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MĂRIȘEL MOUNTAIN AREA ANALYSIS USING GIS TECHNIQUES

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Abstract

Keeping in mind the geographical position of Mărișel Ski & Snowboard Slope from Mărișel, which is at a hight of 1,150-1,250 metres, we have developed a geographic informational system in order to conduct a research on the region's slopes with the help of satellite images.
The database was processed and managed through the methods and spatial analysis technologies offered by Google Earth and ArcMap applications. The collected information was then analyzed by Digital Terrain Model, as well as by specific terrain analysis technology.
By analyzing the raster model, we have pinpointed the sunny areas of the slopes where the snow melts quickly, therefore presenting a disadvantage for the practice winter sports, and creating a need for the intervention of artificial snow machines. In order to discover the surfaces which contribute to water increase, we have ranked the area's elevation points. Another purpose of the research was to determine the slopes' exposition (Northern orientation), the direction of the drainage, as well as the drainage points in the vicinity of the pumping station.
Having experienced both the spectacular view over Beliș Fântânele Lake, and some of the area's adverse meteorological conditions, through the above mentioned process of collecting data, we would like to contribute to monitoring, developing and creating the most favourable conditions for winter sports on these slopes.

Key words*: GIS, Google Earth, MNT.*

INTRODUCTION

The advanced technology offered by GIS (Geographic Information System) can be used in various scientific fields, enabling the user to process, analyze, format and view spatially distributed data through a computerized process. Considering the situation we find ourselves in because of the pandemic, and it being the perfect season for winter sports, we have chosen Mărișel village in Cluj County as our area of interest. Mărișel village is the largest populated mountain plateau of the Apuseni Mountains, with the Somesul Cald River running through it. The area is most popular for its Ski & Snowboard resort, at an altitude of 1250 m-s, and 52 km-s away from the municipality of Cluj-Napoca.
The ski slope of Mărișel was opened just recently, in 2018. It has been built from scratch, as there was no previous skiing trail in the area. As the building of the slope has been gradual, we were interested in the analysis of the relief form, thus creating a geographic information system. This system is of major importance, and it plays a crucial part in drawing thematic maps. This would eventually lead to attaining our goal, which is the following: to determine the functional units of the slopes, to analyze the processes we come across, and to study the area from the perspective of the slopes, which have a larger degree of tilting of 2-3° that connects the interflows and their adjacent drainage line.

MATERIALS AND METHODS

During our research we have made use of a satellite image from *Google Earth*, which helped us identify the area of our interest. By placing four control points, the image now has a regular geometrical shape.

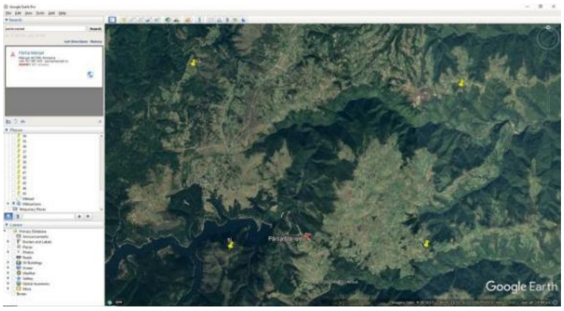


Figure 1. Satellite image from Google Earth

For processing and formatting the database, we used the methods and techniques of spatial analysis offered by the *ArcMap* app. DEM (Digital Elevation Model) facilitated the data management, together with specific surface analysis techniques.

In order to analyze a given surface, altitude needs to be taken into account as well. There is a specific database (terrain) within geographic data which enables the user to generate 3D models. This database is based on vectorial information that have the 'z' coordinate, and generate the numeric model of the given area. The result is a raster-type image, which is made of matrix pixels that display the constantly moving information within a given area, information that isn't easily divisible into vectorial elements. With the help of such raster, one is able to conduct simple and complex analyses that pertain to a particular surface.

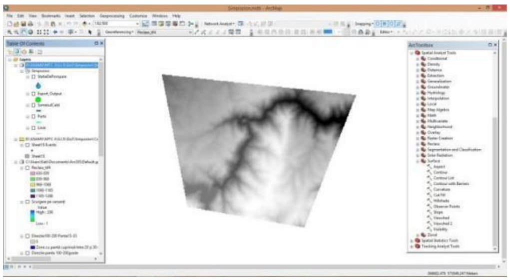
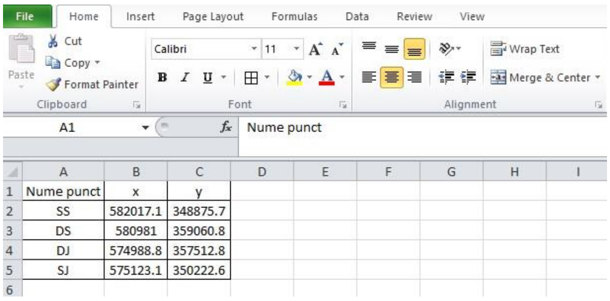


Figure 2. DTM in ArcMap

RESULTS AND DISCUSSIONS

The satellite image from *Google Earth* has the geographic coordination system in itself. With the help of *TransDatRO* application we took the geographic coordinates and transformed them into the specific coordinates of the Stereo 1970 projection system. These coordinates were then saved as *.xls* files.



Nume punct	x	y
SS	582017.1	348875.7
DS	580981	359060.8
DJ	574988.8	357512.8
SJ	575123.1	350222.6

Figure 3. Control points coordinates (Stereo 1970)

The data procured from aerial photos does not have geographic reference. These images need to be connected to spatial references, that is, they need to fit into the corresponding area from the map. This is what we call georeferencing. In order to complete this phase, we have used the georeferencing tool bar of the *ArcMap* app. The connection between control points and a given image is made by clicking on the option 'Add Control Point'. Generally one has to take four points into consideration, which are the coordinates of the corners of the given image. There is a particular way of transforming the coordinates, and for a higher level of accuracy one would need the RMS (Root Mean Squares) to be as close to 0 as possible. Once the least degree of error is reached, the last task of georeferencing is done by clicking 'Update Georeferencing.'

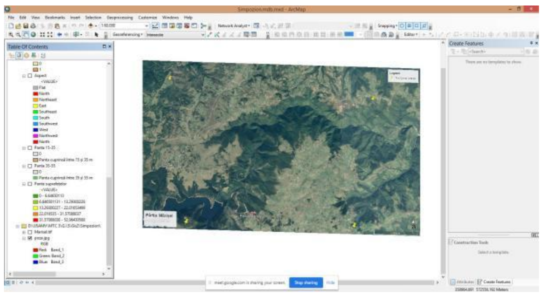


Figure 4. Georeferenced satellite image in ArcMap

In order to achieve what we have proposed for the analysis, we had to activate the following extensions from the tool bar, by clicking on 'Extensions': 3D Analyst and Spatial Analyst. From 'Spatial Analyst' we then went to 'Surface Analyst', which enabled us to generate more analyses.

In the first phase of our analysis we set out to determine the elevation of the surface, in order to be able to identify the areas that have a higher altitude, which would eventually help us calculate the exposition.

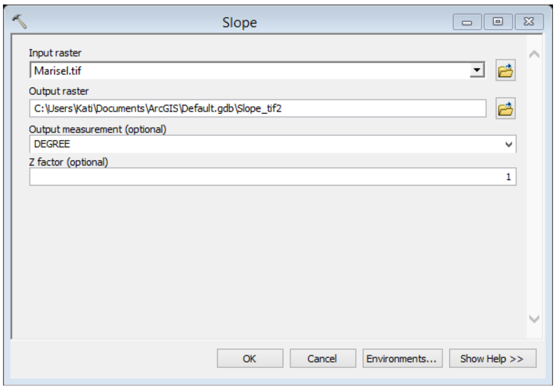


Figure 5. Determining the elevation of the suface

In order for us to obtain the expected results, we divided the pixels into five categories. For a reclassification of the elevation, we chose the option ‘Classified Classes Classify’ from the Symbology layer.

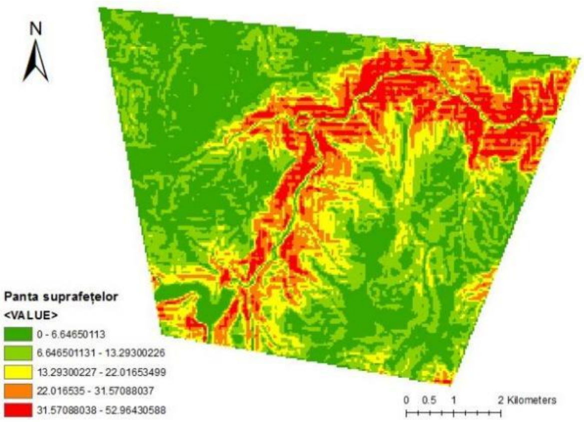


Figure 6. Area elevation according to pixels

The elevation of a given surface was determined by altitude as well. For a reclassification of hypsometry into five different categories, we have settled the difference in relief: 1288 being the highest value, and 630 the lowest. We then worked with pink and blue color palettes in ‘Color Ramp’

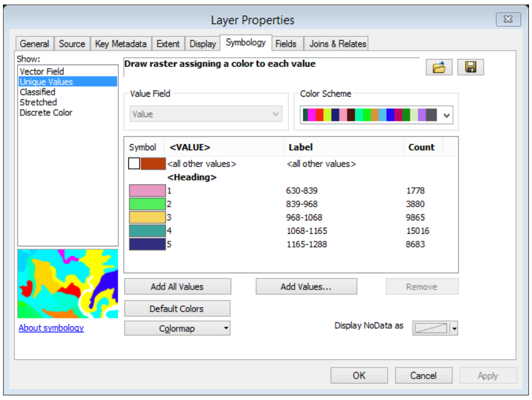


Figure 7. Determining the altitude categories

The map is finalized by going to ‘Insert’, then adding *caption*, *orientation* and *scale*.

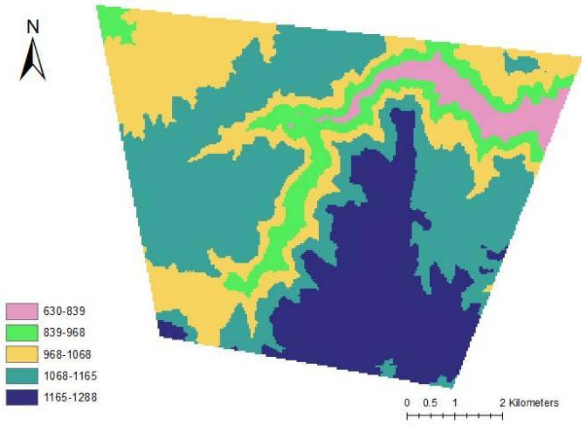


Figure 8. Area elevation according to altitude

The second phase of our research consisted of determining the slope that represents the modification rate of the elevation for each cell of the digital model. The goal was to identify the form of the slope, which turned out to be quite varying. As far as the size of the slope is concerned, we have divided the forms into three categories: abrupt, moderate and mild.

As the attached map shows, we have identified that the slope has quite a tilted form, which determines the direction of the water flow and the erosion capacity of the surface.

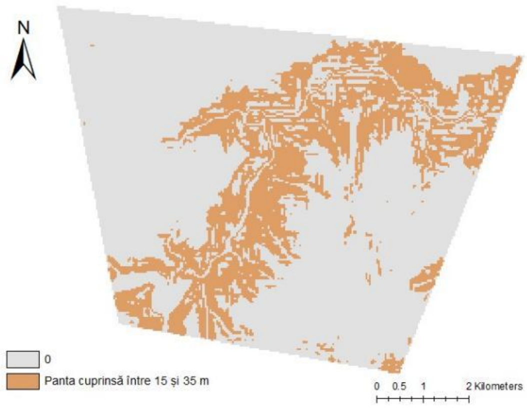


Figure 9. The slope between 15 and 35 m

In the case of the steep slopes where vegetation is reduced or entirely absent, water circulates along the crevices in the rocks, and the removal of smaller sized materials (either by disintegration or alteration) results in places where the ground collapses.

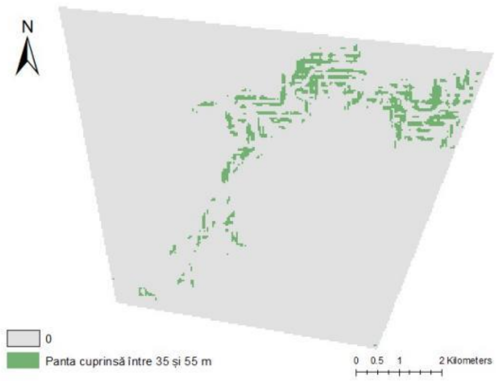


Figure 10. The slope between 35 and 55 m

Raster can be used to represent the melting process of the snow on a given surface, as well as to describe the risk raised by the melting process, which evidently hinders winter sports, and calls for the intervention of artificial snow machines.

The orientation and exposition of the slopes was made through the ‘Aspect’ function of the Spatial Analyst Tools. The initial result has been reclassified, given the orientation of the cardinal points, that is a 360o circle.

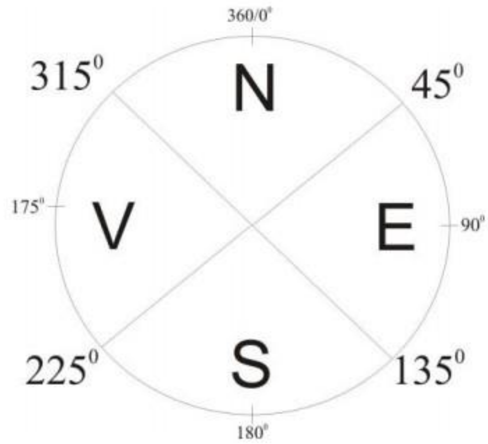


Figure 11. Cardinal points

The exposition of the slopes represents their position in relation to the cardinal points, and their exposure to the indirect solar radiation. As the map shows below, these fall into nine categories. Each color of the orientation map is connected to the respective characteristic of the slopes, as far as orientation is concerned, in the following manner: light blue represents the southern slopes with the highest temperatures; red represents the northern slopes with the lowest temperatures; green represents the eastern slopes; and blue represents the western slopes.

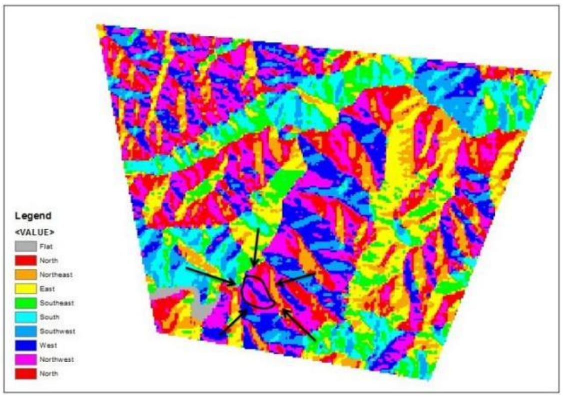


Figure 12. Sunny areas depending on the exposition

For a more detailed analysis, we have set the value of the northern slopes to 1, and 0 for all the other directions which don’t fall into our area of interest.

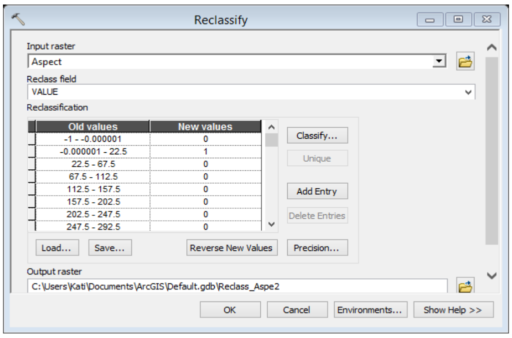


Figure 13. Determining the exposition towards the North

The results are found in the figure attached below, marked with green. In this area the melting process of the snow is relatively low, which is advantageous for ski slopes.

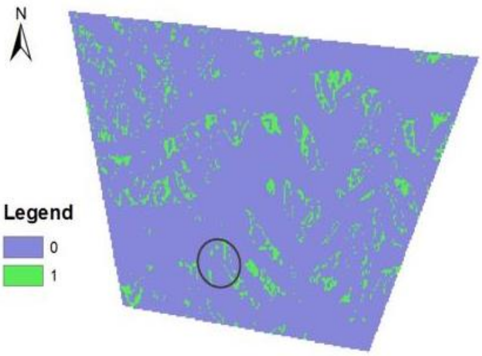


Figure 14. Northern orientation of the slopes

There has been another object of interest as well, namely to determine the sunny areas. For this we have used the same tools as for the previous analysis, and we have looked at the southern, south-eastern and south-western orientation of the slopes, resulting in value 1.

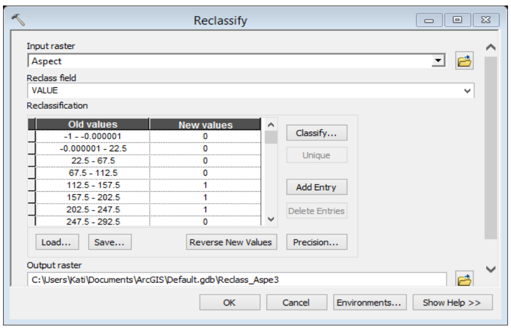


Figure 15. Determining the exposition towards the South, South-East, South-West

The southern and the south-eastern slopes are the ones with the highest solar radiation, which makes them the warmest and driest. These slopes are also the most suitable for certain geomorphologic processes, as the melting process of the snow is a lot more sudden, allowing more time for these processes to take place.

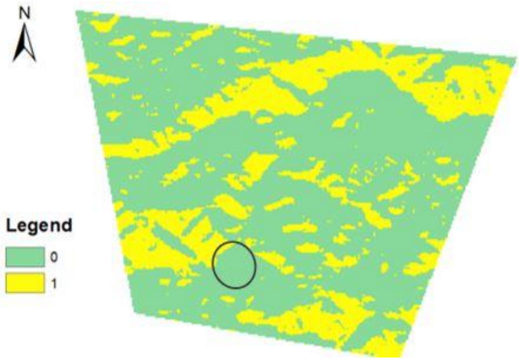


Figure 16. Southern, South-Eastern, South-Western orientation of the slopes

The previous maps have been interpolated using the Spatial Analyst Tools - Map Algebra - Raster Calculator.

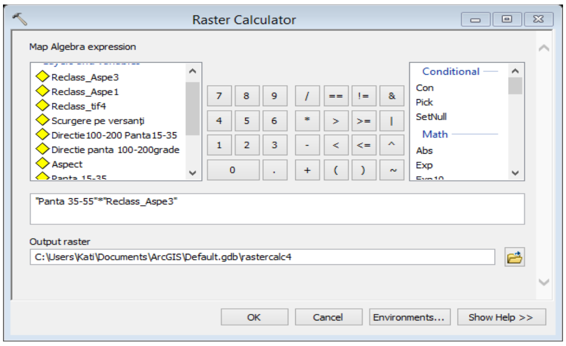


Figure 17. Interpolation of the maps

The interpolation of the maps is relevant for the orientation of the slopes which are steeper, more fragmented and their relief is more intense. This helped us determine those areas where crashes and torrential valleys are more likely to appear.

Figure 18. Sunny areas with steeper slopes

The slopes ensure the flow of water, affected by gravity, vegetation and the soil type of the cumulating system. In this case, we have the Someșul Cald River, which flows into Beliș-Fântânele Lake.

The satellite image below conveys the information gained through vectorization, and it follows the drainage route of the Someșul Cald river, as well as the perimeters of the lake.

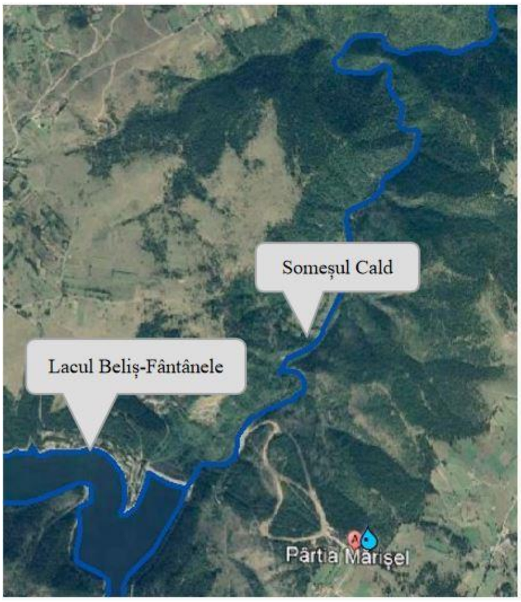


Figure 19. Drainage routes

CONCLUSIONS

As a result of the processed data, we have found the mountain area of our study to be suitable for winter sports, due to its geographic location and exposition.

The results of our analysis of the mountain slopes have a great importance, as they have an effect on the speed at which the water flows along the slopes. At the same time, they ensure the necessary debit for artificial snow machines, which are indispensable for a ski slope in the case of unfavorable weather conditions.

The applicability of GIS techniques plays a crucial role in the analysis of suitability, research of collisions, developing a certain area (mountain, hill, geographical depression, etc.), as well as in the analysis of the possible extension of a constructed site (resorts, locations, etc.).

The very same methodology can be applied to any location, in order to achieve the same degree of complexity in results. The present research is only an example of mountain areas.

Having reached our results, and with the spectacular view over Beliș-Fântânele Lake, we wish to contribute to the monitoring and development of winter sports, in the best possible conditions.

Figure 20. View over Beliș-Fântânele Lake

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SECTION 04
FUNDAMENTAL SCIENCES