Landscape transition after the collapse of communism in Czechia

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ABSTRACT

The paper deals with mapping of landscape transition after the collapse of Communism in Czechia on national and local levels. Three maps demonstrate the main trends of landscape transition on the national level (by cadastral units) in the period 1990–2010. The Main Map shows the four most important Processes of landscape change (afforestation, grasping over, intensification, and urbanization). The second map demonstrates the proportion of area where any kind of land use change occurred (Index of change) and the third map (Extensiﬁcation) indicates the shift to less intensive use of land (increase of forests and grasslands). Two main processes were mapped on the local level, that is, by parcels. The case of Jimmy showed strong sububanization: fertile agricultural land has been turned into residential and commercial areas, roads; soil sealing was taking place. On the contrary, grasping over and afforestation was detected in Hošťka where arable land almost disappeared – it was either abandoned or replaced mainly by pastures between 1990 and 2010.

1. Introduction

The collapse of Communist regimes in Central/Eastern Europe in the 1990s has caused many political, economic, and social changes that triggered new trends of land use/land cover changes influencing landscape transition. Many publications studied these changes on European, supranational, and national levels. Several studies focused on the so-called ‘Post-Soviet Eastern Europe’. These include nation states of the former Soviet Union and neighbouring countries – the studies often deal with European Russia, Belarus, Latvia, Lithuania, Ukraine, Estonia, and Poland (Alcantara et al., 2013; Prishchepov, Müller, Dubinin, Baumann, & Radeloff, 2013).

Researchers from Science for the Carpathians Research Network (S4C) and South Eastern Europe Mountain Research Network, supported also by NASA, published many papers dealing with land use/land cover changes after the collapse of Communism in the ‘Carpathian region’. Different changes across this region typical for the post-communist period were studied. Kuemmerle, Hostert, Radeloff, Perzanowski, and Kruhlav (2007) deal with forest disturbances; Kuemmerle et al. (2008) study agricultural abandonment in the border regions of Poland, Slovakia, and Ukraine. Changes of agricultural land in the Carpathian Ecoregion were examined also by Griffiths, Müller, Kuemmerle, and Hostert (2013). Munteanu et al. (2014) published a complex study covering parts of the Czech Republic, Poland, Ukraine, Romania, Hungary, and Slovakia, focusing on long-term patterns and drivers (including the post-communist period) of forest and agricultural land changes. The latter publication was based on 102 case studies from different countries.

Many studies focused on land use/land cover changes in the individual former socialist countries as well as on changes in smaller regions and cities. Let us mention at least a few: land use changes in the post-socialist Romania (Kuemmerle, Müller, Griffiths, & Rusu, 2009); farmland abandonment, forest recovery, and carbon sequestration in western Ukraine (Bau mann et al., 2011; Kuemmerle et al., 2011); land use/land cover changes between 2000 and 2006 related to the transition from Communist system to free market economy in the Gorce Mts., Polish Carpathians (Bucala, 2015); changes of artificial surfaces in Slovakia (Feranec & Soukup, 2012) and in Bratislava (Pazúr, Kopecák, & Feranec, 2015); urban land cover changes – comparison of Bratislava and Burgas (Kopecák, Vat seva, Feranec, Otahel, & Rosina, 2014).

Though European publications focused on land-use/land-cover changes and landscape transition seldom include case studies from the post-Communist Czechia, there are many national, regional, and local studies dealing with this topic (Bíčík, Himiyama, Feranec, & Štych, 2012, 2014, 2015). Land use/land cover research team at the Faculty of Science, Charles University in Prague led by professor Ivan Bíčík – see Bíčík, Himiyama, Feranec, and Kupková (2015) – has
produced a complex array of publications focused on land use and landscape changes in the period spanning more than 150 years (from 1845) including post-communist period. These research projects chiefly use data from cadastral records that are stored in spatial GIS data set (LUCC Czechia Database).

Regarding the mapping techniques used in the above-mentioned studies dealing with land use/land cover changes on the European and national levels (Alcantara et al., 2013; Feranec & Soukup, 2012; Griffiths et al., 2013; Kolejka & Klímanek, 2014; Kopecka et al., 2014; Prischepov et al., 2013), these mostly include remote sensing data change detection analysis, maps showing one particular type of change (land abandonment, forest development, agricultural land decline, etc.), and general land cover conversion maps in a rather generalized form covering quite extensive areas based, for example, on CORINE data set (Feranec, Soukup, Hazeu, & Jaffrain, 2016). The second common type is represented by detailed land use/land cover conversion maps usually produced as a spatial overlay of time series of manually vectorized maps. These detailed maps (local level) are based on aerial or satellite images with very high spatial resolution, on historical maps, field mapping, and other local data sources (Bucala, 2015; Jeleček, Bičík, Stých, & Bláha, 2012; Kupková & Ouředníček, 2013; Momirski & Gabrovec, 2014).

This paper aims to provide a series of maps documenting main processes of landscape transition in the post-communist Czechia. To produce the maps on the national level, cadastral records converted into a time and space consistent geodatabase (LUCC Czechia Database) were used. The trends indicated on the national level were further illustrated by case studies carried out using different types of data (field mapping, aerial photos or satellite images with very high spatial resolution).

2. Data and methods

In this paper, the landscape transition was studied on the national level (using Cadastral Units/Stable Territorial Units [STUs] as a basic source – see chapter Data on national level), and also in detail (i.e. by parcels) in two selected areas: case studies of Hoštka (rural peripheral landscape in the western part of Czechia close to German border), and Jirny (exposed suburban landscape in the hinterland of Prague).

2.1. Data on national level

Data from cadastral records serve as a source for assessment of landscape transition between 1990 and 2010 on the national level. Our research team has created the Database of Long-Term Land Use Changes in Czechia 1845–2010 (LUCC Czechia Database). Cadastral data from 1845, 1896, 1948, 1990, 2000, and 2010 are stored in the GIS database so that also the last post-communist period can be evaluated.

Land Registry has a long tradition in Bohemia and Moravia. Data for 1845 are taken from so called Stable Cadastre that reflects very well the landscape features of early nineteenth century, that is, in the period of early Industrial Revolution and Agricultural Revolution. Also further years for which the data in the LUCC Czechia Database are stored correspond with key events of the Czech history. For our study year 1990 is crucial. The collapse of communism in Czechia in November 1989 has started many changes that have influenced the landscape transition from 1990 forwards.

In order to secure compatibility over time, cadastral units were amalgamated into so-called Stable Territorial Units (STUs). The year 1990 was chosen as a standard and the maximal fluctuation in terms of unit size among different years was set at 2%. At the moment, some 13,000 cadastral units exist on the national territory and these were amalgamated into 8832 STUs for the research purposes. In some cases, one STU consists of two or more amalgamated cadastral units, usually in areas where changes of administrative boundaries occurred over the years. Almost 80% of STUs, however, consist of just single one cadastral unit (Bičík et al., 2015). The final dataset records seven basic land use classes: arable land, permanent cultures (gardens, orchards, hop gardens, vineyards), permanent grasslands (meadows and pastures), forest areas, water areas, built-up areas, and remaining areas.

2.2. Methods and software used at national level

Three indicators documenting the transition of Czech landscape in the period 1990–2010 were used.

(1) Processes of landscape change

Slovenian geographers have developed a special method evaluating processes of landscape change (Gabrovec, 1995; Gabrovec & Kladnik, 1997). We used this method because it was found as one of the most exact and detailed to document the occurring trends (Bičík et al., 2015). This typology of landscape changes works with four types of processes based on four land use-classes (partly aggregate) increases: (1) intensification – increase of arable land and permanent cultures, (2) grassing over – increase of permanent grasslands, (3) afforestation – increase of forest areas, (4) urbanization – increase of built-up and remaining areas. First, increases/decreases over the examined period are calculated. Next, only increases are taken into consideration. STUs are sorted into types according to the land use class which shows the biggest increase.
Each of the above-mentioned types can be further sorted into subtypes according to the grade of dominance. It is measured by percentage of the ‘prevailing’ increase on all changes combined. Three rates of changes are distinguished: high change (the ‘prevailing’ change accounts for more than 75% of all changes combined), moderate change (50–75%), and low change (less than 50%). STUs where land use changes were recorded on less than 1% of total territory are not examined (Bičík et al., 2015).

(2) Index of change

This aggregate index indicates the intensity of land-use changes over a certain period of time in the area of interest (STU in our case); it does not, however, assess the ‘quality’ (structure) of such changes:

\[ IC_{A-B} = 100 \cdot \sum_{i=1}^{n} \left| \frac{P_{iB} - P_{iA}}{2} \right], \]

where \( IC_{A-B} \) is the index of change between year A and year B, \( n \) is the number of land use classes; \( P_{iA} \) is the proportion of relevant land use class at the beginning of the examined period; \( P_{iB} \) is the proportion of relevant land use class in the end of examined period.

The higher index of change, the more intensive land use change in the area examined. This index ranges from zero to 100 and – put in a simple way – indicates the proportion of area where any land use change occurred, based on the comparison of beginning and end of the evaluated period (changes that may have occurred during the examined period are not reflected) (Bičík et al., 2015).

(3) Extensification

Extensification is shift to less intensive forms of use of land. It is evaluated by combined relative increase of proportion of meadows, pastures, and forest areas (accompanied by arable land decrease) over a certain period of time (1990–2010 in this very case).

All the above-mentioned indicators were calculated on the national level in GIS geodatabase and visualized in cartograms.

2.3. Data, mapping methods, and software used for case studies

State Map (scale 1:5000, coordinate system S-JTSK; source: State Administration of Land Surveying and Cadastre – http://www.cuzk.cz/en) was used to examine the landscape transition in the case study of Hošťka as the main data source for 1990. Hard copies of the maps from the second half of 1980s were scanned, raster maps were georeferenced and land use classes manually vectorized in ArcGIS. Land use classes are marked in the source maps using quantitative raster aligned by lines. Spatial polygon layers for arable land, meadows, pastures, forests, built-up areas, water, and other areas have been created. In 2010, the existing patterns of land use/land cover classes were drawn into the original maps during field mapping and original vector layers were finally edited in GIS according to changes recorded in 2010. One new land use/cover-class – abandoned land – has been added (Vojáček, 2012).

In the case study of Jirny, aerial photos from 1990 and QuickBird satellite data from 2007 (April 21st) were used. Aerial photos were orthorectified on the basis of orthoimages from 1997 and ZABAGED (Fundamental Base of Geographic Data of the Czech Republic; http://www.cuzk.cz/en) as a source for elevation data and mosaicick. Multispectral QuickBird images were pansharpened using panchromatic image; the final spatial resolution equalled 0.6 metres. The 1997 orthoimages and ZABAGED were used to orthorectify the final image also in this case. Manual vectorization and visual classification of land use/land cover classes were used for both raster data sources (1990 and 2007). The first vector polygon layers of 1990 were stored in geodatabase format in GIS; afterwards, these data were edited according to changes recorded on the basis of QuickBird image to create the 2007 layer. Modified CORINE legend was used for both years (http://sia.eionet.europa.eu/CLC2006/CLC_Legend.pdf). The following classes have been defined in the area of interest: residential buildings, commercial buildings, artificial purpose areas, construction sites, roads, arable land, permanent grasslands, gardens and orchards, parks, forests, shrubs, water areas, line vegetation (Kupková & Ouředníček, 2013).

Two land use/land cover thematic maps were created for each territory (1990 and 2010 in the case of Hošťka; 1990 and 2007 in Jirny). The comparison of land use/land cover patterns in 1990 and 2010 (2007) shows huge changes and reflects the specific character of landscape transition in Czechia after the collapse of Communism. Extensification is the main process recorded in Hošťka and suburbanization is the main process recorded in Jirny.

3. Results and conclusions

Twenty years of transformation period in Czechia after the crucial shift from Communist system towards democracy (1990 to 2010) have brought significant changes to the landscapes. The maps prepared for this paper show a number of principal trends that characterize the landscape transition. These trends were traced already in the period 1990–2000 but they have deepened till 2010 and only results of the whole period 1990–2010 are presented.

On the one hand, there are trends like grassing over, afforestation, and land abandonment caused by
general decline of agricultural production and shift towards a more extensive farming. These findings are in accordance with other authors (Alcantara et al., 2013; Baumann et al., 2011; Kuemmerle et al., 2008).

On the national level, one can say that the shift towards a less intensive use of land – extensification (grassing over and afforestation) was really significant in Czechia. Increase of forests, meadows, and pastures by 10% or more has been recorded in 1740 of STUs (19.7% of all, covering 18.1% of the total area). This process was especially distinctive in the mountainous frontier (where less favoured areas are often located) and it reflects natural conditions as well as some social driving forces, for example, changes of subsidy schemes. Under the socialist system, agricultural production was subsidized also in the mountains. After the accession to the EU, however, subsidies were rather available for grassing over and afforestation in such areas.

On the other hand, there is ongoing urbanization, typical for many other regions/nation states in the post-communist Europe (Feranec & Soukup, 2012; Grigorescu, Kucsicsa, & Mitrică, 2015; Pazír et al., 2015). This important process is clearly identified on the Main Map (Processes of Landscape Change) on the national level and it is manifested as urban/suburban development in the major cities (Prague, Brno) and their environs, and as creating of new roads and railways.

Agricultural intensification was not very common in the period 1990–2010 in Czechia. Signs of agricultural intensification (territorial expansion of arable land) have been recorded only in certain low-lying parts of Central Bohemia and Southern Moravia.

The index of change indicates that the most important changes of landscape/land use patterns occurred in the border regions (mostly in the mountains) and also in and around big cities. More than 900 STUs (10.2% of all) that cover 8.5% of Czechia show some kind of land use change on more than 10% of their territory (LUCC Czechia Database).

As cadastral records usually reflect the existing state of land use patterns with a certain delay, remote sensing data with very high spatial resolution as well as detailed field research were used to document the real situation. These methods were employed in many case studies throughout the country (Bíčık et al., 2012). The results from Hoštka and Jirny case studies discussed in this paper confirm the above-mentioned trends of landscape transition.

Hoštka has a peripheral location in a rural, undulating landscape near the German border (mean altitude 570 m a.s.l.). Natural conditions do not favour any intensive agricultural use; on the contrary, forestry and extensive agriculture are appropriate in this region. Under Communism, however, intensive agriculture prevailed here. In Hoštka, dramatic changes have occurred during the period of economic transformation. These resulted in a pronounced shift towards a less intensive agriculture. While in 1990 arable land occupied 59% of the total area, this high proportion has sunk to 2% in 2010. Arable land has been mostly replaced by pastures (increase from 5% to 57%). Abandoned agricultural land was not detected in 1990; however, in 2010 it covered 7% of the total area. Pastoral farming is the main agricultural activity in this area at present, while crop production has disappeared (Vojáček, 2012).

In the latter case, land abandonment has been much influenced by relatively high altitudes and rather low quality soils. Poor natural conditions, however, may not be the only one or the main driving force behind land abandonment (Lipský & Kukla, 2012). As restitution of private property has proved to be a significant driving force in Czechia in general, land abandonment also much depends on the social status and behaviour of the new owners. Attention should be drawn to the fact that many eligible persons reclaimed the land after decades of socialist-style economy. In any case, peripheral location is a significant factor that can strongly influence the expansion of abandoned land – process that was well documented in the Hoštka case study.

While the processes described in Hoštka have brought lower anthropogenic pressure, greenery, and expansion of natural landscapes, the changes recorded in Jirny situated in the fertile lowland near Prague (250 m a.s.l.) document a strong increase of human pressure. Though arable land has also diminished in Jirny (from 53.6% to 45.7%), in this case the change brought a permanent degradation of fertile land because it was being gradually replaced by residential and commercial buildings, roads, artificial purpose areas, and bare surfaces (increase by more than 7.5 percentage points). During the seventeen years of intensive suburbanization, Jirny has irretrievably ‘lost’ 5% of its area and the area has undergone a significant transition.

In this paper, the above-mentioned trends (grassing over, afforestation, agricultural land abandonment, disappearance of fertile soils, soil sealing, suburbanization, etc.) were documented on the national level using cadastral records, and on the local level using field survey and remote sensing data with very high spatial resolution. It is obvious that the Czech landscape has undergone an intensive transition during the post-communist period. This transition should be monitored and controlled on the national level. Attention should also be given to similar landscape changes occurring elsewhere in Europe.

**Software**

ArcGIS 10.2 was the main software used for geodatabase design, polygon layers vectorization and edits,
land use/land cover classes data storage, change parameters calculation, classification and change detection, initial maps production and export. Orthorectification and mosaicking of image data (orthoimages and QuickBird data) for the local level were processed in PCI Geomatics. Adobe Illustrator was used for maps adjustments and finalization of each map. The final map composition was prepared in Adobe InDesign.

Acknowledgements

We express our thanks to Mgr Přemysl Vojáček for preparing the data of Hoštka as well as to his supervisor Dr Jan Kabrda and also to Dr Vit Štěpánek for English revision.

Funding

Funding information: This paper was supported by the Czech Science Foundation (Grantová agentura České republiky): Project [GBP410/12/G113] ‘Historical Geography Research Centre’ (Faculty of Science, Charles University in Prague and The Institute of History, Academy of Sciences of the Czech Republic, v.v.i.).

Disclosure statement

No potential conflict of interest was reported by the authors.

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