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MODELING SURFACE CHANGES IN OPEN CAST MINING

Abstract

In the dissertation high-resolution active and passive sensors of remote sensing were used for the monitoring of surface changes. The main aim of this work was to determine the values of pseudovertical movements and land cover changes of the open cast mine area of the Bełchatów Open Pit Mine, Central Poland, Europe.

The developed methodology was matched to the specifics of a lignite open cast mine, whose surface continuously changes with time. The application of selected remote sensing sensors and methods of mining area monitoring, both open cast pits and underground mines, have been discussed in the literature review. The research part of the dissertation presents the model of data integration from Sentinel mission remote sensors. Additionally, the Planet DOVE and RapidEYE optical sensors were analyzed to recognize land cover changes of the mining dumping area.

The main goal of the research was to process the time series of Sentinel-1A/1B SAR data. The Small Baseline InSAR approach was chosen for data processing. The results of SBInSAR processing were integrated with passive remote sensing data. For this purpose, the Sentinel-2 multispectral imagery was used as an independent source of data on the area to determine the land cover changes of the mining area (LCCMA). Processing of the spectral index of areas not covered by vegetation (bare soil index estimation; BSI) resulted in the construction of a mask identifying regions strongly reflecting SAR signals. The final result was a map of cumulative uplifted and subsided areas for a 2-year period and mean velocities of the pseudo-vertical changes in the LOS (Line Of Sight) direction.

The BSI-SBAS approach allows to detect the mean trend of surface changes in the study area. Application of the Sentinel 1 and 2 satellite missions in this methodology allows for a continuous monitoring of the open cast mine area in 6-day intervals. An attempt to examine the internal quality control of the estimated subsidence was also undertaken. The obtained results show that the LOS measurement noise does not exceed ±50 mm for unfavorable regions (with a vegetation cover) and ±10 mm for the area of the analyzed dumping site.

The developed model provides information on the surface changes with a smaller accuracy than the available classical geodetic surveying techniques. However, the advantage of this study was a high time resolution of the final results and coverage of the entire mining area (700 km^2). The obtained maps of surface changes based on remote sensing data may constitute models for operational purposes. The results of the study are not interpreted by the author in terms of geology and geomechanics, but represent an expert signal. The study supplies information on a local scale and enables pointing out the general trends taking place in the entire mining area. At the same time, the result of the BSI-SBAS study allows for indicating areas, for which measurements with classical geodetic techniques would be advisable.