Scientific Papers. Series A. Agronomy, Vol. LXIV, No. 2, 2021
ISSN 2285-5785; ISSN CD-ROM 2285-5793; ISSN Online 2285-5807; ISSN-L 2285-5785

STUDY ON THE USE OF THE LAND SCAN TO DETERMINE THE SOIL VOLUME DISLOCATED BY EROSION OF DEPTH ON THE PRACTICE OF SUSTAINABLE AGRICULTURE IN AGRITOURISTIC FARMS

Jenica CĂLINA, Aurel CĂLINA, Nicolae BĂBUCĂ, Alin CROITORU, Marius CIOBOATĂ

University of Craiova, Faculty of Agriculture, 19 Libertatii Street, Craiova, Romania

Corresponding author email: aurelcalina@yahoo.com

Abstract

The paper presents a continuation of the study conducted in the paper "Study on the use of land scanning in soil erosion inventory works for sustainable agriculture in agritourism farms" because we found that it is very important to determine the land areas affected by the phenomenon of deep erosion, to present a modern, accurate and fast method of determining the volume of dislocated soil. It is known that a very large amount of soil is washed from that surface and with it the organic matter, which takes hundreds of years to recover, at its initial value. In order to support landowners who own such areas affected by erosion, we thought of presenting a precise and very effective method of monitoring the volume of soil displaced. The method that was imposed from the study is to determine the volume by terrestrial laser scanning, which also has a number of advantages, compared to the classical methods used so far. The terrestrial laser scanning through the large number of data collected from the field offers us the possibility to determine with great ease the total cubage of the studied negative relief form, but also gives the possibility to develop thematic digital 3D maps, which farmers can use in practicing sustainable agriculture, based on precision agriculture.

Key words*: coordinates, cubage, land scanning, point cloud, sustainable agriculture.*

INTRODUCTION

As is well known, agriculture plays an important role in the conservation of natural resources and cultural landscapes and is a prerequisite for other human activities in rural areas. Over the centuries, agriculture has contributed to the creation and preservation of a wide variety of landscapes and habitats (Călina & Călina, 2019). However, agricultural practices can also have negative effects on the environment, effects that are most visible in agritourism farms, as they are located in more remote places, with beautiful landscape and fragmented relief (Adamov et al., 2020).

The European Union's rural development policy provides funding for a wide range of measures that Member States or regions use to support the sustainable development of rural areas (Călina & Călina, 2019). The agri-environment measures within the axes also aim at soil degradation on agricultural land, stimulating farmers to protect, maintain and improve the quality of the environment on the land of their farm (Iagăru et al., 2016).

The phenomenon of soil erosion by water, according to the data of the National Research and Development Institute for Pedology, Agrochemistry and Environmental Protection (ICPA) affects in Romania approx. 6.3 million ha, of which 2.1 million ha of arable land, to which is added another 0.378 million ha (0.273 million ha of arable land) subject to wind erosion (Răduţoiu & Stan, 2013). Of the known forms of degradation, the most severe and widespread is water erosion. As the erosion processes advance, the soil loses its energetic potential and its ecological functions, approaching the parent rock by its properties. Thus, erosion occurs the "counterrevolution of soils" (Burghilă et al., 2016).

In this paper, the achievement of the proposed objective is possible through the use of the geoinformation system, which allows the operative and reasoned approach to the problems of inventory, analysis, planning and design. Thanks to it, premises are created for the elaboration and implementation of measures to combat soil degradation at a new quality level, aimed at maintaining and improving soil fertility. Within this system the essential component is represented by the terrestrial laser scanning.

The advantage of laser scanning is that it can record a large number of points, at a high accuracy, in a relatively short period of time. It's like taking a picture with depth information. The combination of the rotating optical elements and the moving mechanisms of the instrument offers the reflected laser beam the possibility to create a uniform network (grid). Through it the geometry of a structure can be measured completely automatically (more or less). The result of the measurements is represented by a (considerable) set of points called in the literature point cloud (Barazzetti et al., 2010).

MATERIALS AND METHODS

In solving the topic, the same method was used as in the study "Study on the use of land scanning in soil erosion inventory works for sustainable agriculture in agritourism farms" which involved the use of Terrestrial Laser Scanning (SLT) technology, which tends to "revolutionize" measurement techniques in Topography and Engineering Topography (Calinovici & Călina, 2008). The use of this technology allowed the rapid and precise determination of the surface and cubage of a formation that appeared on an agricultural surface, following deep erosion. As with any measurement process encountered in the technique of topographic measurements and in this case the planning or preliminary design is an extremely important step, decisive in obtaining the results, respectively the information needed to describe the object to be scanned (Kolbe et al., 2011).

The design stage is indispensable for the measurement process and due to the fact that in this stage the shape and size of the object are balanced, its position in the environment and last but not least, the requirements of the beneficiary regarding the accuracy to be obtained in object representation at the end (Li et al., 2009).

After a rigorous design, it was concluded that the following phases must be completed: - definition of the area to be scanned and preliminary investigations; - determining the resolution and accuracy required for the points that make up the point clouds, depending on the beneficiary's sorting; - selecting the type of laser scanner to be used, depending on the specifics of the work we intend to perform; - designing the optimal positions of the station points for scanning, starting from the premises of providing the necessary coverage to ensure accuracy and the need to scan the entire object; - the choice of the type of targets that will be used in the georeferencing registration operations and of the positions in which they will be located, in such a way as to ensure the premises of an optimal geometric configuration for georeferencing; - estimating the volume of data that will be acquired during the scanning process (Remondino et al., 2010).

In the case of the relief form studied, it was considered that the use of terrestrial laser scanning is the most optimal due to the following reasons: - very complex surface structure; -presentation of the final 3D product; - measuring the surface instead of measuring the individual points; - the recorded data can be used by multidisciplinary teams, for different purposes; - archiving data without having a priori knowledge, regarding their future use (Mihai et al., 2015).

Stage I. *Analysis of the area to be scanned*

Retrieving as much information as possible about the object to be scanned can provide information about the complexity and time required for such an operation. Field information, reports, existing maps, photographs or video images of the location of the object to be scanned can help a lot in determining possible risks when scanning the object (Păunescu et al., 2020). However, it is also very important to analyze the area, the surroundings of the respective location. Possible obstructions determine the choice of station point positions. Possible time constraints are also decisive in choosing the methods and timing of the scan. Indirectly, the positions of the station points determine the minimum and maximum distances that the scanner could record.

Stage II. *Determining the optimal positions for scanning*

Once the site documentation has been analyzed and laser scanning has been chosen as the most effective recording technique, the scanning positions and those in which the aiming targets will be placed must be designed (planned). The choice of the optimal positions of the station points must guarantee maximum coverage and accuracy but also a minimum number of station points.

When designing the optimal positions of the station points, the following basic rules must be observed: - the positions are chosen that offer a good (wide) coverage of the scanning area, without obstructions on the line of sight, which could produce the shading effect; - it is checked whether the distance limits are met, in order to increase the accuracy; - decrease in the number of scanning stations; - choosing scanning positions in places that ensure comfortable measuring conditions, free from vibrations and the influence of wind; - ensuring a convenient height of the device and ensuring visibility to natural and artificial targets.

Of particular importance in the measurement design phase, in addition to the optimal scanning positions, is the choice of target types, their position and / or geometric configuration. An important remark regarding the use of aiming targets is that they, placed in position, must have a large opening in all three directions of the axes (X, Y, Z).

Stage III. *Data management*

Given the very large amount of data that is collected during the scanning process, it is very important to scan the data so that it is ensured throughout a working day. The positioning accuracy of the image points, defined in the reference system of the station by spatial coordinates X, Y, Z is accredited at ± 6mm / 50m, given that at this distance the laser spot maintains its point diameter of 6 mm. Currently, there is no standard procedure for planning the terrestrial laser scanning session (Doneus et al., 2005).

Based on the records made, the so-called "point cloud" is obtained, which is a collection of points, defined as a position by the coordinates X, Y, Z in a common reference system, which reveals to the observer information on the shape, position, and the spatial distribution of an object or group of objects (Călina et al., 2020). It may contain additional information, such as intensity. It can be concluded that the point cloud contains two types of information: - metrics, which describe the geometry of the object and its spatial relationships with the environment; - thematic, which are used to describe the surface properties of the scanned objects and to estimate the confidence given to the acquired data.

RESULTS AND DISCUSSIONS

The idea of conducting this study arose with previous research in the paper "Study on the use of land scanning in soil erosion inventory works for sustainable agriculture in agritourism farms" from which we found that estimating soil volumes is very important for several applications such as: soil erosion studies, estimation of ore removed from a surface in the mine, evaluation of construction land, etc. Due to the way of taking data remotely, laser scanners have proven to be optimal for this type of work, being able to easily delimit the volume of interest and provide a large and complex amount of data and information (Călina et al., 2018).

This method was chosen because it is known from the literature that many practical comparative applications have been made between laser scanning and conventional methods of data collection, to assess the accuracy and development of procedures to optimize the use of the method in embankment calculations. Based on these studies, it has been established that terrestrial scanners reach the desired level of accuracy in the shortest possible time and quickly provide information on the initial stage of the work required in the design phase or deviations from the project (Chiabrando et al., 2009).

Field operations began with defining the area to be scanned and conducting preliminary investigations, in order to better document and plan the project. This was followed by another important operation in determining the resolution and accuracy required for the points that make up the point clouds, in accordance with the requirements of the beneficiary. Subsequently, the optimal positions of the terrestrial laser scan were established for a proper coverage of the studied area. At the same time, the time required to take over the data was estimated, given that it is a location that is constantly changing and of great complexity.

Further, in order to achieve the purpose of the work of estimating the volume of eroded soil, related to the initial land, the absolute coordinates of the points in the local system were determined, because the determined area is the same as the one determined in the absolute system. In order to connect the measurements performed from several stations, it was necessary to place targets, whose position was established using classical measuring means, landmarks that were the basis for "linking" the scanning and georeferencing stations (Rosca et al., 2020).

Following the scanning of the studied surface, the georeferenced point cloud from the two scanning stations was obtained (Figure 1).

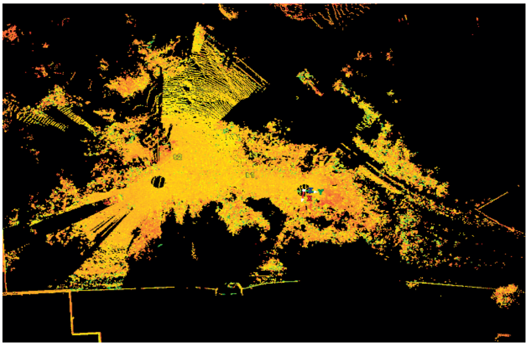

Figure 1. Recording of 2 scans: the point cloud in station 1, referenced with the one in station 2

Calculation of point coordinates in the local system

We worked in the local reference system, this explains the negative coordinates of the points. This way of working is widely used in engineering works, because this way, the eventual tensions in the absolute coordinate system are not transmitted, which leads to obtaining more precise coordinates. It was decided to work in this system because the purpose of the work was to determine the volume of the entire form of relief, and this is done regardless of the reference system chosen.

It must be specified that due to the very large volume of points it was chosen to present only a small part of them, in facsimile (Table 1).

Table 1. Scan point coordinates

Point no.	Point coordinates (m)			Point no.	Point coordinates (m)			Point no.	Point coordinates (m)		
	X	Y	Z		X	Y	Z		X	Y	Z
1	-60.0518	-46.0209	-2.5567	83	-60.1324	-46.0257	-2.5631	165	-60.030	-46.1105	-2.4730
2	-60.0721	-46.0165	-2.5596	84	-60.1395	-46.0352	-2.5656	166	-60.0410	-46.1086	-2.4705
3	-60.0956	-46.0115	-2.5631	85	-60.1027	-46.0537	-2.5624	167	-60.0453	-46.0971	-2.4736
4	-60.1063	-46.0092	-2.5598	86	-60.1165	-46.0509	-2.5606	168	-60.0559	-46.1058	-2.4703
5	-60.1179	-45.9957	-2.5667	87	-60.1324	-46.0477	-2.5610	169	-60.0340	-46.1205	-2.4738
....	....	....	....	....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....	....	....	....	....
35	-60.0483	-46.1180	-2.5455	117	-60.1371	-46.0466	-2.5056	199	-60.1346	-46.1019	-2.4749
36	-60.0867	-46.1109	-2.5577	118	-60.1335	-46.0584	-2.5027	200	-60.1847	-46.1259	-2.4725
37	-60.0670	-46.0931	-2.5571	119	-60.1776	-46.0273	-2.51059	201	-60.1799	-46.0935	-2.4730
38	-60.0410	-46.1300	-2.5495	120	-60.1537	-46.0322	-2.5068	202	-60.1793	-46.0825	-2.4736
39	-60.0411	-46.1405	-2.5399	121	-60.2021	-46.0335	-2.4963	203	-60.1792	-46.0826	-2.4646
40	-60.0542	-46.1276	-2.5476	122	-60.1496	-46.0662	-2.5018	204	-60.1899	-46.0917	-2.4607
....	....	....	....	....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....	....	....	....	....
78	-60.0776	-46.0262	-2.5527	160	-60.0185	-46.1444	-2.4727	242	-60.5955	-45.7904	-2.5545
79	-60.1203	-46.0392	-2.5636	161	-60.0310	-46.1422	-2.4704	243	-60.5998	-45.7766	-2.5487
80	-60.1161	-46.0181	-2.5637	162	-60.0461	-46.1502	-2.4696	244	-60.5946	-45.8033	-2.5529
81	-60.1182	-46.0286	-2.5637	163	-60.0386	-46.1196	-2.4686	245	-60.6141	-45.7858	-2.5538
82	-60.1186	-46.0176	-2.5572	164	-60.0336	-46.0993	-2.4754	246	-60.6156	-45.7727	-2.5465
								247	-60.6391	-45.7927	-2.5634

Representation of existing level curves in the field: Based on the obtained point cloud and the coordinates of the points in the local system, it was possible to perform a precise and fast representation of the level curves (Figures 2, 3 and 4).

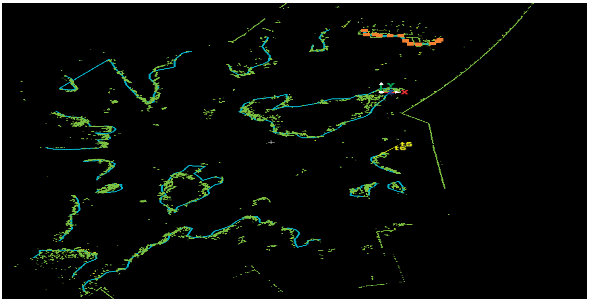

Figure 2. Point cloud at elevation h = 1.5 m

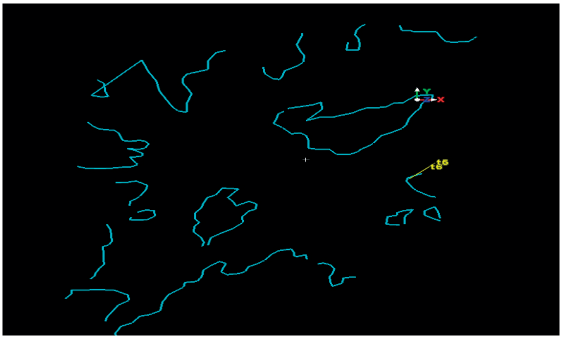

Figure 3. The level curves corresponding to the elevation h = 1.5 m drawn from the point cloud

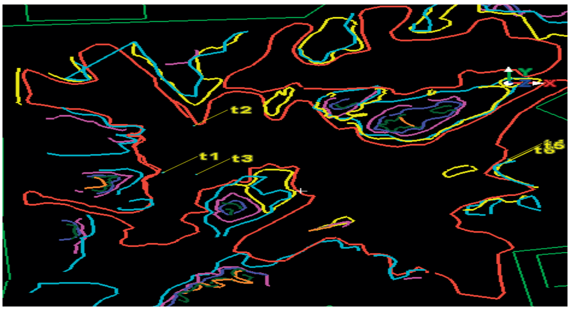

Figure 4. Level curves for relief shape; Red. h = 0.00 m; yellow. h = 0.95 m; blue. h = 1.5 m; purple. h = 1.6 m; navy blue. h = 2.4 m; dark green. h = 2.88 m; orange. h = 3.4 m

Calculation of the volume of eroded soil

Due to the fact that the relief form consists of several valleys, in order to arrive at the total calculation of the cubage, it was necessary to first calculate the cubage of each separate valley wire. In order to achieve this, each valley was divided into elementary geometric shapes (cylinders). Thus, elementary cylinders and the base areas of these valleys resulted, the data being processed in the Cyclone program (Vosselman et al., 2010). Having the areas of the bases of the elementary cylinders in each valley and the height between them, the volume of the cubage of each valley was calculated, and finally that of the negative relief form, appeared on the agricultural land of the agritourism farm on which this study was conducted.

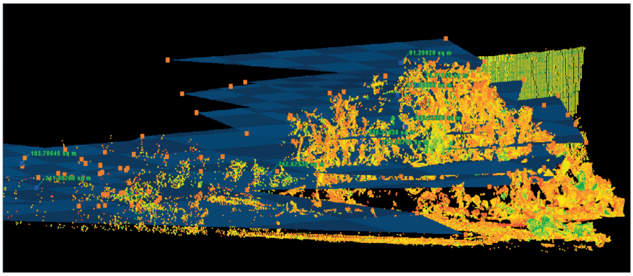

Figure 5. Base area values of the 10 elementary cylinders (image superimposed on the point cloud)

Point cloud processing is a difficult operation and requires a lot of attention (Sala et al., 2020). Using the values of the base areas of the 10 elementary cylinders in Figure 5 and the height between them, the volume of land displaced for the first valley wire was calculated (Table 2).

Table 2. Volume calculation for the first valley wire

Plan number	Surface, (m^2)	Height, (m)	Volume, (m^3)
1	103.795	0.5	51.8975
2	179.087	0.6	107.4522
3	241.092	0.35	84.3822
4	762.625	0.5	381.3125
5	313.227	0.35	109.62945
6	236.31	0.6	141.786
7	152.63	1	152.63
8	117.026	0.37	43.29962
9	75.711	0.83	62.84013
10	91.299	0.5	45.6495
Total			**1180.8791**

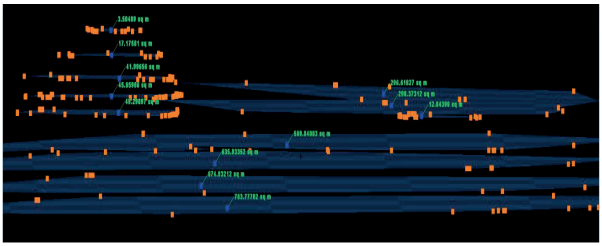

Figure 6. Values of the base areas of the elementary cylinders (Valley 2)

Using the values of the base areas of the 12 elementary cylinders in Figure 6 and the height between them, the volume of displaced earth for the valley wire 2 was calculated (Table 3).

Table 3. Volume calculation for valley wire 2

Plan number	Surface (m^2)	Height (m)	Volume (m^3)
1	3.5	1	3.5
2	17.17	1	17.17
3	41.99	1	41.99
4	45.66	1	45.66
5	49.3	1	49.3
6	296.62	1	296.62
7	298.37	1	298.37
8	12.044	1	12.044
9	569.84	1	569.84
10	635.93	1	635.93
11	674.93	1	674.93
12	763.77	1	763.77
Total			**3409.124**

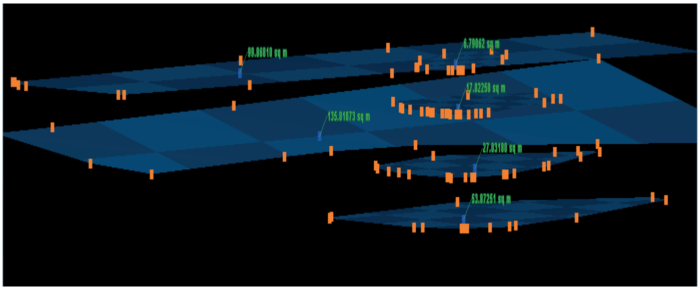

Figure 7. Values of the base areas of the elementary cylinders (Valley 3)

Using the values of the base areas of the 6 elementary cylinders in Figure 7 and the height between them, the volume of land displaced for the valley wire 3 was calculated (Table 4).

Table 4. Volume calculation for valley wire 3

Plan number	Surface (m^2)	Height (m)	Volume (m^3)
1	99.86	1	99.86
2	135.81	1	135.81
3	6.79	1	6.79
4	17.02	1	17.02
5	27.03	1	27.03
6	53.87	1	53.87
Total			**340.38**

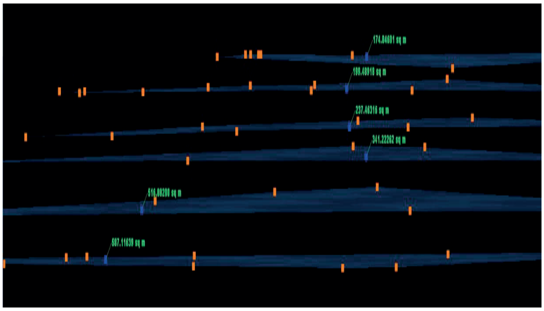

Figure 8. Values of the base areas of the elementary cylinders (Valley 4)

Using the values of the base areas of the 6 elementary cylinders in Figure 8 and the height between them, the volume of displaced earth for the valley wire 4 was calculated (Table 5).

Table 5. Volume calculation for valley wire 4

Plan number	Surface (m^2)	Height (m)	Volume (m^3)
1	174.04	1	174.04
2	199.49	1	199.49
3	237.46	1	237.46
4	341.22	1	341.22
5	516.08	1	516.08
6	587.11	1	587.11
Total			**2055.4**

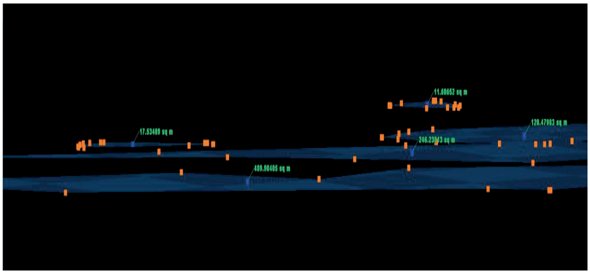

Figure 9. Values of the base areas of the elementary cylinders (Valley 5)

Using the values of the base areas of the 5 elementary cylinders in Figure 9 and the height between them, the volume of land displaced for the valley wire 5 was calculated (Table 6).

Table 6. Volume calculation for valley wire 5

Plan number	Surface (m^2)	Height (m)	Volume (m^3)
1	11.69	1	11.69
2	17.53	1	17.53
3	128.48	1	128.48
4	246.23	1	246.23
5	409.9	1	409.9
Total			**813.83**

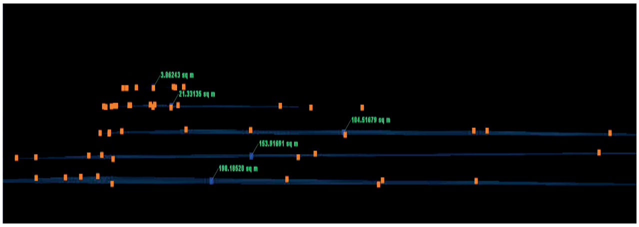

Figure 10. Values of the base areas of the elementary cylinders (Valley 6)

Using the values of the base areas of the 5 elementary cylinders in Figure 10 and the height between them, the volume of displaced earth for the valley wire 6 was calculated (Table 7).

Table 7. Volume calculation for valley wire 6

Plan number	Surface (m^2)	Height (m)	Volume (m^3)
1	3.86	1	3.86
2	21.33	1	21.33
3	104.51	1	104.51
4	153.91	1	153.91
5	198.18	1	198.18
Total			**481.79**

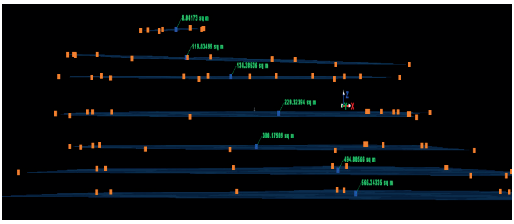

Figure 11. Values of the base areas of the elementary cylinders (Valley 7)

Using the values of the base areas of the 7 elementary cylinders in Figure 11 and the height between them, the volume of land displaced for the 7th valley wire was calculated (Table 8).

Table 8. Volume calculation for valley wire 7

Plan number	Surface (m^2)	Height (m)	Volume (m^3)
1	8.04	1	8.04
2	119.63	1	119.63
3	134.38	1	134.38
4	229.32	1	229.32
5	300.17	1	300.17
6	494.8	1	494.8
7	566.34	1	566.34
Total			**1852.68**

Finally, in order to determine the value of the cubage of the entire form of negative relief, the values of the volumes of each valley were added: $\mathbf{S_T}$ = 1180.88 m^3 + 3409.124 m^3 + 340.38 m^3 + 2055.4 m^3 + 813.83 m^3 + 1852.68 m^3 + 10134.08 m^3 = **20268.168 $\mathbf{m^3}$**.

As can be seen from the value of the obtained cubage of 20268.168 m^3, the amount of soil displaced by the erosion phenomenon is very significant, along with it being removed and a significant amount of organic matter, and therefore carbon.

From the estimates of the Worldwatch Institute, it is estimated that in about 150 years the fertile soil reserves are depleted with an annual depletion rate of 23%. Careful conservation and terracing of sloping land can limit erosion. The quantitative evaluation of the erosion rate is made by experimental researches on the specially arranged plots, and the soil losses are measured in tons/ha/year or tons/km^2/year. Japan is the country with the most sloping land, but has a low erosion rate. For example, on slopes with slopes below 10°, the erosion rate is 1 ton/ha/year. On the steeper slopes, over 10°, the erosion on bare lands (without vegetation) (Răduțoiu et al., 2018) can be of 20-40 t/ha/year, and on lands with vegetation reaches less than 20 t/ha/year. The highest erosion rates in the world have been recorded in the Loess Plateau of China, where soil losses can reach 500 t/ha/year (Pop et al., 2019). In order to control the phenomenon of soil erosion, special control measures must be taken. These measures cannot be applied without a very clear and precise inventory of all areas prone to such a phenomenon. Inventory from the point of view of the surfaces and the volume of dislocated soil, can be done very easily and precisely by modern topo-geodetic methods, of the type presented in this paper.

CONCLUSIONS

The topographic survey method presented is a modern, topical and high precision method, and can be used very easily to monitor and inventory land subject to erosion, both to determine the affected areas and to determine the volume of soil displaced. Research has shown that the method has a number of advantages compared to other methods used so far that it is recommended to be used in such works, such as: high accuracy, considerable reduction in time and costs of measuring and analyzing data, compared to classical measurements; adequate and feasible equipment for measuring the volumes of embankments, ensuring a better vision of project financing, guaranteed quality of data and work performed, quantitative monitoring of any type of engineering work, flexibility to adapt to changes in the field, non-invasive method of taking over of data.

One aspect that clearly differs from the other methods is that the objective under study can be manipulated in the virtual environment, thus providing viewing angles, otherwise impossible. In this way, the original lens is protected, no longer requiring physical manipulation. It is also no longer necessary to travel to the location of the objective under study, its replica being accessible via the Internet. In addition, the digital replica with the information thus applied on its surface, represents a complex digitization of the objective, being able to remain testimony in time, in case of changing the state of conservation of the original objective. In conclusion, the terrestrial laser scanning technology presented can be used successfully as a complementary method to other lifting methods, but it can very successfully replace traditional geodetic methods of measurement, as it has the advantages listed above, which recommend it with great confidence.

REFERENCES

Adamov, T., Ciolac, R., Iancu, T., Brad, I., Peț, E., Popescu, G., Șmuleac, L. (2020). Sustainability of Agritourism Activity. Initiatives and Challenges in Romanian Mountain Rural Regions. *Sustainability*, *12*(6), 2502 p.

Barazzetti, L., Scaioni, M., Remondino, F. (2010). Orientation and 3D modelling from markerless terrestrial images: Combining accuracy with automation. *The Photogrammetric Record*, *25*. 356–381.

Burghilă, C., Bordun, C., Cîmpeanu, S.M., Burghilă, D., Badea, A. (2016). Why mapping ecosystems services is a must in EU biodiversity strategy for 2020. *AgroLife Scientific Journal*, *5*(2), 28–37.

Calinovici, I., Călina, J. (2008). *Topography*. Ed. Mirton, Timișoara, 45–75.

Călina, J., Călina, A., Bădescu, G., Vangu, G.M., Ionică, C.E. (2018). Research on the use of aerial scanning for completing a GIS database. *AgroLife Scientific Journal*, *7*(1), 25–32.

Călina, A., Călina, J. (2019). Research regardig the agriproductive properties of the typical reddish preluvosol between Jiu and Olt rivers and its evolution from 1997-2017 in farms and agritouristic households. *Romanian Agricultural Research*, *36*. 251–261.

Călina, J., Călina, A. (2019). Evolution of the mollic reddish preluvisol in a romanian riverine region and the assessment of its agro-productive properties in farms and agro-touristic households. *Environmental Engineering and Management Journal*, *18*(12), 2729–2738.

Călina, J., Călina, A., Miluț, M., Croitoru, A., Stan, I., Buzatu, C. (2020). Use of drones in cadastral works and precision works in silviculture and agriculture. *Publisher NARDI Fundulea, România, 37*. 273–284.

Doneus, M., Neubauer, W. (2005). 3D Laser Scanners on Archaeological Excavations. In Proceedings of CIPA 2005 XX International Symposium, Torino, Italy, 26 September-1 October 2005; Vol. 34(5/C34/1), 226–231.

Chiabrando, F., Filiberto, R., Piatti, D., Rinaudo, F. (2009). Sensors for 3D imaging-metric evaluation and calibration of a CCD/CMOS time-of-flight camera. *Sensors*, *9*. 80–96.

Kolbe, T., Koenig, G., Nagel, C. (2011). Advances in 3D Geo-Information Sciences. Springer-Verlag: New York, NY, USA, 294 p.

Iagăru, R., Florescu, N., Iagăru, P. (2016). Strategic management of sustainable development in the countryside of Sibiu depression-basic of environmental protection. *Environmental Engineering and Management Journal*, *15*. 1337–1347.

Li, D., Shan, J., Gong, J. (2009). Geospatial Technology for Earth Observation. Springer: New York, NY, USA, 558 p.

Mihai, D., Teodorescu, R.I., Burghilă, D., Mudura, R. (2015). A modern approach in data updating for a vineyard agro-system modernization. *Conference SGEM*, 2, ISBN 978-619-7105-35-3, 651–656.

Paunescu, R.D., Simon, M., Șmuleac, L., Pașcalău, R., Șmuleac, A. (2020). Topo-cadastral works regarding the realization of the gas distribution network in the locality of Constantin Daicoviciu. *Research Journal of Agricultural Science*, *52*(3).

Pop, N., Pop, S., Ortelecan, M., Luca, L.C. (2019). Verification of a triangulation network in Cluj-Napoca for future topographic surveys. *Agricultura*, *111*(3-4), 368–373.

Răduțoiu, D., Stan, I. (2013). Preliminary Data on Alien Flora from Oltenia-Romania. *Acta Horti Botanici Bucurestiensis*, *40*(1), 33–42.

Răduțoiu, D., Simeanu, C.G., Stan, I. (2018). Contributions to halophilic flora and vegetation in Oltenia (Romania). *Scientific Papers-Series B-Horticulture, 62*. 655–660.

Remondino, F., Rizzi, A., Girardi, S., Petti, F., Avanzini, M. (2010). 3D ichnology-Recovering digital 3D models of dinosaur footprints. *The Photogrammetric Record*, *25*. 266–282.

Rosca, A., Juca, I., Timbota, O., Belin, V., Bertici, R., Herbei, M. (2020). Methods for digitalizing information from analogic support and creating

GIS databases. *Research Journal of Agricultural Science*, *52*(4).
Sala, F., Popescu, C.A., Herbei, M.V., Rujescu, C. (2020). Model of Color Parameters Variation and Correction in Relation to "Time-View" Image Acquisition Effects in Wheat Crop. *Sustainability*, *12*(6), 2470 p.
Vosselman, G. and Maas, H.-G. (2010). Airborne and Terrestrial Laser Scanning. CRC: Boca Raton, FL, USA, 318 p.