CREATING THE DIGITAL TERRAIN MODEL OF THE USAMVB AREA USING MODERN TECHNOLOGY

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Abstract: *The digital model of an object or phenomenon is made up of a systematically stored data collection (database) that describes a three-dimensional system of coordinates, arbitrary or particularly can form the object features or states/accomplishments of the phenomenon (conversion as a digital image) and allow by calculation programmes, deducting the object or states shape and features for the phenomenon in new points. Modelling the areas is the process of representing graphically a natural or artificial area by using one or more mathematical equations. Modelling the terrestrial area is a particular case of modelling an area where we should take into account the specific problems of representing the Earth or some of its parts. Several fields in which the digital model has immediate applicability are the following: telecommunication systems analysis, pipe networks (water pipes) design, system command and control. The digital system can be applied in all other fields where it is necessary to know altitude information in different points of an area. The term "digital terrain model" was used for the first time in 1958 by Miller and Laflamme who defined it as "a statistic representation of continuous area by using a great number of points whose horizontal coordinates (x, y) together with the altitude (z) are known and this representation is made in an arbitrary coordinates system". The digital terrain model represents an informatics' instrument composed by terrain data and software that represent a basic component of a G.I.S. The digital terrain model (DTM) has three subsystems: 1. Digital elevation model – DEM – contains altitudes, slopes, curves, etc.; 2. Digital planimetric model – DPM – contains planimetric data and elements; 3. Digital model of objects nature – DEN – contains pedologic, geologic, hydrologic data etc. DTM generation is related to the data acquisition method, the making of the model by using different interpolation methods and also choosing the structure of data representation (raster or TIN).*

Key words: *sustainable development, environment protection, G.I.S., modelling, digital terrain model*

INTRODUCTION

DEM consists of an organised set of information about the planimetric position and altitude of points describing the spatial configuration of relief structures and facilitating area reconstruction in new points.

A DEM describes a terrain surface with the help of an unambiguous function $z = f(x,y)$, so only one z value can be determined for an x, y position in the terrain.

The quality of the digital terrain models is give by the quality of the pixel size (in the case of DEM) or their equivalent in other models. Their quality is a function of a series of variables: terrain roughness, quality of the data source, data acquisition method, sampling density, interpolation algorithm, and vertical resolution.

RESULTS AND DISCUSSIONS

Creating a digital terrain model and its later use involve the following stages:

1. **DTM GENERATION**

The creation of a digital model starts with the digital map of the terrain that contains the level curves (figure 2) and the altitude points (figure 1) with the associated information about height, rivers and ridge lines represented as 3D lines, slope ruptures, as well as all the other elements that are important for the mathematical modelling of the terrain.

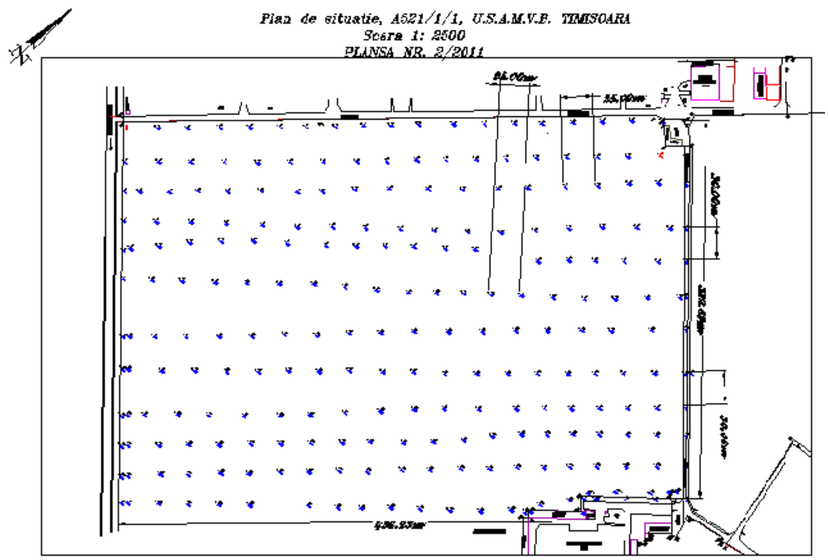

Figure 1 - Altitude points

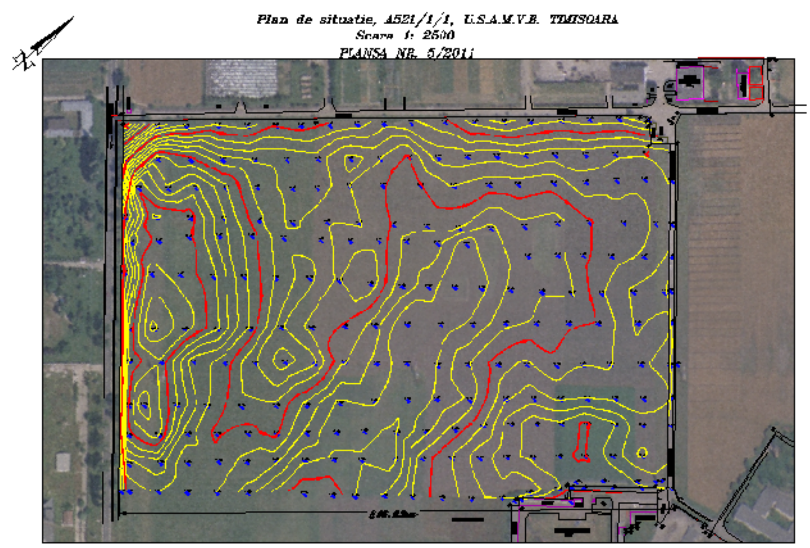

Figure 2 - Level curve map

The generation of the digital terrain model is related to the ***data acquisition method***, the creation of the model with different ***interpolation methods***, as well as the ***choosing of the***

data representation structure (***raster or TIN***) (figure 3). The best is the ***Delaunay interpolation*** that allows for triangles that are perfectly circumscribed by a circle; as a result, the distance between the triangle points is always minimum. The *coordinates and attributes of the three points, the topology as well as the slope and the inclination direction of the triangle surface* are recorded **for each triangle**.

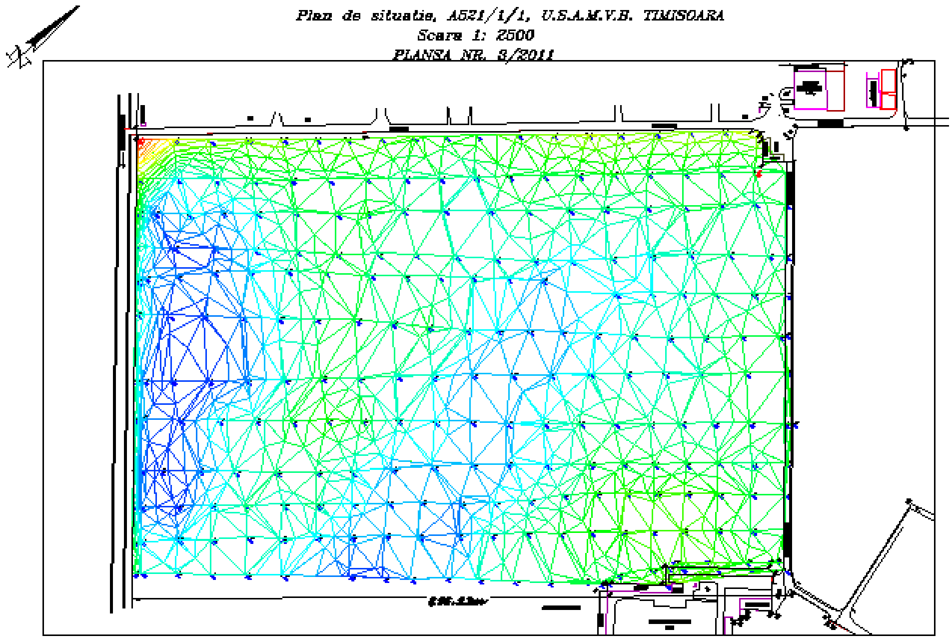

Figure 3 - TIN model of the studied area

2. **DTM MANIPULATION**: error correction and possibly model updating, filtering operations, combining several models from various sources or time periods, changing model structure (TIN – raster and viceversa) (figure 4);
3.

	X	Y	Z
Minimum:	482580.0788	205165.2193	88.673
25%-tile:	482789.5331	205374.4038	89.3759
Median:	402806.6970	205499.7680	89.6058
75%-tile:	483004.1293	205639.4417	89.8098
Maximum:	483256.5416	205922.5995	91.0912
Midrange:	482918.3102	205543.9094	89.8821
Range:	676.46279999998	757.38020000001	2.4182
Interquartile Range:	211.59619999997	265.0379	0.43289999999999
Median Abs. Deviation:	107.85200000001	132.50569999998	0.2252
Mean:	482893.83840389	205503.96057703	89.600818374558
Trim Mean (10%):	482892.57675843	205502.39932157	89.598785098039
Standard Deviation:	148.49298765247	163.76241240863	0.35586570820636
Variance:	22050.167381958	26818.127717894	0.12664040227722
Coef. of Variation:			0.0039716792174681
Coef. of Skewness:			0.26637947284242

Figure 4 - DTM manipulation

4. **DTM INTERPRETATION**: model analysis and retrieval of useful information;

The analysis of the digital terrain models for parameter retrieval depends on DTM interpretation. Retrieval can be performed either through visual or quantitative (interpretation) analysis. The analysis can be grouped in *general geomorphometry* or *specific geomorphometry*. The former deals with quantifying the characteristics of the general surface, such as slope, shape or inclination (figure 5).

The slope is usually expressed as percent, tangent (slope) multiplied by 100.

$$Slope\ \% = Height/\ Base * 100 \qquad (1)$$

Slope is an attribute defining surface and includes inclination and shape. In the mathematical equation, *inclination* (usually calculated in degrees) is related to the first-order derivative of the vertical height and represents size divided by distance. Similarly, *shape* is the first-order derivative of the horizontal height and represents the slope direction. The formula is as follows:

$$Gradient(inclinarea) = \sqrt{\left(\frac{\Delta z_x}{\Delta x}\right)^2 + \left(\frac{\Delta z_y}{\Delta y}\right)^2} \qquad Aspect = \tan^{-1}\left(\frac{\frac{\partial f}{\partial x}}{\frac{\partial f}{\partial y}}\right) \qquad (2)$$

The curve (convexity/concavity) of the terrain can be determined by second-order derivatives. The surface curve helps us determine rock movement.

$$Curve = \sqrt{\left(\frac{\partial^2 f}{\partial x^2}\right)^2 + \left(\frac{\partial^2 f}{\partial y^2}\right)^2} \qquad (3)$$

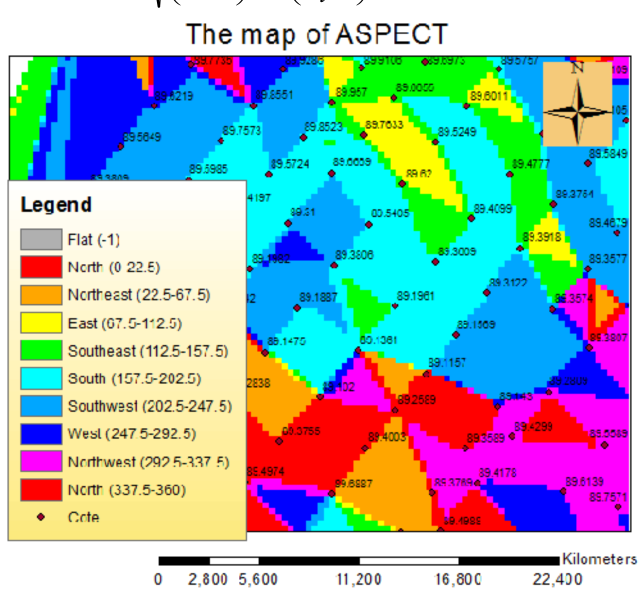

Figure 5 - The map of aspect

5. **DTM VISUALISATION**: DTM graphic representation (2D, 3D representation, animation etc.). This stage is in close connection with the previous one. (figure 6, 7).

Figure 6 - TIN model and level curve overlapping the ortophotoplan

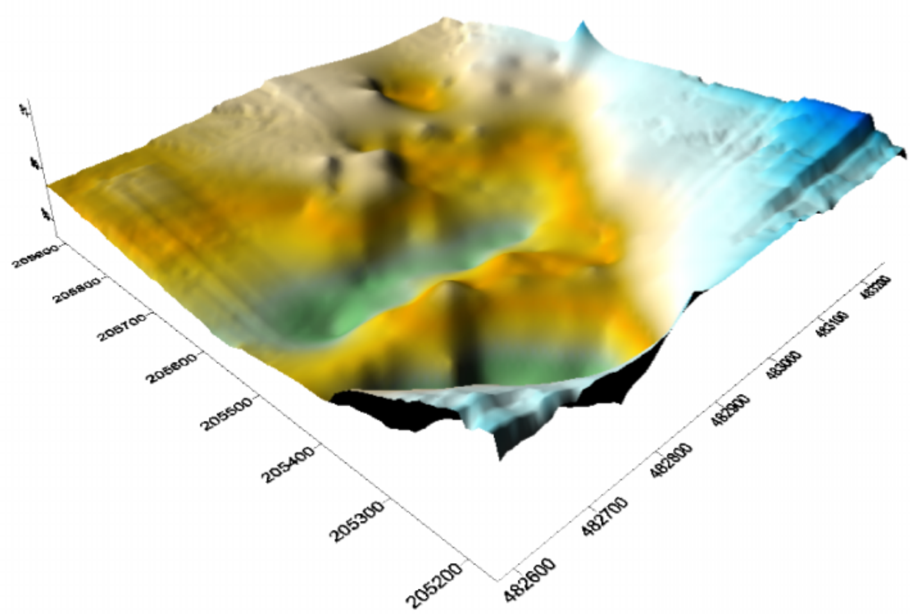

Figure 7 - 3D model visualisation (Surfer)

6. **DTM USE**: developing specific applications for a certain field of activity.

CONCLUSIONS

Several fields in which the digital model has immediate applicability are the following: telecommunication systems analysis, pipe networks (water pipes) design, system command and control. The digital model can be applied in all other fields where it is necessary to know altitude information in different points of an area.

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