

Due to the rapid population growth and industrial development around the world, there is a continuously increasing demand for mineral resources. It mainly concerns clean water, as well as crude oil and natural gas, which are the basic fossil fuels. These mineral resources are usually extracted from underground reservoirs, which are located at considerable depths. As a result of mining these minerals, rock mass is drained and land subsidence is observed on the terrain surface. Moreover, drainage of rock mass can be an indirect result of mining of other mineral resources. In such cases, pumping out water from mine workings is an indispensable measure for the possibility of ensuring the extraction of mineral resources in both underground and open-pit mining.

Land subsidence resulting from rock mass drainage usually has a regional range and may reach the values up to several meters. Uncontrolled land subsidence caused by drainage of rock mass contributes to failures of infrastructure. There may be damage to residential buildings, industrial plants and transport networks. Based on the world experience, this type of land subsidence has the greatest threat in large coastal cities, which are located on fine grain deposits, in river deltas. In these places, the described process usually proceeds the fastest. Simultaneously, due to the constantly rising water level in the world ocean, these areas are exposed to a substantial increase in flood risk. In Poland, land subsidence due to rock mass drainage is mainly observed in the vicinity of mining sites. Although the values of these displacements are relatively small and amount to several decimetres, they often occur in areas that significantly exceed the acceptable limits of the negative impact of mineral resources mining.

The process of land subsidence occurrence due to rock mass drainage is a complex research issue. It depends on the number of mining, geological and geomechanical factors. Methods used so far for predicting of this type of land subsidence have been focused mainly on empirical, theoretical and numerical models, application of which required detailed identification of the characteristics of rock mass deformation process and was often very time-consuming. In addition, due to the inability to fully recognize and describe the complex geological structure of rock mass and the complicated geomechanical conditions in which the given process takes place, the obtained results were characterized by considerable uncertainty. Therefore, in order to minimize the negative impacts of land subsidence resulting from rock mass drainage, there is still a crucial need to seek novel solutions that will allow for more reliable modeling of these phenomena.

The methods which in recent years have been revolutionising developing of complex mathematical models describing the course of complex physical processes are tools based on artificial intelligence, including deep learning. The principle of these methods is based on the automatic processing of observations contained in large databases and finding hidden relationships between them. The models developed in this way are based on algorithms that have the ability to unattended acquire new knowledge and make decisions by recognising, detecting and describing given patterns, that is the ability to understand them. For this reason, the complicated process of developing and calibrating multiparameter models that are built, among others, for numerical simulations, is eliminated. Furthermore, observed in the last years the rapid development of Satellite Radar Interferometry allows for quasi-continuous monitoring of land subsidence all over the globe. The use of this method allows to obtain a full picture of land subsidence with high spatial resolution, at millimetre accuracy. In a view of its properties, Satellite Radar Interferometry is used in determining many values of derivative parameters, among others hydrogeological and geomechanical properties of rock mass, also in areas where traditional measurements or research on these properties are not carried out or obtaining modeling or computation results are unsatisfactory.

The aim of the proposed research is to develop a novel method of land subsidence due to rock mass drainage prediction based on deep learning and Satellite Radar Interferometry. By combining these two methods, an algorithm that will allow to solve the difficulties resulting from the traditional methods of prediction will be developed. Thereby, it will be possible to effectively model and study the features of the surface displacement field in areas where land subsidence due to rock mass drainage occurs. The algorithm will be characterised by a substantial degree of universality. It will allow for a more reliable assessment of the impact of the mining of mineral resources on changing water conditions in rock mass and on the terrain surface. For this reason, the proposed research will contribute to increasing the possibility of predicting the effects of hydrogeological threats and rational planning of mineral resources production on a global scale.