DIGITAL MODELLING OF THE LAND AS A RESULT OF THE PHENOMENON OF MINING SUBSIDENCE

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Abstract*: The digital representation of the terrestrial surface as a result of the phenomenon of subsistence as a result of stratiform exploitation is a cartographic challenge for specialists in the field of engineering sciences. Such information allows a detailed visual analysis of the terrestrial surface deformation and movement, as a result of the appearance of the subsidence phenomenon. The present paper aims to present the digital modelling of the land and to obtain representative diagrams of the characteristic parameters that lead to the appearance of the subsidence phenomenon as a result of stratiform mine exploitation for the South Petrila mine exploitation field from the Hunedoara County.*

Keywords: *digital model of land, exploitation, topographical measurements, deposit.*

1. Introduction

The underground exploitation of the stratiform deposits from the Valley of the Jiu river mining area frequently leads to the displacement and deformation of the surface as well as to the deterioration of the industrial and civil objects located on the surface of the terrestrial space. In order to solve the problem of the protection of these objectives, it is necessary to apply surface protection measures against submergence and to investigate the laws of the terrestrial land movement and deformation process, as well as the laws referring to the variation of the tension state of construction elements.

In case of underground exploitations, the appearance of the subsidence phenomenon has as consequence the filling of the void the created by the extraction of deposits and the propagation of this phenomenon on the terrestrial surface, having repercussions of amplitudes of tens of meters on the surface affected.

In order to be able to analyze and visualize the effects of the subsidence phenomenon, it is necessary to achieve a complete digital graphic representation of the affected area. The picture below (Figure 1) shows the effect of the subsidence phenomenon resulted from stratiform field exploitation on the land surface.

Fig.1. Negative effect of the subsistence phenomenon as a result of stratiform exploitation

The digital representation of the shape and size of the Earth implies the realization of an ample mathematical model, known as the "digital model of the land".

The digital terrain model refers to the digital representation of the terrestrial surface using a mathematical modelling that approximates the terrain topography, modelling that can be used in various civil and industrial applications based on terrestrial surface data.

The data sources used in the digital modelling of the terrain come from the calculi of the measured dimensions of the three-dimensional space. There are currently a multitude of main sources of data collection to produce a three-dimensional model, such as: topographic elevations, aerographs, existing maps and topographic plans, laser scanning equipment and stereoscopic or radar satellite imagery.

The present paper has as objective the realization of a digital model and the obtaining of representative diagrams of characteristic parameters that lead to the occurrence of the subsidence phenomenon as a result of stratiform exploitation.

2. The geographic location of the objective studied

The mining exploitation perimeter covered by this paper is located in the administrative area of Petrila, Hunedoara County, Romania, more precisely in the DN-7A national road, Petrosani-Voineasa, south of the Molidvis hill and west of the road leading to the Popasul Haiducilor mountain cottage and the Maleia stream. In the picture below (figure 2) an area mapping plan of the Jiu river Valley mining basin containing the perimeter of the South Petrila mine is shown.

Fig. 2. Area Plan of the Jiu river Valley Mining Basin, with the perimeter of the South Petrila mine, Petrila, Hunedoara County, Romania

3. Drawing of the digital model of the land affected by the mining phenomenon

In order to make a digital terrain model, it is necessary to define the terrestrial surface in a three-dimensional system, using the details defining the shape and dimensions of the terrain, details determined and recorded as data file. Starting from this principle, one can consider it appropriate in the analysis of the subsidence phenomenon, as a result of the stratiform deposit exploitation to realize a digital model of the land in which the terrestrial surface from the beginning of the mining operations until their completion in a cyclical shape. The realization of a digital model of the land affected by the subsidence phenomenon resulted from stratiform exploitation for the South Petrila mining perimeter located in the territorial administrative unit of Petrila, Hunedoara County, Romania is next presented.

Taking into consideration the fact that the measurements made during the first mining operations were not found in the area surveyed, a topographic plan with level curves edited at a scale of 1:5000 of Petrila from 1978 was used as technical support, representing the year following the first mining excavations made in that area.

Thus, following the digitization, vectorization and georeferencing in the National Stereographic Projection System 1970 of the plan mentioned and reproduced in the figure below (Figure 3), the rectangular coordinates (X, Y, Z) of all the points define the mining perimeter area studied, namely South Petrila, as a .csv file.

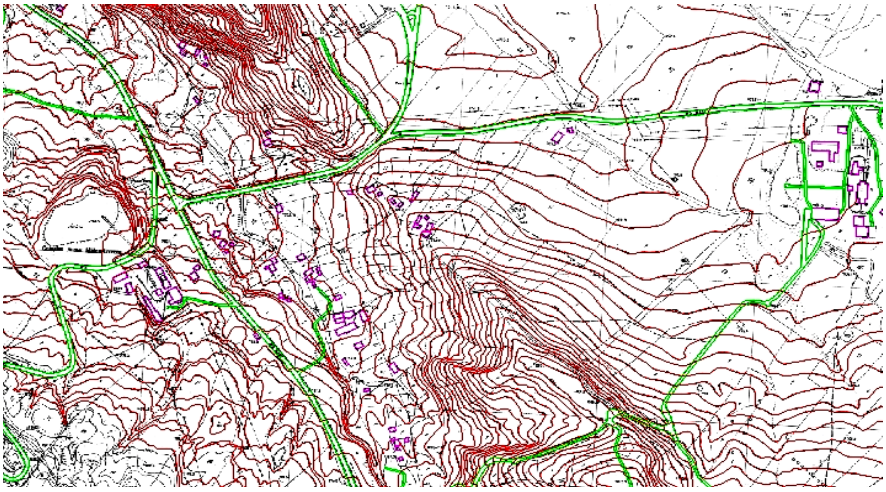

Fig. 3. Digitization and vectorization of the cadastral plan with level curves edited at a scale of 1: 5000 of Petrila locality, from 1978, Hunedoara County, Romania

In order to achieve the digital model of the land as a result of the subsidence phenomenon resulted from the exploitation of stratiform deposits, specialized programs of calculus and graphics were used. To do so, the working window of the software must be opened, where the working parameters required for this project are set.

Using the existing .csv file data, a .grid file is created, as it can be seen in the figure below (Figure 4), which will allow the performance of various operations on the subsidence phenomenon analysis, including the digital terrain model.

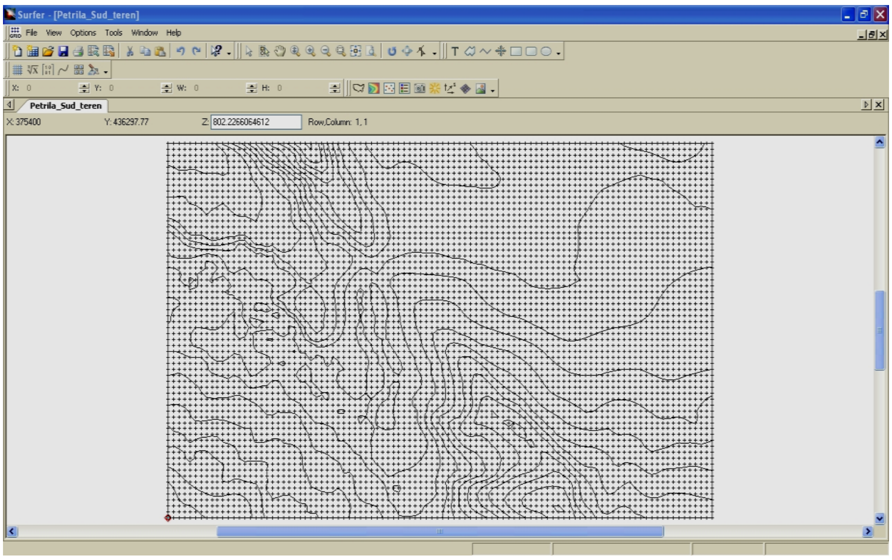

Fig. 4. The model of a .grid file required to create the digital terrain model.

Once this file type has been created, the digital model of the field of the studied area has been made, the final result obtained by processing the data being shown in the figure below (Figure 5).

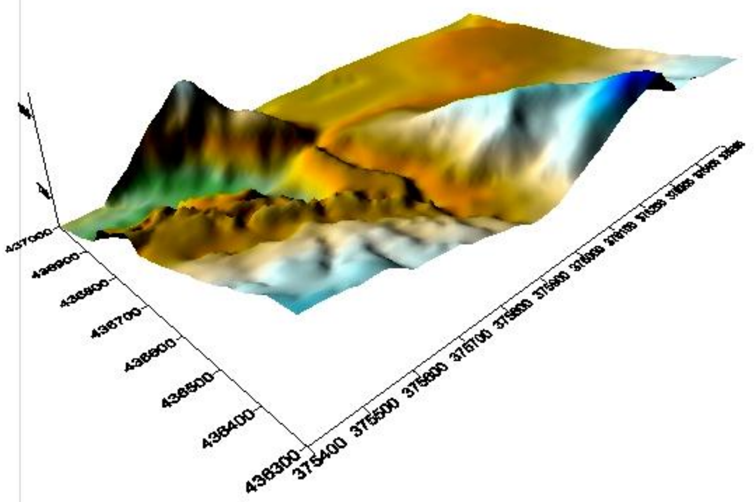

Fig. 5. Digital Terrain Model on Terrestrial Surface Condition prior to exploitation in Petrila, Hunedoara County, Romania

A special way to use a digital representation in the analysis of the subsidence phenomenon resulted from stratiform exploitation is to determine the diving bed using the effect penetration method.

This is obtained by summing up all .grid files resulting from a number of observation sessions on the monitoring alignments.

In order to exemplify such a digital graphical representation a series of observations made on the studied area are used, which with the same graphic program used in the previous case also lead to the obtaining of the curve representation of the diving bed (figure 6) and the three-dimensional representation of the diving bed (Figure 7).

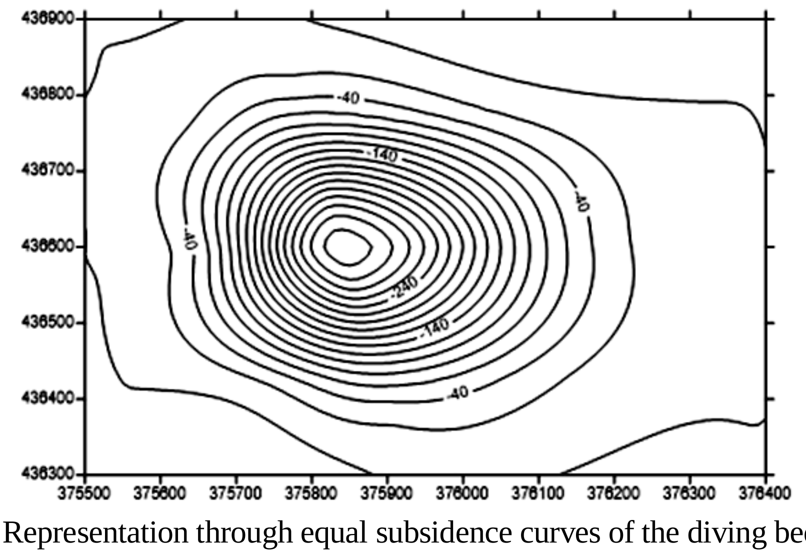

Fig.6. Representation through equal subsidence curves of the diving bed

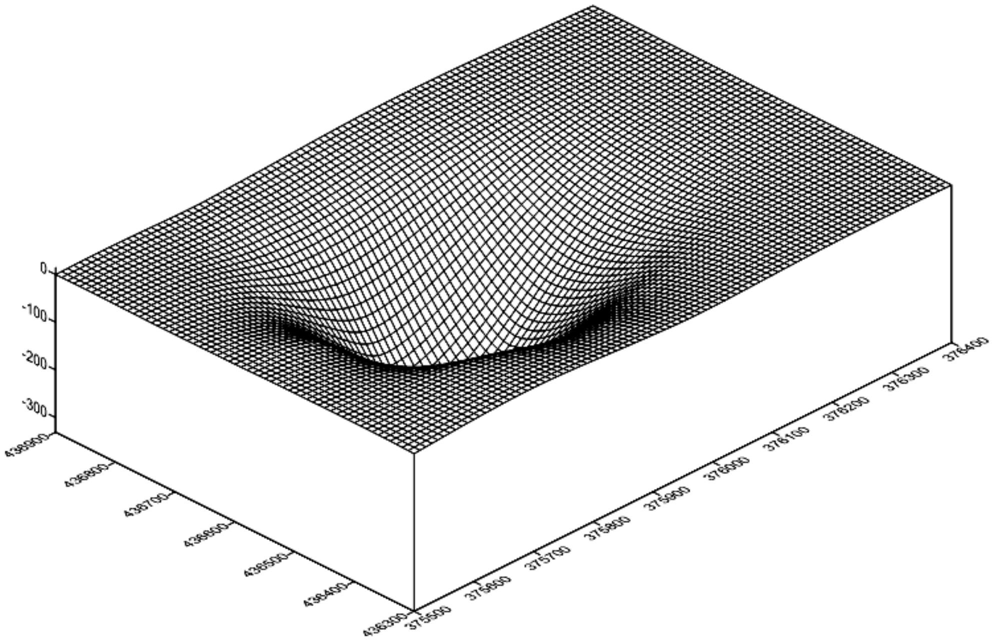

Fig.7. Three-dimensional representation of the diving bed

4. Conclusions

The digital terrain model with all of its existing technologies represents a tool that provides a consistent and complex analysis of the world around us, allowing effective management of metadata and of its use.

The digital model presented allows for a detailed analysis of the shape and sizes resulting from the subsidence phenomenon as a result of the stratiform deposit exploitation.

In conclusion, one can conclude that the present paper has several future directions for research on three-dimensional representations, which will focus on the analysis of the subsistence phenomenon resulted from the exploitation of stratiform deposits.

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