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Analysis of Mining Terrain Deformation Characteristics with Deformation Information System

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Mapping and prediction of mining related deformations of the earth surface is an important measure for minimising threat to surface infrastructure, human population, the environment and safety of the mining operation itself arising from underground extraction of useful minerals.
The number of methods and techniques used for monitoring and analysis of mining terrain deformations is wide and increasing with the development of geographical information technologies. These include for example: terrestrial geodetic measurements, global positioning systems, remote sensing, spatial interpolation, finite element method modelling, GIS based modelling, geological modelling, empirical modelling using the Knothe theory, artificial neural networks, fuzzy logic calculations and other.
The aim of this paper is to introduce the concept of an integrated Deformation Information System (DIS) developed in geographic information systems environment for analysis and modelling of various spatial data related to mining activity and demonstrate its applications for mapping and visualising, as well as identifying possible mining terrain deformation areas with various spatial modelling methods.
The DIS concept is based on connected modules that include: the spatial database – the core of the system, the spatial data collection module formed by: terrestrial, satellite and remote sensing measurements of the ground changes, the spatial data mining module for data discovery and extraction, the geological modelling module, the spatial data modeling module with data processing algorithms for spatio-temporal analysis and mapping of mining deformations and their characteristics (e.g. deformation parameters: tilt, curvature and horizontal strain), the multivariate spatial data classification module and the visualization module allowing two-dimensional interactive and static mapping and three-dimensional visualizations of mining ground characteristics.
The Systems's functionality has been presented on the case study of a coal mining region in SW Poland where it has been applied to study characteristics and map mining induced ground deformations in a city in the last two decades of underground coal extraction and in the first decade after the end of mining. The mining subsidence area and its deformation parameters (tilt and curvature) have been calculated and the latter classified and mapped according to the Polish regulations. In addition possible areas of ground deformation have been indicated based on multivariate spatial data analysis of geological and mining operation characteristics with the geographically weighted regression method.