The Model of Land Surface Movements Induced by Groundwater Rebound in the Area of Former Mining Exploitation

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The objective of the research was to investigate the process of rock mass recompaction related to groundwater rebound induced by underground mining. Research has been conducted in the area of the closed copper ore mine (Konrad) as well as the anhydrite and gypsum mine (Lubichów) in south-eastern Poland.

The mining operation was carried out in the years 1944-2001 in the area of the Konrad mine and 1944-2015 in the area of the Lubichów mine. It resulted in substantial land subsidence of up to 1.4 m and drainage of the aquifer system. However, it is estimated that the subsidence caused by groundwater pumping during these periods was 0.3 m in total. Furthermore, the spatial extent of the depression cone in the aquifer system immediately after the cessation of exploitation significantly exceeded the limits of the mining areas. Following the closure of the mine, a continuous increase in the groundwater head and land uplift is observed.

Classical survey results and the Persistent Scatter Satellite Radar Interferometry (PSInSAR) method were used to determine land surface movements in the period from November 2015 to November 2020. The results of the research show in the area of the Lubichów mine closed in June 2015, vertical land uplift reached a maximum of approx. 92 mm in that period. At the same time, in the Konrad mine area, closed in March 2001, no significant land uplift was observed. However, the main part of the investigation concerned the development of a novel method of land uplifting prediction. As a result, an attempt was made to comparatively analyze the dynamics of land uplift associated with the life cycle of the mine and the increase in the groundwater head.

These analyzes allowed the time factor for the modelling of the land uplift to be determined. This time factor is approx. 5 months in the area of the Lubichów mine and indicates that there is a time lag between the start of the groundwater head increase and the land uplift occurrence. Also, the investigation revealed that land uplift will occur in the analyzed area for the next five years. However, the dynamics of such movements will gradually decline in the years to come.

The methodology developed could be applied to any post-mining area where groundwater rebound-related uplifts are observed. It may be an appropriate tool for estimating both the time during which the land uplift is expected to begin after the mine drainage has been stopped, as well as the total duration of the land uplift phenomena.