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USING DRONES ON 3D MODELLING AND IDENTIFYING ENVIRONMENTAL DAMAGES IN OPEN CAST MINING

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Abstract: *The Drone technology recently has many applications. One of its very popular applications is in geology and mine field. This paper presents a case study on 3D modelling of the open cast mine in Progër - Bilisht, Albania using Drone technology. This open cast mine is located on the south east of Albania, close to Korça city. The main mineral is limestone. The altitude varies from 951m to 895m. The destination of this mineral is the construction industry, cement and lime production. The yearly production capacity is around 30,000 m³ per year. The paper gives a brief explanation of the methods and materials used to create a 3D model in mining. The method used to make a 3D model and identify the environmental damages in open cast mine is using Drone technology. Final result of the Data processing is 3D Model of Progër – Bilisht open cast mine which can be rotated, and zoomed in any direction giving the possibility to check details of the opencast mine, to measure distances, angles, surface and volumes. Furthermore the paper gives conclusions and recommendations. One of the most important conclusions is that using Drones is very easy, and cost less way to collect data, which can elaborate with different software to build 3D models. From the other side the environmental damages must be considered through reforestation of the area.*

Keyword: *Open cast mine; 3D modelling; Drones*

INTRODUCTION

Drone technology is using more and more in different fields of the life. In geology and mine drones can be used to search and carry out processes related to exploration, exploitation and other processes. In exploration Drones help to predict the location of mineral deposits, oil and gas production, and so on. Drone technology provides realistic, measurable benefits in mining operations, reducing risk by increasing the speed and range of geo data collection. The history of using Drones in Albania it is not so old. Mostly they are using from amateurs, movie maker, etc. In the last 5 years drones started to be used also for topographic, geology, mine construction, roads and other purposes. On this paper we will discuss about the using Drone technology for 3D modelling of an opencast mining in Bilisht area in Albania.

The opencast mine of Progër - Bilisht is located on the south east of Albania, close to Korça city (Figure 1, 2). The altitude varies from 951m to 895m. The mineral exploited in this mine is the limestone. The destination of this mineral is the construction industry, cement and lime production. The yearly production capacity is around 30,000 m³ per year. The system used for mineral exploitation is transporting it in a distance around 1km and depositing and processing further there. The exploitation system elements applied in this open cast mine are: height of the ladder h=5-10m; the width of the work area varies from 8-12m and

20-40m; Ladder escarpment angle 60° - 70° ; The width of the final ladder place is 4m.



Figure (1) Satellite image of Open Cast Mine of Proger, Bilisht, Albania. [Source: Google earth]



Figure (2) View of area of elaboration of the limestone mineral

MATERIALS AND METHODS

3D Modelling of Proger, Bilisht open cast mine is done using the Drone technology. We used this method because using drone definitely increase number and improve the accurate of data in a very short time. Because stockpiles are irregular in shape it is difficult to estimate their volume with great precision using traditional methods such as GNSS surveying, but using Drone the calculation is more accurate. Using drones not only reduce the time and the cost, but from the other side the work of the surveyor's is more safe, without forced them to climb up and down stockpiles, or work in the middle of moving machinery.

Because the flight of drones can be realised, as many times as, we want, we can update our data very easily every week or month. Because the data are updated more frequently is easier to administer the opencast mine in better way. In the transport, and machinery moving, because the visual view is clear is very easily to make better design of roads and machinery moving. As it is known the risk of natural disaster like water flood, disruption, etc are always present in opencast, and worker's safety is high priority. Drones can help to prevent these danger activities through 3D digital modelling produced by drone images. Flying frequently allows us to create a database over time, and monitor the progress every week or month.

One of the most important works in open cast mine is drilling and blasting. Both these processes can be better designed using 3D models of the areas where will be drilled or blasted. Inspection of the special points and area are very easy to be realised by drone. These models help accurately analyze the area to be drilled and calculate the volume to be extracted post blasting. This data allows us to better manage resources such as the number of trucks needed. A comparison against surveys taken before and after the blasting will allow volumes to be calculated more accurately. This improves planning for future blasts, cutting the cost of explosives, time on site and drilling.

Because data are collected very fast, just by connecting in a laptop, and using different software we can

create and generate different maps like: *Orthomosaic maps*, where distance, and surface can be measured; *3D point cloud*, where each point contains geospatial (X, Y, Z); *DTM (Digital terrain model)* where each pixel contains 2.5D information (X, Y, and Z values of the highest altitude). These models allow us to identify stockpiles and pit changes, and to model water flows and wall collapses; *3D Textured mesh* which can be used for inspecting unreachable areas, such as pits and slopes.

Very important aspect is the accurate of the measurements. Because drone capture thousands of data points for one stockpile, the accurate of Drones is higher than surveying with total stations and because of that it generate more accurate calculation of volumes and costs. Collecting data with a drone is up to 30 times faster than with traditional land-based methods, and does not require the presence of a surveyor on site. Over the long term, the costs of surveying and monitoring are substantially reduced.

The materials

Materials used to realize this work were: Topographic and geological map of the region; Satellite imagery; Instruments like Total Station and GPS for control points; Drone DJH Mavic Pro; Some software for data processing as Pix4D Discovery; AgiSOFT Software; 3D Survey Software; and Micromine.



Figure (3) Drone DJH Mavic Pro [Source: <https://www.dji.com/mavic>]



Figure (4) Flight path of the Drone

The methods

The method for building a 3D model of Progër – Bilisht open limestone cast mine was by capturing data in the field and processing them in office, manually and automated. Steps followed from data collecting to 3D model printing were:

- [1] Control points defining;
- [2] Flight path of the Drone designing base on the Google earth Satellite Imagery, and Maps of the area

- (Figure 4);
- [3] Data capturing with Drone DHJ Mavic Pro;
 - [4] Downloading data from Total Station, and Drone in computer;
 - [5] Data processing through the Pix4D Discovery program (Figure 5, 6).

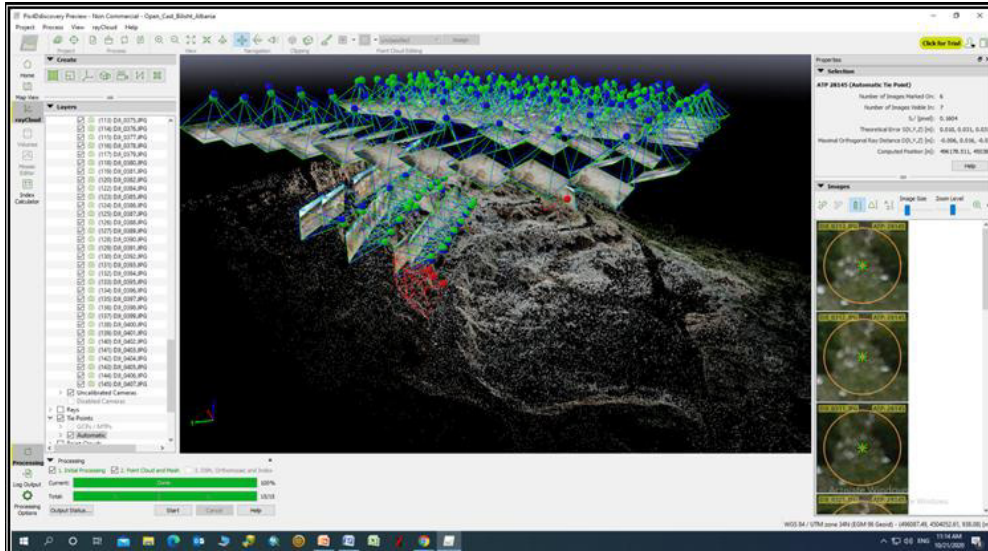


Figure (5) Tie Point view, and camera position



Figure (6) Photo of the opencast limestone mine by Drone

RESULTS AND DISCUSSION

Final result of the Data processing is 3D Model of Progör – Bilisht open cast mine (Figure 7), which can be rotated, and zoomed in any direction giving the possibility to check details of the opencast mine, to measure distances, angles, surface and volumes.

From the other side zooming in very high resolution create the possibility to discover problematic in stairs especially where very danger to inspect there. This model shown clearly all the opencast mine area, stairs, machinery, surrounding environment etc. This model is very good not only for view presentation but also for measurements and calculation taken. Through this model we can calculate volumes of the mineral stocks, height and width of the stairs, blast area, etc.

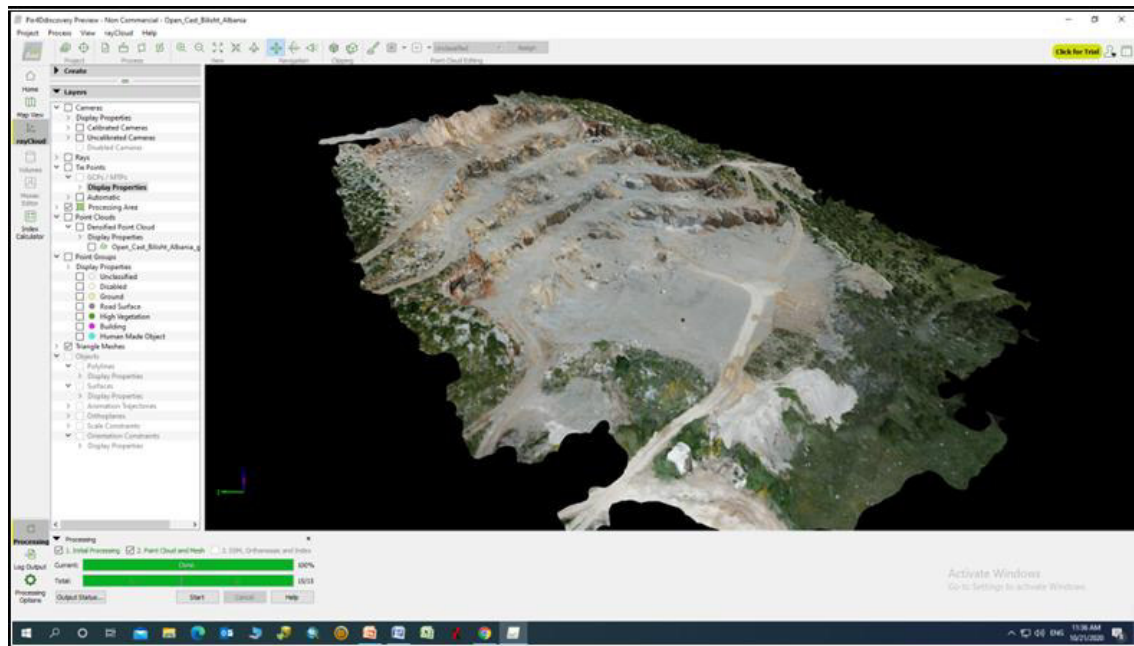


Figure (7) 3D model of the Limestone Opencast of Bilisht, Albania produced by Pix4D program.

As it can be seen through this program we are able to make different measure like distance, surface and volumes, but also we can classify different groups point as: Ground, Road surface, Vegetation, Building, humans, etc, (Figure 8). We can also have different type of view like: Tie Points (Figure 5).

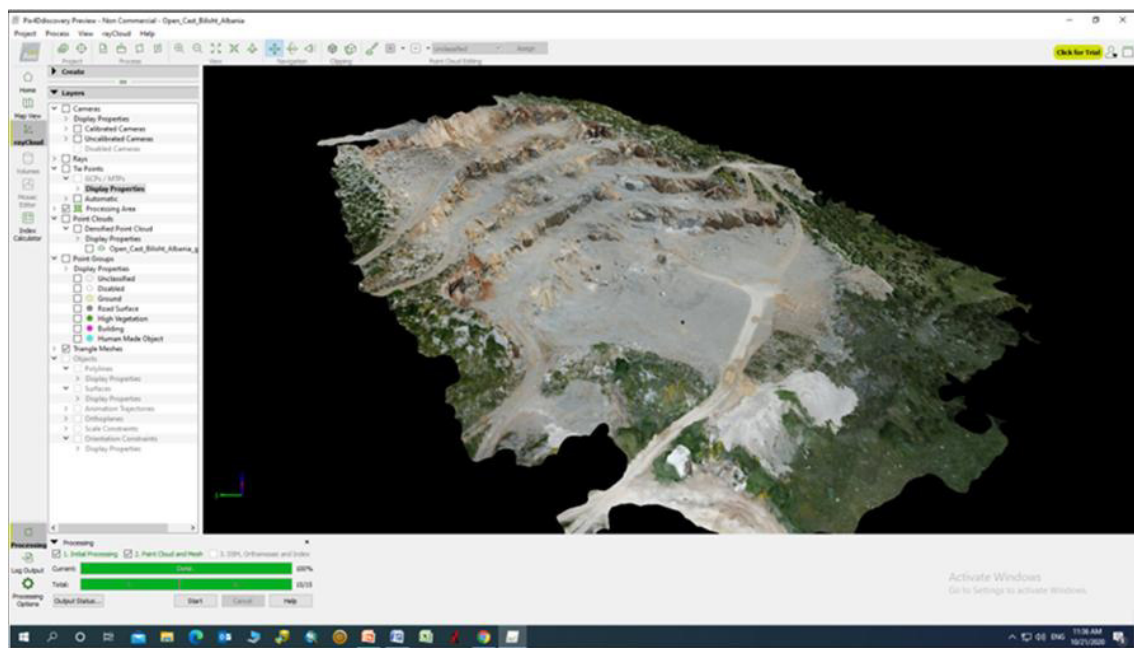


Figure (8) Measurements of distance, surface and volumes in PixD4 program

The environmental damages are shown in Figure 9. There are presented two polygons showing the situation in 2006 and in 2020. As it can be seen in 2006 there were only 0.77 Ha damaged by the open cast activity. In 2020 there are 6.27 Ha. The mainly damages are in forestry and air pollution because of the enrichment plant of the mineral there. The calculation of damages are done comparing the satellite image of 2006 and 2020, also the real situation photographed by Drone

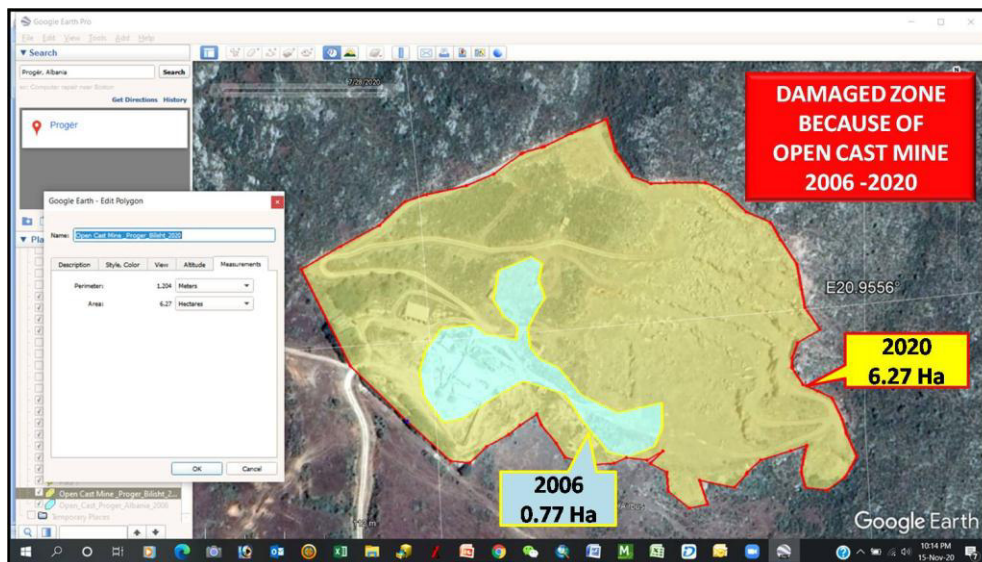


Figure (9) Damaged area because of open cast mine activity

CONCLUSIONS AND RECOMMENDATIONS

- The using of Drones in 3D modelling in geology and mine is still in beginning in Albania, but very fast it will be spread in most of the mine sites;
- Using Drones is very easy, and cost less way to collect data. These data can be elaborated with different software making different analyses and building 3D models. The Drone can offer views of danger areas for the human staff;
- Pix4Ddiscovery program is very easy to use, it offers many possibilities to act and interact in the object making different measurement and design;
- The accuracy achieved by drone is enough good for the purpose of 3D modelling and environmental issues;
- Using Drones in Albania needs a clear legislation, because recently this legislation is missing. It is recommended to start the work for a full legislation according of the European Directive;
- It highly recommended using drones in all opencast mining. Drones can be chosen according of the goals and objectives;
- From the environmental view, it is recommended to make the necessary rehabilitation of the area, planting tree on the open cast steps, also to make necessary protective measures from the the dust produced from the machines.

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