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Mine subsidence-cycle monitoring by use of Sentinel-1 data

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The advantages of the improved ESA's radar satellite Sentinel-1 constellation, namely shorten temporal and perpendicular baselines provide robust tool for DInSAR monitoring of the mine dynamics and triggered terrain deformations. The nature of the Earth's surface changes caused by underground resource extraction depends on several conditions like 1) method of extraction, 2) type, width and depth of strata, 3) local geological characteristics, 4) rate of extraction, etc. In the case of coal deposits the standard method for extraction is the long-wall mining in which, by advancing along the horizontal panels of seams, the roofs of the previously excavated section are allowed to collapse. The use of this coal mining technique is often related with significant land subsidence in the area of mine works with value correlated with the thickness of the exploited seam. The surface deformation is rapid and expending in the direction of extraction with a non-linear rate. The subsidence cycle is divided in three main phases: Ist phase of immediate fast movements in the first several days after exploitation, IInd phase of delayed subsidence which may last from three to six months after exploitation, and IIIrd phase of post-compression in the next two years.

The current study is focused on the application of DInSAR technique for monitoring of subsidence dynamics induced by coal extraction in the area of Upper Silesian Coal Basin in Southern Poland. The observed time period comprises the whole data set of ascending and descending images from the year 2017. The estimated total vertical subsidence for the presented example of Bytom mine is in the range of 1.60 m for 2017. The result is verified with the data from the measurements of the levelling network conducted in the area. The use of Sentinel-1 six-days interferograms contribute to the detailed study of subsidence cycles of the investigated mine. The analysis is supported by the thorough information about the parameters of extraction. Prediction models of the maximum expected ground decrease based on the Knothe-Budryk theory are also generated. An object-oriented method is applied to verify the deviation between DinSAR observations and models.

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