THE KUTINA PYRAMIDS NATURAL LANDMARK – ITS DEGRADATION AND DISAPPEARANCE

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ABSTRACT

The present paper is focused on research and assessment of the landscape changes of the Kutina Pyramids natural landmark. The study is part of the GIS-based monitoring of the Kutina pyramids region, using remote sensing and ground-based data. The relief of the study area has been changed intensively under the action of technogenic factor during the last 65 years, which affected the unique rock formation Kutina Pyramids. The main part of the analysis of the Kutina pyramids landscape dynamics is based on numerous archive and modern photos, field observations and interpretation of aerial photos and satellite images. The results show that the protected site has been constantly degrading over the past 40-50 years due to the raise of the erosion basis as a result of the intensive human activity near Kutina.

Keywords: *rock formations, anthropogenic activity, conservation, GIS*

INTRODUCTION

The intensive industrial growth and the rapid urbanization in the sub-urban areas lead to unbalanced use of the natural resources which affects the biotic and abiotic environment and cause significant landscape changes. As a result of active anthropogenic activity, developed in the 70-ties of the XXth century near Sofia City, a small protected area was seriously affected. The region of Katina pyramids natural landmark is transformed significantly in a short historical period.

PURPOSE

The main objective of the presented work is to study and assess the changes in the area of *Kutina Pyramids* natural landmark using GIS technologies and aerospace data.

STUDY AREA

The region is situated in the southern foot of Mala Mountain, which is a part of the Western Stara Planina Mountain. It is located about 21 km north of Sofia. In administrative terms, the area falls within the Sofia-city District (Metropolitan Municipality). The southwestern foothill of Mala Mountain is characterized by steep, eroded slopes and dry, deep and segmentated ravines and gullies. Surface water streams are intermittent, mainly with torrential character. The main drainage artery is Kutina River, a left tributary of the Iskur River, which acts as an erosion basis for the gullies. Kutina pyramids are the youngest group of such kind of rock formation in Bulgaria. They are represented by weird-shaped erosion formations with irregular outlines, formed among the weakly-bonded Neogene-Quaternary sediments - sandstones. Kutina pyramids are a natural and geomorphologic phenomenon, consisting of groups of earth pillars, with special aesthetic value that have attracted people for decades. Such groups of earth pillars are located at two places in the study area (Fig. 1):

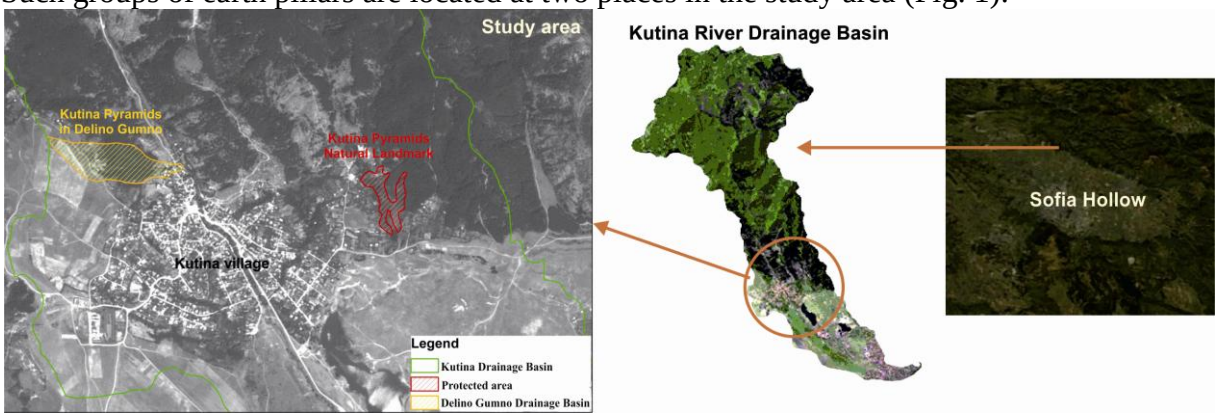


Fig. 1. *Location of the rock formations within the Kutinska River Drainage basin*

The main group is located in the gully Golemiya Dol, in close proximity to the coal sector Kutina which is part of the Sofia coal basin. Since 1940 Golemiya Dol has been a deep erosion gully, whose waters has been drained into the river Kutina. The Kutina Pyramids in Golemiya dol were announced as a natural landmark in 1962. Nowadays, they are in the stage of accelerated degradation.

Similar earth pillars are located northwest of Kutina village, in Delino Gumno Drainage Basin and their height reaches 5-10 m. According to data from various literature sources they are covered with stone caps. Today, these earth pillars are without stone caps and most of them are destroyed. The gully, where this small group of Kutina pyramids is located has intermittent flow, and in its lower part, it is barred from a built-up real estate, the waters being trapped by a catchment. Pyramids are currently among thick vegetation.

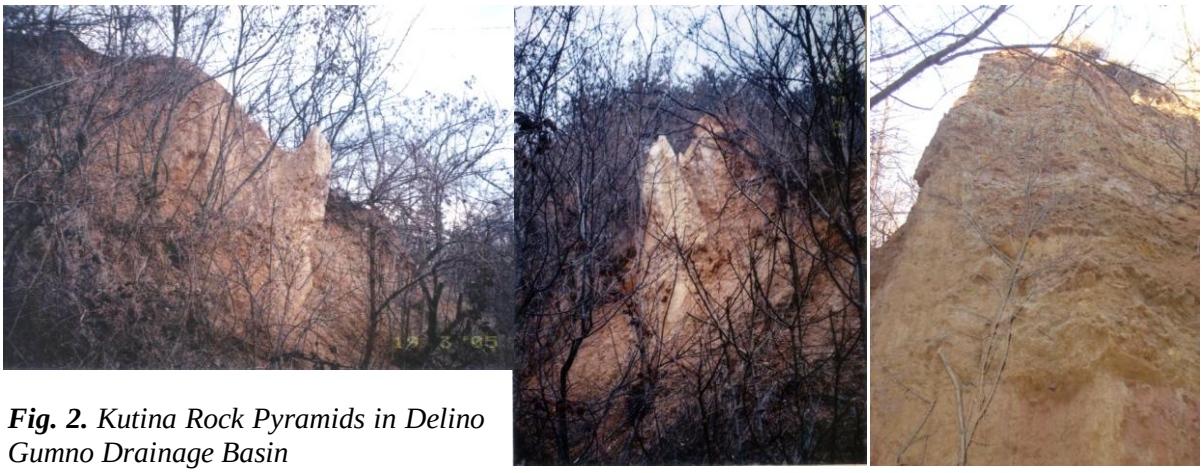


Fig. 2. *Kutina Rock Pyramids in Delino Gumno Drainage Basin*

METHODS

The proposed methods for monitoring the landscape changes of the *Kutina Pyramids* natural landmark include the following stages:

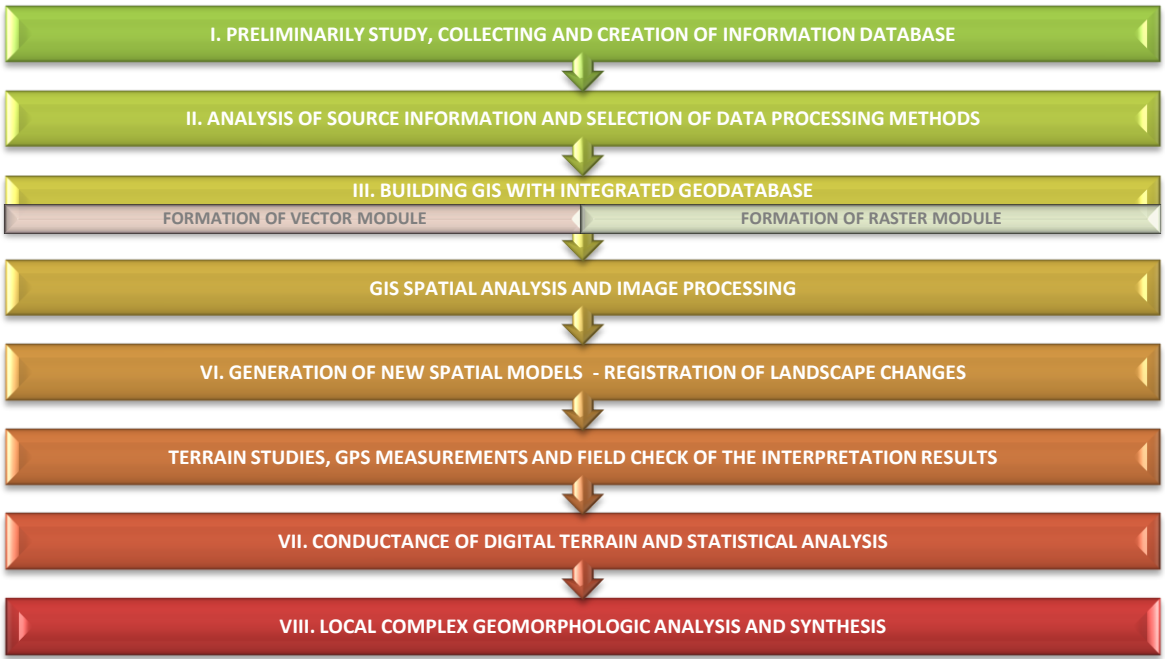


Fig. 3. *Methods for monitoring Kutina Pyramids natural landmark*

The local complex geomorphologic analysis and synthesis in discussed in some previous works by Kanev et al [1]. The present paper is focused on research and assessment of the landscape changes.

Kutina Pyramids are described in the works of Vladimir Popov (1957) and Zdravko Iliev (1992) [2], [3]. Popov made a detailed morphological description of Kutina pyramids and gives us information about what they represented about 50 years ago [2]. Years later, an article of Z. Iliev (1992) analyzed the processes in the region. He is the first who declare that these rock formations are in stage of degradation [3]. The earth pillars are among the most unstable rock formations, formed in young weakly-bonded rocks. He describes the process of Kutina pyramids' formation, where erosion is a major shaping factor and clarifies the reasons for their destruction. Their formation is a result of erosion segmentation of diluvia deposits formed by the weathering of Buntsandstein mantle of Mala Mountain. Kutina pyramids are divided into several groups with different size and color. The depth of erosion incision has reached 30 m. In the past, the area around the pyramids was artificially planted with *Pinus silvestris* and *Robinia pseudoacacia* to reduce the rate of erosion and thus strengthen the pyramids. The conservation of Katina pyramids is of interest not only from geomorphologic point of view, but also because of the great biodiversity of the area [4].

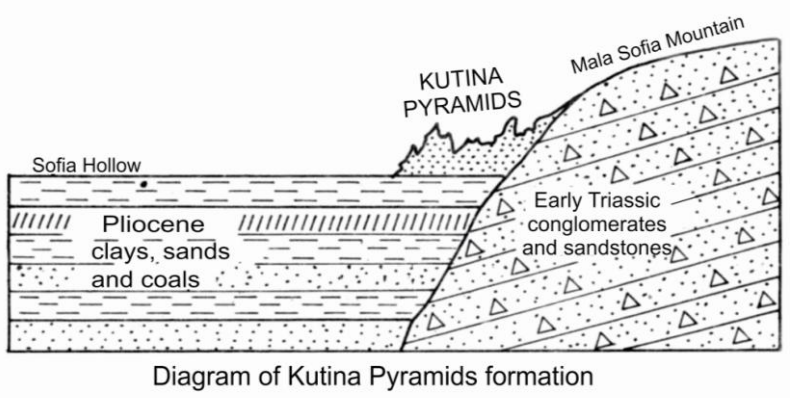


Fig. 3. *Formation of the Kutina Pyramids (according to Zdr. Iliev, 1992)*

DEVELOPMENT AND CHANGE OF THE TERRITORY

Kutina pyramids natural landmark is located north of the coal sector Kutina which is part of the Sofia coal basin. The relief has been changed intensively under the action of technogenic factor during the last 65 years. The development of the Kutina Pyramids area and the adjacent territories can be divided into three stages:

- prior to the mining period
- during the mining period
- after the mining period.

Detailed study of the Sofia coal basin, in particular the Kutina coal sector is performed by Bojinov in 1949 [5]. The pad of the Pliocene is formed by rocks of various age and composition (from Paleozoic to Neogene), while in the Kutina area, lower-Triassic materials (Buntsandstein) dominate [6]. The exploitation of coal mine "Kutina" influence the course of the relief-forming processes in the region of Kutina pyramids.

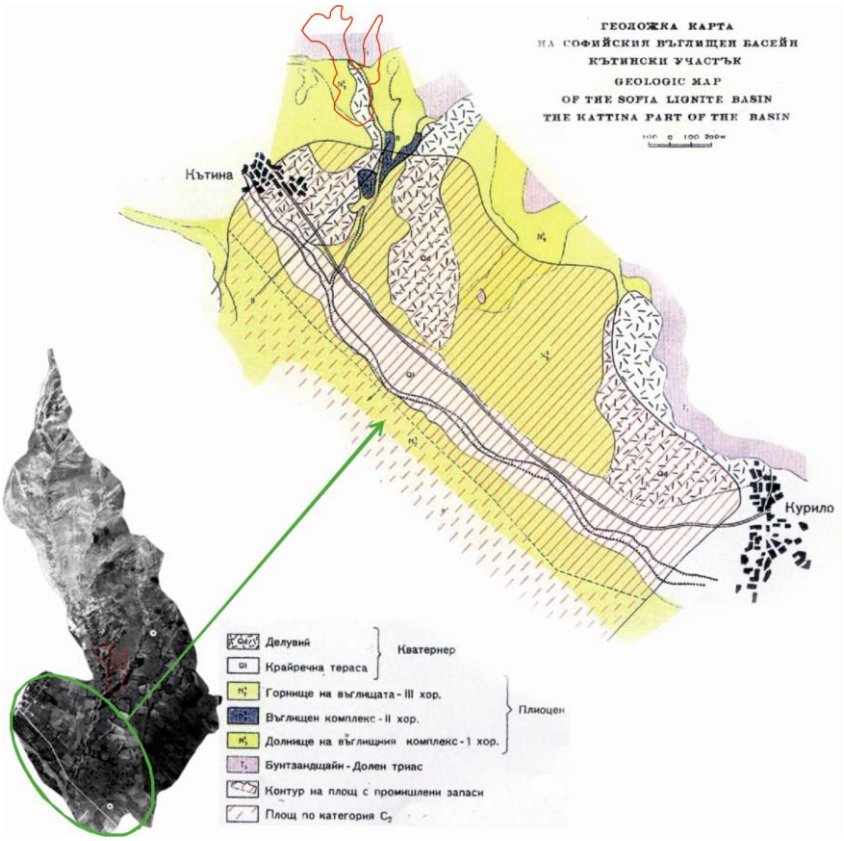


Fig. 4. *Geologic map of Kutina lignite basin (according to Yovchev, 1960)*

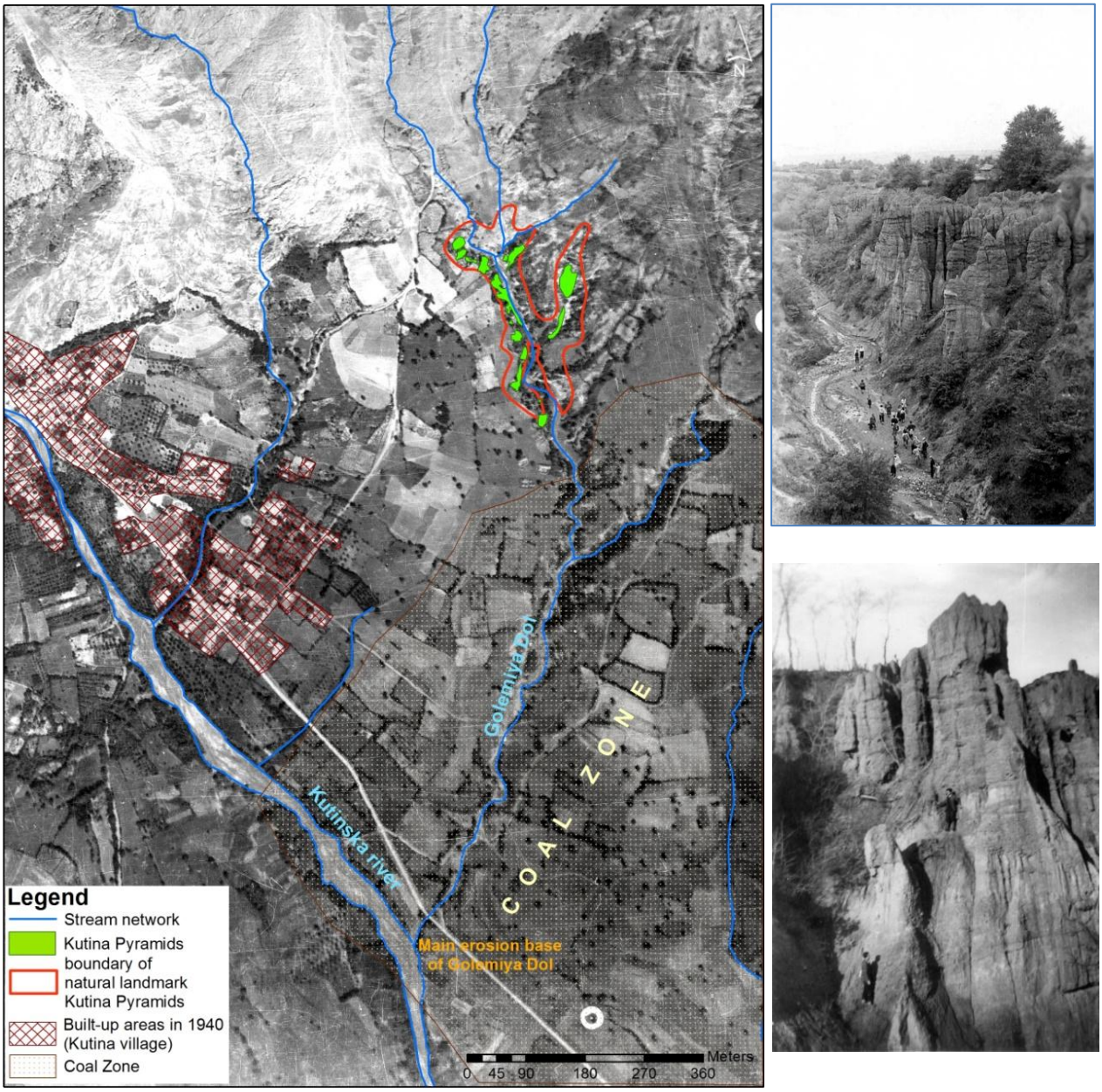
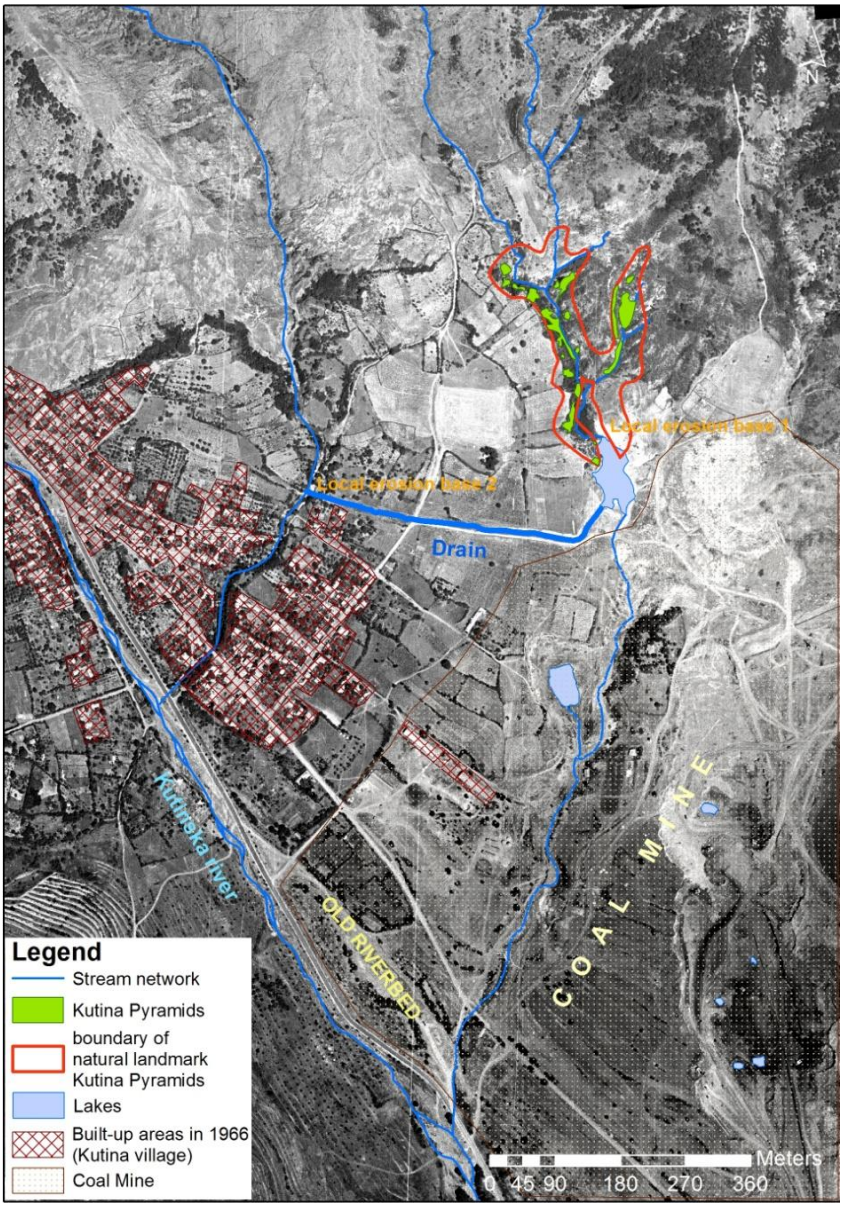


Fig. 5. *The area of Kutina pyramids in 1940*

During the 40-ies of the XX century, the surface of the Kutina coal mining area was occupied by fields and meadows. There are no forests in its immediate vicinity. The territory was a low valley of the Kutina River with gently inclined slope. Kutinska River plays the role of a local erosion base of the Golemiya Dol valley.

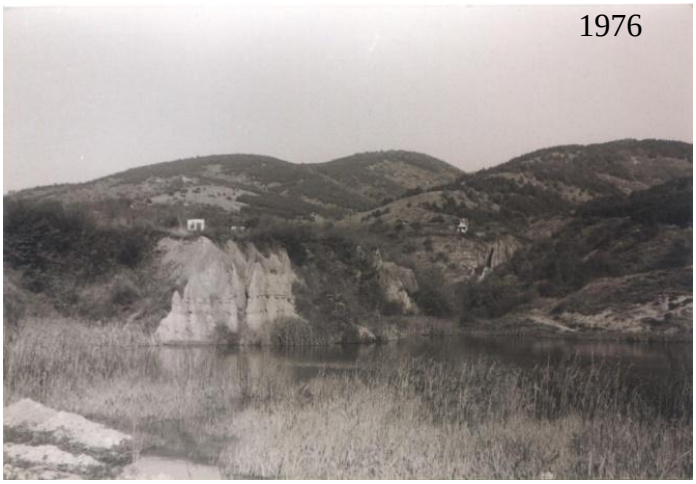
In the late 40s forestation was initiated in the higher areas located north of the coal deposit. Mine "Lignite" has been carried out opencast extraction of lignite coal for few years in the area of Golemiya dol drainage basin, but due to the poor quality of the coal mine was closed in 1949.

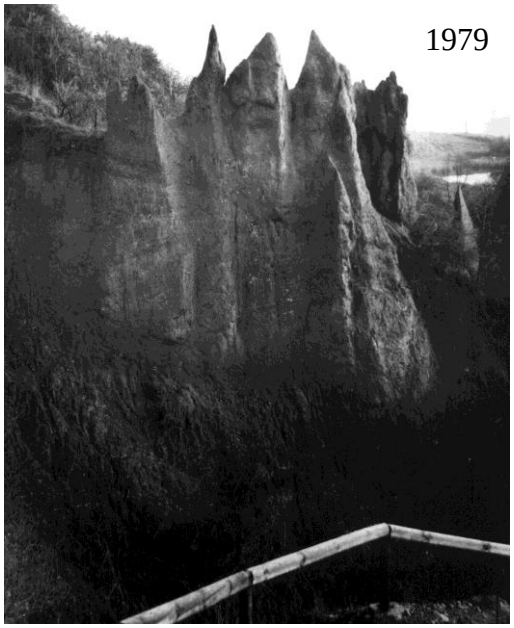
After the termination of mine "Lignite", a new open pit was designed in the Northwest Kutina coal sector, whose borders would reach south to the river Kutina. This requires its river-bed to be mover to south, because without this correction the development of the open pit would not be possible. The comparison of the aerial photos from 1940 (Fig. 5) and 1966 (Fig. 6) shows that this adjustment was made.



During the mining period (1940–1973) began serious changes, influencing the development of Kutina Pyramids. As a result of the the exploitation of the open pit, the drainage basin Golemiya dol was blocked by technogenic accumulative deposits. The surface waters from Golemiya dol are drained into the nearby tributary of the Kutina, located west of Golemiya dol. As a result, artificial lake with a process of swamping was formed. This caused raising of the erosion basis. During this period, there was a change in erosion basis, which results in an increase of its level. This is the main cause, the process of the Kutina pyramids destruction in Golemiya dol to begin. In the mid-40s artificial forestation north of mine "Lignite" on the slopes of the pyramids has begun, which leads to erosion delay. In 1962 Kutina pyramids, located in Golemiya dol, were declared a natural landmark.

Fig. 6. *The area of Kutina pyramids in 1966*





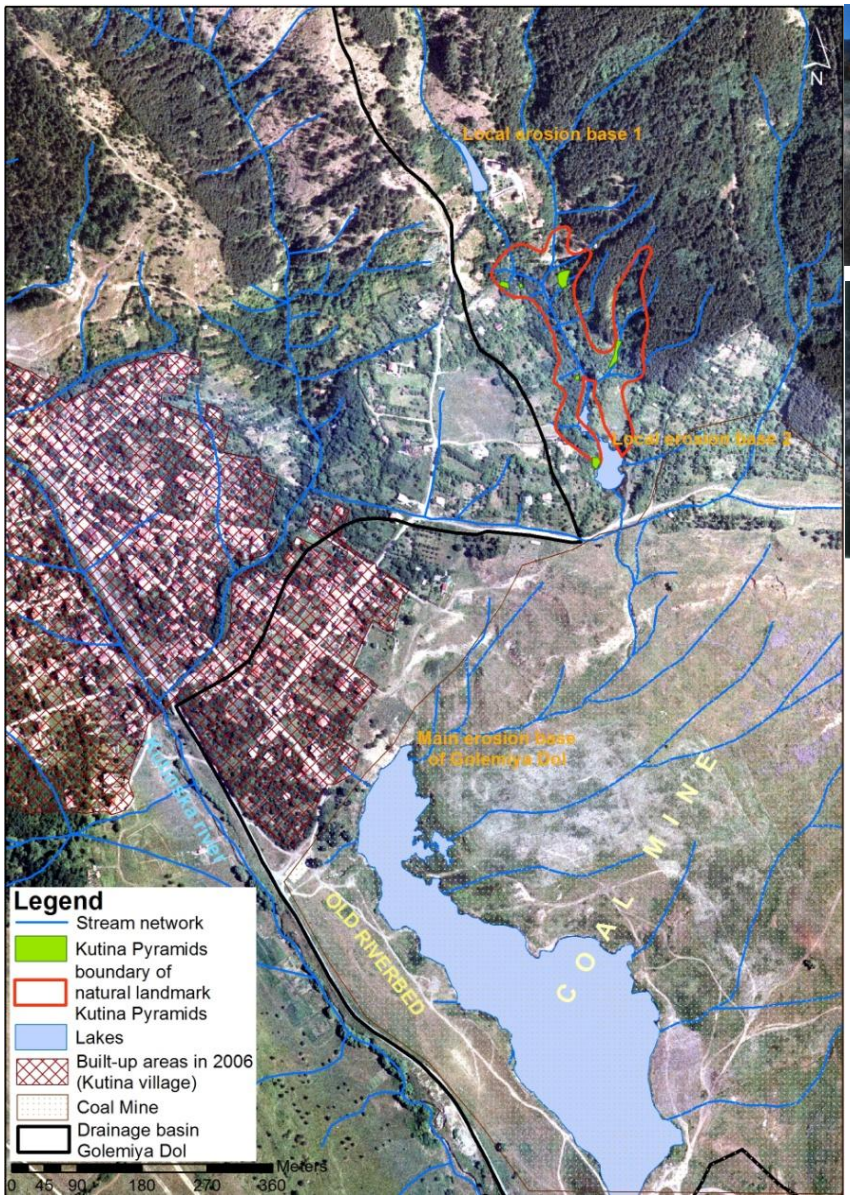


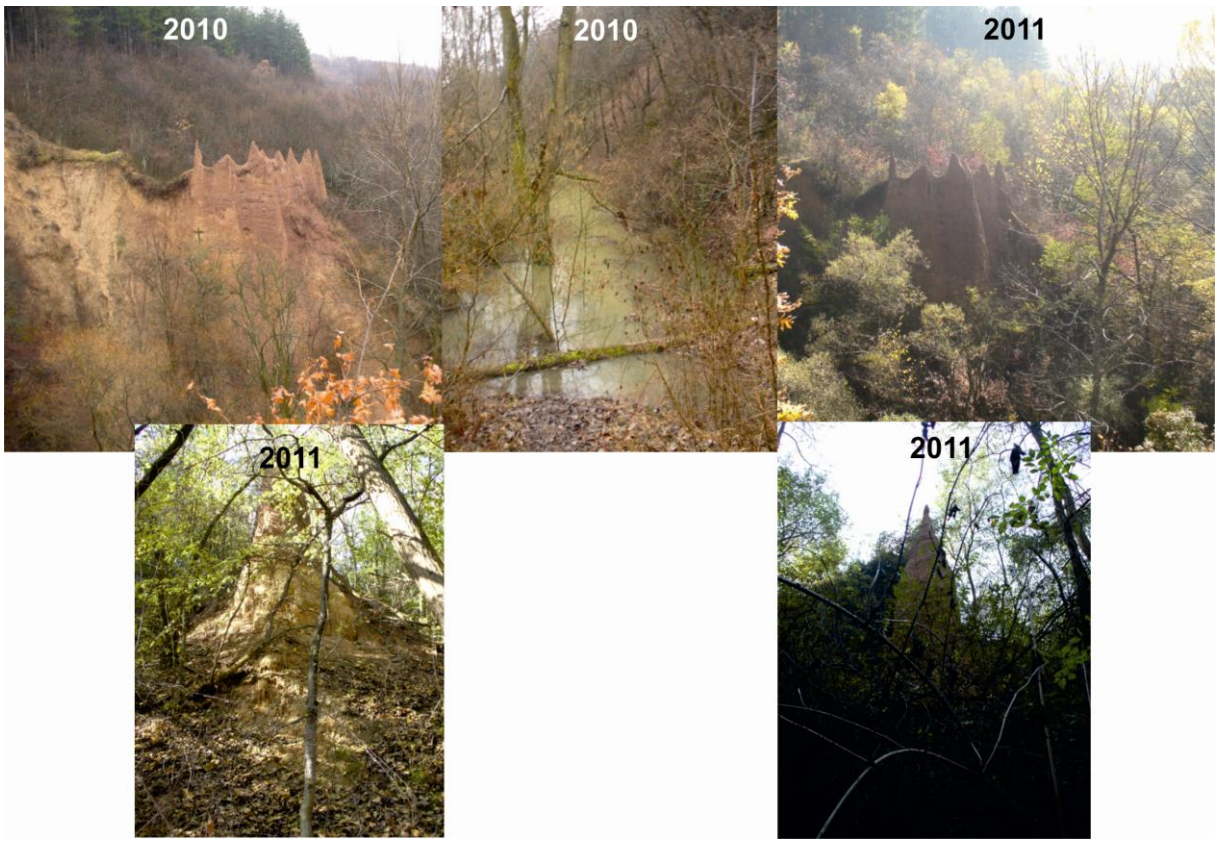
Fig. 7. *The area of Kutina pyramids in 2006*

Fig.8. *Deep linear erosion form*

Across the technogenic slopes formed as a result of reclamation activities after the mine closure in 1973, a secondary segmentation of the slopes has begun which leads to the occurrence of a deep linear erosion forms in the active stage of development (Fig.8). In the period after 1973, when the mine stopped operating the processes of Kutina pyramids destruction continues and violate their dynamic balance.

On the site surrounding the old pyramids, in the basement, the material piles up to the denudation basis. The bottom is covered with clay. The gully starts being filled with gravels and sands. The bottom of Golemiya dol is filled gradually with sandy and clay (accumulative) material that acts as a impermeable layer, erosion basis for neighboring valleys and forms the a long artificial lake - 200 m long, known as the Siniya vir. This artificial lake has periods with high and low water levels. It is observed two maximums in the water level – in March 2005 and in April 2010. On the banks of the lake there are two visible micro-terraces, marking the maximum and minimum water surface and typical fringe marsh vegetation.

The river network in the region is highly transformed as a result of mining exploitation activities, which is clearly evident in the comparison of aerial photos and satellite images for the three periods. There is a change in the hydrographic configuration of the Golemiya dol stream and Kutinska River. Golemiya dol ends to the artificial lake Siniya vir, where the hydraulic connection of the surface runoff changes. The surface runoff is interrupted in length from 50 to 60 m, and then in the form of spring low flow continues to the south. The hydrographic network type is converted into a radial centripetal in the areas of technogenic lakes. This change for a period of 50 years has been accompanied by a change in the configuration of watersheds and watershed surfaces.



CONCLUSIONS

The main part of the analysis of the Kutina pyramids landscape dynamics was made on the basis of numerous photos, field observations and interpretation of aerial photos and satellite images. The photographs from 1976 and 1984 were provided by Prof. Zdravko Iliev. As a result of the coal exploitation, *Kutina Pyramids* natural landmark have been seriously affected, and after the correction of the stream network and the change of the erosion basis the earth pillars have become liable to accelerated destruction. The great change of the relief during the mining activities disturbs the natural relation between the relief elements, which results in absolutely destruction of the formed natural structure. The functional relation between the natural objects is disturbed and destroyed. On the overall, human economic activities have negative consequences in terms of the area's eco-geomorphologic

characteristics. In geo-conservation aspects, the protected site has been constantly degrading over the past 40-50 years and its attractiveness gradually reduces. The photographs made in the early 70s and those in the recent years show a decrease in the number and size of the Kutina pyramids. The artificial backwatering of the lower part of the Golemiya dol enhances this process, leading to overgrowth of vegetation on its slopes. The main reason for this is the raise of the erosion basis and the prevention of the erosion processes that underlie the formation of erosion forms. The stopping of the natural deep erosion processes through inadequate human activity near Kutina has resulted in their degradation.

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