Effects of massive socio-economic changes on land-use: detecting agricultural land abandonment and its drivers in post-Soviet Eastern Europe

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Background
Land use decisions are made by local actors, but their actions are constrained by broad-scale factors (e.g., national policies and global markets). Increasingly, evidence suggests that these broad-scale factors are at the heart of many LULCC trends. The collapse of socialism in the Eastern Europe provides a ‘natural experiment’ to examine how broad-scale change affects LULCC.

Main Goals
- Develop methods to monitor post-socialist agricultural abandonment.
- Quantify agricultural land abandonment in several Eastern European countries.
- Identify drivers of agricultural land abandonment.

MAPPING LAND ABANDONMENT

Background
Multi-seasonal satellite imagery improves classifications, but Landsat image availability is often limited.

Objectives
- Assess the effects of image dates on the classification accuracy of land abandonment.
- Compare Support Vector Machines (SVM) and Maximum Likelihood Classifier (MLC).

Methods
- Classify all possible combinations of Spring, Summer, Fall images for pre- and post-abandonment (1989 and 1999, 49 combinations), using SVM and MLC, for one Landsat footprint (path 186, row 22).
- Assess key image dates and best classifiers to classify “abandoned arable land” and “abandoned managed grassland”.

Figure 1. Study Landsat footprint and reference data collection.

Results
- Conditional Kappa was 90% for “abandoned arable land” with optimal image dates, but as low as 54% for sub-optimal dates (72% and 50% for “abandoned managed grassland”).
- “Abandoned arable land” accuracy depended greatly on spring images for both pre- and post-abandonment.
- “Abandoned managed grassland” required multiple image for pre-abandonment (preferably Spring plus either Summer or Fall) and at least spring for post-abandonment.
- SVM outperformed MLC only for “abandoned arable land” and only with many images dates.

PATTERN OF LAND ABANDONMENT

Background
Each Eastern European country employed unique policies after the collapse of socialism. It is not clear how this affected land abandonment.

Objectives
- Map land abandonment from 1989 to 1999 for several counties in one agro-climatic zone using SVM.
- Relate agricultural land abandonment rates to different transition models.

Methods
- Agro-climatic stratification using climate and soils data.
- Classification of multi-temporal Landsat TM/ETM+ images using SVM.
- Summaries of abandonment rates across and within countries.

Figure 2. Image dates combinations.

Figure 3. Conditional Kappa for two abandonment classes.

Figure 4. Conditional Kappa for two abandonment classes.

Results
- Out of 9.5 million ha agricultural land in 1989, 3 million hectares (31%) were abandoned by 2000/2002.
- Abandonment rates varied sub-continental among countries, and also among districts within countries.
- Latvia (42%), Russia (37%), Lithuania (28%), Poland (15%), and Belarus (12%).
- Cross-border scenes exhibited striking differences between countries that implemented different transition approaches (e.g., Mogilev region of Belarus-10%, Smolensk region of Russia-56%).
- Abandonment rates were lowest in countries with strong institutions during the transition (e.g., Belarus and Poland).

Figure 5. Abandonment pattern.

Figure 6. Agricultural abandonment rates summarized by district boundaries.

DRIVERS OF LAND ABANDONMENT

Background
Agricultural land use is largely driven by economic decisions evolving from human behavior. Abandonment is common throughout the world, but drivers may differ among and within countries as suggested by strong intra- and inter-country variability in abandonment rates.

Objectives
- Develop one spatially explicit, multilevel model for five Russian regions (oblasts) to predict observed abandonment based on socio-economic and biophysical variables.
- Develop fine-scale models for two Russian regions to examine socio-economic variables at the municipality and village level.

Methods
- Objective 1: spatially explicit logistic model (“abandoned” pixels-1; “stable agriculture”-0). Variables: 1) biophysical; 2) land cover, 3) socio-economic, district-level; 4) socio-economic proximities; 5) regional level macro-economic variables.
- Objective 2: same as above, plus village level socio-economic statistics.

Expected results
- Testing the hypothesized relationship between covariates and land abandonment (Table 1).

Table 1. Hypothesized relationship between selected covariates and land abandonment.

<table>
<thead>
<tr>
<th>Group</th>
<th>Driver</th>
<th>Distance to 1989 shrubs (1)</th>
<th>Rural population (%)</th>
<th>Public land ownership (2), dairy and milk production &amp; level</th>
<th>Weighted numbers of registered land titles (3)</th>
<th>Governmental investments in agriculture (1)</th>
<th>Distance to roads (1s), distance to administrative centers (1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land cover – proximities</td>
<td>Driver</td>
<td>Socio-economic – village level</td>
<td>Socio-economic – enterprise</td>
<td>Socio-economic – district level</td>
<td>Socio-economic – regional level</td>
<td>Socio-economic – proximities</td>
<td></td>
</tr>
<tr>
<td>Rural area</td>
<td>Distance to 1989 shrubs (1)</td>
<td>Rural population (%)</td>
<td>Public land ownership (2), dairy and milk production &amp; level</td>
<td>Weighted numbers of registered land titles (3)</td>
<td>Governmental investments in agriculture (1)</td>
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References


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