CONSIDERATIONS REGARDING THE EVOLUTION OF THE LANDSCAPE IN THE AREA OF THE FORMER BAUXITE QUARRIES FROM OHABA – PONOR

N. SÎLI[1], Elena-Maria VESA[1], F. FAUR[1], Izabela-Maria APOSTU[1]

[1]University of Petrosani, Faculty of Mining
Corresponding author: izabelamaria.nyari@yahoo.com

Abstract: *Often the exploitation areas of useful mineral substances through quarry works are compared, in appearance, with selenary landscapes (large areas of land, geologically disturbed, strongly modified physically and morphologically and almost completely devoid of vegetation and fauna). In this paper, a former mining perimeter for the exploitation of bauxite ore was studied. The area of interest is located in Hunedoara county (Ohaba - Ponor locality), more precisely the Comarnic - Poieni mining perimeter. In this case, at the end of productive activities, and for a long time after that, the landscape in the quarry's area looked like a martian surface, rather than a selenary one, due to the reddish-brown color of the bauxite ore. Given the fact that, despite the legal regulations, at the end of the extractive activities no ecological reconstruction works were carried out on the perimeter, we set out to analyze how and to what extent nature managed to repair this "wound" in the landscape (otherwise characterized by spectacular landscapes and in fact included in the Grădiștea Muncelului - Cioclovina Natural Park). For this purpose, a series of comparisons were made of some photographic materials made between 1995 and 2004, with some recent ones made by the authors during field visits, between 2017 and 2020, comparisons that highlight the general trends of landscape evolution in the studied area under the exclusive influence of natural factors. Also on the occasion of these documentary visits, there were observed areas where time seemed to stand still, ie areas where nature has not yet managed to repair the damage done by man, but also areas of modeling, through shallow landslides, still active. Also, some considerations were made related to the plant species re-installed spontaneously in the studied area, finally being made a framing of the landscape in accordance with the rules indicated by the literature.*

Keywords: *Quarry, bauxite, landscape, Ohaba - Ponor, visual analysis*

INTRODUCTION

The landscape is the world around us, including everything we see or feel wherever we are. It is continuous in space and time: in space as a series of physical and social events, and in time as a continuity of these events that constantly change space. The world as we see it is a rather vague concept, given that each person perceives the environment differently, each with its own system of values (BACIU, 2014).

Unfortunately, man is not satisfied only with the status of observer, changing the environment in which he lives. It is an action that cannot be prevented because man, by his nature, evolves by automatically changing his environment. But changes can also be creative, not only destructive (DARMER AND DIETRICH, 2001; WANG ET AL., 2001).

The current problem of the natural environment derives from the fact that man, sacrificing the future for the present, no longer respects the ecological cycles and balances (FAUR, 2009). In this way, the perpetuation of the natural heritage is no longer ensured, undermining at the same time the bases of its own development, mortgaging its future. Therefore, nature appears to us as a fragile entity, to which the human being must provide protection and reproduction (COSSU, 1995).

The landscape is an important resource, being a remarkable natural and cultural heritage that is appreciated for its beauty and aesthetics but also its contribution to the identity of a region (BACIU, 2014; DINCĂ, 2005). The genre represents the general character of the

artistic expressiveness of this landscape as well as its influence on the state of mind. The shapes that landscapes take are multiple, and the feelings they determine are numerous and different depending on the perception of the individual and in no case should we refer to "good landscape" or "bad landscape" (BOLD AND NIMARĂ, 2016).

MATERIAL AND METHODS

Research methods

Over time, the perception of the genre of the landscape has been different, both historically and geographically.

Appeared in the wide field of fine arts and subsequently approached scientifically by naturalists, landscaping deals with the management and arrangement of distinct and limited spaces chorologically or generously expanding in the field, and the purpose of landscaping is to meet the expectations of applicants or simple inhabitants (BOLD AND NIMARĂ, 2016).

By landscape, we could understand the encyclopedic approach that seeks to define by enumeration, but which, at the same time, orders by spatializing the elements that compose it. This is a subtle alchemy that transfers to the visual ability the very identity of the viewing subject. In the modern era, these points of view have multiplied, making our era an era of the panorama, rather than one of the landscapes (SANDU, 2011; TOMESCU, 2011).

Beyond the way the landscape sheds light on ways of looking at the world, it also puts us face to face with the issue of nature and the way we relate to it. On the other hand, urban and industrial development forces us to talk about urban landscape, industrial landscape, or technological landscape (NEGOE ET AL., 2019).

The most elegant landscapes are those whose design begins and ends with the guiding principle of simplicity, because simplicity is the most difficult to achieve, given that there is a constant tendency to use all available elements and tools.

In this context, this paper addresses the issue of the evolution of a landscape severely degraded by human activities, more precisely how it evolved in the area of the former bauxite quarries of Ohaba - Ponor after the cessation of mining in 1990 (VESA, 2020), in the context in which this area is part of the Grădiștea Muncelului - Cioclovina Natural Park (LORINȚ, 2012).

It should be noted from the beginning that this development took place without significant anthropogenic intervention, the way the area has been transformed in the last 30 years being the almost exclusive result of the action of natural factors ***("Nature knows best how to constitute itself"*** (COMMONER, 1971)).

Brief history of mining activity

After 1971, in the Ohaba - Ponor area, the specialists from IPEG - Deva intensified the exploration works of the bauxite deposits highlighted during previous researches, works which consisted in the execution of ditches, drillings and shallow wells.

Following these works, numerous bauxite lenses were highlighted, among which we can mention: Comarnic - Poieni, Murgoi Hill, Robului Hill, Fizeşti, Drăgăneşti, Var, and Ponorâci - Cioclovina (LORINȚ, 2005). The average contents of useful minerals determined as a result of these works for the entire Comarnic deposit are: Al_2O_3: 42,49 – 48,81 %; SiO_2: 10,61 – 19,95 %; Fe_2O_3: 21,15 – 24,23 %; TiO_2: 1,77 – 2,29 % (LORINȚ, 2008).

The stage of exploitation of the bauxite ore in the area of the Comarnic - Poieni lens followed, the extractive activities being organized and executed in the '80s by the Deva Copper Center (C.N. MINVEST S.A. DEVA) – Nonmetalliferous Sector - Boiţa Section - Ohaba - Ponor Working Point and were carried out through micro-quarries, mainly using the process of dislocating the rocks by drilling-blasting methods, using as explosive material nitrogen-based substances. Mining activities have been stopped since 1990 (LORINȚ, 2005).

The Comarnic - Poieni exploitation sector was characterized by the relatively small thickness of the overburden as well as the rather large thickness of the useful rocks, which favored their exploitation in quarries (LORINȚ, 2008).

The method of exploitation of the deposit from the perimeters located at Ohaba - Ponor was the one with long wall, in descending steps. In this case, the extraction of the useful mineral substance is done along the entire length of the exploitation step or on its sectors, advancing in a perpendicular direction to the direction of the deposit (Figure 1).

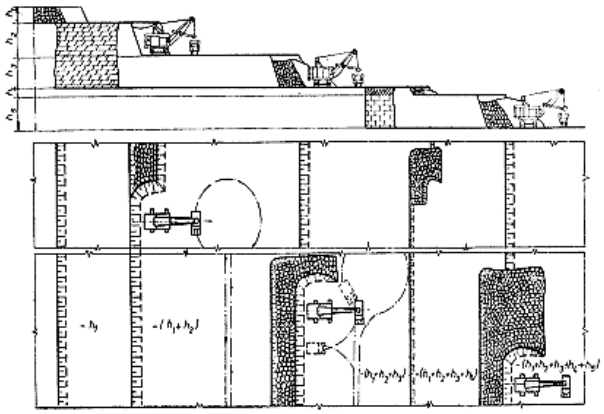


Figure 1. Long wall exploitation method (FODOR, 2011)

Most of the time, the step is divided into entrances, and these into blocks, from which the extraction is done. In this case, the working fronts in the blocks advance in the direction of the deposit. Depending on the production needs, several steps can be operated simultaneously (FODOR, 2011). The extraction of the useful rocks is done with explosives placed in boreholes, loading of the dislocated material is done with excavators (or front loaders), and its transport by trucks.

This method of exploitation has the following advantages (FODOR, 2011):

- a relatively small volume of preparation works;
- the possibility of rapidly increasing the excavated and transported volumes by introducing into production of some equipments from the reserve park;
- a simple scheme and a relatively short length of transport lines and roads.

In addition to the above advantages, the method allows a good organization of work and ensures a high production and productivity.

The waste dump was constructed by tilting the sterile material from the quarry and pushing it with bulldozers. Failure to comply with the technical requirements regarding the dumping process generated the biggest environmental problems (instability of slopes and open contact of mineral matter with environmental components, especially water) (LORINȚ, 2005).

It should be noted that in the mentioned perimeter, after the cessation of the extractive activity, no ecological reconstruction works were carried out, everything being left on the nature's capacity to restore the environment.

Probably the easiest to identify and for this reason the one considered to be the most important was, and still is, the impact on the landscape.

RESULTS AND DISCUSSIONS

Comparative study

In order to carry out the comparative study on how the landscape evolved in the area of the former bauxite quarries from Ohaba - Ponor, we used photographs taken during 1995, 2004, 2017, and 2020 (with the mention that those taken in 2017 and 2020 belong to the authors). Unfortunately, we did not manage to obtain photos at the level of 1990, when the exploitation activities were stopped, or previous.

Satellite images are a very good tool to assess how a territory (landscape) evolves over time (HERBEI ET AL., 2015). Thus, in order to get an overview of how the landscape evolves in the studied area, we compared two satellite photos, from June 2012 and June 2019 (Figure 2).

2012

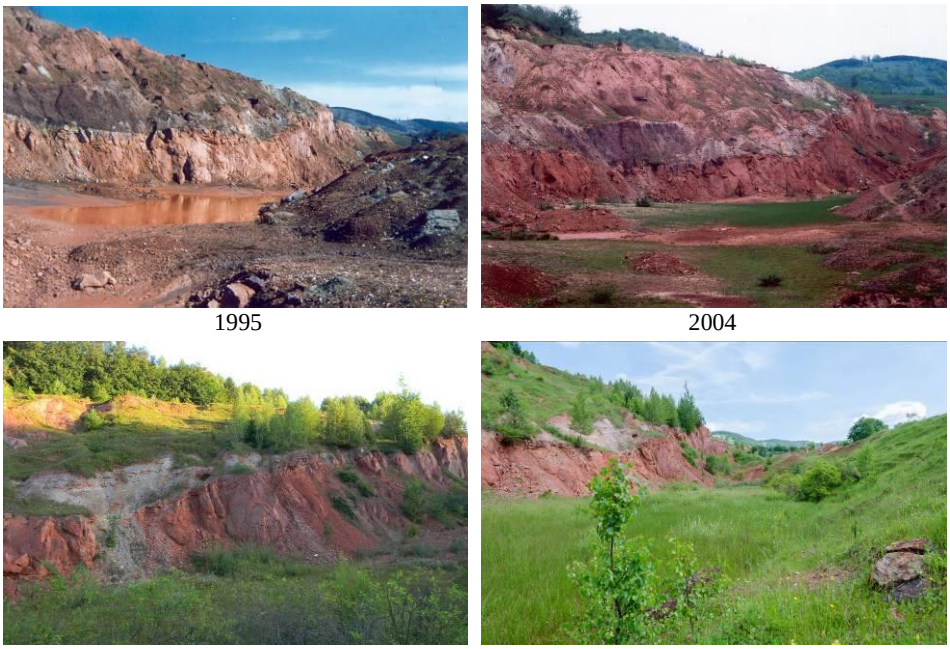
2019

Figure 2. Satellite images with the area of the former quarry Ohaba - Ponor, Comarnic - Poieni sector

As can be seen from the two photos, it is obvious that the degree of revegetation of the quarry's perimeter is much improved in 2019 compared to 2012. This is best seen by making a visual comparison between the percentage covered by discovered rocks in 2012 (surface colored in shades of red) and the lower net percentage from 2019.

Another area where it is easy to see that the degree of revegetation has increased substantially is represented by the upper berm of the quarry where the degree of coverage with arboreal and shrubby vegetation is significantly higher in 2019 than in 2012.

Next, based on the photographs taken from previous studies and those taken by the authors, we will try to make comparisons between the situation in 1995 and in subsequent years. Unfortunately, at the level of 1995 and 2004, we had at our disposal a small number of photographs for comparison, but even so, with their help we can highlight some concrete aspects (Figure 3).



1995 2004

2017 2020

Figure 3. Quarry's slopes (west side of the perimeter)

Analyzing the photos in figure 3 we can make some considerations on how the landscape has evolved (VESA, 2020):

- extremely active dynamic phenomena are present at the level of 1995 (5 years after the cessation of productive activities) and in 2004. During this time, the modeling of the landscape is done mainly by collapse phenomena (Figure 4) and the intense erosion of the slopes;

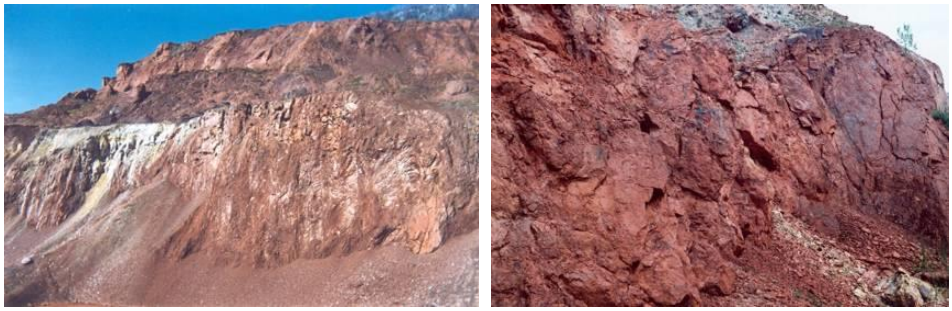


Figure 4. Debris and rock fall on the slopes of the quarry (1995 - 2004) (LORINȚ, 2005)

- also, during this period of time, an accumulation of water is formed at the base of the quarry (fig. 5);
- during this time it is not possible to talk about a reinstallation of vegetation on the slopes and berms of the quarry, only at the base of the quarry, due to the presence of excess moisture, several lake species are installed (Figure 5);

Figure 5. Water accumulation at the base of the quarry in 1995 and 2004 (LORINȚ, 2005)

- compared to the period 1995 - 2004, in the period elapsed until the next field investigations (2017 - 2020), we can see that the accumulation of water narrowed very much, the base of the quarry being clogged with sediments transported from the slopes (Figure 6). However, it should be noted that the water level and the area occupied by this accumulation has a variable character, being influenced by the precipitation regime;

Figure 6. Water accumulation at the base of the quarry in 2017 and 2020

- then, comparing the situation from 1995 - 2004 with that of 2017 and 2020, we can see that the active dynamic phenomena such as debris and rock fall have disappeared (there are still areas where erosion is relatively intense). However, this erosion also occurs in natural areas, unaffected by the human factor, where the bedrock is exposed (where there is no vegetation);

Another important finding is related to the intensity of erosion processes. If in the first interval they manifested themselves aggressively (Figure 7 left), leading to the appearance of

large ravines (which in turn favored the formation of torrents and endangering the few households downstream of the quarry), in the last interval of studied time it is found that these phenomena have decreased in intensity (Figure 7 right), being similar to the processes present in nearby areas, which are not affected by human activities.

Figure 7. The intensity of erosive phenomena throughout the year 2004, respective 2020

However, we appreciate that the erosion processes have a positive influence on the landscape by the fact that this phenomenon leads to the modeling of the initial geometry of the quarry's steps, to forms closer to those naturally present in the nearby areas (Figure 8).

Figure 8. Modeling through erosion of the quarry's steps (2020)

In the studied perimeter there are another series of elements which are identified with anthropic activities, such as the deposition cones of the material from the overburden (Figure 9). These elements appear in the area where the sterile rocks resulting from the exploitation activity were stored, more precisely the altered mineral part (VESA, 2020).

Figure 9. Interior waste dump, geometrized and devoid of vegetation (2020)

The fact that these forms have remained geometrically unchanged for so long, but also the fact that they are very little covered by vegetation, is attributed to the mineralogical and chemical composition.

Also in the area of the interior dump there were identified active phenomena of landscape modeling such as landslides (Figure 10). These landslides are small in size, do not extend deep and involve relatively small volumes of material.

Figure 10. Active landscape modeling phenomena (landslides in 2020)

In terms of vegetation that has spontaneously relocated on the berms of the quarry's steps, at the base of the quarry and on certain parts of the interior dump, observations made in the field lead us to the idea that from this point of view we are facing a landscape constantly changing.

We say this because the areas are revegetated, from an arboreal point of view, especially with birch (*Betula pendula*) (Figure 11), a species that we know is a pioneer and does not require a high fertility of the soil on which it is installed.

Since we are in the bioclimatic floor of deciduous forests, more precisely beech (*Fagus sylvatica*), we assume that with the improvement of station conditions, ie as the soil in the area will accumulate nutrients (here the birch as a pioneer species playing an important role), the predominant species will become the beech.

Of course, this process of ecological succession also depends on other factors (especially climatic ones) and therefore, we cannot determine a period of time until this replacement will be completed.

Figure 11. Spontaneously installed birch trees (2020)

Another interesting aspect related to the vegetation installed spontaneously in the studied perimeter is related to the appearance of some species characteristic of a higher bioclimatic floor, namely spruce (*Picea abies*) and pine (*Pinus sp.*) (Figure 12).

Figure 12. Spruce and pine trees installed spontaneously (2020)

It is very likely that these species have settled in this area due to the fact that they are not very demanding to soil conditions, but also because they are generally adaptable to various climatic conditions.

Of course, in the area, there have been identified a large number of species of shrubs and perennial grasses, some of which produce forest (wild) fruits and berries (*Corylus avellana, Rosa canina, Rubus fruticosus L., Fragaria vesca*, etc.).

Landscape framing of the studied objective

Each landscape can be classified according to a series of characteristics, and from this point of view the current landscape in the area of the former bauxite quarries from Ohaba - Ponor can be classified as (VESA, 2020):

a) according to the state of stability or equilibrium:

- between 1995 and 2004 unstable landscape, includes those subtypes in which complex dynamic transformations take place generating dysfunctions and imbalances that affect the state of the geosystem;
- currently, landscape in relative equilibrium, characterizes the territorial entities in various phases of evolution with deficient equilibrium tendencies.

b) according to the territorial relations between the landscapes:

- landscape with interference elements, in which heterogeneous elements are associated, but with a different degree of proportionality in the structuring of the territorial ensembles;

c) according to the self-regulation capacity:

- landscape with poor self-regulation;

d) according to the type of artificialization induced in the geosystem:

- between 1995 and 2004 landscape with morphological artificializations (quarry landscape);
- currently, landscape with edaphic artificialities (landscape of ecologically restored quarries and waste dump);

e) according to the behavior of the systems:

- landscape in rhexistasis, the balance is strongly disturbed due to natural/anthropogenic causes.

CONCLUSIONS

Following this study, several general conclusions can be drawn:

- the modified anthropic landscape, by the quarry, is in a continuous dynamic, since 1990;

- the dynamic phenomena had an increased intensity in the period 1995 - 2004, then entering in a slowdown process;
- there are still many elements of visible anthropic relief;
- erosive processes have shaped the steps of the quarry, so that these, at present, resemble natural forms found in the vicinity;
- the degree of revegetation of the quarry is currently of approx. 70 – 75 %, and we estimate that in the absence of other interventions it will increase to 90 % in the next 10 years;
- from a physical and aesthetic point of view (visually) the landscape is restored to a greater extent than from a functional and ecological point of view (of vegetation);
- from the point of view of vegetation, we estimate that it will be in an accentuated dynamic for at least another 15 - 20 years.

Overall, the landscape in the area of the former bauxite quarries at Ohaba - Ponor has significantly improved compared to the '90s, but it is still far from its complete reintegration into the more general landscape of the Sebeș Mountains.

BIBLIOGRAPHY

BACIU N., 2014 - Landscape dynamics and typology. Course notes (in Romanian), Bioflux PH, 101 p., Cluj-Napoca.

BOLD O., NIMARĂ C., 2016 - Natural and anthropic landscaping (in Romanian), 123 p., Universitas PH, Petroșani.

COMMONER, B., 1971 - The Closing Circle: Nature, Man, and Technology, New York Press.

COSSU R., 1995 - The multi-barrier landfill and related engineering problems, In Proc. Sardinia 95, 5th International Landfill Symposium, vol. 2, 3 – 26, CISA Publisher, Cagliari.

DARMER G., DIETRICH N., 2001 - Landscape and surface mining: Ecological guidelines for reclamation, 201 p., New York Press.

DINCĂ I., 2005 - Geographical landscapes of the Earth. Landscape theory (in Romanian), 200 p., Universității PH, Oradea.

FAUR F., 2009 - The elaboration of an environmental monitoring system in Jiu's Valley (in Romanian), Doctoral thesis, University of Petroșani.

FODOR D., 2011 - Gravel pits and quarries (in Romanian), 745 p., AGIR PH, Bucharest.

HERBEI M.V., HERBEI R., POPESCU C., BERTICI R., 2015 - Domogled – Valea Cernei National Park monitoring using satellite technology, ECOTERRA - Journal of Environmental Research and Protection 12 (3), 73-78.

LORINȚ C., 2005 - Environmental impact assessment due to the activity in the Ohaba - Ponor quarries (in Romanian), Dissertation thesis, University of Petroșani.

LORINȚ C., 2008 - Study of bauxite deposits in the southwest of the Sebeș Mountains in the context of their inclusion in the Grădiștea Muncelului - Cioclovina Natural Park (in Romanian), Doctoral thesis, University of Petroșani.

LORINȚ C., 2012 - Protected natural areas and biodiversity conservation (in Romanian), 311 p., Universitas PH, Petroșani.

NEGOE L., APOSTU I.M., FAUR F., LAZĂR M., 2019 - Assessment of the urban landscape of Petroșani municipality and the impact of abandoned buildings on it, Research Journal of Agricultural Science 51 (4), 104-114.

SANDU T., 2011 - Landscape architecture (course notes) (in Romanian), U.S.A.M.V., Iaşi.

TOMESCU C.V., 2011 - Landscape architecture and forestry design, course support (in Romanian), Faculty of Forestry, „Ștefan cel Mare" University, Suceava.

VESA E.M., 2020 - Study on the evolution of the landscape in the area of the former bauxite quarries from Ohaba - Ponor (in Romanian), Project for bachelor of engineering, University of Petroșani.

WANG Y., DAWSON R., HAN D., PENG J., LIU Z., DING Y., 2001 - Landscape ecological planning and design of degraded mining land, Land degradation and development 12 (5), 449-459. Wiley Online Library.