High-resolution earth observation for monitoring post-socialist land use change in the Carpathians Ecoregion

Tobias Kuemmerle,
Daniel Müller,
Jacek Kozak,
Jan Knorn,
and Patrick Hostert
Outline of this talk

1. Background
2. Post-socialist forest cover change
3. Post-socialist farmland abandonment
4. Conclusions
The Carpathian Mountains are a region of exceptional nature conservation value

- Europe’s largest temperate forest ecosystem
- Have remained relatively undisturbed
- High biodiversity, many endemics
- Provide habitat for viable populations of flagship species
- Immense cultural diversity
- The Carpathians are also still rich in cultural landscapes
- Carpathian ecosystems provide important ecosystem services
  - highly productive forests
  - freshwater
  - tourism
  - etc
- Rapid and drastic changes in Eastern Europe’s political, societal, and economic structures after 1989
- Changes in land use practices and land management policies triggered widespread land use change
Logging
Farmland abandonment
Questions:

- How has land use change altered Carpathian ecosystems since the collapse of socialism?
- Did land use change vary among Carpathian countries?
Study regions:

1. Western Beskidy Mountains
2. Eastern Beskidy Mountains
3. Ukrainian Carpathians
4. Ukrainian-Romanian border region
5. Southern Romania
Post-socialist forest cover changes in the Carpathians
Example 1: Polish-Slovak-Ukrainian border region

- Forest cover change mapping based on the forest disturbance index (Healey et al. 2005, RSE)
- Increase in disturbance rates after the system change in all three countries
- However, marked differences in disturbance rates among countries
- Overall accuracy ~95%
Poland

Slovakia

Reference:
Kuemmerle et al., 2007, Ecological Applications

Legend:
- Non-Forest
- Unchanged Forest
- Disturbance 1994 – 2000
- Disturbance 1988 – 1994
- Disturbance before 1988
Example 2: Forest cover change in the Ukrainian Carpathians

- Classification based on Support Vector Machines (SVM)
- Five Landsat scenes + four time periods (1990, 1995, 2000, and 2007) → 20 images
  - Classification accuracy >95%
Disturbance rates and forest statistics
Example 3: Forest disturbance vs. forest ownership regimes
Post-socialist farmland abandonment in the Carpathians
Example 4: Farmland abandonment in Southern Romania (Arges County)

- 21% of socialist cropland abandoned after 1989
- Abandonment most extensive in the early transition years
- Abandonment rates were highest in higher altitudes and on steep slopes

Reference:
Kuemmerle et al., 2008, Regional Environmental Change (forthcoming)
Example 5: Farmland abandonment in the Polish-Slovak-Ukrainian border region

- Change classification based on SVM
- Fallow land and reforestation were widespread in the study region (highest in Slovakia)
- Overall accuracy ~91%

Reference:
Kuemmerle et al., 2008, Ecosystems (forthcoming)
Abandonment rates also differed on formerly state-owned and private farmland in Poland.
Widespread land use change since 1989 due to changing politics and socio-economics, for example:

- Economic depression, weakened institutions, and lack of control likely led to increased forest harvesting in the early transition years

- Decreasing profitability of agriculture and migrations caused farmland decline (~15-20%)

Land use trends differed markedly among countries and regions, for example due to different land ownership patterns, land reforms, land management practices

Other factors superpose these factors (e.g., population density, topography)
Post-socialist land use change offers threats and opportunities for Carpathian ecosystems:

- Human pressure decreased considerably in rural areas
- Abandoned farmland offers potential for additional carbon storage, but threatens cultural landscapes and farmland/grassland biodiversity
- The effectiveness of protected areas differed among countries, illegal logging a problem in Ukraine
Thank you for listening!

tobias.kuemmerle@geo.hu-berlin.de

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Remote sensing images contain much more than ‘just’ land cover!

Source: Elvidge 2007
Much can be learned about drivers of land use change in regions where politics, institutions, and socio-economics change rapidly

Post-socialist land use change as a "natural experiment"

Border regions are particularly interesting
Mapping forest disturbance

- Change detection based on the disturbance index

\[ B_r = \frac{(B - B_\mu)}{B_\sigma} \]
\[ G_r = \frac{(G - G_\mu)}{G_\sigma} \]
\[ W_r = \frac{(W - W_\mu)}{W_\sigma} \]
\[ \text{DI} = B_r - (G_r + W_r) \]

Healey et al. (2005),
Remote Sensing of Environment
Support Vector Machines (SVM)

- find the optimal hyperplane that separates two classes
- Strengths: non-parametric, can handle complex classes
Ukraine – Skole Beskydy National Park

- Non-Forest
- Unchanged Forest
- Disturbance 1994 – 2000
- Disturbance 1988 – 1994
- Disturbance before 1988
Outlook: Mapping forest cover change and farmland abandonment for the full Carpathian ecoregion

- Workflow optimization and automating
- Generalization of the change detection approach