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The mining landscape of the Ostrava-Karviná coalfield: Processes of landscape change from the 1830s to the beginning of the 21st century

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ABSTRACT

The paper is focused on identifying and evaluation of the processes in the cadastral areas forming a large part of the Ostrava-Karviná coalfield in the Czech Republic. Seven basic processes, that reflect the trends in the landscape changes in the area of interest, are traced at three levels: across the entire study area, on the level of three smaller parts of the coalfield, and in more detail on the level of individual cadastral areas. The most frequently occurring processes (urbanization and abandonment in each period; deforestation, intensification of agriculture and afforestation in one period) are described in more details. The research was based on the evaluation of temporal-spatial land cover changes over a long period of time, from the 1830s to the beginning of the 21st century. The multitemporal analysis of land cover in the study area was based on stable cadastral maps, historical aerial photographs and orthophotos.

1. Introduction

The landscape in its current form has been shaped by both natural and anthropogenic factors. People have either adapted to natural conditions or attempted to adapt nature to serve their own needs; this has resulted in a wide range of different landscapes – from natural landscapes, through cultural landscapes, to those landscapes that have been anthropogenically transformed (Van der Zee, 1999). Some of the results of landscape transformation may last for centuries or millennia, while others may be replaced by different landscape features over the course of time.

There exist various approaches to the assessment and evaluation of landscape change. For example, Antrop and Van Eetvelde (2000) distinguish between a holistic approach (used to assess the overall structure of the landscape) and an analytical approach (which attempts to describe the structure of the landscape using landscape metrics).

Qualitative descriptions of landscape structure focus primarily on describing the content of the landscape, i.e. the elements which make up the landscape under investigation. Using qualitative characteristics, it is possible to assign all structures in the landscape mosaic to distinct categories – such as the categories of land cover.

Quantitative descriptions are based on measurement, calculation and further analysis of the surfaces of selected landscape structure categories. The advantage of quantitative values is that they enable us to obtain exact numerical data on landscape structure; data from the same location but different years can be compared, as can data from different locations in the same year. This also enables us to trace processes of landscape change. Categorizations of these indicators are given e.g. by Herzog et al. (2001). Numerous landscape-ecological metric indicators can also be found in other publications, e.g. Farina (2006), Leitao, Miller, Ahern, and McCarigal (2006), or in the FRAGSTATS program created by a team led by McGarigal and Marks (1995) from Oregon State University, USA.

Landscape changes can be understood as modifications of the landscape structure over the course of time (Leitao et al., 2006). Quantitative assessments of landscape change can be carried out by analyzing temporal-spatial changes in land use (LU) or land cover (LC); time series of aerial or satellite images represent a valuable source of information for such assessments (Oťahel & Feranec, 1999; Kučera & Guth, 1999; Cooper & Loftus, 1998; Plieninger, 2006; Feranec, Hazeu, Christensen, & Jaffrain, 2007; Sleeter et al., 2013; Sexton, Urban, Donohue, & Song, 2013; etc.). A number of authors have used historic aerial photographs to determine LULC changes, e.g. Bracchetti, Carotenuto, and Catorci (2012), Teferi, Bewket, Uhlenbrook, and Wenninger (2013), Mallinis, Koutsias, and Arianoutsou (2014), Lieskovský et al. (2015), Svenningsen, Brandt, Christensen, Dahl, and

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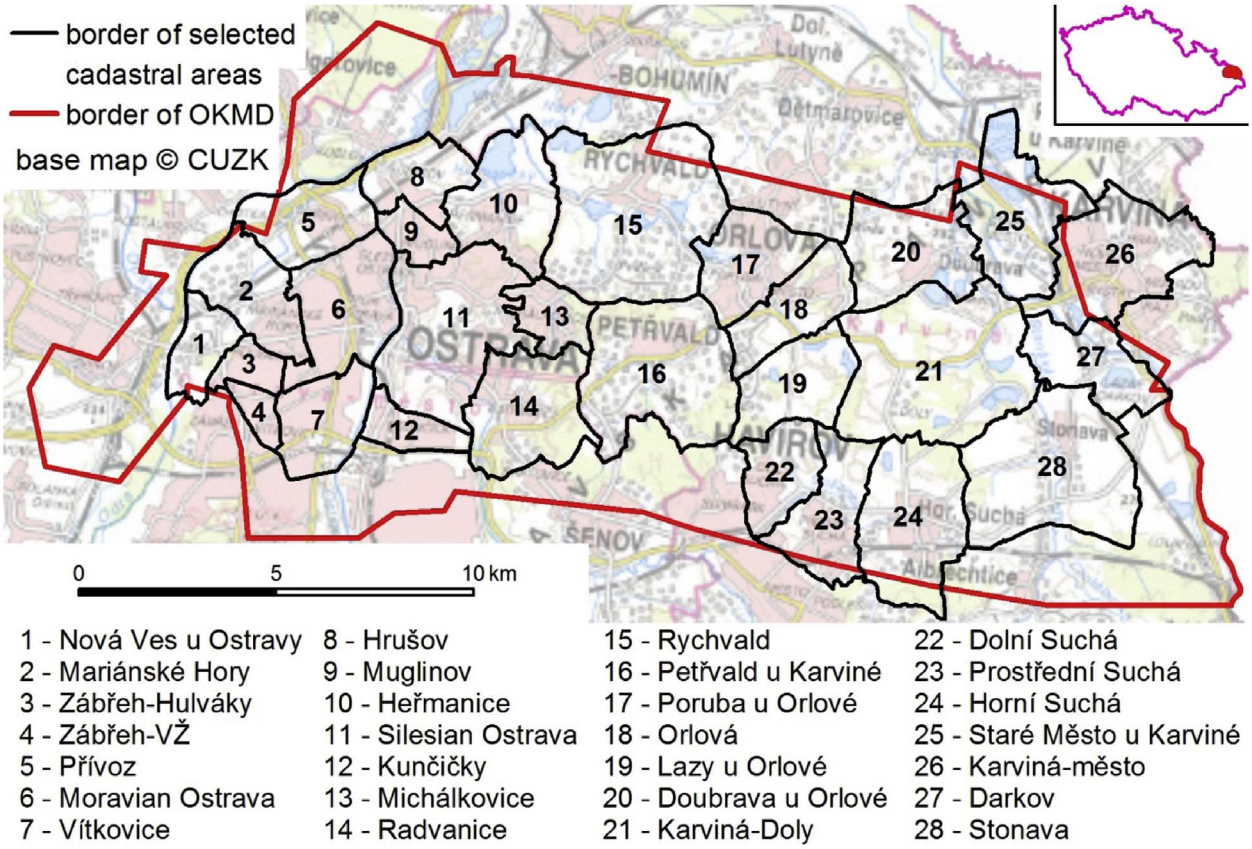

Fig. 1. Study area: selected cadastral areas in the Ostrava-Karviná coalfield.

Table 1
Selected land cover categories.

1 Artificial surfaces	111 Continuous urban fabric
	112 Discontinuous urban fabric
	121 Industrial and commercial units
	122 Road and rail network and associated land
	131 Mineral extraction sites
	132 Dump sites
	133 Waste banks
	141 Allotments
	142 Sport and leisure facilities
	143 Green urban areas
	161 Reclamation areas
	162 Handling areas
	163 Dry tailings ponds
	164 Other vegetation-free areas
2 Agricultural areas	210 Arable land
	222 Fruit trees and berry plantations
	231 Pastures
	242 Complex cultivation patterns
3 Natural and semi-natural areas	310 Forests
	320 Scrub and/or herbaceous vegetation associations
5 Water bodies	511 Water courses
	512 Water bodies
	513 Submerged ground subsidences
	514 Tailings ponds

Dupont (2015). Other studies of landscape changes based on aerial photographs include Cousins (2001), Coppedge, Engle, Fuhlendorf, Masters, and Gregory (2001), Arroyo-Mora, Sanchez-Azofeifaa, Rivarda, Calvob, and Janzen (2005), Fensham and Fairfax (2003), Kadmon and Harari-Kremer (1999), Wentz, Stefanov, Gries, and Hope (2006), Narumalani, Mishra, and Rothwell (2004), Bergen, Brown, Rutherford, and Gustafson (2005), Rocchini, Perryb, Salernoa, Maccherinia, and Chiaruccia (2006). Remote sensing data have been used by Moreira, Rego, and Ferreira (2001), Petit and Lambin (2002) and others to quantify LC changes and trace landscape changes. Besides vertical photographs, oblique aerial photographs can also be used for determining landscape changes (Svenningsen et al., 2015). The importance of remote sensing data grows when researching areas characterized by highly dynamic, anthropologically conditioned changes – such as mining landscapes. Studies tracing changes in landscapes of this type frequently use photographs in connection with open-cast (surface) coal mining (Fernández-Manso, Quintano, & Roberts, 2012; Hendrychová & Kabrna, 2016; Herzog et al., 2001; Lausch & Herzog, 2002; Townsend et al., 2009).

The interest in the topic of the historical development of the landscape grows in the Czech Republic following 1989. From the 1980s onwards, insight in long-term changes in land use constituted a specific topic for Czech researchers. Further, considerable attention was paid to changes of the agriculture land fund and agriculture landscape which was connected to the topic of agriculture land decrease in the Czech Lands. These research activities reached their climax in the founding