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# Landscape modelling of past, present and future state of areas affected by mining<sup>☆</sup>



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visualization

**Summary** Surface mining of brown coal changed Iron mountains basin region fundamentally. Hundreds of millions of hauled masses significantly affected the landscape appearance. Involvement of government authorities and citizens of the affected towns and villages is essential and participation is expected. For proper assessment of the projected mining intent with subsequent remediation of the consequences, processing of 3D models and interactive visualizations options shared with web technology is an important factor. Creation of dump body 3D model, including internal composition, can play important role in various tasks solving, for example in hydrology or geotechnics. High-quality processing of these materials requires use of modern surveying technology, CAD systems and various tools of computer graphics processing.

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## Introduction

The landscape of the Podkrušnohorská area in the northwest Bohemia has already been burdened by the extraction of

brown coal, which is currently realized only by means of large-scale quarrying. In places with underground mining, abandoned pits and subsidence depression often in the form of bodies of water have been left behind.

Currently, brown coal is mined in the neighbourhood of the towns of Sokolov, Chomutov, Most, and Teplice. Every year, many tens of millions of cubic metres of material are moved, resulting in irreversible changes in the landscape. In recent decades, there has been an increasing pressure on the environment issues, and for the organizations carrying out mining activities, it is often very difficult to get permission for their further operation. At present, it is already quite common that while discussing PPOE that mining companies have to prepare together with a study of the effects of mining on the environment (EIA), the state authorities also require a 3D visualization of projects contained in these

*Abbreviations:* PPOE, plan to prepare for opening and extraction; EIA, environmental impact assessment; CMO, Czech Mining Office; MRA, mining reverse analysis; PKAZ, Palivový kombinát (Fuel Combine) Ústí nad Labem; CAD, computer aided design; IDW, inverse distance weighting; GFU, grid file utility; VRML, virtual reality modelling language; RS, remote sensing.

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documents. The subject of the assignment is usually processing visual studies with predefined parameters. The permission for further activities conducted by mining methods requires favourable opinion of other parties concerned (Daněk et al., 2012a, 2012b). These include municipalities whose territory adjoins the extraction area of mining organizations.

An important role in the design process as well as in addressing a number of crucial tasks is played by the spatial model solution of the affected area in the timeline.

## The recapitulation of current trends in modelling mining landscape

Technological development has significantly influenced the change of approaches to the implementation of geodetic surveying and designing mining and quarrying of mineral resources. For these reasons, designing is in fact becoming spatial modelling. At the same time, we can say that the individual specializations of mining activities are becoming multidisciplinary.

## Acquisition of primary data for modelling a landscape

The quality of the primary data intended for processing the 3D model of the particular area significantly affects the final product. It depends on the method of their acquisition or origin.

In principle, the origin of the input data information can be marked as follows:

- direct measurements in the field or downstream data processing, e.g. from photogrammetry, remote sensing, or laser scanning
- processing of the documents created from already processed projects, altitudinal and positional data, maps in the electronic or analogue form, historical aerial photographs, and additional documents.

In geodetic surveying of large areas, an ever-greater role is played by aviation laser scanning and the use of unmanned aircraft as carriers of non-surveying cameras in the



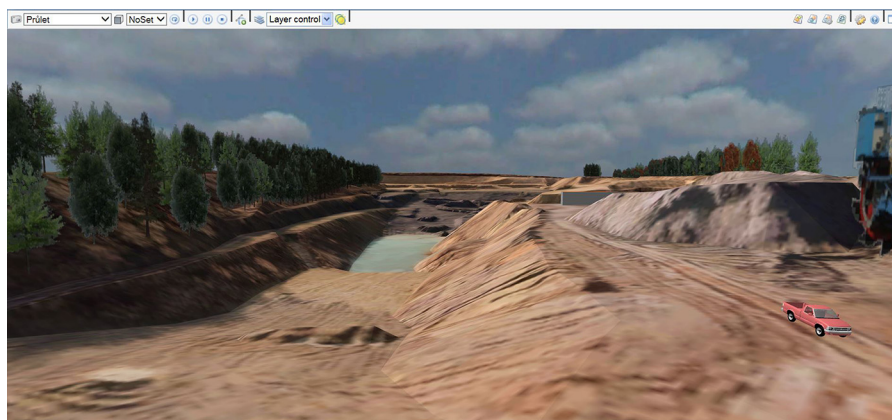
**Figure 1** Dimensional model of the area affected by the mining activity of the Chabařovice Mine.

application of aerial photogrammetry (Plakinger et al., 2013). This is confirmed by the fact that in most cases, the latest versions of the programmes used for modelling terrain and landscapes already have functions for processing laser scanning products (Brejcha, 2014).

A quality source of information for modelling historic states of landscapes are aerial photographs that the Czechoslovak Army started to take at regular intervals from 1937 with a break during WW2. Good results were achieved using software PhotoScan of Agisoft Company when a digital model of the terrain relief in the former opencast large-scale coal quarry PKAZ near Chabařovice from 1953 was created (Fig. 1).

## Modelling of the past, present and future states

Modelling of the current state of a landscape affected by surface mining usually constitutes creating aboveground or underground structures with their subsequent insertion into the prepared three-dimensional model of the landscape; modelling of the future designed conditions assumes cooperation of many experts from many fields, including mining specialists, landscape architects, ecologists, dendrologists, hydrologists, and a number of other experts.



**Figure 2** Interactive visualization of the quarry in Microsoft Internet Explorer.

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