USING LanDTM TO GENERATE A DIGITAL TERRAIN MODEL FOR DRAINAGE AND IRRIGATION WORKS IN GHELINTA – BRATES AREA, ROMANIA

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ABSTRACT

The paper describes the result of an interdisciplinary work at the intersection of computer science, civil engineering and land development. It is also a cheap and reliable method to asses the terrain condition before carrying out land reclamation projects.

Key Words: digital terrain models, land development

1. Introduction

In the process of answering a question, solving a problem, or addressing a topic that is too broad or complex to be dealt with adequately by a single discipline or profession we come together, in our Internet connected world, in a manner that often surpasses the classic definition of interdisciplinarity.

Disciplinary knowledge, concepts, tools, and rules of investigation are considered, contrasted, and combined in such a way that the resulting understanding is greater than simply the sum of its disciplinary parts, by people with different backgrounds, from different locations in different countries, who share only a common interest in solving a certain problem.

As civil engineers and land development experts, we all need a cheap and reliable method to asses the terrain condition before carrying out a new land reclamation project. Unfortunately, the raw data for such an assessment are not easy to find.

In order to override this issue, a Spanish company “Aplicaciones Topograficas” S.L has developed a software application, LanDTM, which helps us building a DTM (Digital Terrain Model) for the area of interest. This useful application can be downloaded for free from www.landtm.com website [1].

2. Lan.DTM. Main Characteristics

LanDTM is powerful tool, which can be integrated in AutoCAD and BricsCAD, allowing us to create and design a DTM, including break lines and containing options for editing, viewing and file sharing. It has also a module called "Geographic information", with a lot of tools for the representation of digital models, not only in plan, but in other reference systems too, such as UTM (Universal Transverse Mercator), which is used by the GPS system, the most widespread in the world.

And last but not the least, this program can access the database of digital models from all the world, created by the SRTM (Shuttle Radar Topography Mission), which contains a representation of points on the earth, with their corresponding elevation at every three seconds of arc (90 meters), in every area of the world and at every 1 second of arc (30 meters) in the area of United States [2].

In our opinion, this software application deserves not only a wide recognition but it has really earned a privileged place among the tools that professors and trainers, generally, should teach in Universities and Education Centers, because the way it is presented, allows a clear learning of many aspects of topography and cartography.

For now, the application is available in English, Spanish and Romanian language and is in a continuous development.

The application was tested with good results in the frame of the project "Water excess removing in Ghelinţa-Brates area, Covasna County, Romania".

LanDTM has three main sections, which are:

- Creation, editing and viewing of the digital models;
- Survey tools;
- Geographical information.

Further on, the paper presents LanDTM features and illustrates the results of its use for Ghelinta – Brates area.

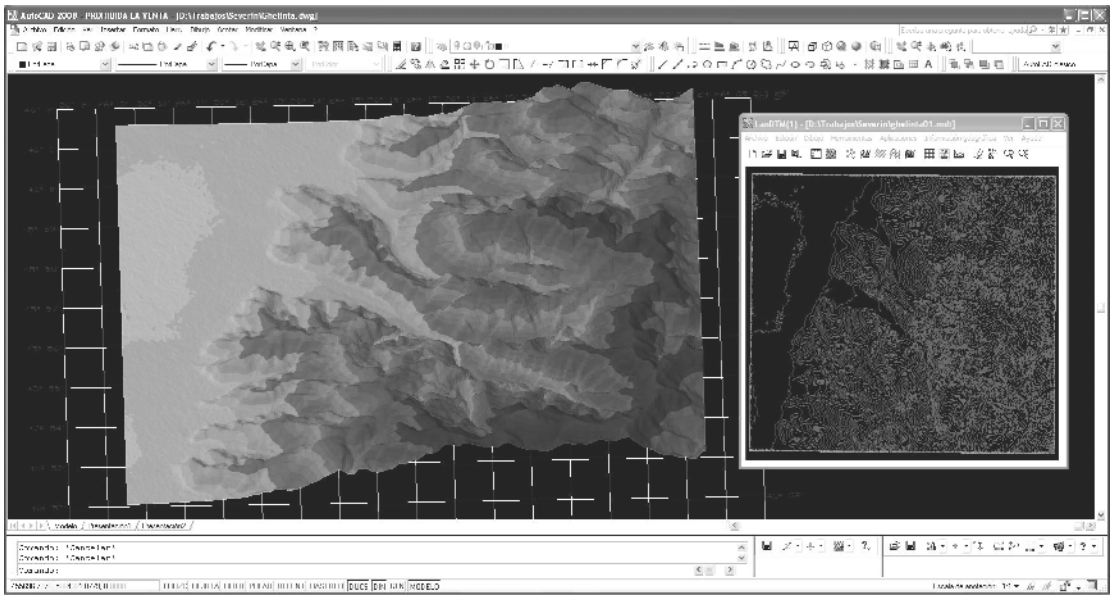

Figure 1- Integration of LanDTM tools in a CAD environment

2.1. Digital terrain models creation, editing and viewing

In the beginning, it is necessary to explain briefly all the special features added to this new version of LanDTM [1]:

- **Built on a powerful CAD, (Computer Aided Design):** It was wise to integrate these type of tools in a CAD environment, well known worldwide as AutoCAD from Autodesk Inc. or BricsCAD from Bricsys Inc., because it turns to its own benefit the full potential of these CAD systems, such as: viewing, design and editing. Figure 1 shows the studied area in a .mdt file of LanDTM and in a AutoCAD .dwg file.
- **Environment for viewing and editing of numerical data:** the software creates a digital terrain model and draws it in a CAD file. Integrated in a Windows environment, the data can be easily accessed in order to be analyzed and modified in an alphanumerical and/or graphical way.
- **Number of points and computation speed:** The triangulation is based on Delaunay method, creating the corresponding Voronoi polygons and is tested to process 1 million of points in less than 10 seconds. This performance is the result of the optimization of the corresponding algorithm.
- **Inclusion of break lines in the digital terrain model:** As any reliable program for digital terrain model generation, LanDTM allows to include breaklines, take them into consideration and observe them when computes the triangulation, succeeding to obtain a digital model as close as possible to the actual terrain.
- **Contours:** Quick calculation of the contours generated from the triangles

as well as their representation, both unsmoothed and smoothed as parameters.

- **3D and solids:** It allows the 3D drawing for subsequent rendering and representation of solid colors for a better understanding of the terrain.
- **Grids calculation:** On any digital model created the grid of points can be computed, according to a given interval.
- **Volume calculation:** LanDTM allows easily computing the volumes between grids or TIN (triangulated irregular network) digital terrain models as well. This is the most accurate existing procedure.
- **Computation of the longitudinal profiles:** the software application allows the calculation and display of the longitudinal profiles, by simply placing a polyline on the model.
- **Calculation of slopes of platforms / route:** It allows the calculation of the slopes of any platform having the corresponding values the same ones. Once calculated, they are projected in the CAD as 3D polylines.
- **Dynamic editing of the model:** A number of tools are included, with which aid, it is possible to edit dynamically the triangulation within CAD environment. Thus, when you move, delete, create any new line, the triangulation and curves are automatically amended.

2.2. Survey tools

The software application installs a tool bar, which can be accessed to change the properties of the entities generated by the digital models software and contains a number of very useful tools for anyone who wants to work in a CAD environment [1].

- **Delete area:** Option which allows deleting or changing the layer for the existing entities within a given polygon.
- **Draw slopes lines:** Representation of the slopes with 3D lines, marking the directions of excavation and embankment.
- **Designing entities on the terrain:** this option allows designing any type of CAD entity, not only on the digital terrain model, but on any other entity also.
- **Elevation change:** With this tool, one can put everything at 0.000 elevation, which is the most common used, and also at any elevation you want with a series of variations that makes it more interesting.
- **Join lines / polylines:** Typically, CAD systems have a method to join entities, but there is hardly compare to this very powerful tool that links 3D and 2D entities. It has not to keep the ends linked, but allows those ends to be separated, thus facilitating to join all types of entities, which are far from each other.
- **Draw the grid on the layout:** Helps to label the final plan.
- **Refine manually:** If we receive a plan with all the elevation contours set to 0.000, thanks to this tool, we can refine all these curves very easily and dynamic.

2.3. Geographical information.

This is one of the last parts we worked on for this program, and perhaps the most spectacular. We can summarize as an access to any database in the world, containing digital models. We know that every country has done or is doing its own map database at the highest possible scale and that one of the data you need to take are the points with elevation separated by a distance, the smaller the distance is the better.

LanDTM allows access to these points to create the corresponding digital terrain model, not only in plan coordinates, but also to represent it using one of the most commonly used reference systems, like UTM (Universal Transverse Mercator) and can draw the model, both in plan coordinates and on the correspondent ellipsoid [1], [3].

Among the most important aspects of this section, we highlight the following:

- **Access to the data:** All the files containing the points with elevation, which form the digital terrain, can be found on the Internet, 30 Gbs for now,

with WMS (Web Map Service) access type. Using WMS, the user don't need to keep that information on his own hard drive. The program automatically seeks the necessary data for the area to be processed, on the Internet [1].

- **Points representation:** Normally, the points with elevation, downloaded from the Internet, have latitude and longitude and the program is able to represent these data, in a CAD environment, both in plan coordinates (Figure 2) and on the reference ellipsoid for the corresponding projection [3].
- **Contours:** The best system to view the digital terrain model is represented by the contours (figure 3) and the software application allows drawing them, smoothed or unsmoothed, at different scales, for a better appreciation of the relief in the selected area [3].

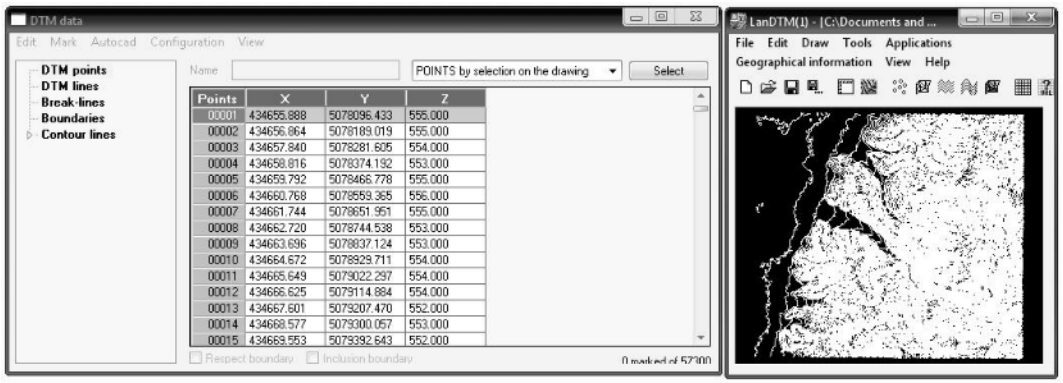

Figure 2 - Data representation in plan coordinates for Ghelinta-Brates area

Figure 3- Ghelinta – Brates contours in connection with area relief

- **Drawing and view of meridians and parallels:** The meridians and parallels, according to a chosen interval, can be represented in CAD environment (figure 4), so that the digital model will be much better defined. This can be done on the corresponding UTM Zones or on the corresponding reference ellipsoid.

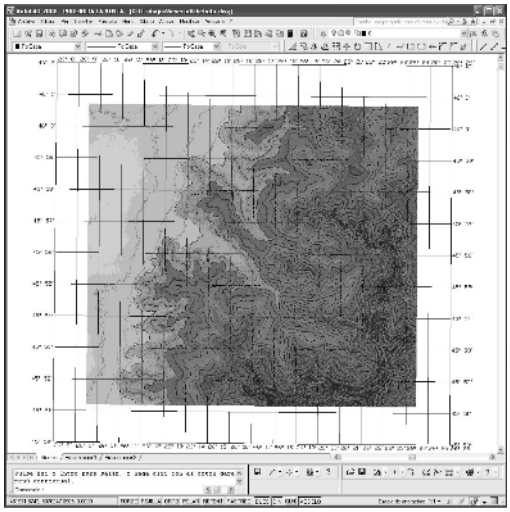

Figure 4 – Contours representation viewing meridians and parallels in AutoCAD

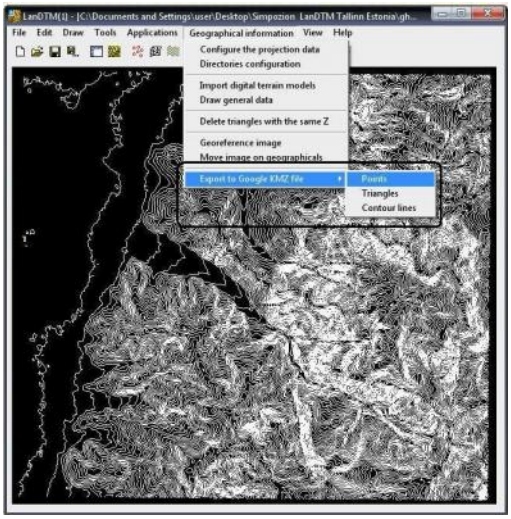

Figure 6 – Points and DTM lines export

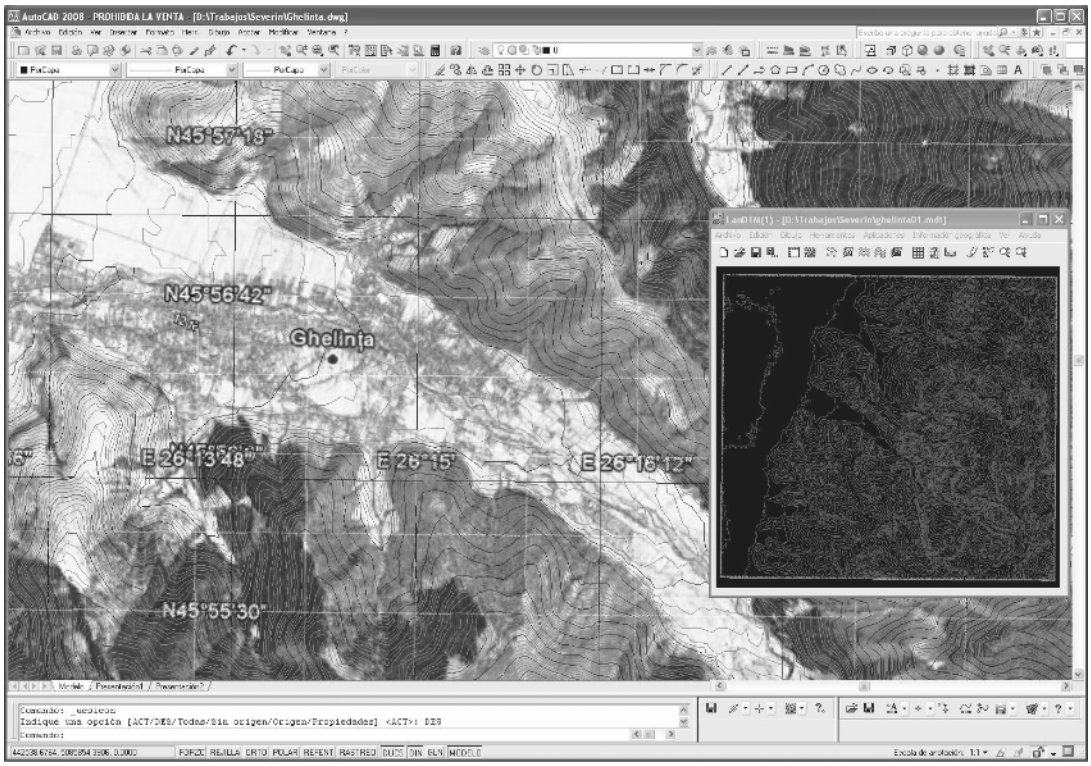

Figure 5 - Ghelinta – Brates georeferenced image

- **Georeferencing of any image:** If one has a picture or drawing in any part of the world, it can be georeferenced quickly, using the working coordinates and put it in the digital model we develop. Thus, any aerial photography may be placed in our model for a better appreciation of the land on which we are working (figure 5).
- **Export data to kml / kmz in Google Maps / Google Earth:** The program has a series of options to export points,

DTM lines and contours (figure 6) in KML / KMZ format files of Google Earth and Google maps.

These files can be put as Google images (figure 7). The program utility may be visual or as representation of a project performed by us, in real photographs of the terrain.

3. Conclusion

LanDTM is a software application created using all the new computation techniques. It is useful not only for general surveying, but for civil and environmental engineering, too.
The application uses Delaunay triangulation in order to represent the real terrain in a CAD environment and has professional approach and design. It is reliable and runs fast with unlimited number of points and can use a large number of breaklines (more than 20000).
The program runs on AutoCAD 2007/2008/2009, AutoCAD 2010 and BricsCAD v.10 and uses "Protopo" libraries, a famous Spanish engineering civil and surveying program [3].
Once a DTM has been created, contours, profiles, volumes between surfaces and 3D displays are available.

The key feature of successful interdisciplinary practice is not the disparity of the chosen disciplines. What demonstrates real interdisciplinary thinking is the use of each discipline as a valid source of knowledge in its own right and a valuable contribution to the discussion at hand.
Interdisciplinary studies suggest one reason for engaging in interdisciplinary analysis: there are real-world issues and "problems" that are broader than any single discipline and can be fruitfully examined in an interdisciplinary framework. In addition to this "problem-solving" orientation, achieving deeper understanding can be an important motivation for interdisciplinary endeavours.

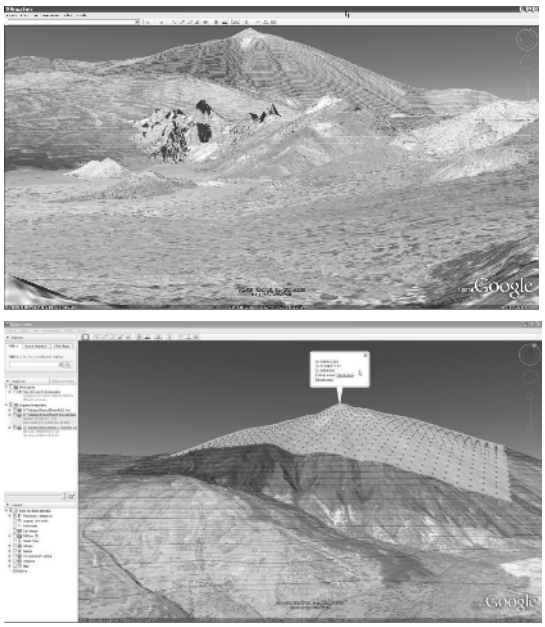

Figure 7 – DTM surface draped in Google Earth and the actual image of the terrain

4. Acknowledgements

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5. References

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