

Tom 57(71), Fascicola 2, 2012

Using GIS technologies in the management of Petrosani city

Mihai Valentin Herbei¹

Lucian Dragomir²

Iacob Nemes³

Abstract. The GIS technology is used in all fields for which the spatial information is relevant, that means in all fields that use the geographical map for stocking, analyzing and representing the data which are processed. No matter what is the field, any GIS application includes a spatial data base (a digital map) and a soft which exploit these data bases. The digital map must contain the spatial data specific to any field whose it is designated to this application. In order to furnish some useful information, this data base must be actual, which means it must represent correctly the terrain (geographic space) that is always under changing. This exploitation soft is made from many functions of analyzing the spatial data contained into the digital map and of visualizing the resulted information, specific to the application field.

Keywords: GIS, spatial analysis, 3D, slope, surface, TIN, vector, raster

1. INTRODUCTION

The sustainable development of mining regions as Petrosani city cannot be done without studying the influence of the underground exploitation over the environment and the constructions on the surface. Thus it is necessary to make a statistical analysis of this phenomenon and to continually monitor the surface spaces in order to protect them.

Creating a Geographic Information System in the region of Petrosni city will lead to a continuous monitoring of this surface, which is necessary due to the subsidence phenomenon found in Livezeni region, nearby Parang mountains. Petosani city is located in the center area of Romania, in the south of Hunedoara County, to the confluence of East and West of Jiu river. The administrative territory of the city has an area of 19.556 hectares, containing also a few villages: Slătinoara, Peștera Bolii, Dâlja Mare and Dâlja Mică. The GPS coordinates of the city are located between 45024'44 "N and 23022'24"E.

The purpose of this research is the accomplishment of some spatial analysis using GIS

elements regarding territorial and infrastructure development in the area of Petrosani city.

2. PRINCIPLE OF ACCOMPLISHING A GIS IN PETROSANI CITY

Into the presented application it was defined a series of layers as follows: Digital Elevation Model, mining areas, roads network, underground works, exploited area, GPS network, constructions, proprieties, land cover, protected natural areas etc.

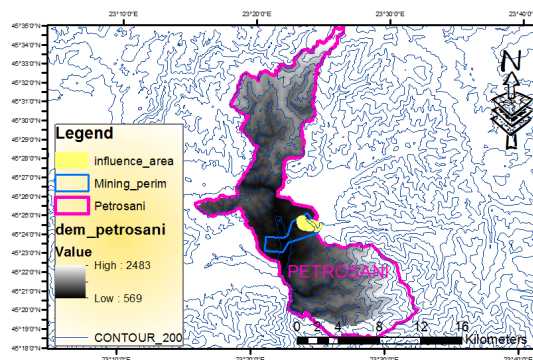


Fig. 1 Data representation on layers in ArcGIS

The data brought to the GIS working environment can be manipulated in different purposes. The data manipulation is made as follows: Finding; modifying the data structure; Interrogating and analyzing.

2.1. Enquiry the data

Enquiring the data includes the following steps:

- Selecting a data category;
- Selecting the graphic data or attribute data by using graphic windows, circle, polygon;
- Selecting the graphic data

² USAMVB Timisoara, Faculty of Agriculture, e-mail: mihai_herbei@yahoo.com, ³“Politehnica” University of Timișoara, ³Department of Hydrotechnical Engineering, George Enescu Street, no.1A, Zip code 300022, Timisoara, Romania

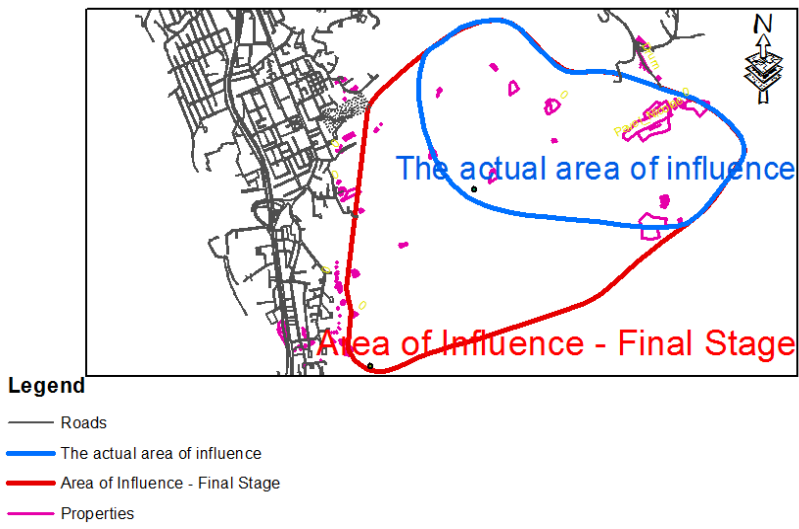


Fig. 2 Marking and foreseeing the present influence and future area for the next 20 years regarding the Livezeni mining area

2.2. Interrogating and analyzing the data

When it is put into service the system that contains the geographic data, it was be able to be interrogated by using some simple questions: Who is the owner?

What is the distance between 2 points? etc. or there can be used some analytic questions: Where are some proper areas for building a house? etc.

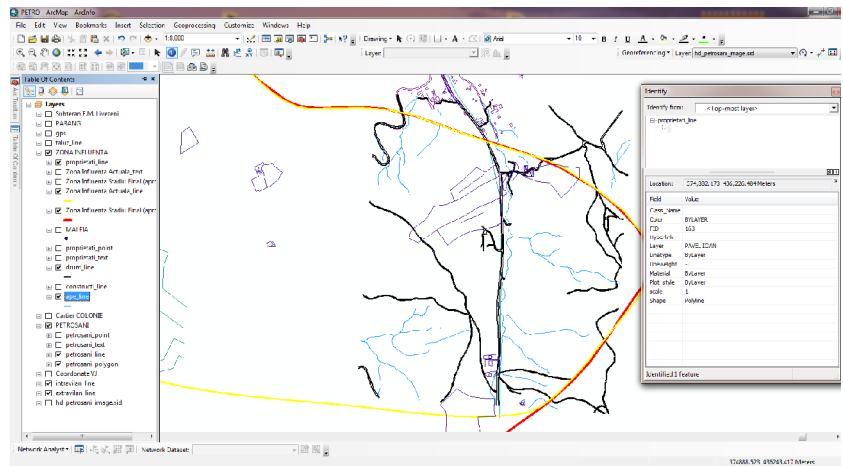


Fig.3 Identifying the proprieties from the influence area

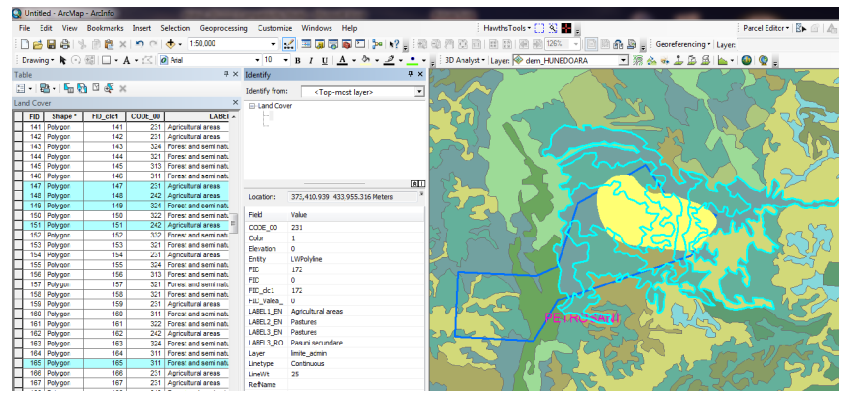


Fig. 4 Identifying the terrains and land use from subsidence area

2.3. Showing the data

Showing the data and generating the reports has the following processes:

- Creating, memorizing, finding, generating the structure;
- Libraries of conventional signs as points, lines, surfaces having the possibility to generate, edit, insert the new signs;

- Libraries of writing characters having the possibility to generate, edit, insert the new characters, styles;
- Possibility to represent the same frame of some data with different locations, different scales;
- We associate to the attributes some conventional signs, colors, texts;
- Insert the legends.

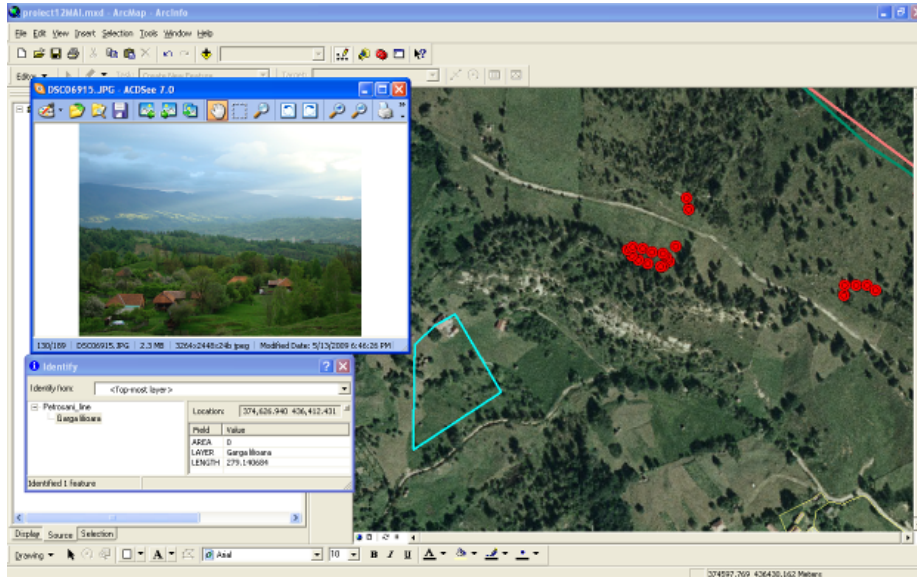


Fig. 5 Visualize some proprieties affected by Livezeni mining exploitation

3. GENERATING AND INTERPRETATION THE DTM FOR THE JIU VALLEY MINING BASIN

The digital model of the terrain is composed by a collection of saved data meaning a database. This model is used in processing applied on satellite raster images thus making a link between photo images with the real ones. The database which forms the digital model of the terrain are made by spatial elevation data in digital format presented as a grid.

The digital model of the surface is the result of photogrammetric process and contains all the characteristics (vegetation, buildings etc.) when filtered results a digital model of the terrain. This model is correlated with raster data, and it is represented in a Cartesian coordinate system with a high resolution.

DTM is an important tool in GIS. It can be saved in a geodatabase like a vector contour, like a grid or like a Triangular Irregular Network.

The interpolation methods type triangulation one after whom it is obtained a TIN structure (Triangular Irregular Network), are multiple.

Interpolation methods such as triangulations, when it is obtain a TIN (Triangular Irregular Network) are also multiple. The best one is Delaunay Interpolation that allows to be obtained some perfect triangles inside a circle so the distance between the points from the picks of the triangle is always minim. For each triangle there are memorized the coordinates and attributes of the three picks, topology and slope and declination direction of the triangle surface.

The most important applications of the DTM are: visualization of a terrain, the correction of a terrain, the analyze of a terrain, the extraction of some parameters of a terrain etc. The data sources of a DTM are: surveying measurements, photogrammetry, GPS etc.

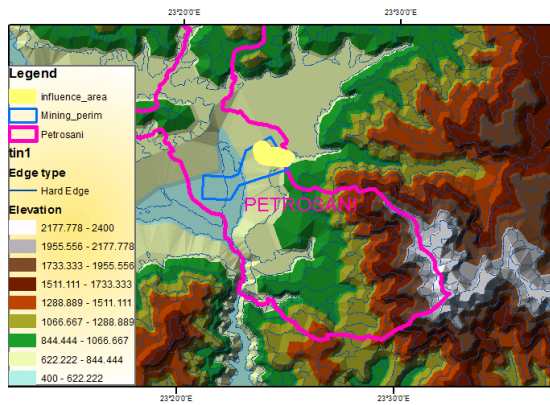


Fig. 6 The TIN structure

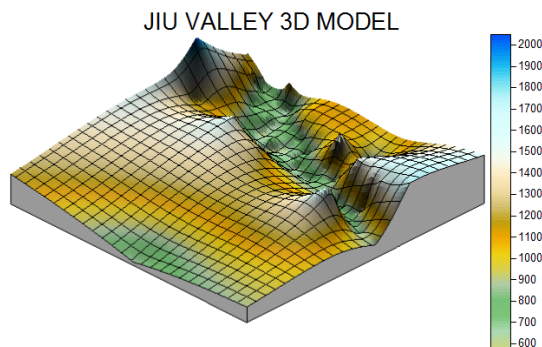


Fig. 7 The 3D model of Jiu Valley

The analysis of DTM's to extract terrain parameters is termed DTM interpretation. The extraction can be performed by either visual analysis or quantitative analysis (interpretation). The analysis can be grouped into general geo-morphometry or specific geo-morphometry. General geo-morphometry deals with quantification of general surface characteristics such as slope, gradient or aspect. The concept of measuring slope from a topographic map is a familiar one for most professionals in the landscape planning/surveying professions. Slope is a measurement of how steep the ground surface is. The steeper the surface the greater the slope. Slope is measured by calculating the tangent of the surface. The tangent is calculated by dividing the vertical change in elevation by the horizontal distance. If we view the surface in cross section we can visualize a right angle triangle. Slope is normally expressed in planning as a percent slope which is the tangent (slope) multiplied by 100.

Slope is an attribute to define surface and comprises gradient and aspect. When written in the form of a mathematical equation gradient (usually calculated in degrees) refers to the first vertical derivative of altitude and represents the rate of change in its magnitude over distance.

Similarly aspect is the first horizontal derivative of the altitude and represents the direction of the slope. The curvature (convexity / concavity) of the terrain can be determined by the second order derivatives.

Curvature of the surface helps define the movement of masses. The formulas for calculation are mentioned below:

$$\text{Gradient} = \sqrt{\left(\frac{\Delta z_x}{\Delta x}\right)^2 + \left(\frac{\Delta z_y}{\Delta y}\right)^2}$$

$$\text{Aspect} = \tan^{-1}\left(\frac{\frac{\partial f}{\partial x}}{\frac{\partial f}{\partial y}}\right)$$

$$\text{Curvature} = \sqrt{\left(\frac{\partial^2 f}{\partial x^2}\right)^2 + \left(\frac{\partial^2 f}{\partial y^2}\right)^2}$$

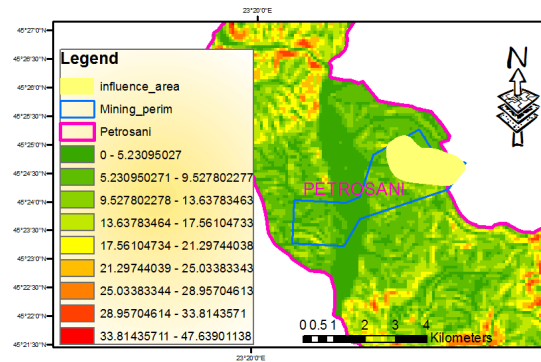


Fig. 8 The map of Slope

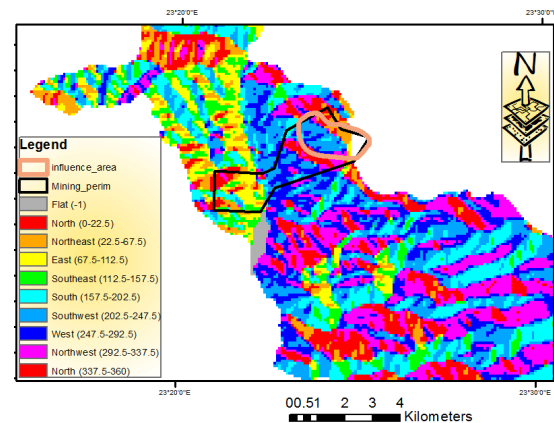


Fig. 9 The map of Aspect

REFERENCES

- [1] Herbei O., Herbei M. (2010), Geographic Information Systems. Theoretical and applications, Ed. Universitas, Petroșani, 2010
- [2] Booth B. (2000), Using ArcGIS 3D Analyst, GIS by ESRI
- [3] McCoy J., Johnston K. (2001), Using ArcGIS Spatial Analyst, GIS by ESRI