APPLICATION OF GEODESIC DETERMINATION METHODS USING 3D TERRESTRIAL SCANNING IN MONITORING SALINE AREAS SUBJECT TO LANDSLIDES

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Abstract: *3D modeling allows the creation of three-dimensional models of the shape, surface or objects with the help of the computer and dedicated software, as a result 3D modeling makes product design much more efficient. Using 3D modeling, specialists from different fields of activity can walk through a virtual project model before it is built. Accurate 3D modeling of various projects helps estimate project costs. The use of 3D modeling for construction and architectural design allows the architect to make constant changes as the 3D model is developed and apply changes to suit the requirements, resulting in not only a better finished design, but also a more efficient use of materials used.*

Keywords: *Modelling; Cloud points; Scanner 3D; Coordinates*

1. Introduction

a. The scanning process:

3D terrestrial scanning brings accurate and complete information from the ground resulting from the 3D measurement regarding the scanned and measured elements, the equipment called 3D scanner has the possibility to measure millions of points, so-called cloud of points that later allow after processing with specific programs to obtain the design of 3D models of objects, respectively their transposition into projects necessary for execution.

b. Functionality

Called innovative 3D scanning technology, it offers special advantages at any stage of the project, such as:

- ✓ Measured elements can be stored without suffering any damage, compared to direct measurements that can affect the measured elements;
- ✓ 3D scanning lends itself to irregular surfaces, for example built structures, carved stones and archaeological features;
- ✓ 3D scanning allows the recording of accurate and precise information below 1 cm,
- ✓ 3D scanning can be performed even if there are no visibility conditions, low light, indoors or outdoors (open areas);
- ✓ Measured data and results from 3D scanning are available in real time, they can be viewed anytime, they can be analyzed by architects, designers, engineers in real

form according to the situation in the field, without the need for another trip to the field;

c. Technology 3D

Compared to classical methods, the 3D scanning method is more efficient and convenient for field data collection.

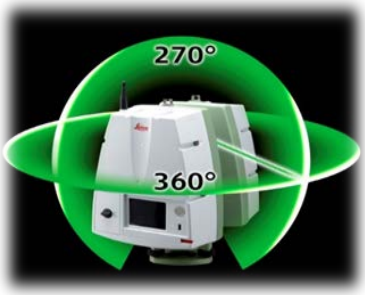

Fig.1 – Scanner Leica C10

Benefits of Technology 3D

- ✓ reduces the time and cost of the measurement;
- ✓ high data recording speed;
- ✓ high precision;
- ✓ fully automated measurements
- ✓ 3D visualization;

2. Materials and Methods

Location of research:

The study was carried out at Salina Praid, the old mining mine.

Fig.2 – Study areas

To carry out the study, the following steps were taken:

Establishing the control network

The methodology typically used for terrestrial 3D scanning revolves around the time- honored use of prisms or targets, (Babuca et al., 2011), but it is necessary to create a control network.

The proposed method – GPS RTK method

It is a method for creating geodetic networks that require very high precision, precision 1-2 cm.

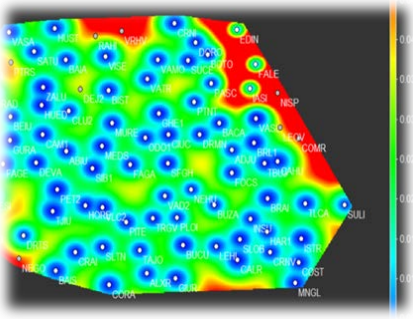

Fig.3. Network RTK

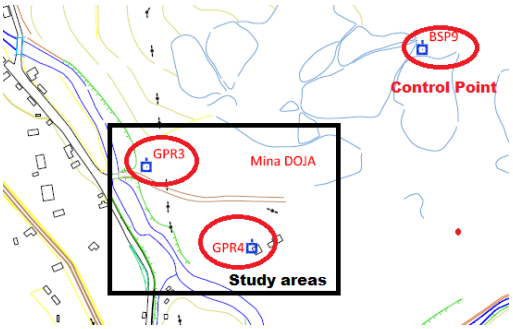

Fig.4. Control points Network RTK

➢ *Condition for GPS observations*

The geometry of the satellites, in order to ensure the most accurate determination, it is necessary that at the time of observation the satellites have an optimal geometric arrangement (for example, they are not all on the same direction), [5].

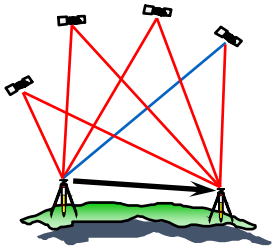

Fig.5 - Point positioning with at least 4 satellites and good geometry

After the control network was created, the scanning process was started: the acquisition of images, targets and control points, the traverse and the full scanning (Fig.6), [4].

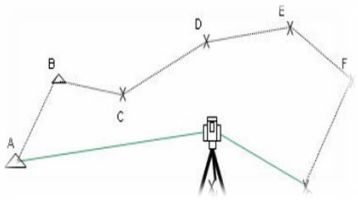

Fig. 6 - Traverse with a 3D scanner

The five basic steps for performing a field setup are:

- ✓ Definitions;
- ✓ Acquire Back sight;
- ✓ Known Back sight;
- ✓ Taking the Main Scan;

Scanning Methodology

The scanning was done with a 3D scanner – *Leica C10*

Resolution: 5 cm
Density: 400 points / sq.m
Accuracy: < 1cm
Approximately 80,000,000 (mil.) points were read for each location
The scan was performed from 4 station points

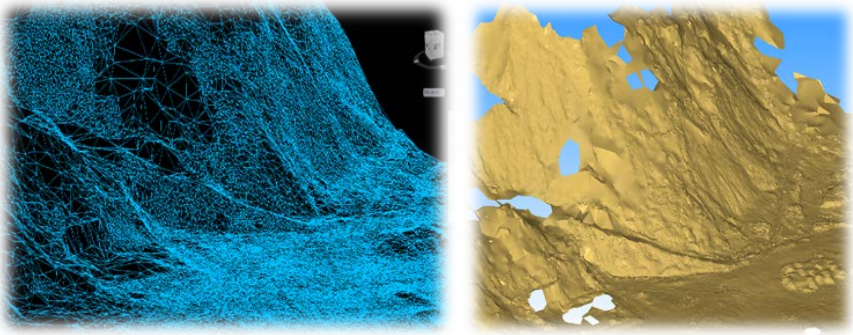

Fig.7 – Measurement with C10

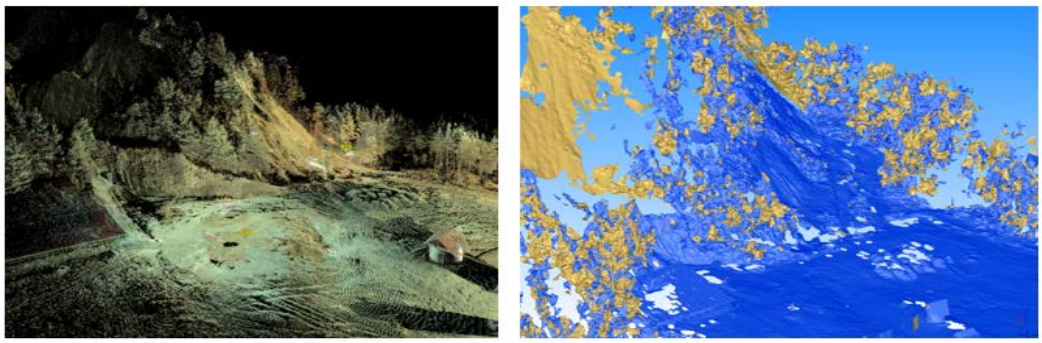

Fig.8 – Data collection from the field

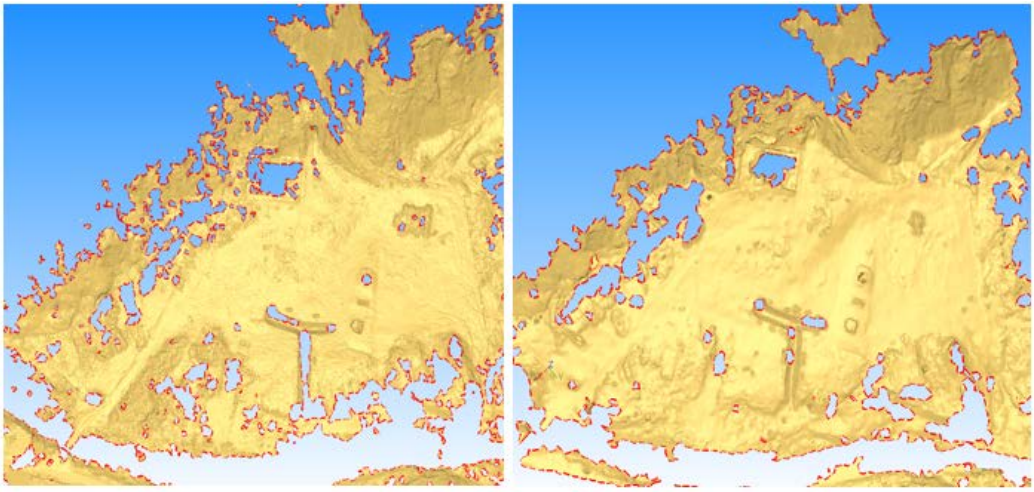

Fig.9 – Data collection from the field

3. Results and Discussion

Land deformations can be determined by comparing several scanning cycles. 3d scanning is feasible and convenient for detecting displacements offering centimeter precision.

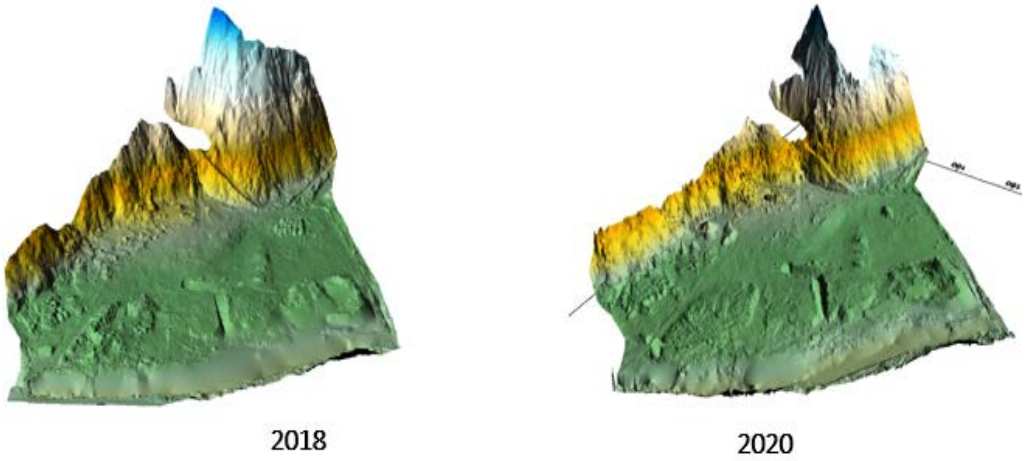

Fig.10 – Digital Terrain Model 2018-2020

The virtual points form a grid of 44 points located in high density areas of the point cloud to achieve maximum accuracy.

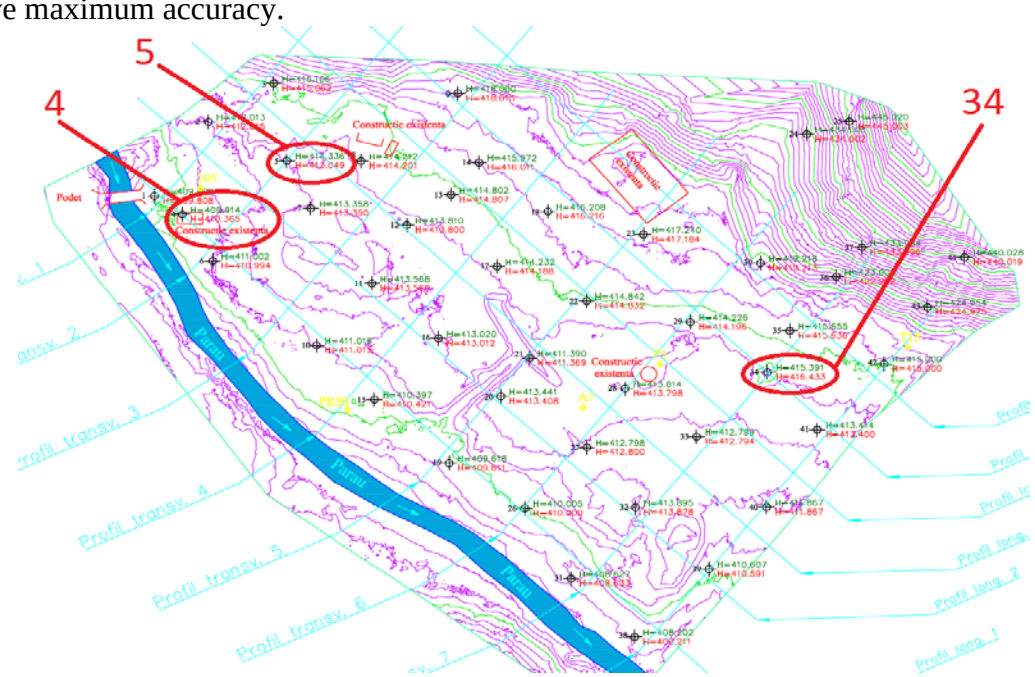

Fig. 11 - The area scanned with the 44 points

For the detailed monitoring of the surface, the 3D model of the landslide was built by carrying out a series of two topographic surveys with the Scanner Leica C10, in 2018 and 2020.

For a model of the land as accurate as possible, the radiated points were chosen in such a way as to capture every perceptible change in the slope of the land, both in the area of detachment and in the area of the wave-sliding body.

Points	2018	2020	Dif.20-18
1	409,809	409,808	0,1
2	412,013	412,015	-0,2
3	415,106	415,062	4,4
4	409,914	410,366	-45,2
5	414,336	413,049	128,7
6	411,002	410,994	0,8
7	413,358	413,350	0,8
8	414,212	414,201	1,1
9	418,000	418,015	-1,5
10	411,016	411,015	0,1
11	413,568	413,560	0,8
12	413,810	413,800	1,0
13	414,802	414,807	-0,5
14	415,972	416,011	-3,9
15	410,397	410,421	-2,4
16	413,020	413,012	0,8
17	414,232	414,188	4,4
18	416,208	416,216	-0,8
19	409,618	409,611	0,7
20	413,411	413,408	0,3
21	411,390	411,369	2,1
22	414,842	414,832	1,0

Points	2018	2020	Dif.20-18
23	417,240	417,184	5,6
24	434,000	434,002	-0,2
25	445,020	445,003	1,7
26	410,005	410,000	0,5
27	412,798	412,800	-0,2
28	413,814	413,798	1,6
29	414,226	414,196	3,0
30	419,218	419,213	0,5
31	408,627	408,633	-0,6
32	413,895	413,878	1,7
33	412,799	412,794	0,5
34	415,391	416,433	-104,2
35	415,655	415,636	1,9
36	423,008	422,992	1,6
37	433,984	433,996	-1,2
38	408,202	408,211	-0,9
39	410,607	410,591	1,6
40	411,867	411,867	0,0
41	413,414	413,400	1,4
42	415,000	415,000	0,0
43	424,954	424,975	-2,1
44	440,028	440,019	0,9

Tab.1 - The odds of the points and the difference between measurements 2018-2020 (mm)

4. Conclusions

Landslides are forms of land degradation that can have a disastrous evolution in a very short time or can remain in a latent stage for certain periods. The associated risk can be manifested on social-economic objectives, directly through dislodged land masses, but can also associate other repercussions, such as floods or the clogging of some lakes.

The actual values of the volumes displaced by sliding can be taken into account at most as estimates, because the accuracy of the two terrain models differs due to different data sources – plans with level curves on the one hand and topographic elevations on the other on the other hand. However, these differences show the gravity of the phenomenon and represent the only source of information regarding the geomorphological parameters from the period before the slide.

The comparative data analysis led to the following conclusions:

- In the period 2018-2020, a relative stabilization of the main surparation areas was observed. The main significant negative differences were recorded at points 4 (-45.2 mm), 5 (128,7 mm) and 34 (-104.2 mm).
- monitoring with the help of 3D scanning technology, although expensive, is established as a modern solution for data collection from the ground for detailed monitoring of active degradation phenomena, such as landslides.

5. References

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