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THE MODERN MEASUREMENT TECHNOLOGY APPLIED IN MINING PERIMETER EXPLOITATION ACTIVITIES

Bianca Maria CREȚ

Scientific Coordinator: Lect. PhD Eng. George POPESCU

University of Life Sciences "King Mihai I" from Timișoara, Calea Aradului 119, 300645, Romania, Phone: +40256 277280, Fax: +40256 200296, Email: popescu.george25@gmail.com

Corresponding author email: popescu.george25@gmail.com

Abstract

Modern technology combined with classical technology plays a fundamental rol in engineering activities undertaken in day-to-day operations, with the aim of obtaining the necessary materials for construction or obtaining certain useful materials found near the surface. A significant contribution of this branch of engineering measurements, using modern technology, is manifested through specific studies carried out from the preliminary design phase of the exploitation to the phase where the perimeter is ecologized. The purpose of this article is to test and evaluate the accuracy of data for volumetric predictions of exploited materials, using modern technology and specialized software based on topographic altitude, through which we can create a three-dimensional model of the exploitation perimeter. For this purpose, a suitable surface exploitation was chosen as a case study, referring to the Lucaret-Sud perimeter in Timis county, where the volume of useful material forecasted in the exploitation program for the year 2023 was determined.

Key words*: 3D model, Engineering measurements, Leica GS08, UAV, volumetric calculations*

INTRODUCTION

The importance of the study works based on the research conducted for obtaining extensions of the mining waste and sand and gravil deposits exploitation licenses in the Lucaret Sud perimeter in Timis county. It was necessary to prepare documentation required for approval regarding the capacity to carry out mining works for mineral resources, including useful rocks and mining waste, through topographic surveys. In order to shorten the study time in this perimeter, state-of-the-art technologies were used. The data was acquired, in order to obtain the most accurate results.

In cases where we encountered areas with high inaccessibility factors, we made use of cutting-edge technologies (Bârliba, 2017).

During the World War II and the Cold War, UAV (Unmanned Aerial Vehicle) technology has significantly improved. (Haala, N et all, 2008)

Although initially notable for military reconnaissance and surveillance purposes as well as maritime surveillance, over time it has proven to be useful in engineering measurements. Subsequently, it has become increasingly recognized as a standard research tool for acquiring detailed imagery of an area of interest and creating detailed 3D models and orthophotoplans. Precise measurements can be performed using GNSS (Global Navigation Satellite System) technology, such as GPS (Real-Time Kinematic), along with modern drone and geodetic data processing technologies.

MATERIALS AND METHODS

Engineering measurements play a crucial role in surface mining operations, supporting the smooth execution of the extraction process by providing essential information for engineering activities. New techniques and methods need to be introduced in various fields, as dynamics are inherent in our world (Casian et all, 2019).

For the extraction, transport and delivery of sand and gravel deposits from the Lucaret Sud exploitation perimeter, the necessary documentation has been prepared for its certification regarding the capacity to carry out specific works for the development and exploitation of mineral resources-useful rocks, mining residues, through topographic and geological works (Cret et all, 2021).

The surface area of the perimeter where the

exploitation works will take place is 32635.09 m^2,equivalent to 3.26 ha, and is delimited by the following coordinates (STEREO 70 SYSTEM):

Table 1. Stereo 70 coordinates

Nr. punct	X	Y
1	524700	229500
2	524500	230500
3	524000	230500
4	524000	229500

The subject of study for the present documentation is located in Timis county and aims to obtain the exploitation permit for useful mineral substances from Lucaret Sud perimeter, through volumetric calculation of the exploitable material, using the cross-sectional method for the year 2022-2023.

In order to accurately determine the stages that form the basis of the final results, certain steps have been taken, including field reconnaissance and establishment of strategic points for commencing topographic measurements, as well as consultation of the topo-cadastral plans provided by the beneficiary.

The current technology offers new opportunities for landowners or prospective buyers: with the help of orthophotoplans, they can obtain clear and objective information about specific areas.

Regarding the topographic-cadastral perspective, recognition of the land was performed using UAV (Unmanned Aerial Vehicle) technology (Nocerino et all, 2018).

For our particular study case, we used a Phantom 4 Pro quadcopter UAV. The device is equipped with GPS and GLONASS positioning system, which allow it to quickly connect to satellites and accurately position itself in the air (Herbei et all, 2018).

Phantom 4 Pro automatically records the details of each flight performed, allowing the checks on previous flights. As for data processing using UAV platform, the flight plan for collecting ground images and determining ground control points was established using Pix4D software. Pix4D mapper Is a photogrammetric software for professional mapping of images captured with the help of drones. It transforms the images into digital spatial models, both through local hardware solutions and with the help of cloud technology.

Figure 1. Phantom4 Pro UAV (https://www.mpb.com/en-eu/product/dji-phantom-4/sku1529737?utm)

For centimeter-level accuracy, prior to flight control point are established on the target area using surveying instruments, which are then marked for reference.

Figure 2. Ground Control Points (GCP)

These ground control points need to appear in the images so that they can be used as reference points by the software. The steps underlying the data acquisition and processing are as follows:

-the target area is determined and the flight plan is created, which will be uploaded to the drone.

-during the flight, the UAV captures overlapping images, with a 70% overlap, and determines the geographic location of each capture.

-after landing, the images and data from the drone are downloaded and then correlated using specific software.

-the final phase is characterized by image processing, which is done using state of the art programs. This involves three important steps: image alignment (resulting in a point cloud), geometric reconstruction to calculate the three-dimensional position of each point (resulting in a three-dimensional model), and exporting the results.

Figure 3. System GNSS Leica GS 08(****-https://kb.sccssurvey.co.uk/introduction-to-gnss-surveying-with-a-leica-gs08-network-rover/)

The benefits of this measurement method are derived from the high quality and quantity of topographic data, as well as the high-quality aerial imagery. Using traditional topographic measurements methods, to achieve such a large quantity and quality of data without imagery, would require GPS equipment to be placed in a very large number of points (Șmuleac, A et all, 2015, 2018).

RESULTS AND DISCUSSIONS

The studied area is located in Romania, in the Northern region, Timis county, and the main exploitation object is hard rock for civil constructions and beyond, from the Lucaret Sud perimeter. The resulting material will be utilized by various beneficiaries in its natural state, as the mining residue conglomerate cannot be processed.

The name of the exploitation perimeter is Lucaret Sud, which is located approximately 1.2 km south of the village of Lucaret, Brestovat commune, Timis county, to which it belongs administratively.

From Topolovatu Mare commune, access to the perimeter is through the road Topolovatu Mare-Lucaret(7 km)-Brestovat-DJ572.

From this road, approximately 3 km from Lucaret, a 2 km long agricultural road for exploitation-DE 1950-branches off, providing access to the actual perimeter. The nearest city is Lugoj, located approximately 25 km away.

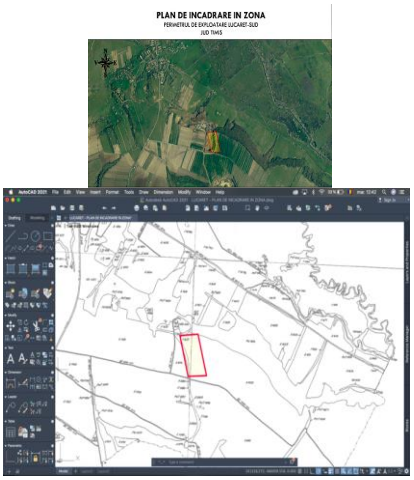

Figure 4. Zoning Plan for the Lucaret Sud Area

The perimeter has been exploited since 2003.

The points in coordinates that delimit the exploitation perimeter, were referred to the Stereo 70 system and provided in the table 1 from "Materials and Methods" chapter. Accordingly, overburden removal works have been planned after ensuring access to the deposit through opening works. The topographic technical documentation had a previous version, which has been updated and submitted to the institution authorized to issue the exploitation permit, following certain works that fall within its domain.

The requirements for completing the topographic documentation included the elaboration of up-to-date site plans, with quarterly progress works, longitudinal profiles, cross-sectional profiles, as well as volume calculations from the obtained profiles.

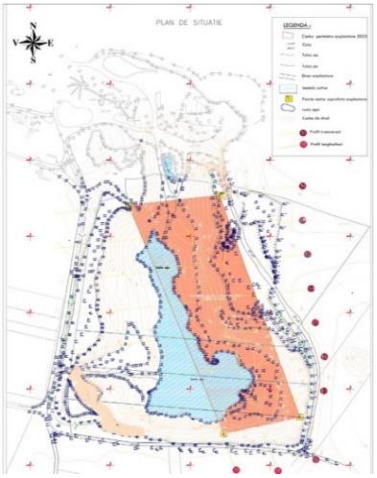

Figure 5. The geometric shape on contour lines for the studied perimeter.

In order to accurately establish the stages that will form the basis of the final results, certain steps were taken, including field reconnaissance and identification of strategic points for initiating topographic measurements, as well as consultation of previous cadastral topographic plans. The field reconnaissance was carried out using UAV (Unmanned Aerial Vehicle) technology, specifically the DIJI Phantom 4 small-sized drone (Figure 1) to capture as many details as possible from the terrain.

Figure 6. Image captured with UAV (Unmanned Aerial Vehicle) technology.

In order to determine the exploitation areas, consideration was given to respecting the control points physically marked in the field. These points represent the outline of the proposed exploitation perimeter for 2023.
The topographic measurements to determine the outline of the proposed exploitation and the elevation points, that are the basis of the situation plan, as well as the transverse and longitudinal profiles, in order to calculate the volume of useful or sterile material, for the Lucaret Sud perimeter, were executed in the Stereographic coordinate system 1970, with reference the level of the Black Sea using the RTK (Real Time Kinematic) method.extending the Lucaret Sud exploitation perimeter.
This plan serves as the basis for calculating the scheduled volume for each quarter.

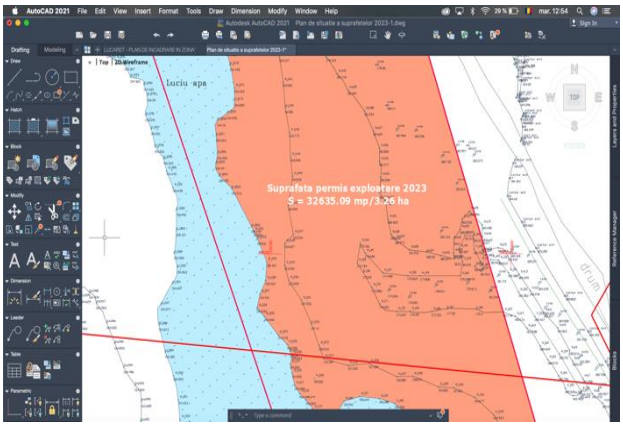

Figure 7. Up-o-date site plans with the scheduling of exploitation surfaces.

Within this studied perimeter, 7 cross-sectional profiles and 3 longitudinal profiles were established, one of which is located in the area where the deposit will be excavated, with a base elevation of +182m.

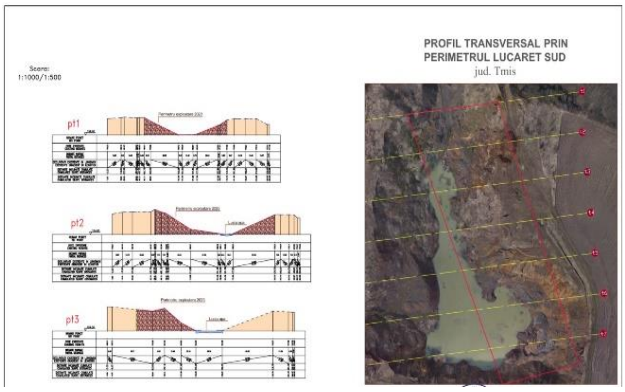

Figure 8. Cross-sectional profiles through the exploitation area.

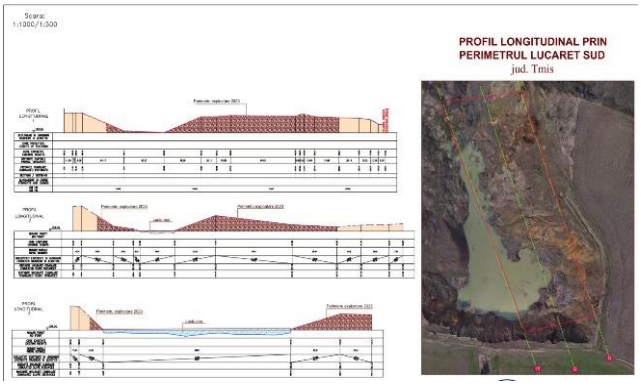

Figure 9. Longitudinal profiles through the exploitation area.

The calculation of the volumes from the transverse and longitudinal profiles is a step in establishing the main quantities of work required for the execution of excavations in the layers of useful material. was imposed by the issuing institution of the permit. As such, the areas resulting from the profiles were calculated, and then multiplied by the applicable distance for each section, resulting in the mining volume.

BRESTOVAT, JUD. TIMIS						
No. crt.	NAME PROFILE	DISTANCE APPLICABLE m	CALCULATION OF VOLUMES			OBS
			VERTICAL SURFACE mp	VOLUME mc	VOLUME tonS	
0	1	2	3	4	5	
1	PT1	20	527,28	10.545,10	16.872,16	The applicable distance is measured and represents the distance between point P1 and ½ of the distance between T1 and T2
2	PT2	40	486,36	19.454,40	31.127,04	The applicable distance is measured and represents ½ of the distance between PT1 and PT2 and ½ of the distance between PT2 and PT3
Total Trim I (2022) = 30.000 mc						
3	PT3	40	436,70	17.467	27.947,2	The applicable distance is measured and represents ½ of the distance between T2 and T3 and ½ of the distance between T3 and T4
4	PT4	40	184,84	7.393,60	11.829,76	The applicable distance is measured and represents ½ of the distance between PT3 and PT4 and ½ of the distance between PT4 and PT5

Figure 10. Example volumetric calculation in the exploitation perimeter Brestovat, Timis

CONCLUSIONS

In conclusion, the current study is based on the premise of rational exploitation, aiming at the possibility of exploiting the mineral aggregates and their valorization from the sand and gravel deposit within the studied perimeter, considering the fact that the exploitation license 1.374/2000 for Lucaret Sud perimeter expires during the third quarter of 2022.

The main reason for an efficient and prospective exploitation is to schedule the works only for the first three quarters, as per the terms of the current permit, with the intention to obtain a 5th year extension of the exploitation license thereafter. The topographic works are carried out in accordance with the requirements imposed by the issuing authority of the permit.

In order to carry out the activities of extraction, transportation, and delivery of the sand and gravel deposit from the Lucaret Sud exploitation area, the necessary documentation has been prepared for its certification regarding the capacity to perform specific works related to the development and exploitation of mineral resources-useful rocks, through topographic, geological and other works.

The obtained results have been achieved through the use of state-of-art technologies in the field of geodetic engineering, employing modern acquisition methods, with the aim of making the achievement of objectives easy, and keeping the time factor for data acquisition and processing relatively small.

With the help of modern technologies such as drone-based surveys or geodetic data acquisition using GNSS (Global Navigation Satellite System) and GPS (Real-Time Kinematic), measurements can be carried out remotely without leaving traces along the measurement path, while other data acquisition

methods can yield highly accurate results within a very short time interval. Geodetic data processing software is an integral part of modern packages, contributing to the optimization of obtaining results efficiently.

Based on the processed data results, topographic documentation is created, which includes all the

drawn elements, starting from the up-to-date topographic site plan with longitudinal and cross-sectional profiles through the Lucaret Sud exploitation, up to the volume calculation from sections, volume phased for each quarter.

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