MODELING OF JIMBOLIA LANDFILL IN VIEW OF ECOLOGIZATION

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Abstract: Before presenting the topic addressed in the diploma project, it is necessary to place the research in the broader context of three-dimensional modelling field, which is currently at a stage of unprecedented evolution. Over the last three decades, the continuous development of specialized programs has changed the way data obtained from surveying engineering measurements are processed. This is also due to the improvement of data acquisition technology, such as terrestrial and airborne photogrammetric methods or Remote Sensing. In the context of the challenges facing the world community in the 21st century, particularly for our country, an important aspect is the closure of landfills to reduce the danger posed by them, the aim being to ensure the sustainable development of human societies. For this purpose, the disciplines specific to the field of land measurements are used in different stages, for surveying the area represented by landfills and for their 3D modelling.
Keywords: landfill, ecologization, surveying engineering, TIN, DTM

1. INTRODUCTION

The greening of settlements, generally understood as sanitation, aims to achieve and maintain the hygiene of a settlement (urban or rural), on which the quality of life of the population depends to a large extent. According to the current legislation in our country (Law No 139/2002 approving Government Ordinance No 87/2001 on local public sanitation services), sanitation is 'a local public service of municipal management, organised, coordinated, regulated, managed, monitored and controlled by the local public administration authorities'.

In Romania, in 2000, out of almost 13,400 localities, towns and villages, only the 263 towns and municipalities and some villages located in the area of influence of large cities benefited from sanitation services. These data confirm that sanitation is now mainly a city-based activity, as these settlements have a large number of inhabitants.

In rural areas, according to previous research (2001), only in 19 counties there were 2,003 urban and rural landfills (mixed landfills) with an estimated area of over 1,800 ha. Romania is currently facing inadequate waste management. [1] [2] [3]

As has been shown, a particularly frequent impact of these landfills, which is noticed by the population, is on the atmosphere, through which the odours emanating from the waste are spread. Although the rules on the siting of municipal waste landfills stipulate that they may not be located closer than 1 km from a locality, most do not comply with this requirement. [4]

After joining the European Union, Romania undertook to close more than 100 landfills operating without a permit. The deadline for transposing the directive was 2009.

The Ministry of Environment revealed that, as of 2018, "only 13 non-compliant municipal waste landfills and 38 hazardous and non-hazardous industrial waste landfills remain open".

2. MATERIALS AND METHODS

In recent years, more and more engineers around the world have taken up this relatively new field of three-dimensional modelling, preferring 3D design systems to traditional 2D drawing systems. Designing on a 3D model (Figure 1) is faster than traditional 2D design. [5] [6]
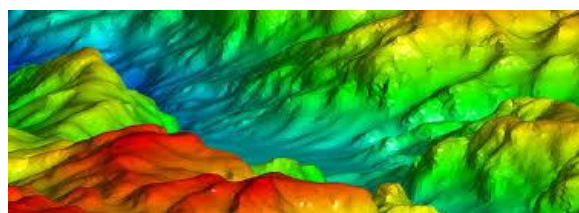

Figure 1 – 3D model example

Most applications that deal with spatial data manipulation do not need (or only in very few cases need) to use DTM. This is particularly the case for cadastral and real estate management. On the other hand, a large number of applications require DTM, most of which are related to natural resource management. [7] [8]

2.1. Principles of a digital terrain model

A digital terrain model is by definition a data set that allows interpolation of an arbitrary point on the terrain to a predetermined accuracy. In this sense the DTM is substantially different from contour lines or contour lines on a map. Contour lines and contours only provide elevation information for the line element; also, the image of contour lines should give an idea of the morphology of the terrain (straight terrain, slightly undulating, smooth wavy lines, rough terrain, very wavy lines, etc.). Contour lines should represent levels and small geomorphological features through their typical shape and "family effect". This sometimes requires an exaggeration of certain landforms. Therefore, contour lines are mainly used for terrain visualization, while data for a DTM are intended to provide information on elevation and elevation changes inland at any point in the terrain in a form that can be read by a computer. Contour lines obtained from a DTM dataset

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will not specifically show terrain morphology analogous to profiles drawn by a surveyor. [9] [10] [11]

2.2. Basic DTM data and interpolation principles

Interpolation is the procedure of estimating a value at a location without measurements, using measured values at neighbouring points. It involves finding a function f(x, y) that represents the entire area of z-values associated with irregularly arranged points (x, y). This function makes a prediction of z-values for other regularly arranged positions (Figure 2). [12]
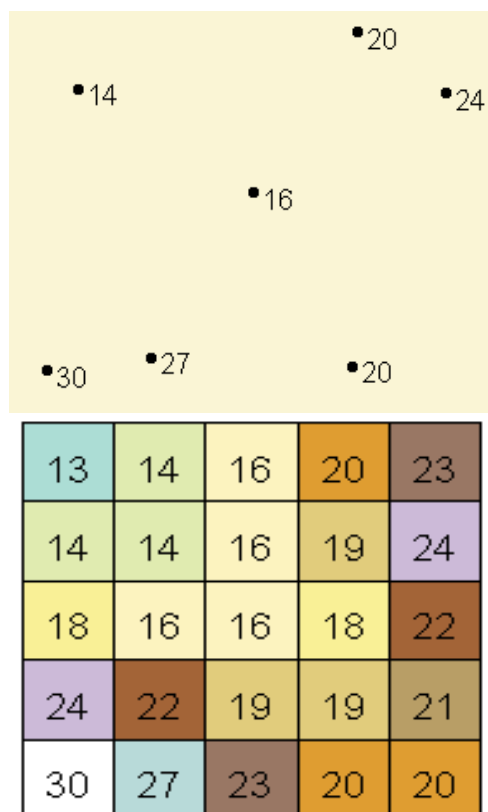

Figure 2 – Raster obtained from interpolation of known values

Interpolation can be:
➢ Exact (when the model obtained preserves the original data values);
➢ Approximate (when initial data values are altered);
➢ Local (only values from neighbouring points are taken into account);
➢ Global (all points with known values are considered).

In other words, interpolation consists of predicting the cell values of a raster file based on a limited number of point measurements (Figure 2). [13]

The basic idea of interpolation is illustrated in (Figure 3) and is called the method of least squares, which finds the approximating function when the values of a function are known at some points and we need the values of this function at other points. With this mathematical method we will look for that approximation function that is "closest to all points". [14]

The construction of the Digital Terrain Model consists of creating a continuous surface using the interpolation method from data collected in the field. [15]
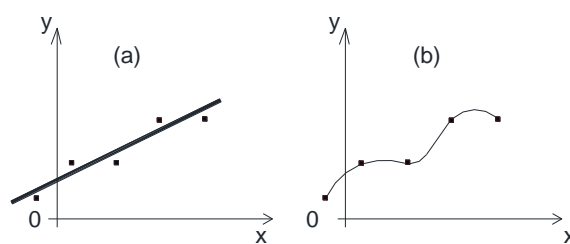

Figure 3 – Line found by least square method (left) and Interpolation approximation function (right)

Thus, linear and non-linear interpolation methods based on support points belonging to the physical land surface can be used to approximate the topographic land surface from the recorded data.

3. APPLICATION STUDY

The volume of information perceived by any user today is constantly increasing, thanks to the almost unlimited possibilities of management and exploitation provided by keeping this information in digital form.

The application study involved 3D modelling of data measured in the field in order to green the landfill in the town of Jimbolia. The modelling was carried out using the specialised software, namely Trispace produced by the company Geostru. [16] One of this software's properties is that, before triangulation, it is possible to choose how to obtain triangles. In the properties panel, Triangulation section, you can find the type of algorithm that the user can use to perform the modelling.

Once all triangles are generated, it is possible to represent the surface in several ways. In the properties panel, Mesh section, there are some settings to customize the visualization.

3.1. Location of the studied zone

The geographical location of Timis County gives it a privileged location, being the westernmost county in Romania. It is bordered to the west by Csongrad County - Hungary and to the south-west by Vojvodina Province - Serbia.

The town of Jimbolia is located in the extreme west of Romania, in the historical province of Banat, on the western edge of Timis County, on the border with Serbia, in the Banat Plain, 85m above sea level, at the intersection of the meridian of 20º43'20" east longitude with the parallel of 45º47'30"north latitude, 44km west-northwest of the city of Timisoara.

Figure 4 – Location of the studied area – Jimbolia locality, western Romania

3.2. 3D processing of the study area using the specialized software Trispace

For Digital Terrain Models, measurements must be three-dimensional. In the figures below (Figures 5 - 7) we have shown the reporting of measured points in AutoCad.
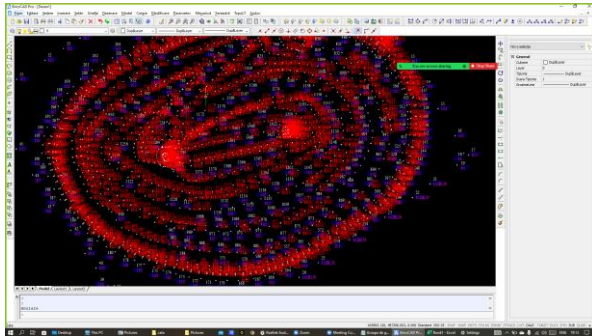
Figure 5 – Appearance of the measured points represented by the codes with which they were surveyed in the field
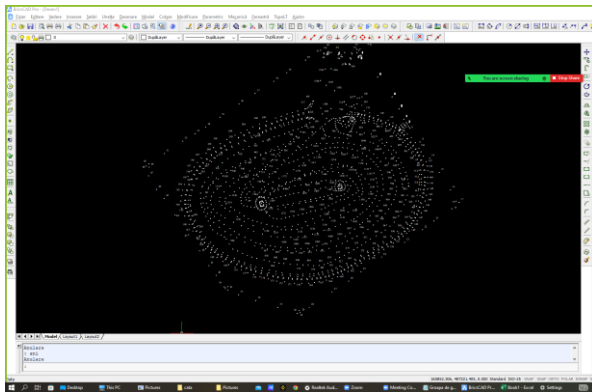
Figure 6 – The aspect of measurements made for the Jimbolia landfill

Next phase consists in overlapping the measurements over the orthophotoplan of the area, for a more suggestive representation (Figure 7).
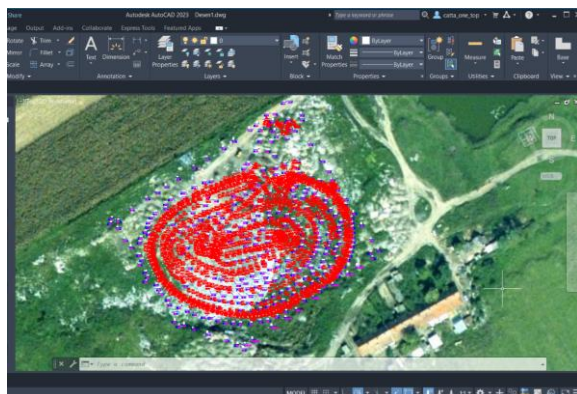
Figure 7 – Overlapping measurements over orthophotoplan

After analysing the survey in AutoCad, we proceeded to introducing the measured points in the Trispace program for the 3D processing of the landfill in Jimbolia.

The first stage of the modelling consisted of importing the measured points into the program and generating the perimeters of interest. The points were saved as an Excel file with the csv extension (Figure 8).
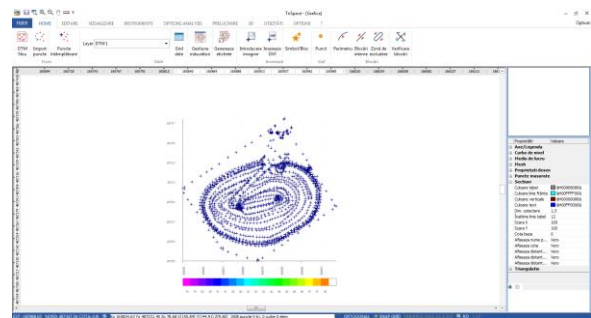
Figure 8 – Import of points measured in the field
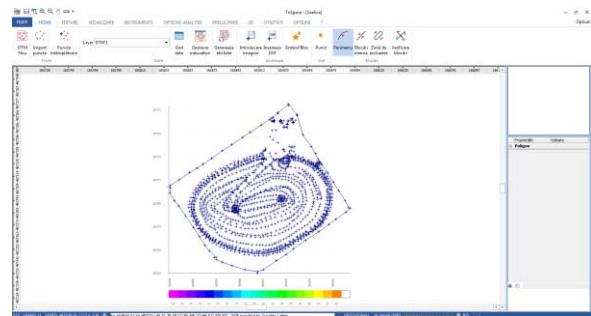
Figure 9 – Highlighting the perimeter of interest of the study area

After applying the appropriate blocking illustrated in the figure (fixation-perimeter) (Figure 9), the TIN (Tringulated Irregular Network) for the landfill surface has been realized (Figure 10).
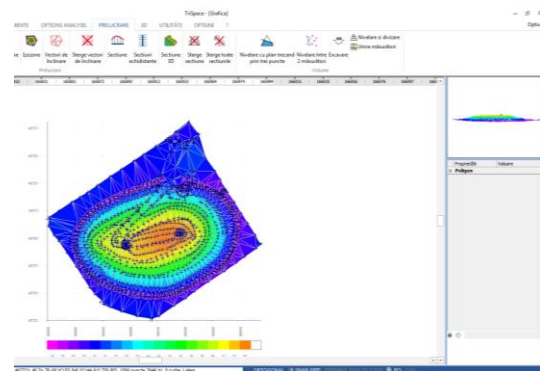
Figure 10 – Triangulation of the study area

On the created surface, contour lines can be generated as shown in the figure below (Figure 11).
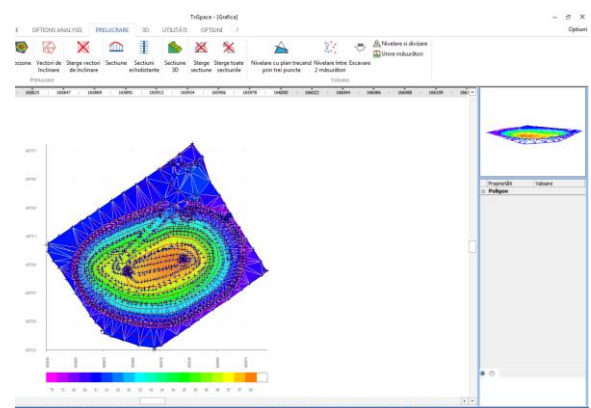
Figure 11 – Contour processing

In the program it is possible to add text labels containing the value of contour lines for easier understanding (Figure 12).
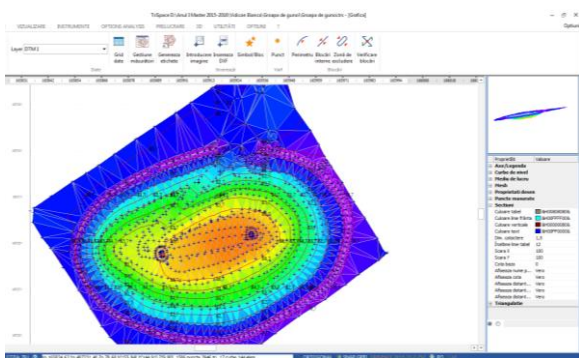
Figure 12 – Generating contour labels
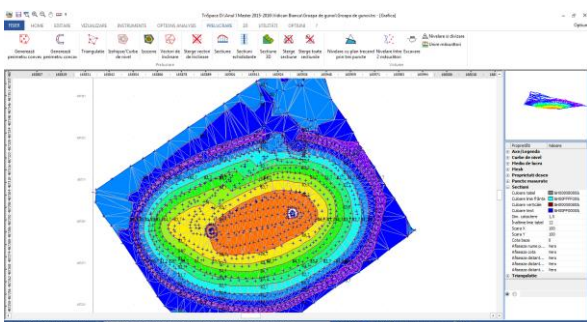
Figure 13 – Izozone processing

In order to create a suggestive overview of the terrain slope in the study area, the program offers the possibility to add slope vectors (Figure 14).
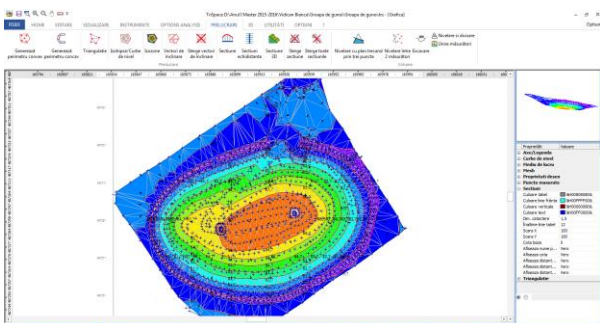
Figure 14 – Tilt vector processing

If adding tilt vectors to the 3D surface loads the drawing, they can be deleted (Figure 15).
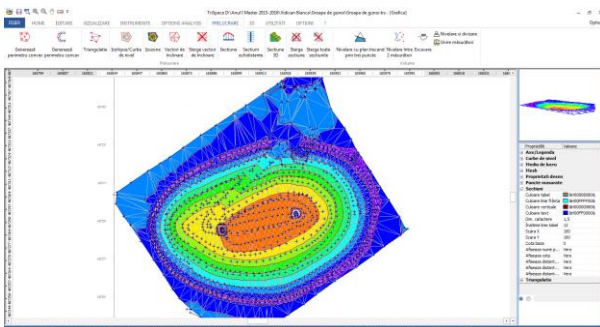
Figure 15 – Processing: tilt vector deletion

Generating profiles through the 3D surfaces made involves drawing a line defining the direction of profile generation (Figure 16).
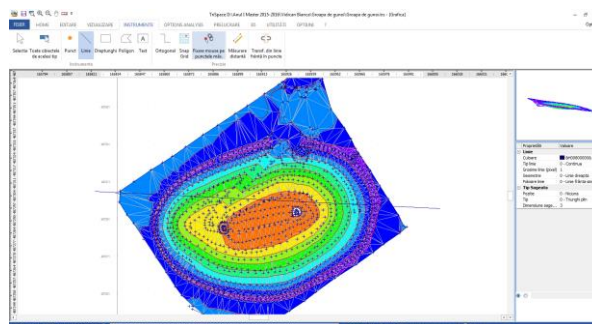
Figure 16 – Positioning a line to serve as the basis for creating the section

Selecting the profile generation direction offers 2 possibilities to obtain profiles, namely: entering the size of the perpendiculars to the profile generation direction or specifying the number of sections desired.

After generating the profiles (Figure 17), they can be edited to have a more technical aspect and then be used for various purposes in engineering projects.
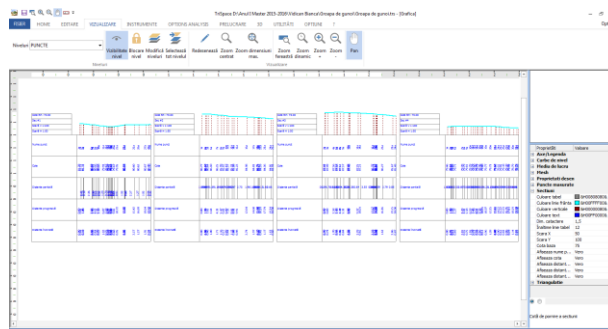
Figure 17 – Equidistant section processing

The profiles produced are exported in dxf format (Figure 18) to be further arranged and used in specialized Computer Aided Design programs, such as AutoCad (Figure 19).

Figure 18 – Using the dwg export command of the profiles

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Figure 19 – Example of profile exported from TriSpace to AutoCad

4. CONCLUSIONS

Surveying Engineering is the basis for the production of topographic documentation for the elaboration of projects for the systematisation of populated centres and for the design of investments by means of large-scale topographic plans with contour lines, profiles, etc., for the field application of construction projects.

Surveying methods and tools form the basis of construction works involving the application of the construction project on the ground. The various projects cannot be carried out without up-to-date topographical plans and topographical profiles, drawn up at the largest possible scale to show the technical details as clearly as possible.

Nowadays, thanks to the advance of technology (both high-performance topographic instruments and specialised programs for processing measured data) the processing of topographic terrain features is done in a three-dimensional system, offering great possibilities for data analysis and interoperability, while making processing time more efficient and minimising it.

In terms of the application study carried out, I can say that sustainable landfill management aims at source separation of the different categories of waste, collection of the full amount of waste generated, streamlining the flow of separately collected waste, closure and greening of non-compliant landfills and construction of new compliant landfills. The major objectives are to protect the environment and the health of the inhabitants, extend solid waste collection to all localities, introduce and extend separate collection systems and, last but not least, comply with European legislation. For these reasons, I believe that 3D modelling of landfills is an important step towards achieving the goal of sustainability.

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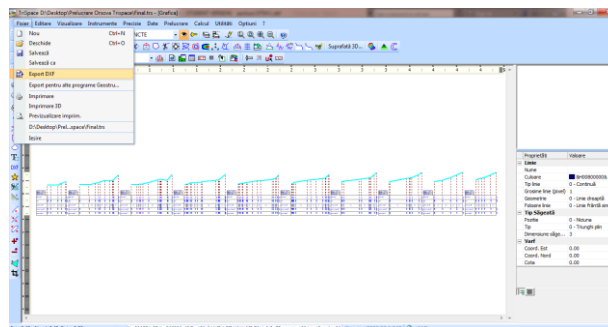
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