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Re-Cultivation of the Area from the Ecological Aspect where Limestone has been Exploited in Pasomë Village

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ABSTRACT

Environmental degradation often occurs either from natural phenomena such as earthquakes, floods from surface or underground water, but it often happens that the human factor itself can be the cause in cases where, by developing certain activities, it destroys the structure and texture of the environment's landscape. As a concrete case of this study, the limestone source in the village of Pasomë is taken, where limestone is being exploited, the study aims to find solutions through which the sliding of the side slopes and the degradation of the environment will be minimized, since this directly affects the life and activity of the inhabitants of the village, over 70% of whom are engaged in agriculture and farming. The purpose of this paper is to find adequate solutions for the rehabilitation of the side slopes of the limestone source by creating the geometry of the side slopes with the safety factor allowed according to geotechnical standards to enable the re-cultivation of the source area where limestone was extracted because the vegetation plays an important role in creating a better environment for the inhabitants of the village and in general, as well as the preservation of flora and fauna.

Keywords: exploitation of stone, rehabilitation of side slopes, re-cultivation of the area.

INTRODUCTION

The degradation of the area was done by not respecting the criteria during exploitation of the limestone, in which case slopes with high heights above the allowed values were created, endangering the residents of this area as shown in Figure 1. The activity that takes place here is related to extraction and processing of limestone, which is used for construction of road layers, production of concrete and asphalt. The location where the limestone was extracted is located in the village of Pasomë as shown in Figure 2, this place from the administrative point of view belongs to the Municipality of Vushtrri which lies in the northern part of Kosovo and includes an area of 345 km^2 (3.2% of the territory of the Republic of Kosovo), and is divided into 64 cadastral areas, part of the study area is bordered by municipalities such as Mitrovica in the north, Podujeva in the east, Obiliq in the south, Drenas in the southwest and Skenderaj in the west. The population of the entire territory of the municipality is estimated to be 104,000 inhabitants, of them, over 39,800 inhabitants in the urban area and about 64,200 inhabitants in the rural area, the terrain around the location is hilly – mountainous, therefore the population of this area is mainly engaged in livestock farming and agriculture, with a low economic development, this area is characterized by a mild, continental-Mediterranean climate.

STUDY AREA

The location of this study area covers an area of about 5 hectares and 45 acres. During the study, the map of the situation shown in Figure 3 was taken as a basis, where using the Surfer V21 2021 software, the topography of the terrain was

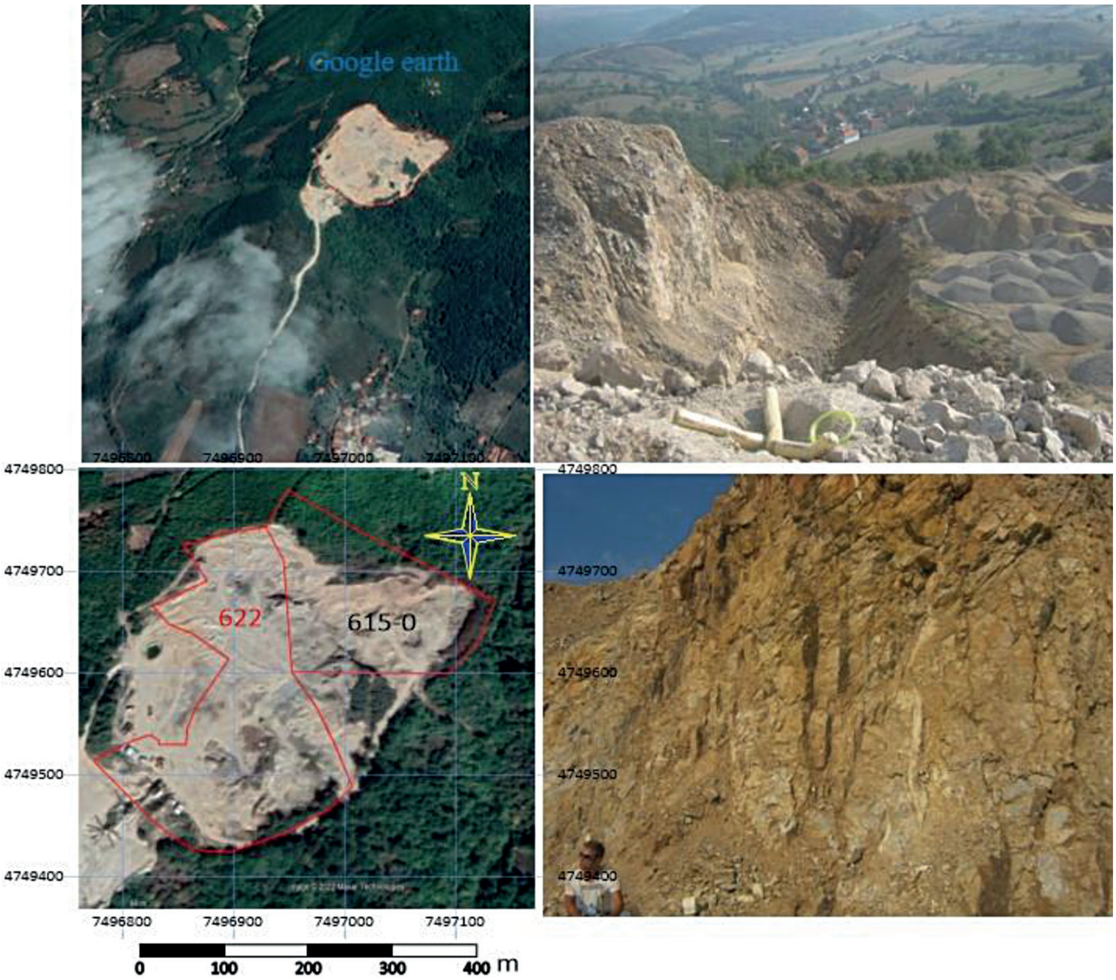

Figure 1. Current position of the site where the study was done

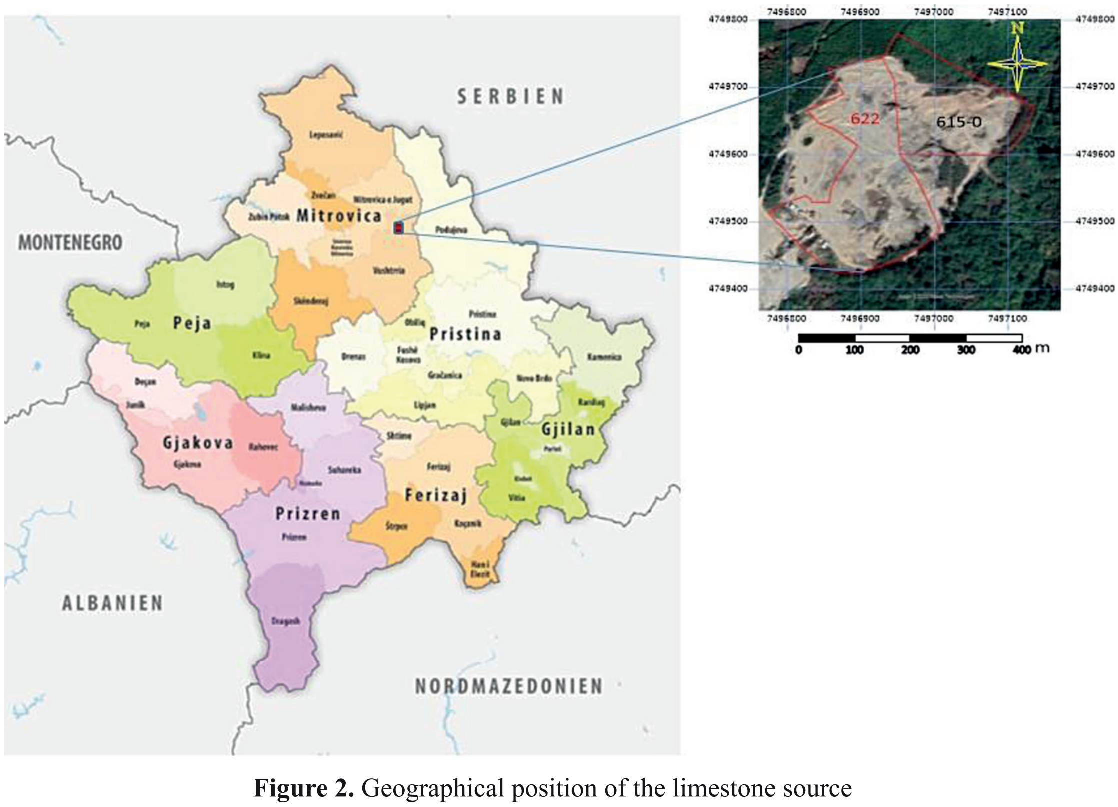

Figure 2. Geographical position of the limestone source

constructed according to the existing condition and the longitudinal profiles were extracted as shown in Figure 4 based on the calculation from the geotechnical aspect (software Slide 2022, Selvamuthu and Das, 2018, Smith, 2014, Ming Xiao, 2015). The limestone quarry is located on a hilly terrain with an altitude of 830 m. The side slope, created after exploitation, based on the actual situation, has a height of H≥30 m and the slope angle is α = 90°, so with the safety factor Fs<1 as seen in Figures 4 and 5, which represents a potentially high risk for the residents of the area, therefore, in order to reduce the risk of this area during the study, the plan was prepared according to the designed condition given in Figure 12, with a safety factor according to Figure 7, through the planting of saplings in the degraded part according to the designed condition as in Figure 12 where the placement of a layer of humus with a thickness of one meter is foreseen and the adequate vegetation is determined for the rehabilitation of the area from the ecological aspect through their planting according to Figure 6 and Table 1, with these solutions it is intended to achieve largely returning to the previous state of the soil (Almas, 2016; Cilliers et al., 2013; Goddard et al., 2010; Lepczyk et al., 2017) which will ensure the safety of the slopes and the achievement of ecological goals, and this will have a positive impact on the residents of the area and beyond.

GEOLOGICAL COMPOSITION

The geological construction of the narrow region of the limestone source in the village of Pasomë mainly consists of Paleozoic Pz2 rock formations which are widespread and cover over 80% of the narrow area of the source according to Elezaj and Kodra [2008]. The rest of the narrow area of the reservoir is built by rocks of Miocene age. They have the greatest distribution in the southwest (SW) and northeast (NE) part of the narrow area of the source in Pasomë locality.

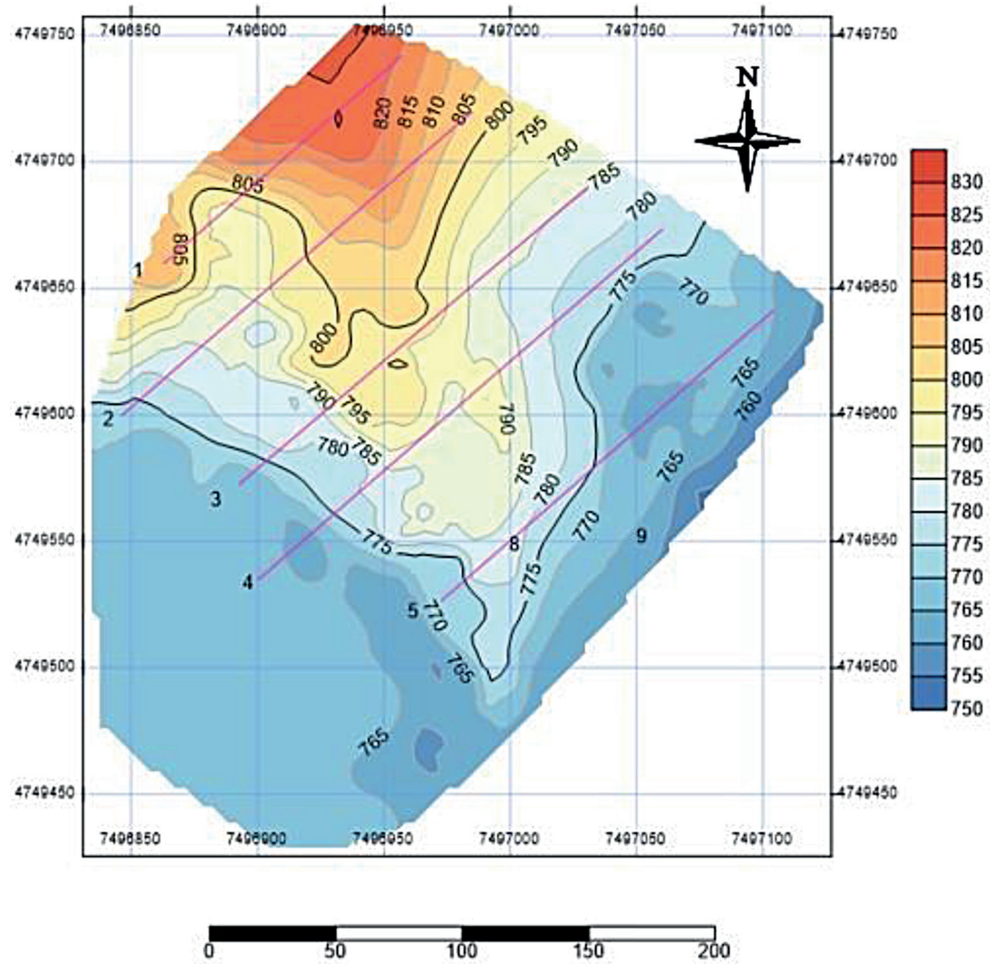

Figure 3. Map of the situation with the position of the profiles, February 2022

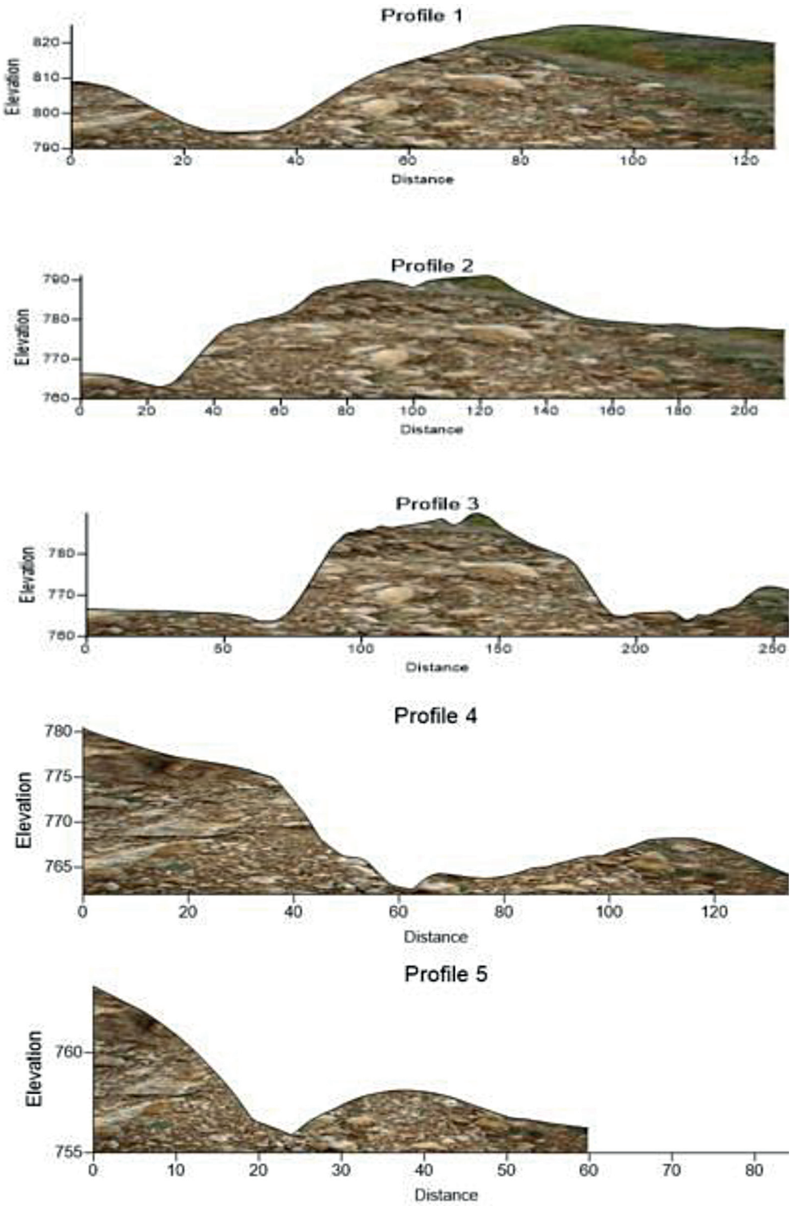

Figure 4. Longitudinal profiles condition

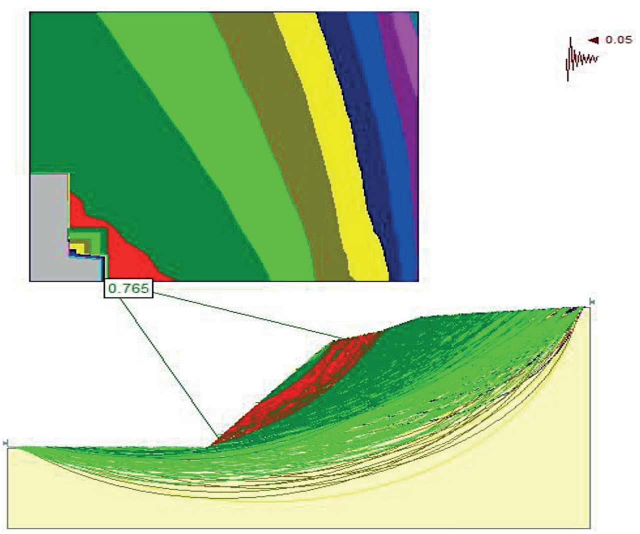

Figure 5. Existing condition with safety factor Fs<1

These formations are represented by: Pyroclatites, quartzites, dacites and andesites. Quartzites (Q) – spread in the central part of the narrow zone of the source. They have the form of narrow bands in the direction extending from the southeast (SE) to the northwest (NW). Their continuity throughout the narrow area of the site is affected by the elements of tectonics, dividing and displacing them.

Metadiabases (ßß) – have a limited distribution in the narrow zone of the source. They appear in the form of lenses with dimensions from several tens of meters to several hundreds of meters. They belong to the New Paleozoic (Pz2). Metasandstones, green shales, argillophillites, clays and stables – these rocks occupy most of the narrow area of the source in the Pasome locality. They spread from the southeast (SE) to the northwest (NW).

The early Paleozoic is represented by shale terrigenous formations and consists of argillaceous-siliceous, quartz-chloritic shales, dark to gray silicitic siltstones. In the upper part, metamorphosed siltstones of these green to black phyllites can be observed, in these formations the medium acidic and basic volcanic flows represented by andesites, basalts of the Tertiary age are interrupted, within the Paleozoic complex are also widespread marbles, in addition to these formations, the Triassic, Jurassic, Cretaceous and Quaternary formations also take part, from the geomorphological point of view we can distinguish: proluvial deposits, terracotta alluvial deposits, alluvial deposits on river beds, deluvial - eluvial deposits, mixed loamy slope breccias. Tectonics is quite complicated due to the position and configuration of the terrain. The tectonics of the region under study corresponds to the fault structures with the direction of extension that are 198–15° and 170–350° in the Kopaunik block. In tectonic terms, the area where the source is located belongs to the Vardar area. The tectonic setting of the region is very complex with transverse faulting with a large number of faults in the northeast-southwest direction, which generally interrupt the structures with a north, northwest, south and southeast orientation, but there are also cases the other way around.

MATERIAL AND METHODS

For the realization of this study, a work methodology divided into two phases was implemented, in the first phase, the terrain was recorded to reflect the existing situation, which is presented in the March 2022 situation map in Figure 3, where 5 longitudinal profiles were drawn, and in the second phase, the final designed condition for the preparation and rehabilitation of the degraded area was analyzed from two aspects: a) from the aspect of the safety of the side slopes (Das and Sobhan, 2014; Budhu, 2010) so that the rock masses do not slide, which would endanger the residents of the village area and b) from the other aspect, the slope was calculated using the methods according to the standards with the safety factor according to (Ashok Chugh, 2001; Ahmeti, 2021; Slide 2022 software) for the rehabilitation of the limestone side slopes and the return of the terrain to its previous state by classifying the types

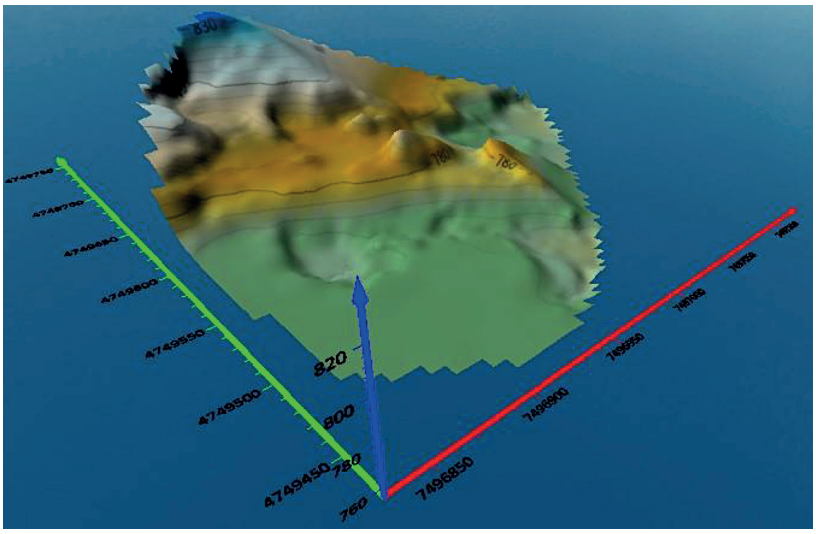

Figure 6. Current 3D rendering of the area for re-cultivation

of plants, according to the chemical and biological analyzes of the soil, which will be suitable for the climate of this area presented according to (Muhlisin et al., 2021; Maruani & Amit-Cohen, 2007; Arnberger & Eder, 2012; Almas, 2016).

The distance of planting seedlings is 4 m row to row and 4 m plant to plant. The planting direction should be north-south. To calculate the number of seedlings to be planted, the formula is used:

$$Nof = \frac{S}{a \cdot b} = seedlings/ha \qquad (1)$$

RESULTS

For the planned solution for the protection of the slopes given in Figure 12, the modeling and analysis of the stability of the geometry of the slopes was done based on the safety factor Fs≥1.2 as well as applying the values of the seismic factor (Jiang Xueliang et al., 2018) according to the geological-geo-mechanical profile that is presented in Figure 7. Based on the results obtained for the geo-mechanical parameters that are presented in Figures 8, 9 and 10, it can be seen that we have a high correlation according to the cohesion value C (Figure 11). Based on the calculations performed with the Slide 2022 software, the adequate width of the safety berm for filling with humus with a thickness of up to one meter has been determined according to Figure 13, where the types of vegetation have also been determined as given in Table 1 for planting seedlings and returning of the degraded state of the land from an ecological point of view, which will have a positive impact on increasing air quality for the residents of the area and beyond.

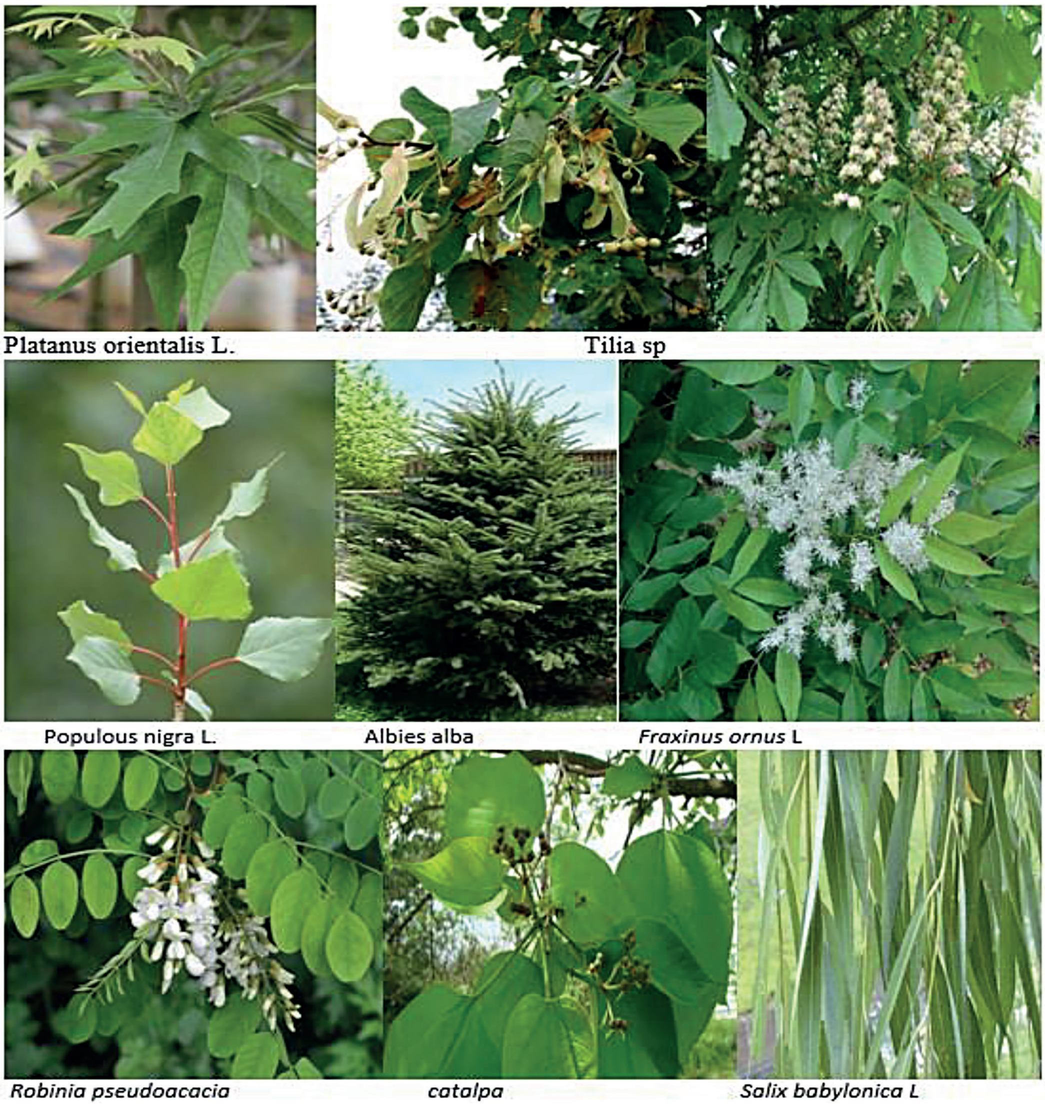

Figure 7. Types of seedlings planned for planting

Table 1. Plants planned for planting in the green belt

No.	Plant species	Planting in piece/hectare
1	*Platanus orientalis* L.	60
2	*Tilia* sp.	70
3	*Aesculus hippocastanum* L.	50
4	*Populous nigra* L.	80
5	*Abies alba*	150
6	*Fraxinus ornus* L.	75
7	*Robinia pseudoacacia*	500
8	*Catalpa*	100
9	*Salix babylonica* L.	50

CONCLUSIONS

The degradation of the environment in the area of the limestone source was almost of a high degree, but based on the research and analysis presented above, we have come to the conclusion that this part of the area can be returned to its previous natural state by implementing the construction of the side slopes according to the designed geometry and applying the relevant proposed vegetation that suits this area. With this solution, it is possible to build the side

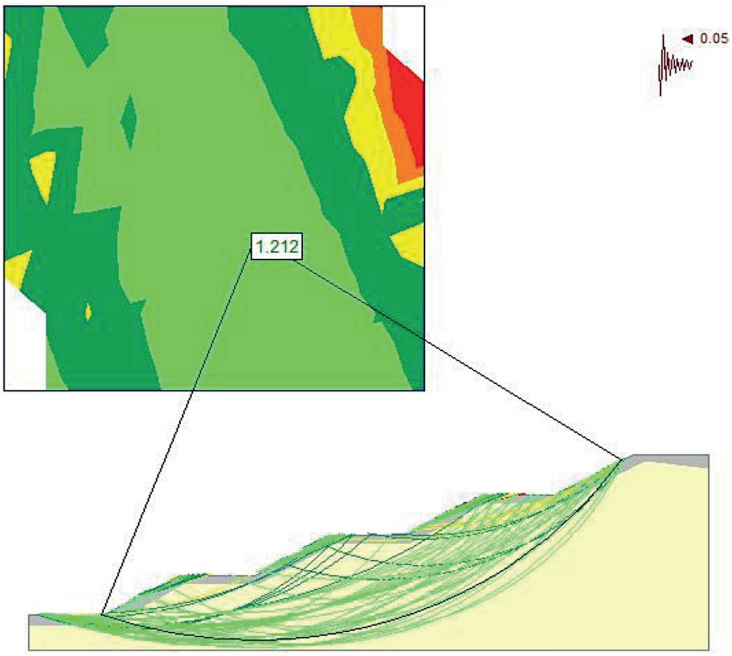

Figure 8. Design condition with allowable safety factor

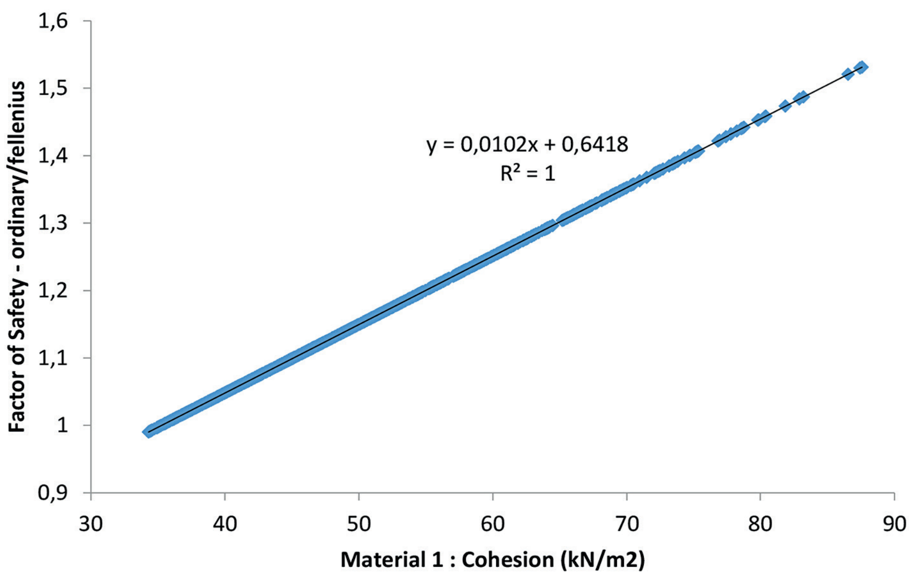

Figure 9. Correlation in relation to the cohesive values with the safety factor

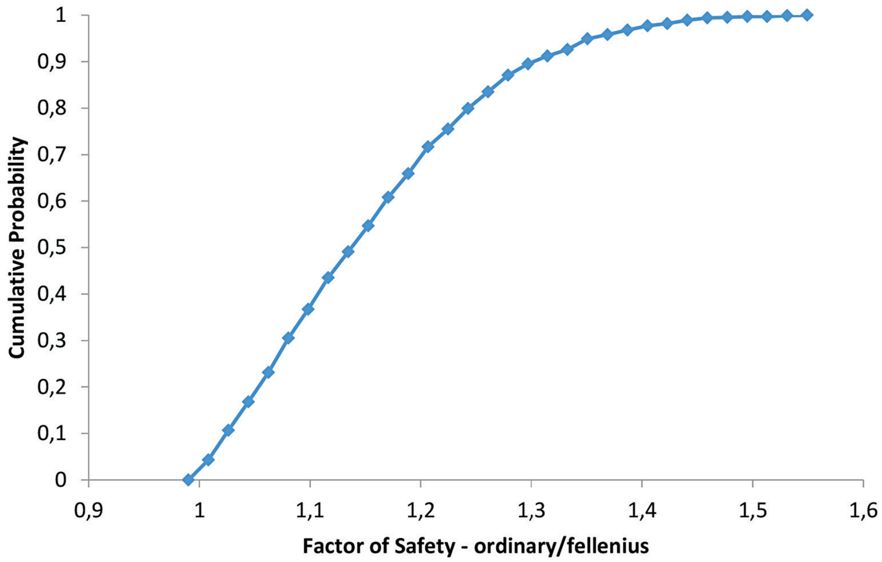

Figure 10. Safety factor relative to cumulative probability

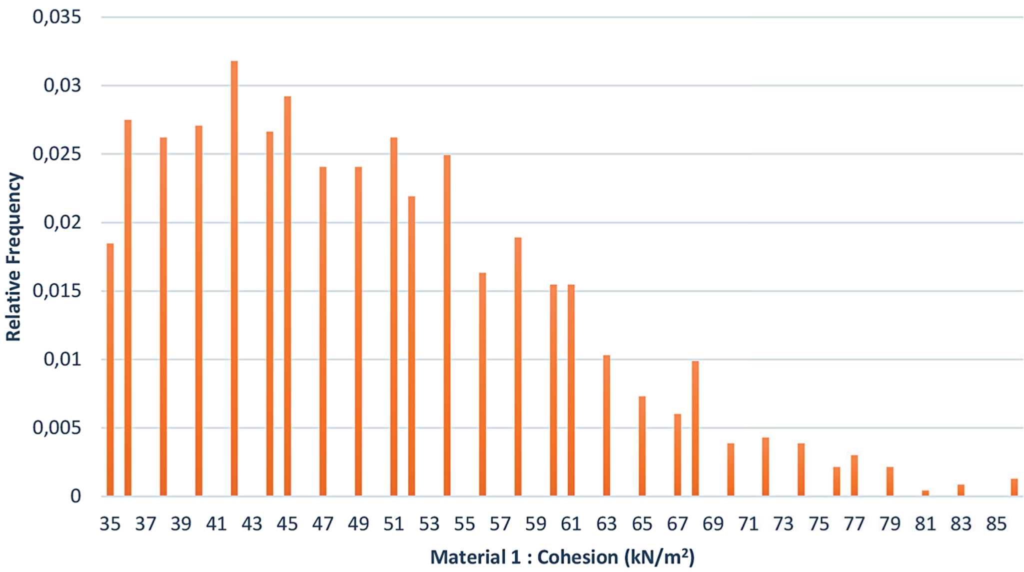

Figure 11. Histogram of the distribution between relative frequency and cohesion

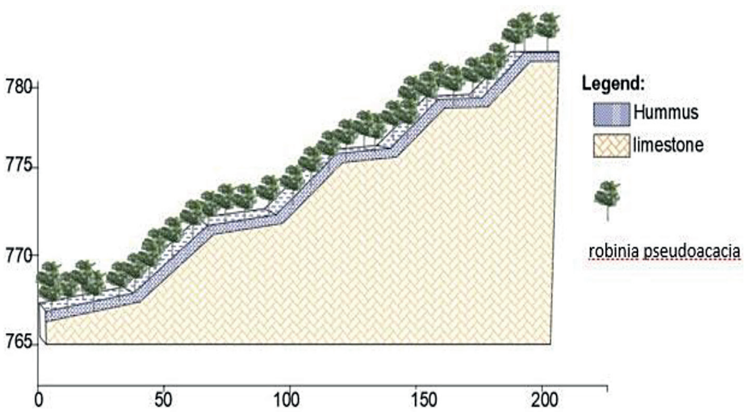

Figure 12. Transverse profile design condition with the allowable factor of safety

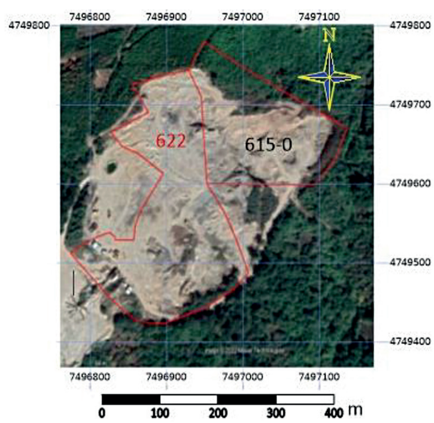

Figure 13. Longitudinal profile, final state with vegetation cover

slopes with a safety factor allowed according to geotechnical standards.

Since this solution foresees the coverage of the entire treated surface with seedlings, then we understand that positive conditions will be created for the residents of this area since the air quality will be reached within the values allowed by the standards. With the application of such measures for the re-cultivation of exploded surfaces, the legal condition for returning the area to its previous state by its user is fulfilled. The shape and inclination of the designed slopes are designed with parameters to provide physical security in the analyzed area after the completion of the project.

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