DRAWING UP THE NUMERICAL MODEL FOR THE FIELD RELIEF BASED ON THE DETAILED TOPOGRAPHIC ELEVATIONS PERFORMED IN THE UNDERGROUND PIPE DRAINAGE SYSTEMS

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Abstract

For The modern cartographic representations of field relief as plans and digital maps, and numerical models, respectively, require the existence of new topographic measurements made with modern methods. In this context, a series of hydroameliorative systems with underground pipe drainage are taken into consideration so that afterwards the fields can be exploited as agricultural fields. The case study included the execution of detailed topographic elevations on 210 ha that included a pipe drainage system. The area was situated in the Baia-Sasca, Suceava County, hydroameliorative system. For conducting the field works there were used GPS receivers, total measuring stations and the A class network of permanent stations from the GPS-GNSS national system. After the real time processing of the on field observations it resulted the plan metric and altimetric set of elevation points. Based on this set of points it was created the digital plan in the 1970 Stereographic projection system of coordinates and the numerical model of the relief in the normal heights system – 1975 Blank Sea.

Key words: digital elevation model, digital topographic plan, pipe drainage

The development of cadastral and real estate works including the systematic recording of the real estates from all administrative territorial units represents a necessity for the national economy.

The electronic data in this field of activity results a priority for an accurate land management, both public and private, considering its technical, economic and legal records. The ***Geographic Information System (GIS)*** is used in numerous fields of activity as ***agriculture, forestry, land planning, water, incorporated, communication paths, natural protected areas, natural disasters, and others*** . Considering the *graphic entities* of the basic maps and the *records* of the general cadastral plan of an administrative territorial unit, the resulting database can be structured on various elements of interest. The resulting database ensures the analysis and the processing of the data recorded for various purposes with direct local and regional application. The lands used in agriculture have a set of geographic information systems for different types of hydro-ameliorative works.

The following categories are mentioned: ***irrigations, underground pipe drainage, preventing and counteracting soil erosion, landslides, flooding and others***. For recording the vectorial geo-spatial data necessary at creating the graphic elements of a ***GIS project***, different methods and technologies are used.

The most frequent ones are the ***GPS technology*** and the total stations, used for topographic surveys, and secondly there is mentioned the vectorization of analogical plans/maps (Băduţ, M., 2007). At the same time, this data must also be taken from the graphic and textual records of the technical projects corresponding to different land improvement works made in the territorial administrative units.

Over the years, in the extra Carpathian area of Suceava County there have been made various hydro-ameliorative systems with the purpose of collecting and eliminating the water excess. The total surface foreseen with drainage systems covered **55,100 ha**, on **26,300 ha** of this entire surface being also a systematic network of sub-surface drainage consisting of collector and absorbent drains (Moca, V., Bucur, D., 2014).

Surface drainage and pipe drainage works have contributed on the one hand, to reduce excess soil moisture and secondly to increase production capacity of these soils.The computer application of

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the present case study for the type of "*underground ceramic pipe drainage system"* was created based on the geospatial data collected on the field.

For this purpose, the ***GPS – GNSS spatial technology*** was used and it was associated with detailed topographic measurements obtained using the total station.

MATERIAL AND METHOD

The integrated real estate and cadastre system provides the primary database of the cadastral sectors from the administrative – territorial units of Romania (Cadastre and Real Estate Advertising Law no. 7/1996). After making the measurements and the graphic representation of real estates on the basic cadastral plans results the updated records of the technical cadastral data that can be stored on electronic devices.

The technical cadastral database can be used to organize the graphic entities of agricultural and non-agricultural land in layers, according to their usage categories and hydrographic basins as well as according to other categories (Crenganiş, Loredana, Balan, Isabela, 2013). Considering the agricultural surfaces from the administrative territorial units where various hydro-ameliorative works have been conducted, then it is necessary to identify, describe and record them in cadastral documents. The limits of those cadastral sectors with hydro-ameliorative works must be represented graphically using the plane rectangular coordinates (X, Y) of the contour points.

The natural conditions of Suceava County required in time the existence of various works for preventing and counteracting the water surplus from various areas. In these representative areas, the area with the highest water excess was identified as the "*Baia Depression"* .

The relief and the microrelief of *Baia Depression* led to the uninform distribution of rainwater and of the water from the versants. The climate through its components along with the other natural and anthropic factors influenced the development of water excess in the soil and at the surface of the land.

In the low meadows and the high terraces of the *hydrographic basin of the Moldova river* it was created the **Baia – Sasca – Horodniceni** surface and subsurface pipe drainage system.

The total surface covered was of **5.527 ha**; on **1,806 ha** of the total surface it was placed a systematic drainage system consisting of plastic and ceramic pipes. The graphic support of the hydro-ameliorative system from the *Baia Depression* was cartographically included on the *control area* of *28 geodetic trapeziums*, scale 1:5 000 (Moca V., et. al., 2016).

For the three-dimensional modelling of the land from the geographic areas of the hydrographic basins and other natural areas it is necessary to know the spatial coordinates X, Y, Z, of a group of points from that particular area.

The basic principle of modelling is to define an area of land with coordinates X, Y, Z of the characteristic points of land, followed by interpolation with a specialized software to obtain the height of any point desired for which the planimetric coordinates X and Y are known (Didulescu, C., et. al., 2013).

The primary data sources that formed the basis for the analysis consisted of not only two spatial data types, raster and vector, but also of descriptive data. The raster data type used consists of the cartographic materials obtained from the National Agency for Cadastre and Land Registration, worksheets at scale 1:2000 and 1:10000 (the aerophotograpthy was realized in 1984) and the related orthophotoplans of the area, respectively (Dimen, L., et. al., 2013).

The Geographical Information System – GIS is a collection of data organized according to the needs of the field it is used in. The concept of information system considers the following two key elements: storing a large amount of information and having quick access to any information.

ArcGIS is a complete platform that allows its users to visualize, explore, search and share maps. Some of the main features of this application include: *spatial analysis, data management, creating and visualizing maps etc*.

The main objective of this paper consists in creating a geospatial database in order to enable the analysis of the relief from agricultural fields that include surface and subsurface drainage works.

In order to obtain the graphic elements of the geospatial data for *GIS* there have been made geodetic and topographic measurements on a cadastral sector of **208 ha** from the ***Baia -Sasca – Horodniceni*** surface and subsurface drainage system. The field measurements were made using *GPS-GNSS receivers* (Păunescu, C.,et. al., 2006) and the total station using the tachymetric traverse method. From the field measurements on the direction of the ***48 transversal and longitudinal*** *profiles* resulted ***2,966 detail points*** on coordinates X, Y, Z.

The network of points of topographic survey was used for creating the digital cadastral plan. On the graphic elements of the digital plan it was built the three-dimensional model for the surface measured; it represents a network of small-interconnected polygons – *Triangulated Irregular Network – TIN;* the coordinates of the nodes were calculated using gridding algorithms.

This three-dimensional representation of the surface and the polygonal approximation method laid at the base of the *Digital Terrain Modeling – DTM* and at the representation of the level curves.

The isolines of equal height, also known as *level* curves were drawn using an automatic system with the distance value of 2.50m. For drawing up the digital model of the land, the

ArcGIS desktop application was used*: release 10,* (*Environmental Systems Research Institute, 2011)*.

The geospatial database calculation and assignment was established in the official system of plane rectangular coordinates of the 1970 Stereographic projection. The digital model for the land was generated on the following thematic plans: *the hypsometric map, the map of the gradients, the exposition of the slopes*.

RESULTS AND DISCUSSIONS

The study conducted for the three-dimensional modelling of an agricultural land with pipe drainage network included a geographic area that is part of a category known as ***"areas with excessive water"***. After performing the measurements at the level of the basic administrative territorial units are obtained the primary technical data of the unitary cadastral system and land register on cadastral sectors and real estate/parcels.

The cadastral sector from Horodniceni commune that is part of the topographic survey is situated on a terrace from the Moldova river basin.

a. The digital plan of the land

First, it was created a support geodetic network and afterwards it was performed the detailed topographic survey using the traversing method combined with profiles and radiations.

This geographic area is represented by depression with negative relief form and altitudes lower than the marginal areas of the hydrographic basin. Based on the *X,Y,Z coordinates of 2,966 detail points,* there were created the digital plan in the 1970 – Stereographic projection and the 1975 Black Sea reference plan. Respecting the measurements and the contour it resulted a **surface of 208.4446 ha** (*figure 1*).

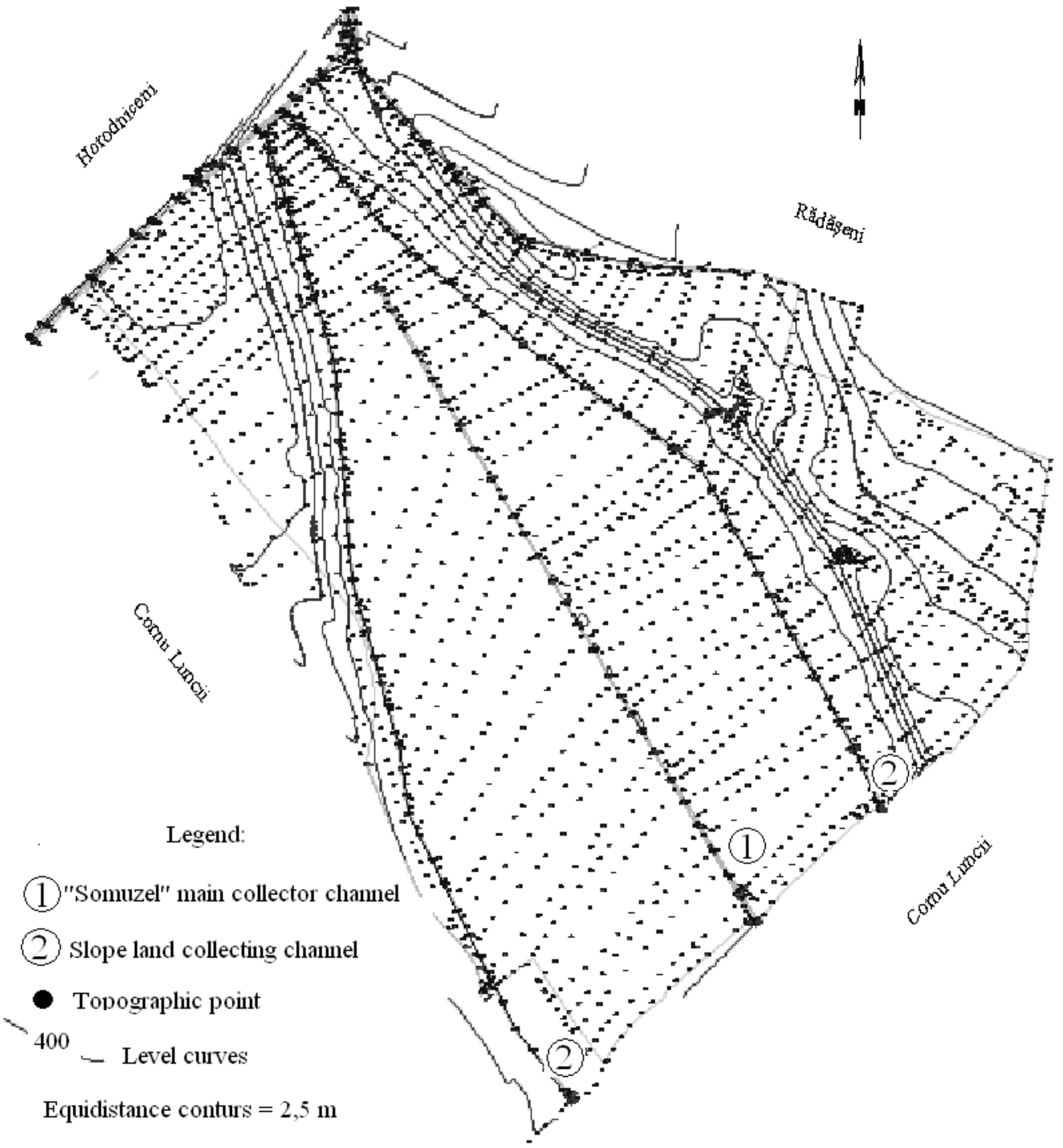

Figure 1 **Digital plan of Horodniceni cadastral sector – the Baia – Sasca hydro-ameliorative drainage system**

b. The digital plan of the land

The present case study includes the absolute quotas of the detail points in relation to the zero level surface of the *1975 Black Sea* reference plan. The digital morphological presentation of the land that included the absolute quota of the detail points pointed out the spatial distribution of the relief.

The distribution of absolute altitudes on height classes from 5 to 5m included the measured surface in the interval represented by the classes *390 – 395 m* and *415 – 420 m*. The level difference between the maximum quota of the land **- 418 m** and the minimum **- 393 m** was of **25 m** (*figure 2*).

The spatial distribution of the land on classes of absolute altitude indicated a surface of almost **120 ha**, that was included in the hypsometric class of **390 – 395 m** that is almost **60%** of the digital model.

The measurements made in the *Horodniceni cadastral sector* on an area **of 208.4446 ha**, allowed the delimitation of an area of **116.7935 ha** with sub-surface drainage system that is included in the hypsometric class of **390 – 395 m**.

In principle, altitude is considered a primary quantitative variable of the land relief. The primary derivates of absolute altitude for the points on earth are the slope (declivity) and the exposition.

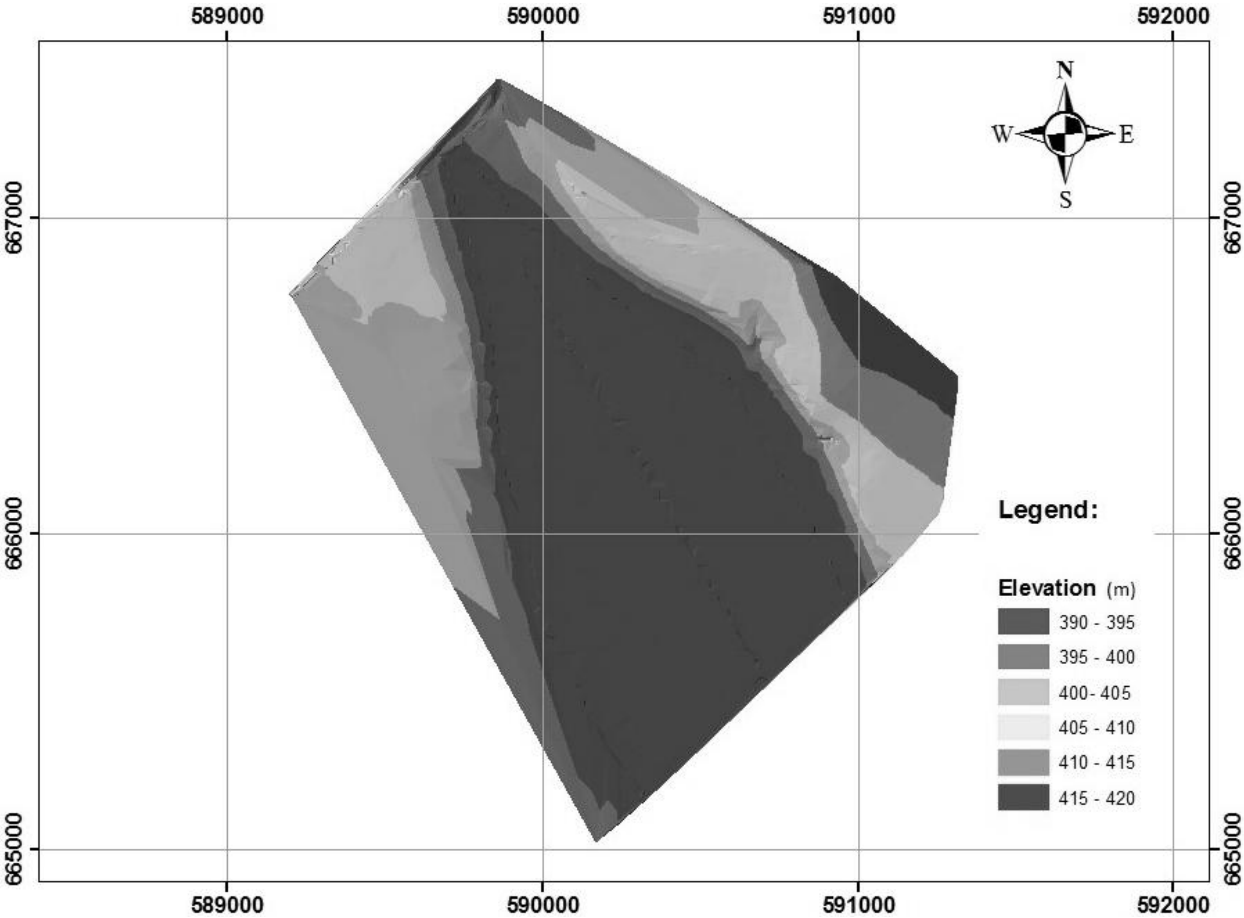

Figure 2 **The hypsometric map**

c. Land slope

Geometrically speaking, the land slope is represented by the inclination angle of the relief in relation to the horizontal plane.

The land slope is calculated in sexagesimal or centesimal degrees and it depends of the inclination angle. Simultaneously, the land slope can also be expressed using percents if we consider the trigonometric tangent of the inclination angle in relation to the level difference and the horizontal distance between the two ends of an alignment.

The analysis of the land inclination based on the digital model was conducted on seven classes, starting from *smooth slope* (***0 - 3^0***) and *highly inclined slope* (***18 - 21^0***).

The spatial distribution of the land on slope classes included **120 ha** with the absolute altitude of **390 – 395 m** in the category of relatively plane land, with *smooth slopes* (***0 - 3^0***).

On this surface it was recorded in time the collection of water from the versants. For counteracting the water excess, a pipe drainage network was introduced in 1980 (*figure 3*).

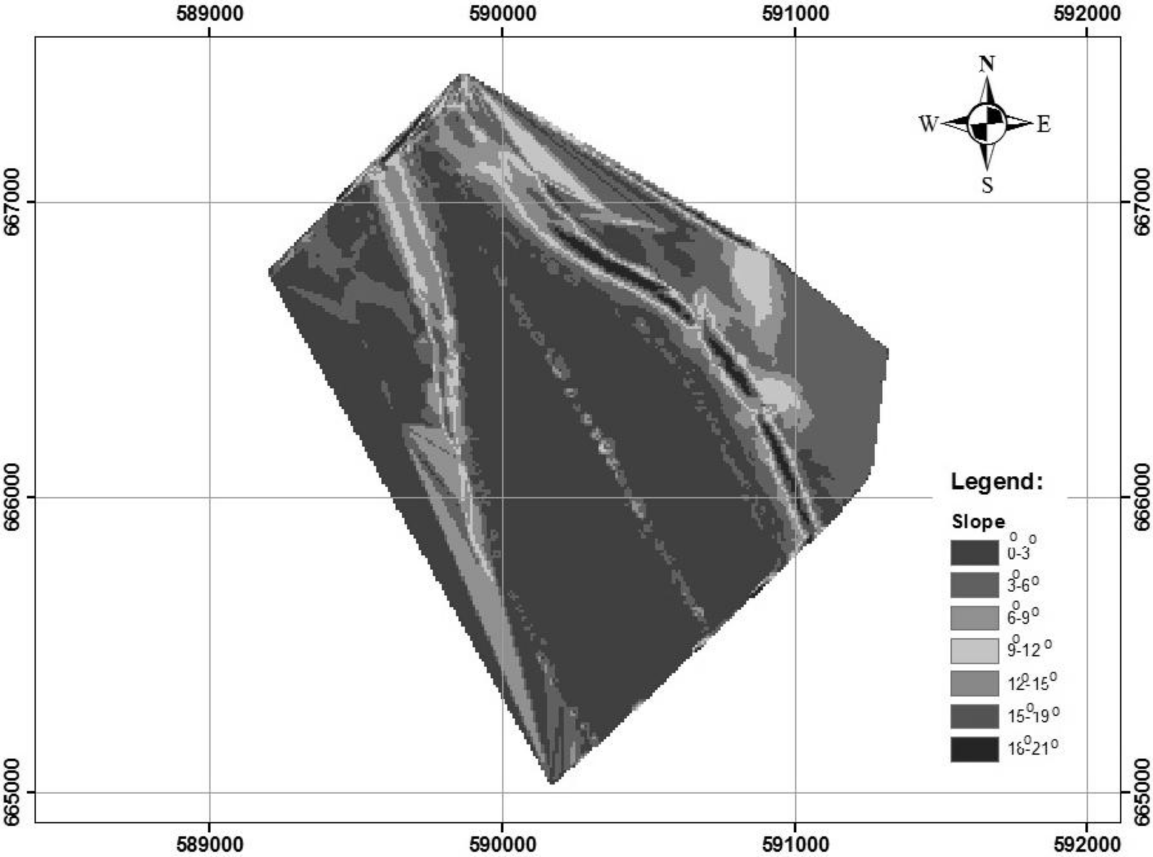

Figure 3 **The slope map of the relief**

d. Land Exposition

A versant's exposition is given by the size of the *angle between the north and the direction of the line from the highest slope*.

The angle is measured clockwise using sexagesimal degrees, being established for eight directions: *north, northeast, east, southeast, south, southwest, west, northwest* (www.geospatial.org), with 45^0 (*figure 4*).

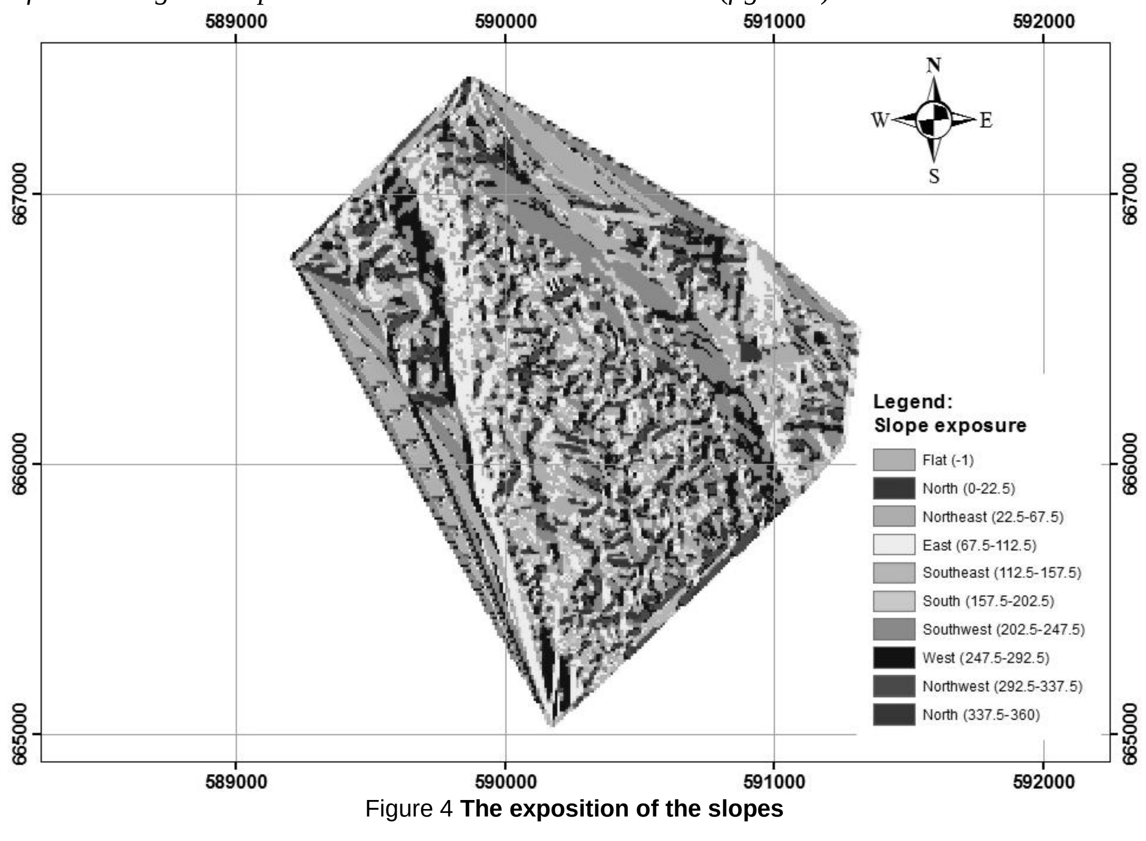

Figure 4 **The exposition of the slopes**

On the high terrace of the hydrographic basin of the Moldova river with the absolute altitude of 390–395 m and land slope of 0 – 3^0 the following expositions were noticed the: north, east, south, south-west, west, and north-west (Figure 4).

The landscape of the surface analyzed based on the digital model of the land is represented in this particular area by the way in which the natural factors interact. The pedogenetic factors from the "*Baia Depression*" were characterized by great longitudinal and transversal diversity. On the middle and high terraces from the left side of the Moldova River there were identified a large number of soils with different features and fertility levels, that were influenced by the general and local climate.

The synthesis of geo-spatial data on the values of absolute altitude, distribution of level curves, inclination and versant exposition contributed at the classification of this area into a *local microdepression* of almost **250 ha**.

According to the local toponymy, this area is named "*Bahna Mare- Rotoponeşti*", being included in the administrative territorial unit of Horodniceni commune, Suceava County.

On this platform of plane terrace with depressionary and accumulation features – for rainwater and the water from various slopes – appeared soils with excessive humidity. On these soils with percolative hydric regime there have been intense processes of eluviation, debasification, acidification, alteration and migration of the claylike fraction of soil profile. In the above mentioned natural conditions, these agricultural lands have been used as low productive natural pastures.

For making use of the fertility potential of these soils, various measures and ameliorative works have been applied. Among them we can mention: *calcareous amendments, organic and mineral fertilizers, deep soil airing and eliminating the water excess using sub-surface drainage*.

In the "***Bahna Mare-Rotoponeşti***" unit from the cadastral territory of Horodniceni commune it was created an agricultural surface of **116.7935 ha** using a systematic sub-surface drainage network consisting of absorbing and collecting drains that evacuate in the "*Şomuzel*" channel.

Among the dimensional elements of the drainage system we can mention: *the distance between the drain lines **(20 m)***; *the depth of the pipes **(1 m)***; the nature of the drain pipes *(pipe are from ceramic)*. By optimizing the aero-hydric regime of the drained land there have been created the normal conditions for these lands to be used for agriculture, and /or as ameliorated pastures and meadows.

CONCLUSIONS

The geospatial database used for creating the digital model of the land relied on the detailed topographic survey of a surface of **208.4446 ha.** This way it was established the planimetric and altimetric position of ***2,966 points***, using ***X, Y, Z coordinates***.

The digital model of the land was obtained using the *ArcGIS desktop release 10* application, resulting the following themed planes: *the hypsometric map, the map of the gradients and the exposition of the slopes*.

After analysing the total surface of the digital model it resulted that the relatively plane land was predominant – on almost **160 ha –** characterized by the following elements: *altitude 390-395m; average slope 0 - 3^0*.

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