



A fuzzy inference-based approach for building damage risk assessment on mining terrains

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ABSTRACT

Reliable evaluation of risk of building damage due to the mining impact is problematic owing to the magnitude, diversity and uncertainty of factors that may affect the surface, as well as the subjective character of methods of assessing resistance of the objects. The uncertainty and ambiguity elements in the decision process can be accounted for by fuzzy inference method. This tool employed together with GIS enabled one to integrate such diverse factors affecting damage risk as surface deformations and resistance of building objects, taking into account uncertainty of data and subjectivity of evaluation of experts making the assessment.

The results of investigations of the damage risk model based on fuzzy inference are presented in the paper. The successive stages of working out a fuzzy model are presented, the most important stages indicated and the choice of specific elements of the model justified. The advantages of fuzzification are presented on the example of building data subjected to the mining impact in one of the Polish mining areas.

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1. Introduction

Exploitation of raw minerals in Poland and abroad is partly conducted in strongly urbanized areas, therefore a number of objects are subjected to their negative impact. As a consequence, it is crucial to correctly assess the mining risk and the potential impact this might have on building objects. The main problem related with building damage risk in mining areas is the complexity of factors and difficulty in actual evaluation of potential damage that can be brought about to the objects [1–6]. Another problem lies in the mass character of the effect, especially in view of the fact that some methods enable only individual evaluation of building damage risk. In the case of areas under the mining impact where a number of objects exist in the affected area, these methods are too costly and time consuming, therefore expert methods of object resistance evaluation are used [7]. However, thus acquired knowledge of object resistance is non-homogeneous and strongly burdened with subjectivism of construction experts. The magnitude and non-homogeneity of risk factors, uncertainty of information, incompleteness of data and subjectivity of expert assessment make precise evaluation of the risk of building damage impossible [2,4,8,9]. The currently applied methods of building damage risk assessment in Poland are not sufficient. The results

of Polish achievements, which introduce real scientific novelties concerning modeling (fuzzy inference system) and computational problems (geographical information systems), are discussed in the presented paper. Successive stages of creating a fuzzy model for assessing risk of object damage in mining areas are presented, and the selection of its specific elements justified. The functioning of stages of fuzzy inference was exemplified. With such a model one figure value corresponding to the potential risk of object damaging can be obtained, which value accounts for factors related with continuous surface deformations and resistance of objects. The final part of the paper is devoted to the advantages of the presented model on the example of objects hazarded by mining activity.

2. Background

2.1. Assessment of surface structure damage due to mining impact

The building objects hazard in the Polish mining areas is determined based on principles defined in the 1950s [7,3,10]. The methodology consists of a two-stage procedure, which lies in analyzing the hazard generated by mining activity and vulnerability of the buildings.

The first step is evaluation of the land surface hazard caused by underground mining exploitation. The prediction of surface deformations is made on the basis of geologic, mining and other data with the use of a calculation model based on the influence function [1,3]. The prediction is made for a planned mining

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