REALIZATION OF THE DIGITAL TERRAIN MODEL IN ORDER TO ANALYZE THE LANDSLIDES

POP[1)*] Sergiu, Nicolae POP[2)]
[1)]*Tehnical University, Faculty of Civil Engineering, 15 C-tin Daicoviciu St., Cluj-Napoca, Romania*
[2)]*University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, Faculty of Horticulture, 3-5 Mănăștur St., Cluj, Romania*
*Corespondent author: popsergiu36@gmail.com

Abstract: The paper aims to create the 3D model of the land located in the southern area of the Transylvanian Advanced Horticultural Research Institutes within the U.S.A.M.V. Cluj-Napoca. The land is presented in the form of unencumbered earth terraces, which during the last years has undergone the phenomenon of sliding on the slope, visibly changing the shape from the original one given at the time of the landscaping arrangements that were made after the construction of the building next to it, which over time it can affect the structure of the building. In order to observe the degree of sliding and breaking of the terraces on the slope it is necessary to model them and to observe the vulnerable areas for the consolidation work. As a first action to stop the gliding phenomenon, young shrubs were planted along the terraces, while other more expensive consolidation works may be required. When making the digital terrain model, the data obtained prior to this analysis were used, ie the quoted topographic plan of the area and the existing photogrammetric flight in the area.

Keywords: Azimuth directions, zenith directions, multiple crossing, pilaster

INTRODUCTION

Just as the topographic map is the basis of the different geomorphological maps, the Digital Elevation Model (MDE) represents the starting point both for calculating morphometric elements of the relief and for making digital geomorphological maps and for spatial analysis and mathematical modeling, methods specific to Information Systems Geographic, in order to solve some theoretical and practical problems in the field of geomorphology and beyond.

As the relief through its characteristics has a great influence, direct or indirect, on all the physical-geographical processes (with direct role in the distribution of ecosystems) to which is added its very strong control over the anthropic activities related mainly to the land use, digital elevation models are currently the basis of any GIS application regardless of the domain concerned. Moreover, because most processes, phenomena and activities are carried out in a geographical space and therefore have a spatial distribution, it can be stated that MDEs are absolutely necessary tools in almost any type of analysis or modeling. This is why, since the 50s, since the beginning of the development of mathematical modeling applications of the land surface, digital elevation models have represented basic components within the Geographic Information Systems, being considered as their subsystems (Digital Terrain Modeling Systems).

Surface modeling is the process by which a natural or artificial surface is graphically represented by one or more mathematical equations. The modeling of the earth's surface is therefore a particular case of modeling the surfaces in which the specific problems related to the representation of the Earth or parts of it must be taken into account.

MATERIAL AND METHODS

The area of interest analyzed was modeled for further observations and research based on the existing topographic plan. The realization of the plan was carried out both by measurements determined with the classic equipment (Leica TCR 805 total station) with the corresponding prisms and reflecting targets), as well as on a plan determined by the U.A.V. technology.

A number of processing programs were used to determine the digital terrain model, these were: TopoLT application which is an indispensable tool in the field of topography and cadastre, the AutoCAD program which represents the most widespread computer graphics and design environment, the Global Mapper program, which is a must-have for operating with maps or spatial data, well adapted as a standalone spatial data management tool and as an integral component of a GIS.

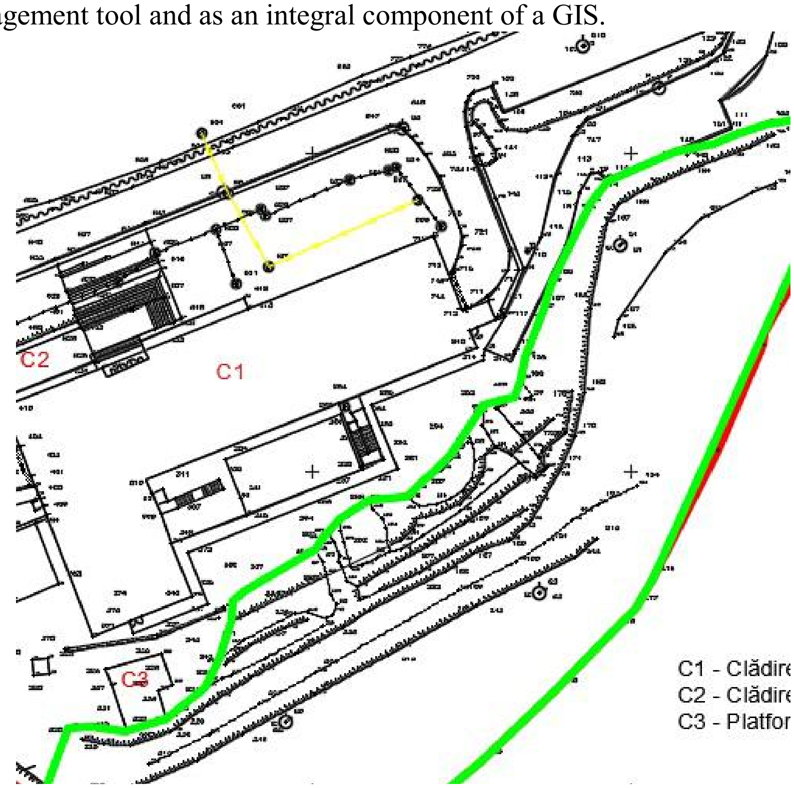

Fig. 1. Slopes area disposed of landslides

Classically, the relief is represented by level curves, through points marked according to a grid defined by the rectangular coordinates X and Y or φ and λ. This method can be improved by adding some characteristic points of the relief, the dimensions of the boundaries of the water surfaces (lakes, seas, etc.), hill tops, valley bottoms, the lines of the highest slope, the ridges of the hill, the slopes, etc. The optimal description of the relief is a numerical function that associates with each point of the topographic surface, a dimension. At the moment, this is unattainable, in practice seeking to define a method of digital modeling of such a function.

The relief can be represented by the following digital methods:

- by the vector model, corresponding to which the digitized level curves are represented by a succession of points of constant altitude H relative to their planimetric coordinates X and Y, or φ and λ. The density of these points must take into account the cartographic generalization of the relief, depending on the density and the connection techniques used in the cartography,

- by quotas taken corresponding to an ordered network. Each node of the network representing either physical points corresponding to the characteristic lines of the terrain (ridge point, valley bottom, drainage lines, river basin boundaries, etc.), to obtain a variable density of points depending on the slope changes of the terrain), or the corners of the ordered network. The ordered grid, seeks to represent the topographic surface through small areas of square, rectangular or triangular shape, having a constant or variable step depending on the slope of the terrain. Each corner of the network can be defined by its coordinates (linear / column) to which the point share is associated. Another method is to define profiles for which one of the two coordinates is recorded and the quota of the respective point when the points are collected evenly along the profile

- by quotas taken according to a dynamic network of triangles developed in connection with the GIS systems corresponding to vector data processing methods. This method is known as TIN (Triangulated Irreegular Network) and is increasingly used in GIS databases.

RESULTS AND DISCUSSION

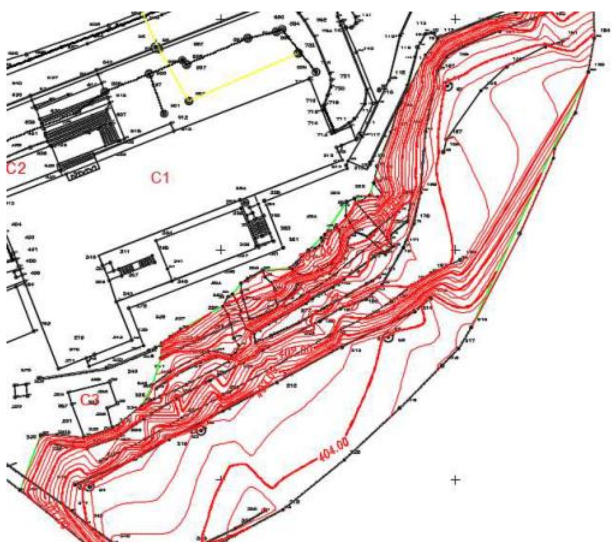

Fig. 2 . The topographic plan with highlighting the slopes by level curves

Based on the measurements from the classic area, see in the south-east part of the analyzed area that there is a sliding phenomenon, in this sense the area exposed to the slopes was modeled by applying the level curves for a better highlighting. The level curves were located using a distance of 0.25 m for a good view of the relief and the slope breaks.

Digital model based on photogrammetric flight:

With the help of the Global Mapper program, the analyzed area determined by the UAV technology was modeled, after which the area subjected to the landslide, the slopes, both classic and UAV were modeled. The 3D models were made according to the different characteristics of the surface.

To make the 3D model from the classic measurements of the area of the slopes for landslides, the TopoLT program was used, which generated the digital model with an accuracy proportional to the number of points measured at the ground level.

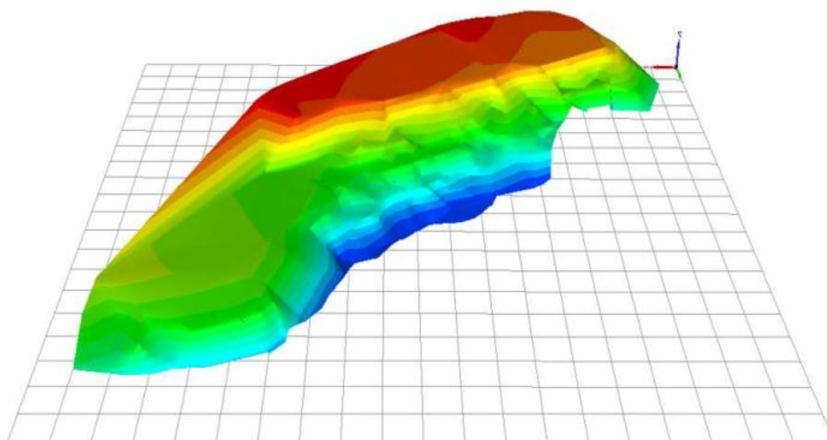

Fig. 3. 3D modeling using color levels for altitude

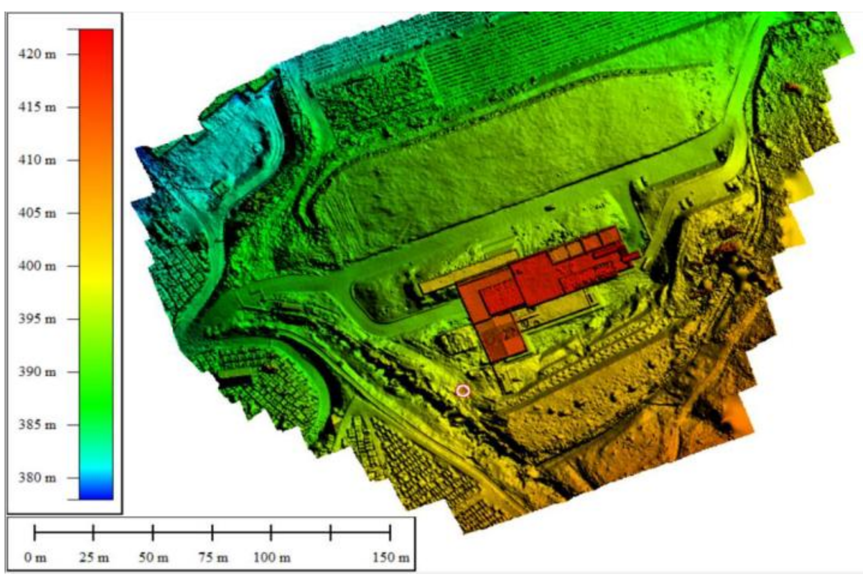

Fig. 4. Elevation model for the entire area taken photogrammetrically

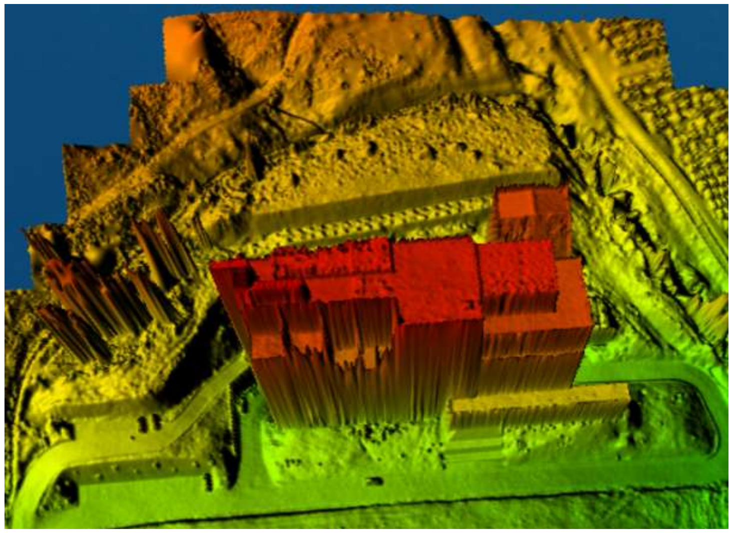

Fig. 5. Top model 3D perspective

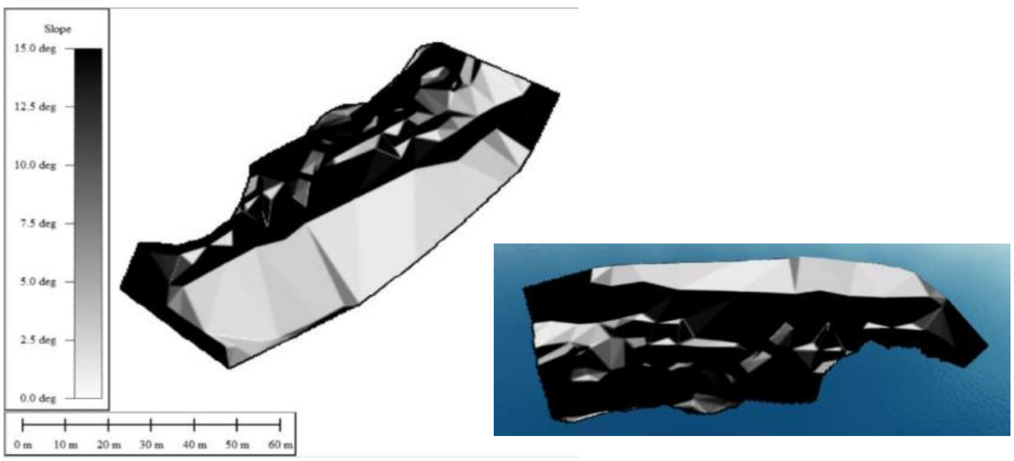

Fig. 6. 3D classic model - TIN displayed as a slope map

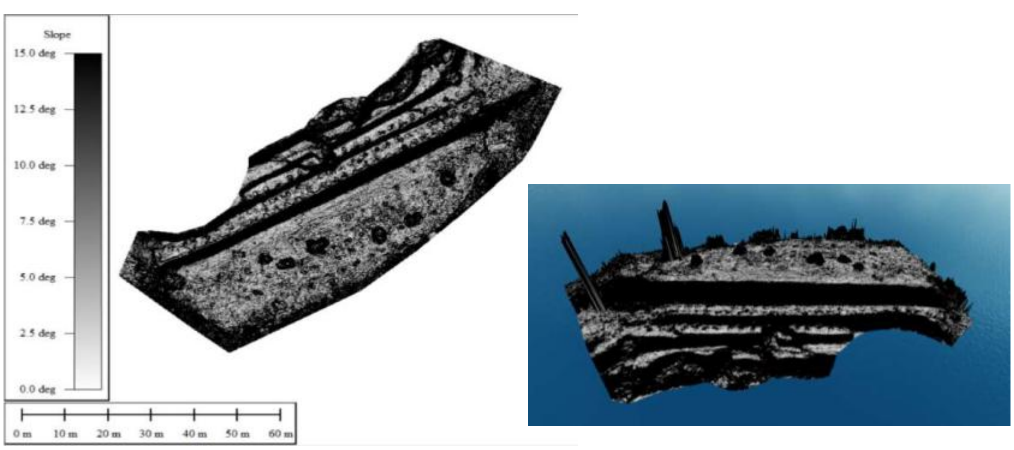

Fig. 7. Photogrammetric 3D model displayed as a slope map

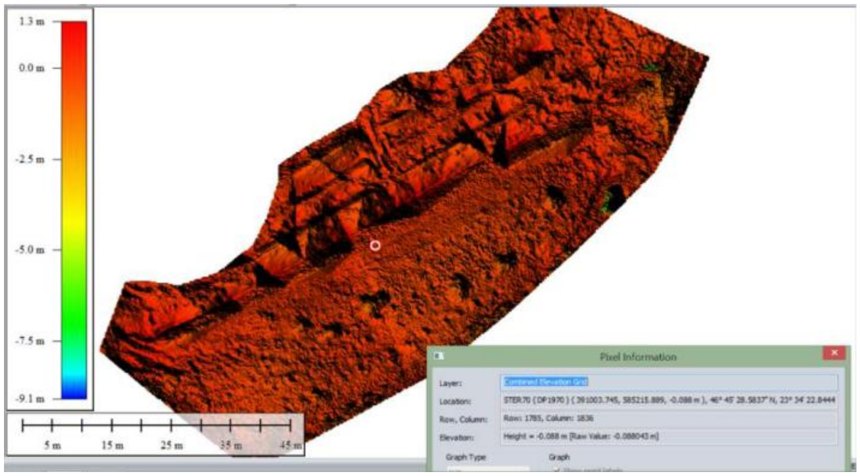

Fig. 8. The resulting overlap of the two models, classic and photogrammetric

In order to compare the models, they overlapped, resulting in differences between -9.1m and 1.3m. The difference is largely due to the high vegetation which, in the case of classical modeling, has not been calculated.

CONCLUSIONS

As a result of the land rises and the digital model preparation, there are slips in the slopes executed in the southern part of the construction, which requires taking measures to stabilize these slides.

Thus, based on the above, certain recommendations regarding the prevention and control of landslides from the analyzed slope in the I.C.H.A.T area can be established: as measures to strengthen the slope, a mixture of plant species with deep roots can be used. This will increase the slope resistance of the slope. As it is an efficient method and due to the fact that it involves low costs, it is recommended to cover the land with vegetation as the main measure to strengthen the slope of the studied area.

REFERENCES

1. Florea Z., Ersilia Oniga, 2017, Fotogrammetria digitală, Ed. MatrixRom, București.

2 Ortelecan M. Pop N., 2005, Metode topografice de urmarire a comportarii constructiilor si terenurilor înconjuratoare, Ed., Academic Press.

3. Ghitau D., 1983, Geodezie si grvimetrie geodezică, Ed. Did. și Ped. București.

4. Dima N., 2005, Geodezie, Ed., Universitarias, Petroșani.

5. Botez M. 1961, Teoria erorilor si metoda celor mai mici pătrate, Ed., Did. și Ped., București.