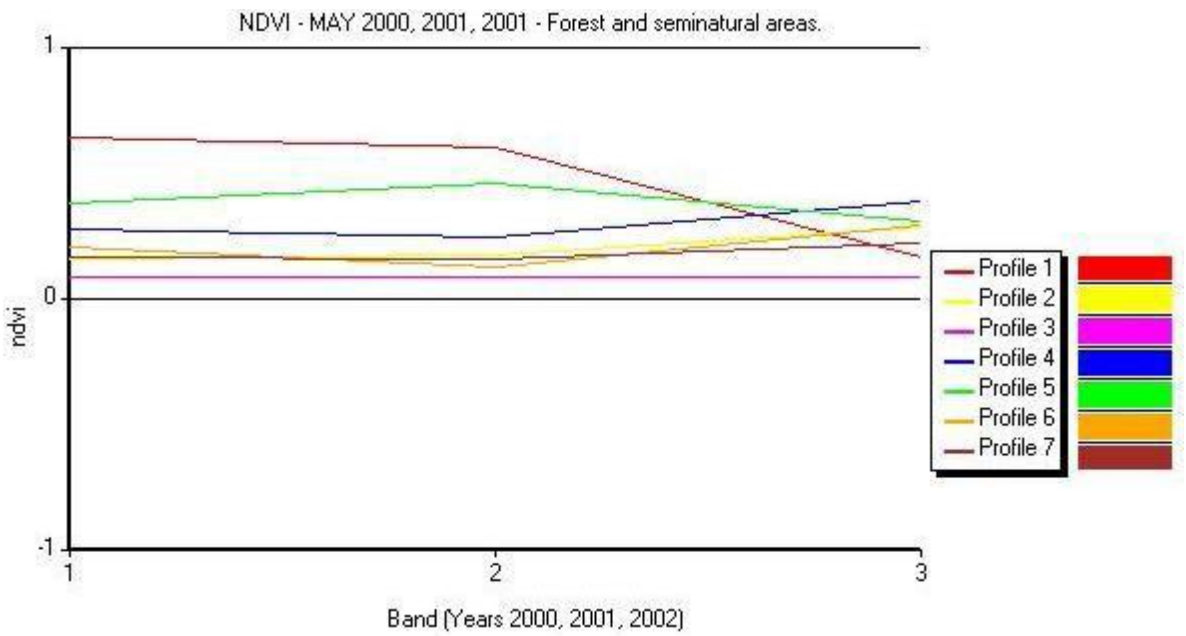
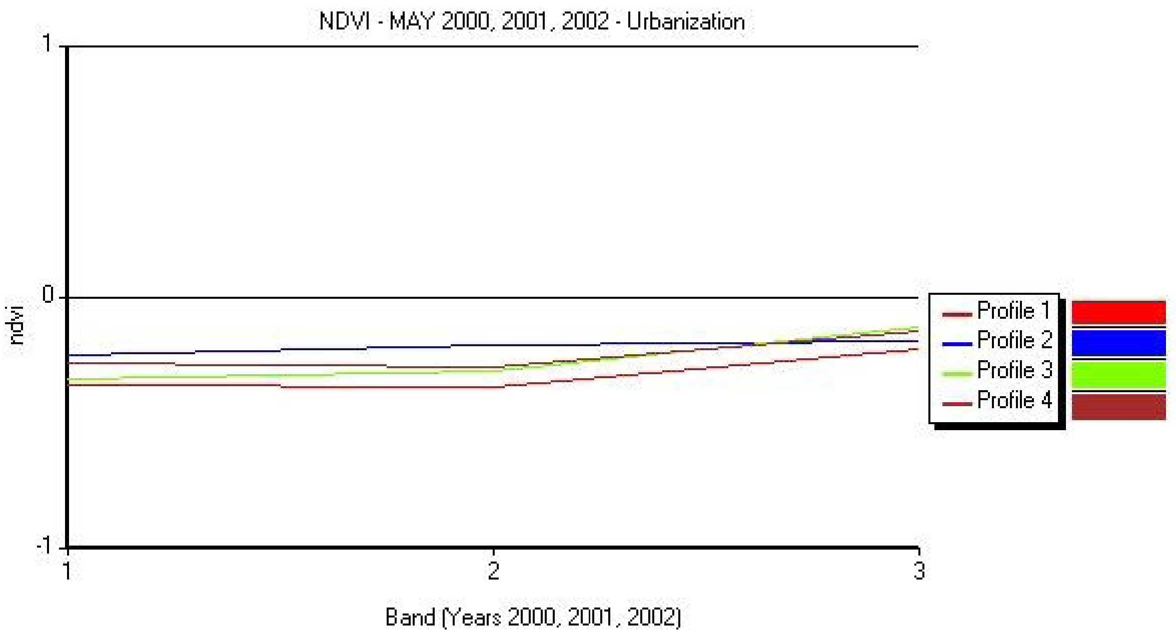


Fig. 3. NDVI 2000, 2001, 2002 RGB composition. Landsat ETM+ data. Forest and eminatural areas.





Infrared Vegetation Index (II) follows NDVI equation using near and middle-infrared bands sensitive to changes in plant biomass and water stress.

$$II = \frac{(NIR - MIR)}{(NIR + MIR)} \qquad (2)$$

Moisture Stress Index (MSI) uses simple ratio with middle and near infrared bands.

$$MSI = \frac{MIR}{NIR} \qquad (3)$$

Visual analysis of ERS-2 data confirmed agricultural areas variations from year to year, but also the deciduous forest fenological variations. Due to mountainous AOI and radar imagery characteristics in such areas we didn't carry out further processing.

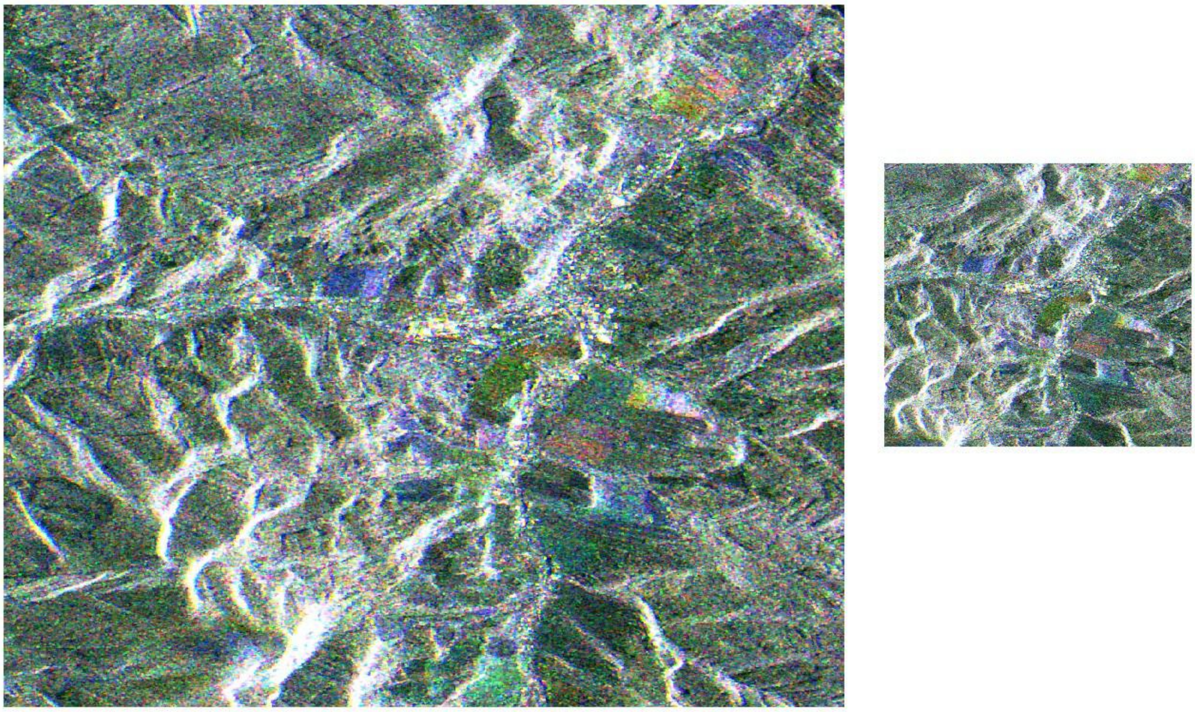


Fig. 4. ERS-2 multitemporal analysis, zoomed in Jesenik city.

5 Conclusion

Agricultural areas were the most unstable land cover in the area, which was foreseen due to agricultural seasons. NDVI method brought the most valuable assessment. Deciduous forests fenological start seems to come later in 2002 than in 2000 and 2001 but even 10 days difference may play role in this case (data 2002 were obtained earlier, 04 May, than the other two).

6 Acknowledgments

The study has been carried out under grant project „Application of Geoinformation Technologies for Improvement of Rainfall-Runoff Relationships“ (GA205/06/1037) thanks to Czech grant agency and under internal grant project „Land cover change assessment using EO data “ (IGS/2007/548) thanks to Faculty of mining and geology.

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