ROSIA MONTANA PROJECT - 3D MODELING FOR PROGESIVE DEVELOPMENT AND ECOLOGICAL REHABILITATION

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Abstract: *Roşia Montană (Roman name: Alburnus Maior, German name: Goldbach, Hungarian name: Verespatak) is the oldest mine documented in Europe. The locality is situated within the Central-Western area of Romania, at approximately 80 km North-West of Alba Iulia town and 90 km NNE of Deva town. The Project is located within the region known as the Golden Quadrilateral of Metaliferi Mountains, which is part of the Apuseni Mountains. An open-cut mining project involves major changes of the land and landscape. Therefore, irrespective of the place where it is located, such Project will raise several controversial issues in terms of environmental impact and protection; and, given the Project in discussion, the issues relate also to the archaeological and architectural heritage.*
In May 2008, S.C. Roşia Montană Gold Corporation S.A., the titleholder and the manager of the mining project, proposed a 3D Project to include the main development phases: Current situation, End of year 7 of operations and Year 19 of operations – the completion of the progressive rehabilitation and restoration. Such Project uses several GIS techniques and 3D graphic models which help viewing the above mentioned phases of the mining Project, specifically the changes of the land during exploitation and how Roşia Montană will look after the industrial activities and environment reconstruction are complete. The presentation of the 3D Project displays as 3D animation.

1. Introduction

Rosia Montana (Alburnus Maior Roman name, German name Goldbach, Verespatak Hungarian name) is the oldest documented mine in Europe. The village is located in central-western Romania, Alba County, approximately 80 km northwest of Alba Iulia town and 90 km NNE of Deva (Fig. 1).
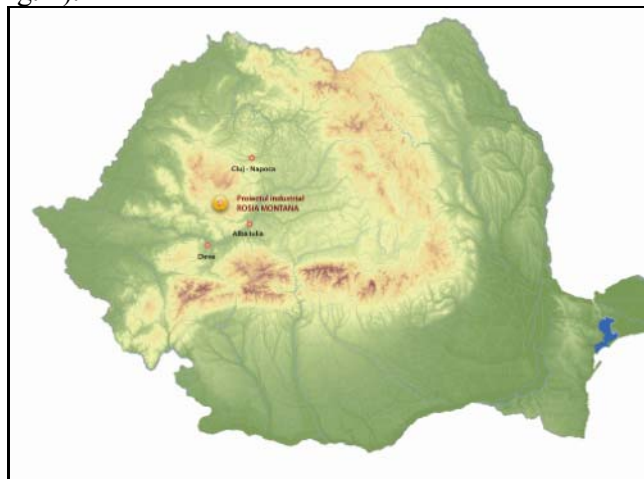

Fig. 1. Location of studied area in Romania

The project is located in the region known as the Gold Quadrilateral of the Metalliferous Mountains, part of the Apuseni Mountains massif (Fig.2).

Fig. 2. Location of studied area in Apuseni Mountains

A project involving the surface mining operation changes the terrain and landscape. Therefore, wherever is done, it raises an account of the controversy in terms of impact and protecting the environment and, as is the case, the architectural and archaeological heritage.

In May of 2008 s.c. Rosia Montana Gold Corporation SA, owner and manager of the mining project, wanted a 3D project in order to present the main development phases: present situation, end of the 7 operational year and the 19 year of operation - the end of greening and progressive rehabilitation.

The purpose of this article is to present several GIS techniques used to visualize the above phases of the project. It will be shown how, using GIS techniques and 3D graphics modeling, can be seen changes over exploitation of land and will show how Rosia Montana shall look after completion of industrial activities and environmental restoration, as a 3D animation.

2. Methods & Source of the data

Pentru realizarea proiectului au fost folosite mai multe tehnici şi seturi de date pentru a obţine modelarea şi vizualizarea 3D. Marea majoritatea a procedurilor au fost realizate prin folosirea softului ArcGis 9.2 şi ArcScene 9.2 produse de ESRI, excepţie facând prelucrarea şi mozaicarea orthofotogramelor, operaţiuni realizate cu Erdas Image 9.0

For the project were used several techniques and data sets to obtain 3D modeling and visualization. The vast majority of procedures were performed using the software ArcGIS 9.2 and 9.2 ArcScene ESRI products, except processing and mosaic of the orthophoto images,, operations performed with ERDAS Image 9.0.

The main steps in the project were:
A. Establishing the boundary of the study area and creation of the Digital Elevation Model (DEM);
B. Orthophoto image processing and interpretation;
C. Conversion of technical data from .dwg format (AutoCAD) in .shp format (ESRI ArcMap) and creation of the GIS data base;
D. 3D modelling and textural simbolisation of the different project components;
E. Data integration in ESRI ArcScene in order to obtain the virtual scenes.

A. Achievement of the Digital Elevation Model (DEM)

Land modeling (the topographical surface study by numerical methods) has become an important component of geomorphologic, hydrological, climatologically or oceanographic applications. More recently it acquires a growing importance in other fields (planning, mobile communications, construction, etc.).

Procesarea computerizată a modelelor altimetrice ale terenului a revoluţionat acest domeniu de activitate, atât partea de analiză topografică cât şi cea de reprezentare (afişare, imprimare) a rezultatelor.

Computer Processing of altimetric models of land has revolutionized this field, both the topographic analysis and the result representation (display, print).

Numerical altimetry modeling of land requires a portion of the topographic surface approximation using electronic means of calculation and an appropriate mathematical model based on the coordinates (X, Y, Z) of "known" points on it so that, by interpolation, to obtain a Z value for any point in the same area defined by its coordinates (X, Y), with a corresponding precision. A numerical model of the land is a raster image that describes the surface by (square) cells, whose size determines accuracy of the DEM[1].

The first step towards obtaining the DEM is to collect the necessary technical data in digital format containing elevation values needed for interpolation. The source of these data can be diverse (topographic measurements, GPS measurements, etc.), the most common being digitizing contours and elevation points listed on topographical plans. Choice of data is based on accuracy and detail required for land representation.

Initially was bounded the study area. Thus it was decided to cover an area of 7713 hectares (Fig. 3).

Following delimitation, in order to obtain a representation of le landscape as close as the reality, and because RMGC had 2m precision contours omly for the project area, it was decided to purchase a DEM from SPOT. The DEM is in WGS84 coordinates with 20 mresolution and altitudinal precision of 4 m who covers the entire study area.
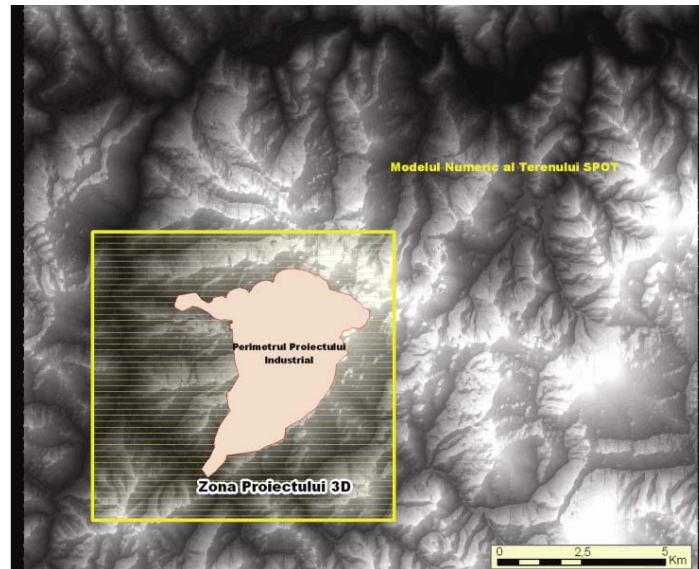
Fig. 3. Delimitarea zonei proiectului 3D (Arc Gis 9.2)

Since data were available in Stereographic 1970 projection system has made DEM to be reprojected from WGS84 coordinate system in national Stereographic 1970 projection system using ERDAS IMAGINE 9.0 software. After bringing the DEM into Stereographic 1970 projection, the project area and the area covered with 2 m contours were cut out, using as mask the perimeters in *.shp* format. The 2 m contour lines were interpolated and thus achieved for an area DEM cell size of 2 x 2 m it was interpolated with the remaining after cutting the SPOT model, and 2 x 2m cells size, resulting eventually be uniform throughout the DEM (Fig. 4).
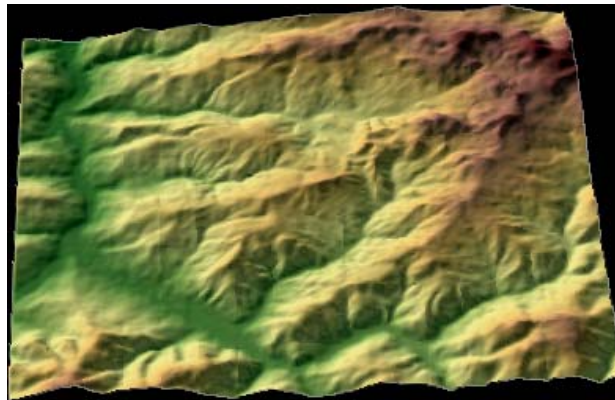

Fig. 4. DEM for the study area. (Arc Scene 9.2)

B. Orthophoto image processing and interpretation

For an accurate rendering of reality land RMGC bought from ANCPI the necessary orthophoto images that covered the project area. These were made from a flight ortofotogrametric in 2005 and have a precision of 0.5 m (pixel size is 0.5 x 0.5 m, i.e. the smallest detail can be seen is 0.5 m).

As can be seen from Fig.5, the orthophoto images presents a qualitative difference in terms of color composition. To standardize them they were processed, in order to obtain an overall picture in terms of color compact with ERDAS IMAGINE 9.0 software. (Fig.6)
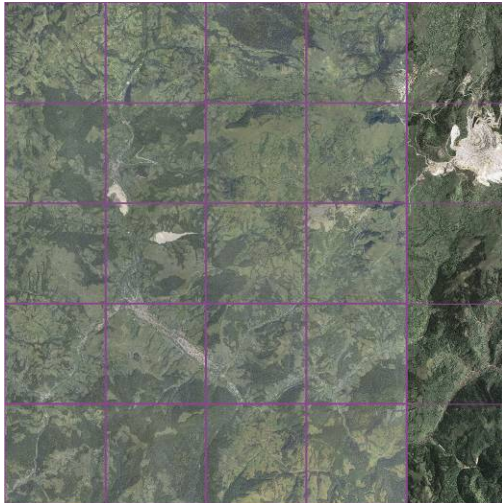
Fig. 5 The orthophoto images before
processing.(Erdas Imagine);

Fig. 6. The orthophoto images after
processing. (Erdas Imagine)

In order to remove the Rosia Montana's technical objectives footprint, the masaic was cutout. Thus, three themes were constructed polygon shp type mask representing the three stages of project development - Year 7, Year 14 and year 19 - greening. Using cutting function as a mask ArcGIS software was done cutting their overall image, resulting in three images showing the impact zones by the gradual development of the project (Figure 7).

a

b

Fig. 7. Cropping mosaic by the mask - Example year 7 (a) and year 19 (b),
ERDAS IMAGINE

C. Conversion of technical data from .dwg format (AutoCAD) in .shp format (ESRI ArcMap) and creation of the GIS data base.

An important set of data, consisted of industrial development projects for the two phases of project development, was used. They were in *.dwg* format (Fig.8.a). To make 3D objects was essential to build a GIS database containing information identifying each target and altimetry information. Thus were created two different classes – the outline of the digitized objectives, polygon *.shp* type, and altimetry information represented by the quota lines in *.shp* type (Figure 8.b). For each item - career, landfill, dam, pond etc. export was done individually, checking data and filling the database with information tabulated above.

D. 3D modelling and textural simbolisation of the different project components

Since this is a mountainous area that is irregular slope, valleys, steep slopes, etc., for the outline of objects and targets the altimetry information was taken from the DEM. This operation was done with ArcGIS 9.2 - 3D Analyst by converting 2D data (Fig.9) in 3D (Fig9.b, c). All this module, interpolation form TIN was built each item (Fig.9b) and symbolized by rendering textured look as close to target (Fig.9c).
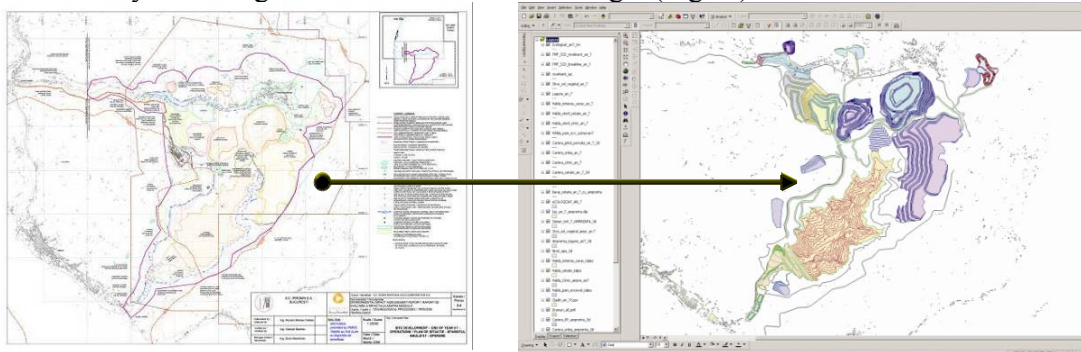

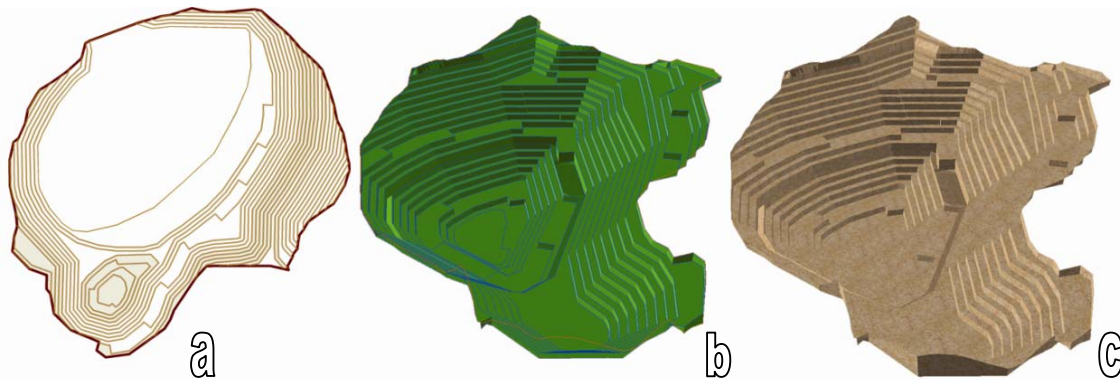Fig. 8. Data conversion from .*dwg* format in .*shp* format format

Fig. 9. Making 3D objects: Example 19 year Carnic Qarry – a-2D contour, b- TIN, c-texture rendering (ArcGis 9.2, ArcScene 9.2)

TIN means connecting structure (interpolation) of altimetry quotas according to certain rules (Fig. 4) resulting in an irregular triangles network. The inclination of the land is considered constant on each triangle. Triangle size varies depending on the land aspect. Thus small variations in land areas is represented by large triangles and in zones with high-energy the triangle size decreases in order to be closer to the reality. A TIN network data structure type comprises points, edges, triangles and geometric information (points X, Y coordinates) and topological (points, edges of the neighbouring triangles).

Being a 3D representation also the buildings were symbolized. They have been structured as follows: 1. Ordinary buildings, memorial buildings and church buildings. Ordinary buildings were built in the form of blocks by extrusion with a fixed rate and memorial buildings and churches were built in 3D by their shape.

F. Data integration in ESRI ArcScene in order to obtain the virtual scenes

After the above steps the final scenes were built in ArcScene9.2. Thus were created three separate projects - the initial situation (Fig. 10), operating An7 End of the operational 7

year (Fig.11), 19 End year (Fig.12). Of these three projects was done a movie as part of a video presentation of the project.
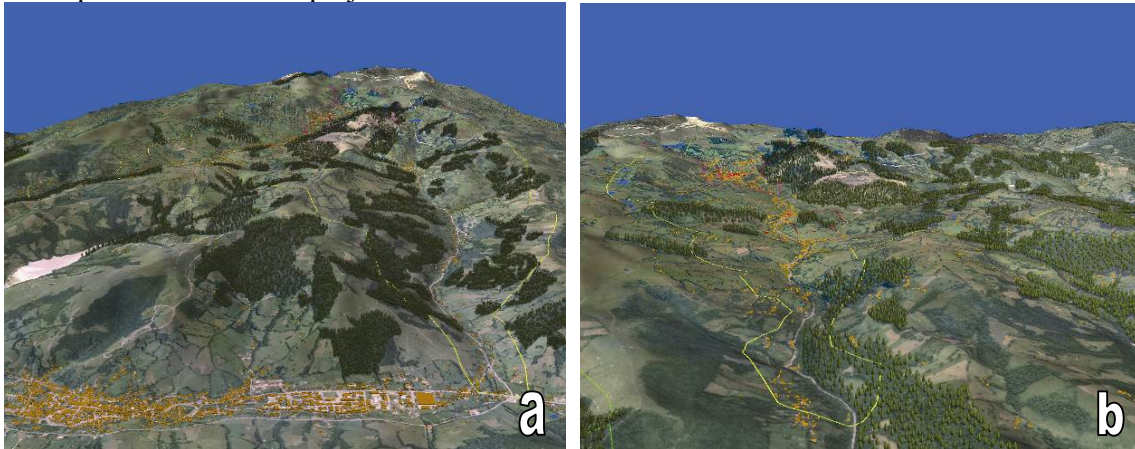

Fig. 10. 3D Project - Initial situation: (a) Aerial view from Abrud city; (b). Aerial view from Gura Rosiei; (ArcMap9.2, ArcScene 9.2)
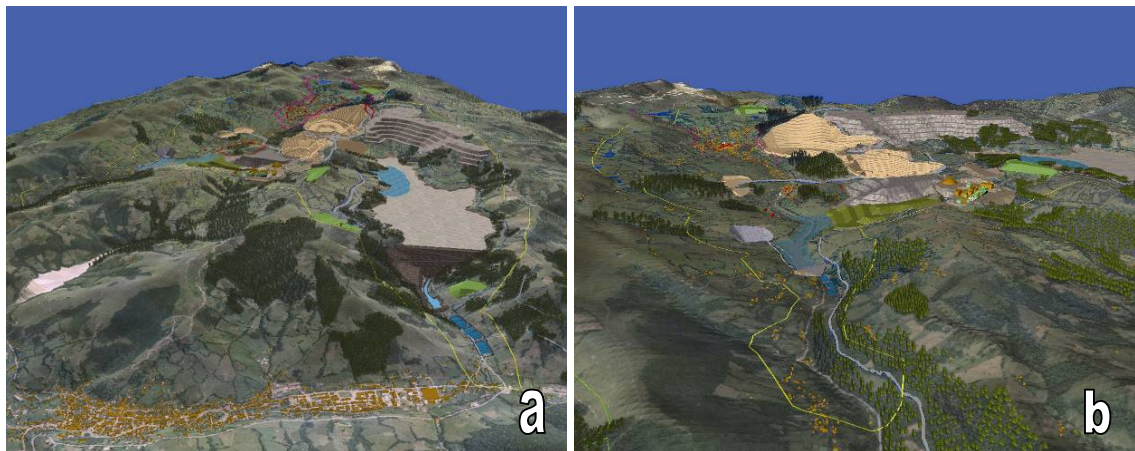

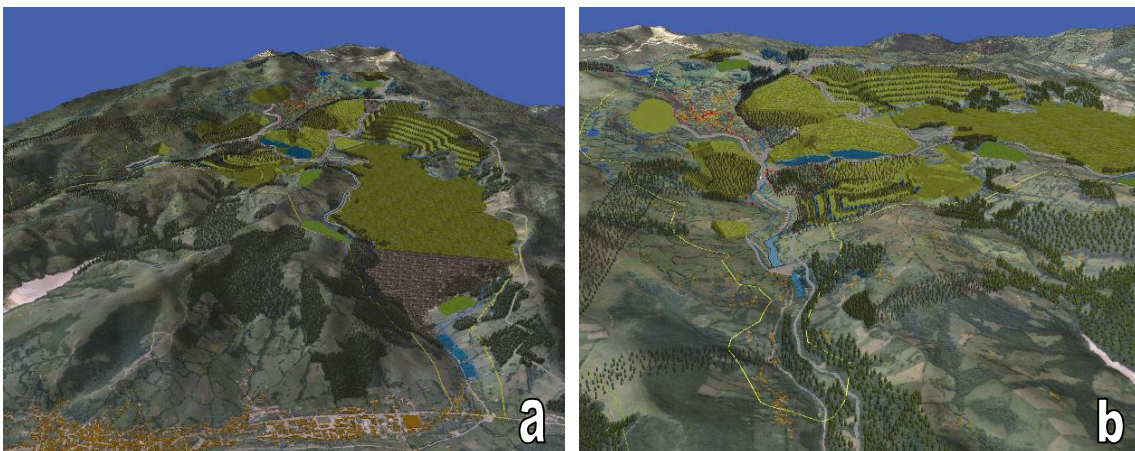Fig. 11. 3D Project - Year 7: – 3Dproject - Year; (ArcMap9.2, ArcScene 9.2)

Fig. 12. 3D Project - Year 19 – 3Dproject - Year; (ArcMap9.2, ArcScene 9.2);

3. Conclusions

The purpose of this article is to present GIS methods and techniques used to conduct an industrial project and how 3D animation can provide visual information and understanding of a project evolution. GIS technology and 3D modeling are tools that should not be absent from work for presentation and design, as benefits of using it are huge. We hope that the images presented are enough examples to be able to differentiate between 2D modeling and 3D modeling.

4. References

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4. *ESRI AcrGIS şi ArcScene 9.2 Online documentation*