

# LANDSCAPE CHANGES IN THE CENTRAL PART OF THE KARVINÁ REGION FROM THE FIRST HALF OF THE 19<sup>TH</sup> CENTURY TO THE BEGINNING OF THE 21<sup>ST</sup> CENTURY

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## Abstract

Mulková M., Popelka P., Popelková R.: Landscape changes in the central part of the Karviná region from the first half of the 19<sup>th</sup> century to the beginning of the 21<sup>st</sup> century. *Ekológia (Bratislava)*, Vol. 31, No. 1, p. 75–91, 2012.

This study deals with the impact of industrialization on the landscape in the Ostrava-Karviná Mining District. The authors focused on the analysis of the landscape changes in the central part of the Karviná region from the first half of the 19<sup>th</sup> century to the beginning of the 21<sup>st</sup> century. Land cover and land cover development were analyzed in detail in the observed cadastral areas of Lazy near Orlová, Karviná-Doly, and Darkov. With regard to the existing data sources, the years 1836, 1947 and 2003 were selected as significant time milestones. Landscape changes derived from the image data sources of cadastral maps and aerial photos are explained in historical contexts related to the selected areas.

*Key words:* landscape development, land cover, aerial photo, Ostrava-Karviná Mining District, industrialization

## Introduction

Modern industrial society originated in Europe with the rise and development of the “Dual Revolution” (Doppelrevolution) which incorporated two essential modernization processes: (1) the industrial revolution which began in England and brought great changes to the economy and societal structure, (2) the political and social revolution, inspired by both the French revolution and the fight of North American colonies for independence, which transformed political conditions and brought the beginnings of constitutionality. In the course of the 19<sup>th</sup> century, these processes facilitated gradual transformation of a traditional agricultural society into a modern industrial society. The industrial revolution represented a basis for and a part of a more complex process of industrialization. The term *industri-*

*alization* defines a multi-level process during which societal livelihood shifted from the primary sector of agriculture into the secondary and tertiary sectors of industry, business, and services. The industrialization process further involved quite significant technological, social, economic and cultural changes. This transformation process is also closely related to important landscape changes and land use.

The presented study deals with concrete examples of the impact of industrialization on a specific landscape type. Attention here is focused on an originally agricultural landscape affected by the subsequent mineral resources extraction. The territory of the Ostrava-Karviná Mining District, selected areas of which are analyzed, forms part of the zones of great dynamics of anthropogenically-conditioned landscape changes associated with underground black coal mining. It represents a territory affected by the industrialization process both intensively and also specifically.

## Study area

The Ostrava and Karviná regions form parts of areas whose social economic character changed considerably with the rise of the Industrial Revolution. Originally indistinctive agricultural territory with undeveloped and unspecialized industry and insufficiently favourable conditions for agriculture began to change only following the onset of rapid demand for new mineral resources, particularly coal (Myška, 1968). Together with the neighbouring Ostrava region, the Karviná region became one of the economic centres of the Austria-Hungarian Monarchy and later of Czechoslovakia as well.

The industrialization process affected not only the social economic characteristics of the region but also the landscape and its use. To capture the impact of the industrialization process and the much later process of de-industrialization after 1989, a proven micro-analytical method was applied. The landscape change analysis comprised three selected cadastral areas in the eastern part of the Ostrava-Karviná Mining District (OKMD). These comprised Lazy near Orlová, Karviná-Doly and Darkov. Spatial delimitation of the localities is given in Figure 1 and their basic characteristics are presented in Table 1.

The selected cadastral areas are of similar historic evolution. Within the whole observed period up to 1918, Karviná-Doly and Darkov were part of a vast manorial complex of the family of Counts Larisch-Mönnich, whereas the Karviná region was its centre. As early as the 1830's, the Larisch family manors were among the most flourishing manors in Silesia, and their economic activities in the 19<sup>th</sup> century were characterized by a combination of traditional agriculture and industrial manufacturing (Rodan, 2008). Although black coal mining in these areas represented an insignificant complement of the Larisch-Mönnich family's business activities until the 1840's, the following decades witnessed its rapid development (Zářícký, 2004). In 1860, the Larisch-Mönnich mining company

Table 1. Basic characteristics of selected localities.

Name of cadastral area	Total area (ha)	Neighbouring cadastral area	Mines within a cadastral area
Lazy near Orlová	597.38	Orlová, Petřvald Karviná, Šumbark, Dolní Suchá, Prostřední Suchá, Karviná-Doly	Lazy, Poruba, Petřvald I, Dolní Suchá
Karviná-Doly	1643.41	Doubrava u Orlové, Staré Město u Karviné, Orlová, Lazy u Orlové, Prostřední Suchá, Horní Suchá, Stonava, Darkov, Karviná-město	Karviná-Doly I, Karviná-Doly II, Doubrava, Lazy, Dolní Suchá, Stonava, Darkov
Darkov	541.70	Karviná-město, Karviná-Doly, Stonava, Louky nad Olší, Ráj	Darkov, Karviná-Doly I, Karviná-Doly II, Louky

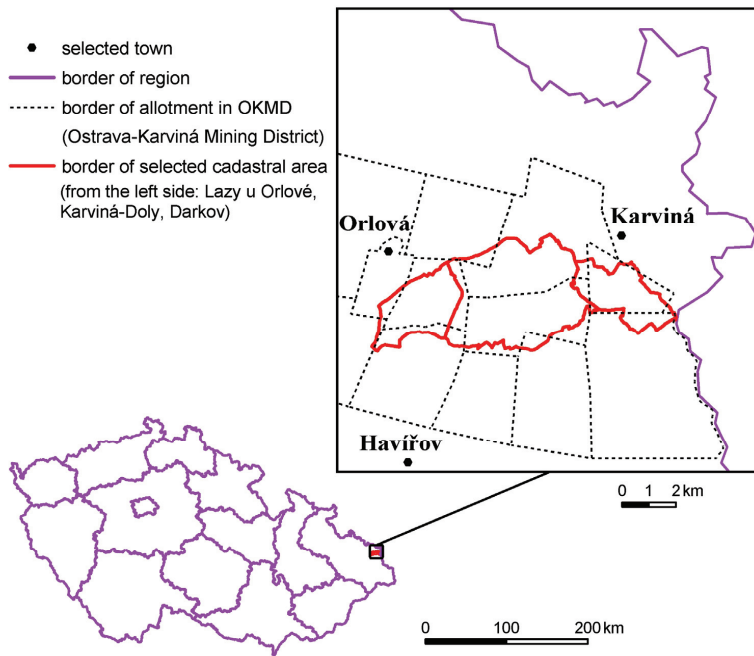


Fig. 1. Spatial delimitation of selected localities (data source: Portal of the Public Administration of the Czech Republic).

disposed of almost 185 ha of mining areas, and this area expanded to 866 ha by 1920 (Gabriela Františka Mine, Jindřich Mine, Hlubina Mine, Jan-Karel Mine and František Mine in the village of Karviná-Doly). Together with the Larisch-Mönnich family, mining in this locality was also carried out by Teschen Chamber (Hohenegger Mine, Gabriela and Barbora Mines) (Zářícký, 2004; Šlachta, 1937). The Lazy near Orlová cadastral area belonged to the Orlová estate owned by the Mattencloits from 1844. Beside traditional agriculture, mining gradually became more important in the Orlová region beginning from the 1840's. Lazy near Orlová locality was most affected by mining activities in the Hlavní jáma Mine (originally called Egon Mine) and from 1890 also in the Nová jáma Mine (presently known as the Důl Karviná Mine, Lazy Section).

All three cadastral areas represent original agricultural territories with later intensive anthropogenic exploitation related to mining activities. Underground black coal mining caused negative changes in both abiotic and biotic landscape factors and their functions. This anthropogenic activity fundamentally changed the landscape character in all the selected localities. All studied cadastral areas are characterized by the evident impact of black coal mining on landscape development and this impact can be observed in typical landscape changes, such as waste banks and submerged ground subsidence.

## Material and methods

The initial detailed analysis concerned land cover and its development in the studied cadastral areas in the years 1836, 1947 and 2003. From available 19<sup>th</sup> century historic maps, the study made use of stable cadastre maps from 1836 obtained from the Central Archives of Surveying, Mapping and Cadastre in Prague. The land cover in individual years

was further studied on the basis of 1947 contact copies of black-and-white aerial photos provided by the Military Geography and Hydrometeorology Office in Dobruška and also a coloured orthophoto from 2003. This orthophoto was visualized using the map service of the Portal of the Public Administration of the Czech Republic (PVS ČR, 2006). The map server was utilized through the services of ArcIMS in ArcGIS 9.2 software. Data verification and identification of questionable results was based on additional information sources, such as historic maps, archival materials, scientific publications, internet data sources, cadastral maps from 2005, ZABAGED and also other data.

Geometric correction was carried out after the scanning of stable cadastre maps and contact copies of aerial photos from 1947. The transformation of aerial photos from 1947 into the S-JTSK coordinate system was performed in the PCI Geomatica 9.1 software, which is an OrthoEngine Module. Considering the fact that there is no exact data from the calibration protocol for archival aerial photos, second-order polynomial transformation was utilized. This polynomial transformation is based on the collection of identical points (e.g. building corners) and on the calculation of transformation equations for the transformation of pixel positions into a relevant coordinate system. A photo-mosaic was created for each locality on the basis of the transformed photographs. No modifications were required for the orthophoto from 2003.

The transformation of stable cadastre maps into the S-JTSK coordinate system was performed by means of the Gramis and ArcGIS softwares. The Gramis software was mainly used to identify the map sheet corner coordinates which, along with other points (building corners and break points of plots), were used as ground control points at geo-referencing in the ArcView 9.2 software.

The landscape structure was studied by means of visual photo interpretation of aerial photos and visual interpretation of the transformed maps. A classification scale used to study the land cover considers the scale, the method of processing and the purpose and characteristics of this area of interest. The basis for the land cover categorization was a classification of the CORINE Land Cover (CLC), a European Union project, in a scale of 1:100,000 (Feranec, Ořaheř, 2001; European Environment Agency, 2005).

Considering the specific features of these chosen localities and mapping in a more detailed 1:5,000 scale, the CLC classification required modifications by omitting or joining some categories. Where the categorization under CLC (Feranec, Ořaheř, 2001) controversially placed agricultural buildings and facilities in the category of industrial and commercial units, the original classification was then respected in order to maintain comparability in this study. The third major CLC category of forest and semi-natural areas was renamed to natural and semi-natural areas, since forest areas can also have semi-natural characteristics (Popelková, 2009). The applied land cover categories are presented in Table 2.

Land cover vectorization was carried out for each year and each studied area on the basis of visual interpretation in the ArcGIS software (Popelková, 2009). With regard to the fact that the contemporary boundary of the cadastral areas does not fully correspond with the boundary in 1836, map sheets of neighbouring cadastral areas were used. These areas were Orlová, Ráj, Karviná-město, Staré Město near Karviná, Stonava, Horní Suchá, Prostřední Suchá, Dolní Suchá and Doubrava near Orlová.

The studied area's land cover analysis preceded the landscape pressure determination. Landscape processes play a priority role in landscape changes and its transformation, and their definition enables generalization of land cover changes. Four major processes defined by Biopress methodology were identified in the studied area (Biopress, 2008). These have been supplemented with another process associated with undermined areas, namely flooding (Table 3).

Urbanization processes within the Biopress methodology represent a rise in artificial surfaces (the category of urban fabric) to the detriment of agricultural areas, natural and semi-natural areas and water bodies. This conception of urbanization differs from the perception of historians and of social geographers and sociologists. These specialists understand the urbanization process to be a complex systemic change in the spatial organization of society occurring in connection with European industrialization and all the associated transformational processes (Musil, 2002). The process of agricultural intensification includes the transformation of all land cover categories into arable land. The term "intensification" is somewhat simplified here because it represents agricultural intensification in an extensive way. On the other hand agricultural intensification means land-fund restructure, with the application of new economic systems and the innovative processes of fertilization, chemicalization and amelioration. The following definitions apply; (1) The process of forestation is defined as the transformation of agricultural and urban, natural, semi-natural and water areas into natural and semi-natural forests. Untended and unused areas are normally overgrown by rapidly spreading vegetation (2) The process of abandonment involves the change of urban artificial and agricultural areas, forests and water bodies into scrub and/or herbaceous vegetation associations, and (3) Flooding is defined as the occurrence of water bodies in areas where no water previously existed. This entails the transformation of artificial surfaces, agricultural areas and natural and semi-natural areas into the water body classification (Mulková, 2007).

Table 2. Selected land-cover categories.

<b>1 Artificial surfaces</b>	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
	133	Waste banks
	141	Green urban areas
	142	Sport and leisure activities
	161	Reclamation areas
	162	Handling areas
	163	Dry tailings ponds
	164	Other vegetation-free areas
<b>2 Agricultural areas</b>	210	Arable land
	222	Fruit trees and berry plantations
	231	Pastures
	242	Complex cultivation patterns
<b>3 Natural and semi-natural areas</b>	310	Forests
	320	Scrub and/or herbaceous vegetation associations
<b>5 Water bodies</b>	511	Water courses
	512	Water bodies
	513	Submerged ground subsidences
	514	Tailings ponds

Table 3. Changes within the area of interest and their characteristics.

<b>Process</b>	<b>Land cover category change direction</b>
Urbanization	agricultural area, natural and semi-natural areas, water bodies → urban fabric
Intensive agriculture	urban fabric, fruit trees and berry plantations, pastures, complex cultivation patterns, natural and semi-natural areas, water bodies → arable land
Forestation	urban fabric, agricultural areas, scrub and/or herbaceous vegetation associations, water bodies → forests
Abandonment	urban fabric, agricultural areas, forests, water bodies → scrub and/or herbaceous vegetation associations
Flooding	urban fabric, agricultural areas, natural and semi-natural areas → water bodies

## Results

### *Land cover development in Lazy near Orlová*

In 1836, Lazy near the Orlová locality represented an agricultural landscape with a small portion of forests. Arable land occupied 56.4% of the total area. The second most represented category was the category of forests with 32.6%, and pastures existed on 8.4% of the total

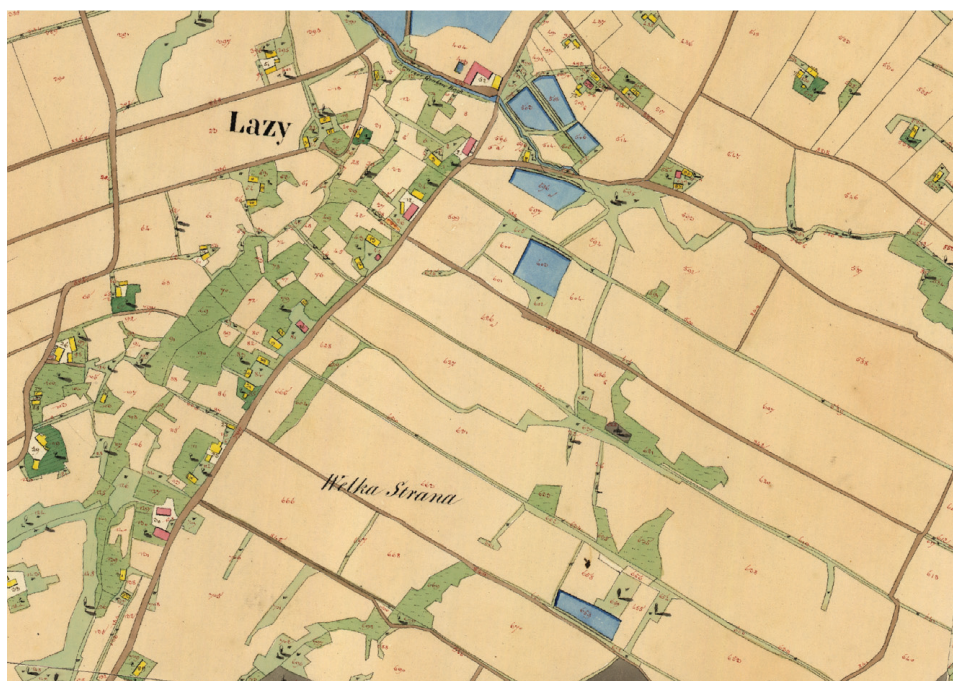


Fig. 2. The agricultural landscape still unaffected by industrialization. A cut-out of Lazy near Orlová stable cadastral map. Demonstrated in the map original are: fields – ochre, meadows – dark green, pastures – light green, roads – brown (lines), buildings – yellow or red, gardens – darkest green, water bodies – blue. Map source: Central Archives of Surveying, Mapping and Cadastre in Prague.

cadastral area. Discontinuous urban fabric covered 7.51 ha, which is 1.3% of the total area. Roads running through the cadastral area in the N-S direction contributed only 0.6% and water bodies occupied a mere 0.8% (Fig. 2). Neither industrial and commercial units, nor mineral extraction sites could be found in Lazy near Orlová.

Fig. 3 shows that by 1947 the landscape in Lazy near Orlová had changed considerably as a result of black coal mining and the associated industry and infrastructure under construction. The largest shares of the total area comprised categories of scrub and/or complex cultivation patterns (44.9%), discontinuous urban fabric (12.6%), forests (12.3%) and scrub and/or herbaceous vegetation associations (7%). Meanwhile, the share of pastures decreased to 3.5% compared with 1836, and new landscape features included continuous urban fabric in the form of mining colonies (6.4%). The following land cover categories began to appear in connection with underground black coal mining: mineral extraction sites (2.4%), waste banks (3%), other vegetation-free areas (2.4%) and also handling areas (1%). This locality also contains the first submerged ground subsidences and tailings ponds. The category of road and rail network and associated land expanded to 1.9% with the construction of the mining





Fig. 3. The Orlová region landscape heavily affected by industrialization. A cut-out from a 1947 aerial photo. A body of Starý odval waste bank to the north of mine buildings (5), a waste bank in the N-E (2) and a part of a coke plant and associated land (1). Two mining colonies are seen: Liberdova colony (4) and Chobotova colony (3). The photo was provided by the Military Geography and Hydro-meteorology Office in Dobruška. © MO ČR/GeoSI AČR.

railway connecting the mining plants in the Ostrava-Karviná Mining District. Industrial and commercial units occupying 1.7% of the area included the Lazy Mine coke plant to the north of the mine buildings and a small brick-yard area situated to their S-W.

At the end of the study period in 2003, Lazy near Orlová locality represented a totally anthropogenically transformed landscape (Fig. 4). The highest percentage in the total cadastral consisted of forests with 28.6% and scrub and/or herbaceous vegetation associations with 24.3%. While continuous urban fabric and complex cultivation patterns totally disappeared, arable land occupied 11% and discontinuous urban fabric accounted for 5.5% of the area. Anthropogenic activities resulted in the occurrence of mineral extraction sites (4.6%), waste banks (2.2%), handling areas (3.3%), other vegetation-free areas (2.9%), submerged ground subsidences (4%) and tailings ponds (2.6%). Through recultivation, 3.9% of the area was transformed into fruit trees and berry plantations. The category of road and rail network and associated land (2.9%) increased due to the construction of double-lane roads and a parking lot near Lazy Mine and also because of the expansion of a railway siding track to the Lazy Mine. The area of industrial and commercial units also decreased due to the termination of

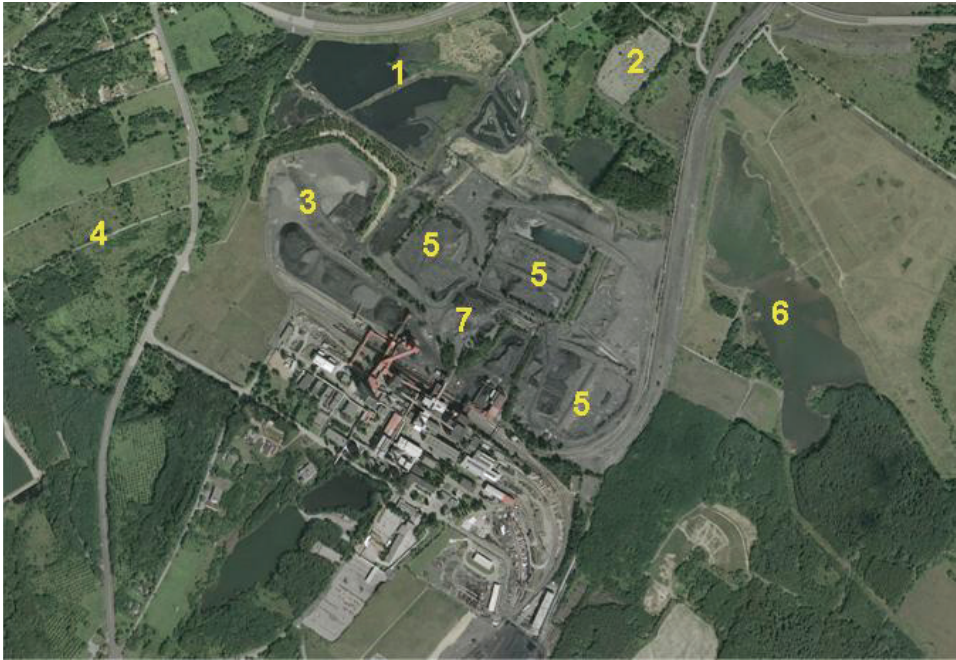


Fig. 4. The Orlová landscape completely transformed by industrialization at the beginning of the 21<sup>st</sup> century. Cut-out from a 2003 orthophoto. 1 – final sedimentation tailings ponds, 2 – area of a former coke plant, 3 – Nový odval waste bank, 4 – area after the Chobotova colony, 5 – tailings ponds, 6 – submerged ground subsidences, 7 – Stary odval waste bank. Photo source: Portal of Public Administration of the Czech Republic, 2006.

the coke plant operation in the 1960's and closure of the brick-yard. In 2003, this category with 0.3% was only represented by small factories, such as a breeze-block factory.

#### *Land cover development in Karviná-Doly*

The Karviná-Doly cadastral area in 1836 comprised an agricultural area with forests and a small number of agricultural and industrial units, where 72.5% of the total cadastral area was used agriculturally, of which 59.2% was dominated by arable land, and the remaining 13.3% was meadows and pastures. While forests occupied 20.7%, there were also large ponds in the north-eastern part (3.9%), and discontinuous urban fabric had 1.7% of the area. The cadastral area contained a few important road communications which took up only 0.5% of the total area, and some of these had ditches and lines of trees as seen in Fig. 6. Furthermore, the category of industrial and commercial units was apparent in the cadastral area in 1836, but its percentage of the total area is very small at 0.2%. However it includes interesting buildings. glass works complexes, a distillery and three agricultural estates (Figs 5, 6).





Fig. 5. A cut-out of a stable cadastre map of the Karviná-Doly cadastral area. Distillery buildings (Brennerey) on the left, a clay pit on the right (a lot No. 211). Map source: The Central Archives of Surveying, Mapping and Cadastre in Prague.



Fig. 6. Beginnings of industrialization in Karviná region. A cut-out of a stable cadastre map of the Karviná-Doly area with a coal mine (Stemkohlen Bergwerk), glass works (Glasofen) and an agricultural estate (Heinrichshof). Map source: The Central Archives of Surveying, Mapping and Cadastre in Prague.

Mineral extraction sites occupied only 0.1% of the Karviná-Doly cadastral area in 1836, including two clay-pits (Fig. 5) and a coal mine (Fig. 6).

Data from 1947 showed that the Karviná-Doly area now represents a completely transformed landscape. Agricultural areas occupy 36.2% and arable land is only a small frac-

tion (3.8%). The remaining part is covered by complex cultivation patterns (28.2%) and pastures (4.3%). The area of forests is almost unchanged at 19%, and 10.5% is occupied by scrub and/or herbaceous vegetation associations. A great amount of the area is covered by urban fabric, particularly discontinuous urban ones (13.2%). Another 4.4% is represented by continuous urban mining colonies. An important category of this period concerns mineral extraction sites which occupy 5% of the total studied area. There are also other categories associated with black coal mining such as waste banks (2.2%), tailings ponds (1%), dry tailings ponds (1.5%), other vegetation-free areas (1.9%) and to a lesser extent also submerged ground subsidences (0.4%). Industrial and commercial units including brickworks, a brewery and water reservoir constitute 1%, and industrial activity is reflected in construction of relevant transport infrastructure. In the Karviná-Doly locality, this mainly concerns the Košice-Bohumín railway which opened between the towns of Bohumín and Těšín in 1869. Additionally, local mines were gradually connected with the Mining Railway, and the category of road and rail network and associated land therefore occupied 2.4% of the total studied cadastral area.

In 2003, agriculturally used areas occupied only 3.4%, whereas 2.9% was arable land and 0.6% was pastures. There was a considerable increase in the forest category which accounted for 31% of the studied area and scrub and/or herbaceous vegetation associations covered a third of the locality (33.6%). As a result of intensive mining the area of urban fabric decreased to 2.5%, while an increase occurred in the following mining categories: mineral extraction sites (5.9% of the cadastral area), tailings ponds (6.7%), dry tailings ponds (2.9%), waste banks (2.6%), other vegetation-free areas (2.7%), submerged ground subsidences (1%) and handling areas (0.9%). There was also a new category of reclamation areas (1.6%). In comparison with 1947, there was an increase in road and rail networks and associated land (3.7%). The cadastral area is traversed by an important first-class road passing from the north-west through the centre of the area and towards the north-east. This area contains new parking lots and the railway expansion here is connected with mining. The industrial and commercial units category occupies 0.7% of the total area, and these include a saw-mill, a water reservoir, a waste-water treatment plant and engineering and building industry facilities.

#### *Land cover development in Darkov*

In 1836, the whole Darkov cadastral area had an agricultural character, where arable land covered 77.4% and pastures 8.5%, while forests constituted only 4.5% of the studied area. Water courses, represented mainly by the Olše river, occupied 4% of the area and water bodies 3.2% of the area. Discontinuous urban fabric was observed on 1.1% of the total area. Mineral extraction sites were recorded on 0.6% of the area. This, however, does not concern coal mining but rather sand and gravel pits along the Olše river in the eastern part of the Darkov cadastral area. Reasonably unimportant roads designated for local transport occupied 0.5% of the area. A negligible share of 0.1% in the total area was taken up by the category of industrial and commercial units which was represented by just one agricultural estate.

In 1947, more than half of the total Darkov area was occupied by complex cultivation patterns (52.7%), 19.7% of which was arable land and 1.3% was composed of pastures. In comparison with 1836, discontinuous urban fabric increased to 8.8%. Unlike the Lazy near Orlová and Karviná-Doly localities, no mining colonies were built there. The area of scrub and/or herbaceous vegetation associations also increased to 5.6%. In contrast, there was a decline in the area of forests by more than half to 2% compared with 1836, while the new categories of sport and leisure activities represented by the Darkov Spa took up 2.3%. The category of road and rail network and associated land occupied just 0.5% and industrial and commercial units included only two agricultural estates covering 0.4%. Unlike the Lazy near Orlová and Karviná-Doly cadastral areas, no mineral extraction sites were found in the Darkov cadastral area in 1947. The Darkov allotment was established later on 11 March in 1977, as reported in the State Mining Administration (2009), and water bodies had also disappeared.

In comparison with 1836 and 1947, natural and semi-natural areas were found on almost half the Darkov locality in 2003. The biggest proportion was in the category of scrub and/or herbaceous vegetation associations (41.7%) which can be considered a secondary effect from mining activities. Forests occupied 7% of the Darkov area. The second most represented category was arable land (11.4%) whose areas had decreased in comparison with previous years. Pastures covered 2% of the total area. While a slight decrease was recorded in the category of discontinuous urban fabric (7.4%), figures for sport and leisure activities had increased to 4.2%. In 2003, land cover categories related to underground black coal mining were identified. The largest part of the territory was occupied by reclamation areas (8.5%), further submerged ground subsidences (7.1%) and other vegetation-free areas (4.5%). The remaining land cover categories associated with mining only reached a proportional representation of less than 1%. These were dry tailings ponds, tailings ponds and handling areas. No mine buildings were found in Darkov in 2003, and since no significant communications crossed the Darkov locality, the category of road and rail network and associated land therefore occupied a mere 0.9%.

#### *Assessment of land cover development with regard to joined categories*

Partial land cover categories were joined into related categories of a higher order to enable a more detailed and comprehensive assessment of land cover categories within the areas of interest. The following joined land cover categories were selected:

- urban fabric: continuous urban fabric and discontinuous urban fabric,
- agricultural areas: arable land, pastures, and complex cultivation patterns,
- natural and semi-natural areas: forests and scrub and/or herbaceous vegetation associations,
- mining conditioned areas: mineral extraction sites (coal extraction areas only), waste banks, reclamation and handling areas, dry tailings ponds, other vegetation-free areas related to mining, submerged ground subsidences and tailings ponds,
- water bodies: water courses and water bodies.

The percentage representation of these selected joined categories in the total area of all the cadastral localities in the studied years is given in Table 4.

Although urban fabric recorded the smallest proportional representation in all studied localities in 1836, in 1947 it was the highest. A more important role for urban fabric was played in Lazy near Orlová and Karviná-Doly localities where its figures increased as a result of construction of mining colonies. In 2003, the urban fabric area decreased due to the negative impact of undermining on building foundations, which particularly influenced the localities of Lazy near Orlová and Karviná-Doly.

The highest share of agricultural areas was recorded in 1836 in Darkov (85.6%). In 1947, before commencement of mining activities, the smallest decline in agricultural areas was observed in Darkov in comparison with the other studied localities. However, a decrease in agricultural areas was observed in all areas of interest in both the studied periods. The smallest proportional representation was identified in Karviná-Doly in 2003 (3.5%), and a significant decline was recorded in Darkov between 1947 and 2003 owing to the initiation of black coal mining.

Natural and semi-natural areas occupied the largest parts of all the three studied areas in 2003, taking up 64.6% of the Karviná-Doly cadastral area. In Lazy near Orlová this category was found on 52.9% of the area and in Darkov it was on 48.6%. Natural and semi-natural areas occur especially in areas transformed by deep mining. These include forestation related to reclamation and rapidly spreading vegetation in abandoned areas. Throughout the entire studied period, this category had a tendency to increase except in the locality of Lazy near Orlová where a decline in area occurred in 1947 due to the expansion of complex cultivation patterns and discontinuous urban fabric, which proved detrimental to forest growth.

The first black coal mining area was recorded as early as 1836 in Karviná-Doly. In 1947, these areas began to increase rapidly in the landscape in Lazy near Orlová and Karviná-Doly cadastral areas. By 2003, the share of mining-related areas composed 20-25% in all the areas of interest.

In 1836, natural water bodies and water courses had a higher proportion in the Karviná-Doly and Darkov localities. Large ponds traversed by the small Stonávka stream were found in both these areas and the Darkov locality is traversed by the very important Olše river. In 1947, both localities recorded a decrease in the area of water bodies and water courses, mainly due to the disappearance of these ponds.

Table 4. Percentage representation of selected joined categories in the total cadastral area of Lazy near Orlová, Karviná-Doly and Darkov localities.

Category	Lazy near Orlová (%)			Karviná-Doly (%)			Darkov (%)		
	1836	1947	2003	1836	1947	2003	1836	1947	2003
Urban fabric	1.26	19.05	5.53	1.71	17.56	2.48	1.12	8.82	7.38
Agricultural areas	64.75	48.45	12.45	72.49	36.24	3.45	85.85	78.19	13.46
Natural and semi-natural areas	32.56	19.30	52.86	20.72	29.54	64.55	4.60	7.61	48.63
Mining-related areas	0.00	8.80	20.40	0.08	11.98	24.36	0.00	0.98	21.24
Water bodies and streams	0.84	0.59	0.19	4.27	0.95	0.78	7.24	1.27	1.35

### Processes in selected localities

Pressure processes occurring in the landscape within a concrete study period can be identified in a contingency table exhibiting the values of changes in all the land cover categories. Table 5 represents a sample of a contingency table for the Darkov cadastral area for the period 1947–2003, and contingency tables have also been created for all areas of interest for both the 1836–1947 and 1947–2003 study periods.

The total areas of changes caused by landscape processes and their percentage shares of localities in the total area are calculated in Table 6.

The urbanization process dominated the period 1836–1947 in Lazy near Orlová and Karviná-Doly with 30% of the area, and this also affected 11.8% of the Darkov area. In the

Table 5. Contingency table for the Darkov cadastral area for the period 1947–2003.

Area Year (ha) 2003																
Year	112	122	141	142	161	162	163	164	210	231	310	320	511	513	514	Total
112	11.28	0.12	0.94	2.48	5.52	0.52		1.97	2.73	0.65	1.58	11.61	0.33	8.05		47.78
121										0.67		1.40				2.06
122	0.86	0.01		0.05	0.15			0.24			0.04	0.62	0.03	0.56	0.09	2.65
142	1.09			10.86								0.29	0.02			12.25
164											2.23	1.11	1.73	0.23		5.30
210		1.32		1.09	2.73		2.48	2.84	1.89	7.43	6.85	73.15		5.24	1.82	106.84
231	0.00			6.34	0.25						0.04	0.13				6.77
242	26.54	2.70	13.58	0.60	29.26	1.43		18.90	57.03	2.37	13.50	118.60	1.36	24.06		309.93
310	0.00				7.87						0.91	1.63		0.24		10.65
320	0.20	0.55	0.89	1.51				0.14	0.14		10.45	14.97	1.67	0.05		30.57
511					0.38			0.02	0.00		2.04	2.30	2.15	0.01		6.90
<b>Total</b>	39.97	4.70	15.41	22.92	46.15	1.95	2.48	24.12	61.80	11.11	37.63	225.82	7.29	38.45	1.91	541.70

Table 6. Total changed areas from observed processes, and their percentages of the total area of interest in both studied periods.

Process	Lazy near Orlová				Karviná-Doly				Darkov			
	1836–1947		1947–2003		1836–1947		1947–2003		1836–1947		1947–2003	
	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%
Urbanization	179.79	30.10	75.88	12.70	498.37	30.33	216.04	13.15	63.79	11.78	121.61	22.45
Forestation	5.12	0.86	106.90	17.89	71.68	4.36	298.24	18.15	3.20	0.59	36.72	6.78
Abandonment	41.94	7.02	136.08	22.78	172.37	10.49	497.36	30.26	30.25	5.58	210.85	38.92
Intensification	0.00	0.00	65.94	11.04	15.85	0.96	44.83	2.73	16.11	2.97	59.90	11.06
Flooding	3.95	0.66	38.51	6.45	38.83	2.36	132.17	8.04	4.08	0.75	45.48	8.40
<b>Total</b>	230.80	38.64	423.31	70.86	797.11	48.50	1188.66	72.33	117.43	21.68	474.56	87.61



period 1947–2003 urbanization reached the highest figures in Darkov at 22.5%, while it decreased in Lazy near Orlová and Karviná-Doly.

The forestation process played the most important role during 1947–2003 in Lazy near Orlová and Karviná-Doly. Here, forests occupied 17.9% of Lazy near Orlová cadastral area and 18.2% of Karviná-Doly cadastral area.

The process of abandonment dominated all areas of interest in the period 1947–2003, occurring mainly in original agricultural areas with a residential function. This was due to the negative impact on the landscape from deep mining, and the highest proportions of abandoned areas were recorded in Darkov (38.9%) and Karviná-Doly (30.3%).

Agricultural intensification with transformation of all areas into arable land occurred particularly during 1947–2003 on 11% of the Lazy near Orlová and Darkov areas. This process is also closely related to the land consolidation after 1947. By 2003, however, many agricultural areas had disappeared, and therefore the impact of this process was less apparent.

Although less significant than the processes of abandonment and urbanization, flooding also plays an important role in these localities. This process is a common result from deep mining accompanied by the occurrence of submerged ground subsidences and tailings ponds which mainly occurred during 1947–2003. The highest proportion of water bodies is found in Darkov (8.4%), followed by Karviná-Doly (8%) and Lazy near Orlová has 6.5%.

Generally stated, the most distinct landscape transformation occurred in 1947–2003 and the largest changes were recorded in Darkov (87.6%), in Karviná-Doly (72.3%) and in Lazy near Orlová (70.9%).

An overview of land cover categories which participated most in individual processes in the periods of 1836–1947 and 1947–2003 is shown in Tables 7 and 8. The processes of urbanization in 1836–2003 were manifested mainly in the transformation of arable land (210) in Lazy near Orlová and Karviná-Doly with a percentage share in the urbanization process of 23% of the total cadastral area. Urbanization also took place in the area of pastures (231) in all areas of interest, and this affected forests (310) in Lazy near Orlová and Karviná-Doly

Table 7. Overview of land-cover categories which recorded the highest proportional representation in individual processes in the studied localities in 1836–1947. Percentage figures are relative to the total area.

Processes	Urbanization			Forestation			Abandonment			Intensification			Flooding		
Lazy near Orlová															
Category	210	310	231	210	231	–	310	210	231	–	–	–	210	231	310
%	23.2	3.7	2.6	0.6	0.3	–	3.4	2.0	1.5	–	–	–	0.4	0.2	0.02
Karviná-Doly															
Category	210	231	310	210	231	512	210	310	231	231	112	511	231	210	310
%	23.1	3.5	2.5	2.4	1.3	0.5	4.5	2.6	2.2	0.8	0.05	0.02	1.2	1.02	0.2
Darkov															
Category	210	231	511	210	231	–	210	511	310	231	–	–	210	310	231
%	9.6	0.8	0.8	0.5	0.1	–	2.1	1.7	1.4	2.9	–	–	0.3	0.3	0.2

Table 8. Overview of land-cover categories which had the highest share in individual landscape processes in the studied areas in 1947–2003. Percentage figures are relative to the total area.

Processes	Urbanization			Forestation			Abandonment			Intensification			Flooding		
Lazy near Orlová															
Category	242	231	320	242	320	112	242	112	111	242	112	111	242	133	320
%	9.5	1.5	1.0	10.3	3.4	2.2	9.7	4.7	3.7	8.2	1.5	0.7	3.0	0.7	0.6
Karviná-Doly															
Category	242	310	320	242	320	112	242	112	111	242	112	320	242	310	320
%	6.2	2.3	2.0	5.8	4.0	3.2	11.5	5.8	2.6	2.0	0.4	0.2	2.5	1.4	1.0
Darkov															
Category	242	210	310	242	320	210	242	210	112	242	112	320	242	112	210
%	17.2	2.0	1.5	2.5	1.9	1.8	21.9	13.5	2.1	10.5	0.5	0.03	4.7	1.6	1.3

and in Darkov it affected the water bodies (511). Forestation took place in all three localities in the area of arable land (210) and pastures (231), with the largest proportion of arable land (2.4%) and pastures (1.3%) forested in Karviná-Doly. In addition, some water bodies were also forested in this locality. During 1836–1947, the abandonment process concerned arable land (210) and forests (310) in all the localities of interest. It also included pastures (231) in Lazy near Orlová and Karviná-Doly and water bodies (511) in Darkov. However, no agricultural intensification was recorded in Lazy near Orlová during 1836–1947. Although this intensification process affected only the pastures category in Darkov (231), as well as having an impact on a minimal pasture area in Karviná-Doly (231), it also affected discontinuous urban fabric (112) and water bodies there (511). The flooding process can be observed in all the studied localities in relationship with the arable land (210), pastures (231) and forests categories (310).

During 1947–2003, urbanization was connected with the complex cultivation pattern category in all the studied localities (242). Other categories affected by urbanization included pastures (231) in Lazy near Orlová, forests (310) in Karviná-Doly and Darkov, arable land (210) in Darkov and scrub and/or herbaceous vegetation associations (320) in Lazy near Orlová and Karviná-Doly. Equal participation in the forestation processes for all studied cadastral areas was recorded in the complex cultivation patterns and pastures (242) and in the scrub and/or herbaceous vegetation association category (320). The decontaminated areas of discontinuous urban fabric (112) were forested in Karviná-Doly and Lazy near Orlová, while forestation in Darkov consisted partly of arable land (210). The abandonment process primarily affected complex cultivation patterns (242) in all studied localities. However, in Lazy near Orlová and Karviná-Doly this process also concerned continuous and discontinuous urban fabric (111 and 112). This reflects a negative impact of deep mining on buildings observed in connection with discontinuous urban fabric (112). This impact was also apparent in Darkov, where, the abandonment process affected arable land (210). Agricultural intensification occurred in all localities with areas of complex cultiva-

tion patterns (242), and this was connected with the land consolidation which occurred after 1947, when discontinuous urban fabric (112) was transformed into arable land. This process also affected forests (320) in Karviná-Doly and Darkov and continuous urban fabric in Lazy near Orlová (111). The process of flooding, which occurred as a consequence of depressions in the landscape and the expansion of tailing pond areas, also manifested itself most in the category of complex cultivation patterns (242). Flooding further affected areas of discontinuous urban fabric (112) and arable land (210) in Darkov and also the area of waste banks (133) in Lazy near Orlová and forests (310) in Karviná-Doly. A minimal area of the category of scrub and/or herbaceous vegetation patterns (320) was flooded in Karviná-Doly and also Lazy near Orlová. These above mentioned facts clearly indicate that the complex cultivation patterns category recorded the highest participation in all landscape processes during 1947–2003.

## Conclusion

The studied region of Karviná represents a regional type where the socio-economic character fundamentally changed with the start of the industrial revolution. Originally an indistinct agricultural area with undeveloped industry, it began to be transformed due to the rapidly growing demand for new raw materials, particularly coal, initiated by the industrialisation process. Along with the neighbouring Ostrava region, Karviná became an important economic centre of the Austro-Hungarian Monarchy and later also of the Czechoslovak Republic of the 19<sup>th</sup> century.

The very first modern cadastral mapping in this studied area was carried out in 1836, and this identified a typical agricultural landscape with a prevalence of arable land and forest in the studied cadastral areas of Karviná-Doly, Darkov and Lazy near Orlová. Intense industrial action including the operation of a coal-mine, glassworks and distillery was observed in the Karviná-Doly locality. The first aerial photos from 1947 showed the strong industrial impact on the Karviná landscape. This original agricultural landscape was transformed into an industrial area accompanied by a significant decrease in arable land, an extension in the area of complex cultivation patterns and increasing affected areas of urban fabric, industry and mining. These transformational processes appeared to be completed at the beginning of the 21<sup>st</sup> century, when the urban fabric area had decreased due to the negative effects of mining, and the arable land extent was also decreased to an historic minimum level in all studied areas. Meanwhile, the largest increase was observed in the scrub and/or herbaceous vegetation association category in areas previously abandoned following mineral resource extraction. Increases were also noted in categories directly associated with mining, such as in the areas of mineral resource extraction, waste banks, handling areas, tailings ponds and submerged ground subsidences.

The study of these landscape processes revealed the most significant results from 1947–2003, during which the most intensive process of abandonment was recorded in all studied localities and forestation particularly affected Lazy near Orlová and Karviná-Doly

localities. The process of flooding, as a consequence of intense mining activities, also played an important role in all three studied localities. However, during the period from 1836–1947, it was the urbanization process that was overwhelmingly manifested in the cadastral areas of Lazy near Orlová and Karviná-Doly.

*Translated by the authors  
English corrected by R. Marshall*

#### *Acknowledgements*

The contribution was created on the basis of the grant project solution: GAČR P410/12/0487 „The process of industrialization and landscape changes in the Industrial Zone of Ostrava in the 19<sup>th</sup> and 20<sup>th</sup> century“.

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