

STUDY ON SUSTAINABLE LANDSCAPE DESIGN AND FUNCTIONALITY OF MINING WASTELANDS FROM JIU VALLEY

Oana BĂRĂLAC, Victor ARAD**, Susana IANCU (APOSTU)**

ABSTRACT

Although there have been written numerous specialty papers about the natural resources of a region, few are focusing on the outcome of economic opportunities in terms of re-cultivation process. In Jiu Valley coal basin, because of the finish of mine production and the phenomenon of idle land resources, the number of industrial wastelands has been increasingly growing. This paper focuses in particular on the process of re-cultivation and regeneration, recovery of degraded land, good practices of recovery of areas affected by quarrying. It is necessary that these industrial wastelands to be reshaped again, and work on the necessary changes upon landscape in a natural way, but with human help. We took for this study Jiu Valley as an example of resource-exhausted mining area, analyzing the landscape characteristics, and putting forward a sustainable development strategy of a systematic design-landscape for ecosystem and local economy. From this point of view, the ecological restoration and landscape reshaping can be favorable for the ecosystem, local community, local economy, putting forward some solutions in order to improve people's living standards. Finally, the solutions and approaches of the regeneration and reutilization of the mining industrial wastelands were discussed in the view of land development and ecological environment restoration.

Key-words: resource-exhausted mining region; industrial wasteland; regeneration; sustainable utilization; abandoned quarry; functionality; landscape design

1. Introduction

Although there have been various specialized works for the analysis of the natural resources of a region, few focus on the outcome of the economic opportunities in the process of recultivation.

Particularly in the Jiu Valley, one can see that more and more studies are analysing and focusing on the touristic aspect of the area. In addition to the geological survey of the area, the tourist and economic analysis, which was done, this paper focuses specifically on the process of recultivation and regrowth, contributing to the development of the tourist and economic aspects, which have been identified so far. The Jiu Valley area, promising and with good potential, is currently in a very delicate situation where, after the gradual closure of the remaining mines, mining activity has affected existing surroundings, most of the them with a very high landscape potential.

These surroundings need to be reshaped again and one should work on the necessary changes on the natural-based landscape, but with human assistance.

The recultivation process of former mining exploitation areas has advanced so much at present, and the related flooding processes and quality improvement of the water in the surface lakes have been improved from a technical point of view, and chemically, on a very professional level. Campu lui Neag area, which was affected by mining activity in the past, is now already an area of attractive refuge and privacy for the local population, proving that there is a certain potential of the lake and of the open places, which can be improved by means and special projects to give a new face to the region's attractiveness and beyond administrative boundaries.

The green network in the area of the former mine pit in Campu lui Neag also connects the landscape elements of the area, blending the overall ecotourism concept.

The surrounding forests and the lake on site can become as many destinations for hiking and weekend tourism. By new enfranchising of the surfaces of the mining perimeter and by area-

*Ph.D stud. – University of Petroșani, Romania

**Prof. Ph.D eng. - University of Petroșani, Romania

specific ecosystem restoration, the entire natural environment can be used as an active life environment.

A possible eco-friendly brand of Campu lui Neag is primarily using its position in the natural environment.

The preservation and development of a harmonious, fluent relationship between the village of Câmpu lui Neag and its vast natural environment is therefore vital. Restoring the different greening landscapes provides support in the development of new forms of tourism, in which natural attractions will be dominant.

2. Ways of reusing the exhausted areas

The rehabilitation of degraded lands alludes to knowledge of the recovery destinations and of the new functions that these can take as a result of recovery and restoration interventions. Based on these considerations, the interventions are targeted on three general directions [5, 6]:

- restoring the landscape as it was before the degradation;
- finding possibilities for re-use, so a physical conformity which is absolutely genuine, inventing new forms of use or seeking satisfaction of the proposals put forward by local communities;
- provisional systematization for economic sustenance, without carrying out interventions that could jeopardise the future uses which are more clearly defined.

Depending on the execution of environmental rehabilitation works, the possible destinations of the affected areas fall within at least one of the types mentioned above. Thus, we have:

- ecological reuse;
- natural recovery;
- recreation and leisure recovery;
- productive recovery;
- residential recoveries;
- cultural recovery;
- recovery for controlled wastes dumps;
- other types of re-use.

The concept of ecological recovery

In time, the restoration concept definitions have evolved, and nowadays they describe an ecological approach of the ecological recovery. The Ecological Society for Recovery defines restoration as "the process of assisting the recovery and management of ecological integrity", while some authors define it as "the art and science of repairing degraded ecosystems to a maximum level of historical authenticity" [7].

As more and more people depend on today's degraded ecosystems, ecological recovery must

approach four elements, which are very important for a correct management of the ecosystems [11]:

- the improvement and conservation of biodiversity;
- raising the living standard of the population;
- empowering the local population;
- improving the ecosystem productivity.

So, the ecological recovery can be a major constituent of the programmes for the conservation and sustainable development throughout the world, through its ability to give people the opportunity not only to repair the damage, but also to improve the human condition.

Recovery of the degraded areas

Recovery of degraded lands is an increasingly urgent need, demanded both by economic actors in different sectors of activity, and by the administrative and legislative framework, but most of all by the local community. Either it is a necessity that is born from the concerns of environmental protection or from the refusal to consider that the destroyed areas must be a price paid for progress [5].

The recovery and rehabilitation of degraded lands consists in the formulation and implementation of a set of measures and interventions necessary for organizing the area in order to trace the direction of reuse that is environment compatible and friendly.

As a result of the mining activity, we can speak of the following types of recoveries, depending on the components of the territory that have been affected:

- recovery of the waste dumps.
- recovery of residual voids of the pits.
- recovery of eroded land etc.

Modern solutions regarding the functional reintegration of the degraded geomorphological systems

A **recultivation** of the waste of dumps consists in a complex of technological and biological measures that have the purpose to stop the deflation phenomenon: the removal and transport of the ash particles under the action of the wind, and to finally change a large surface deposit, which used to be a powerful pollution source of the environment, into a new area able to support the grown of plants.

The solutions proposed for re-use, relatively new in our country, point at the use on a more extensive scale of fields to be given back to the economic circuit, including afforestation of then land surfaces on the slopes which do not allow carrying out agricultural works with mechanized equipment safely. Cultivation of energy crops, planting Paulownia tree or photovoltaic panels

installing are some of the solutions proposed for land use on the waste of dumps, a part being already included in the pilot programs.

We will make a brief overview of the species likely to be cultivated on the heaps of debris:

➤ **Paulownia (*Paulownia fortunei*) [13]:**

The advantages of planting Paulownia trees on the lands are the following:

- Investment on hectare is minimal and decreases with the number of planted hectares;
- Trees require minimal care in the first 1-2 years, then only needing the water to grow healthily.
- Trees regenerate up to 9 cycles of 3 years each or 4-5 cycles of 6, so there may be subsequent investments made after several tens of years, and the production of the following two decades won't be harmed.
- After the first year you can plant different crops, even strategic ones, among the Paulownia trees, the new crops being harvested annually, thus bringing a very important extra income to the plantation owner.
- It can be planted in soils that contain heavy metals or on heaps of debris and ash dumps from CETs, where Paulownia has proven remarkable adaptation, helped by suitable fertilizers.

As a result of lab experiments and at pilot level to determine possible species to be cultivated in the dumps, five species have been chosen: Acacia, sallow, bayberry, miscanthus and phalaris.

➤ **Miscanthus [4]:**

Reusing the degraded areas to **plant energy plants** could be a viable alternative on land areas prone to erosion, such as those on the heaps of debris. Miscanthus plant cultivation, with a rapid growth of the shoots provides approximately 20 tons of dry mass /ha /year, a replacement of fossil fuels, a raw material for paper, building materials, decorations, or bioethanol, which can be used as fuel.

Miscanthus can be cultivated successfully in Romania, even on acid soils polluted with lead and cadmium.

➤ **Phalaris arundinacea [14]:**

Phalaris arundinacea – silver grass, is a perennial grass species with great height, which normally forms pure meadows on the edge of lakes and wetlands, with a wide distribution in Europe, Asia, Africa and North America. Sometimes it can be an invasive species, especially in moist areas where it removes native vegetation and reduces diversity. The stems can reach 2.5 m in height.

It can be used as food for animals, but also as a plant that colonizes very quickly and stably the heaps of ash and slag in steam power plants.

➤ **Acacia:**

For arboreal plantations, very good results have been achieved in our country in planting raw waste from the coal basin of Oltenia with Acacia. Acacia can be used with good results on the heaps of flotation-Moldova Nouă.

➤ **Sallow:**

It turns out favourable for fixing instable lands and fast backfalls, due to the toughness of entering of its root system and at the same time, it enriches the soil, due to nitro-bacillus fixers. Very good results have been achieved in our country in planting heaps of slag and ash from coal power plants-Sânpetru-Brasov, or heaps of copper flotation.

➤ **White bayberry:**

It is a fruit-bearing shrub that grows naturally in our country, but it is very recently introduced into cultivation around the world. The underbrush shrub presents itself as a bushy shrub, globular in aspect, with highly developed surface roots, 3-5 m high.

The advantages of white bayberry growing are:

- It grows extremely quickly, reaching full maturity in not more than 8 years, compared to other trees and shrubs that need 30-35 years to develop completely.
- It is valuable when it comes to bioactive principles stored in the leaves and fruit. In particular, the fruit of the white bayberry is recognized as a natural multivitamin.
- It recycles the soil on which it vegetates in a relatively short time, depending on the degree of erosion and pollution, being the most economic and secure investment of recycling soils on large land surfaces, which at the time of meeting the objectives is completely written off and it has recorded a profit.
- It is a valuable fuel through its superior calorific value and complete combustion, almost without smoke, an alternative that cannot be neglected for some plain areas, where solid fuels are expensive and hard to find.

3. Possible alternatives of integrating the degraded areas in the Jiu Valley into the natural landscape

Local authorities in the JIU Valley in collaboration with academic environment - teachers, graduate students, doctoral students, based on various studies and comparative analysis, propose three main directions:

1. natural recovery;
2. productive recover;
3. recreational and leisure recovery.

For degraded land in the Jiu Valley it has been decided, most of the time, for **the natural recovery**, which provides action only with regard to the stabilization of the land, even grass planting in order to minimize the risk of plastic flows.

This type of recovery has in view the recreation of the natural cadence of the degraded landscape, including specific measures for nature protection. It is suitable for the surfaces in mountainous areas and it is done in case of slopes of a quarry surrounded by natural forested mountainsides. The advantages consist in relatively low cost, and can be accessible even to poor local economies, but there are also disadvantages such as the long time necessary to restore ecosystems.

The main operations that natural recovery has in view are the following:

- works to improve the levelling of the land, and shall ensure that the slopes of the quarry are not excessively geometrical;
- management and maintenance works;
- ensuring the conditions for drainage of the rainwater;
- improving stability conditions;
- vegetation planting, etc.

For dumps and quarries in the Jiu Valley, the reinstating in surrounding natural landscape by restoring the spontaneous flora of grass that grows and arboreal vegetation, will mean the return of wildlife characteristic of the place and restoring the ecosystem as a whole.

Productive recovery, much more expensive, more risky, but possible sustainable over time involves the establishment of orchards of fruit trees.

Such a growing is the hazelnut plantation, which can bring substantial economic benefits to the local community, while ensuring the reintegration into the surrounding landscape, as the hazelnut is more often met in the hill parts in the Jiu Valley, the climate being a propitious one.

The hazelnut is known for the fact that it secures the soil by stopping erosion, purifies the air, has a high medical value, and as food, the peanut has multiple nutritional properties.

The waste of dumps in the Jiu Valley are located in natural surroundings, in the premontane hills in poorly productive areas in terms of agriculture. As a matter of fact, the whole basin cannot be regarded as an agricultural area, but an

area with traditions related to animal husbandry, and more recently the exploitation and processing of wood mass.

Especially in the West Jiu Basin, the dumps occupy lands which were originally occupied by beech forests mixed with spruce and birch as main species plus a number of shrubs such as the dog rose, the hazelnut or hawthorn, these forests alternating with areas for grazing, resulting from deforestation carried out by local people.

The third variant, **the recreational and leisure recovery** lends itself to the degraded areas of the Jiu Valley, in particular where there are mirrors of water, such as the lake of Câmpu lui Neag, for which several development solutions have been proposed.

Some of the experts and entrepreneurs in the scientific and economic environment have opted for the reconstruction of the heaps for sporting purposes, by creating sport centres, which could host biathlon competitions. We would not insist on presenting them as these possibilities of ambient and economic reconstruction have been treated individually in other works, with the presentation of concrete actions that need to be carried out.

What we need to remember is that all projects to rehabilitate the dumps are pursuing the same thing: the conversion of unproductive areas or rather the non-viable ecologically and economically ones, into an improved area, with a well-established functionality, capable of attracting tourists and investors [10].

4. Recovery of the remaining cavities of the quarries. Case study: Câmpu lui Neag

In the Jiu Valley, in lowland areas of the heaps, or between dumps, you can differentiate aquatic ecosystems. They occur in the battered parts of the heaps, they can be formed through the accumulation of rainwater, either directly or as a result of dripping on the dump slopes, or by lifting water from some holocene springs covered by sterile, or by crossing out some surface waters. It has not been addressed the specific diversity research in this kind of stagnant ecosystems, its dynamic over time, specialists' attention being focused, especially on the periodic evaluation of the stability of heaps [12].

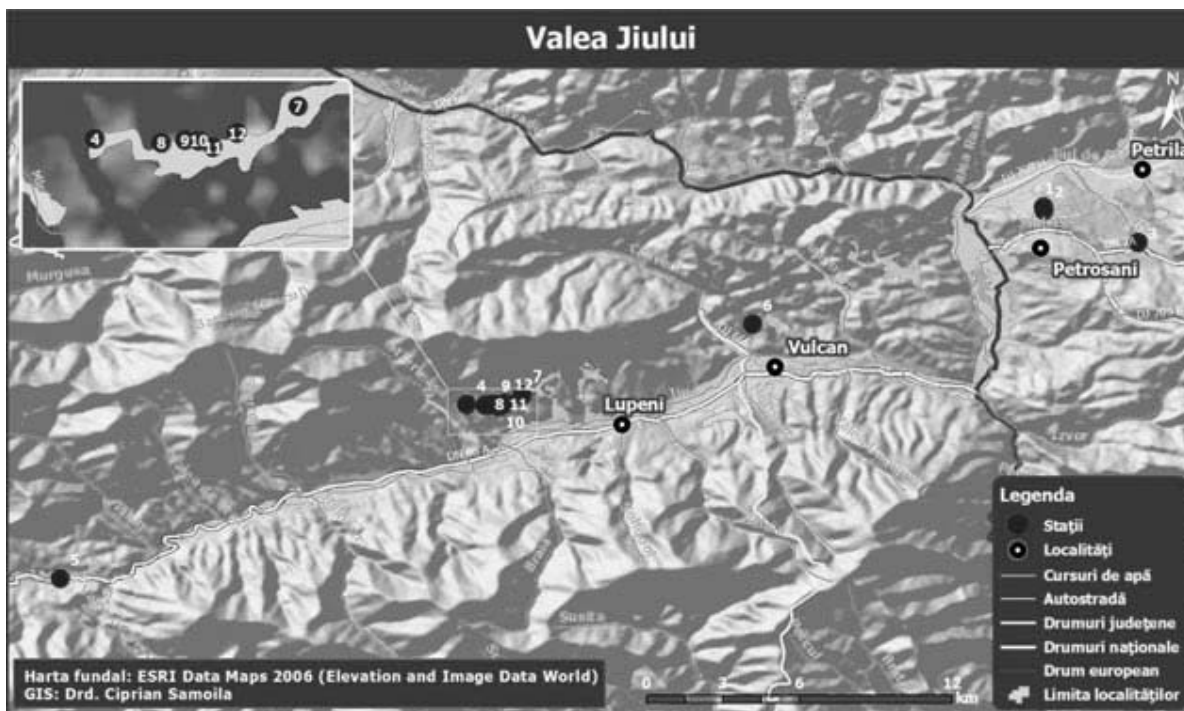


Figure 1. *Water accumulation areas in the Jiu Valley mining basin [12]*

The most common and successful way of re-using remaining cavities are the following:

- the pisciculture ponds, and for this it is necessary that the water contain a slightly higher level of nutrients, the bottom of the Lake be as flat as possible, and the borders be planted with corresponding vegetation;
- retention basins and water reservoirs, as flood protection system;
- water - storage basins for water and irrigation;
- improving the waste dumps;
- lakes for recreational purposes.

The objectives of sustainable development, in line with the national strategy for rehabilitation of ecosystems are as follows [12]:

- 1) highlighting and removing the dangers of anthropogenic origin, which threaten the integrity of ecosystems and conservation of species;
- 2) determination of the optimal conditions for restoring the environment by preserving the biodiversity of aquatic ecosystems;
- 3) ecological informing and educating the population, its drawing into decision making in the field of conservation and the rational use of biodiversity of these ecosystems.

Currently Câmpu lui Neag is not part of the general tourism potential of Romania. The service industry is very poorly represented in the area.

Câmpu lui Neag area is not an established tourist destination and the places and surrounding attractions have only a regional role. Although the project for improvement of recreation will be a success, it is an unequal comparison vs. the re-cultivation costs, and most of the jobs will be seasonal.

Lake from Câmpu lui Neag is representative for the Western end of the JIU Valley basin and for the entire depression.

One of the projects with the greatest potential and benefit to the community has already been taken into account by the local authorities and it refers to the arrangement of the Lake by putting up a modern recreational facilities.

Because of the neighbouring forest, the mountains, the area has a large landscape potential. The coming of investors would help the development of the area in terms of tourism. With respect to other similar projects in Germany and Austria, it could benefit from those already made, as is the case of Lausitz area and its project of lakes, as well as in the example of the Köflach area.

In the recent years, there have been several proposed models of landscape and functional reintegration, one of which involves improvement of the Lake and surrounding ground surface exactly as a water park.



Figure 2. *The surroundings of the lake from Câmpu lui Neag [15]*

Functional reintegration concerns:

- creating a recreational base with specific shipping or arranging the Lake for fishing for recreational purposes; creating a cycling track around the Lake;
- arrange parking spaces near the road DN 66A;
- construction of a rental place for boats: rowing boats, pedal boats, in the case of specific recreational shipping base;
- arranging a floating platforms on which a restaurant will be located;
- establishing a tourist information centre;
- setting-up a space for the sale of natural products, bio, produced and collected by local people: honey, berries, mushrooms, vegetables, dairy products, etc.

Development of ecotourism activities in the local community and in the framework of integrated functional areas involves a series of socio-economic benefits [9]:

- generates employment locally;
- boosts the local economy through the development of infrastructure and tourist services: accommodation, food, transport, recreational facilities, hand-made products, etc.;
- boosts the rural economy by creating or increasing demand for agricultural products for the necessary tourist services;
- to promote infrastructure development;
- boosts the development of regions / neighbouring localities;

Landscaping re-integration [8]:

- Rehabilitation of mountain located in the northern part of the Lake, Păroasa Hill, due to active geomorphologic processes that take

place on the surface of its gravitational field movement. For this it is proposed to the mountain forest cultivation;

- Grass planting of the lakeshore: *Festuca rubra* and *Agrostis palustris*;
- The location of a layer of stems with branches or root suckers of white bayberry;
- Planting of the area of created terraces: pine;

It has also been proposed the creation of a forest strap consisting of pine (*Pinus sylvestris*) planted near the national road DN 66A, having both a functional role-noise barrier and an aesthetic role-keeping continuity of landscape texture [8].

5. Conclusions

Recultivation and rehabilitation of the mining areas include not only a ecological and geological changes but also an important social, environmental and economic factors of the area. The major purpose of rehabilitation and recultivation of the area is to create a space for the mining area which can be useful in future, with impact on public interest.

Government Emergency Ordinance no. 195/2005 (approved by Law no. 265/2006) on Environmental Protection and Mining Law. 85/2003 creates the legal framework for the sustainable exploitation of natural resources, which involve special care on how to manage the land occupied by the mining industry.

Returning back in the economic circuit of areas degraded by mining activity and occupied by waste dumps, is done under a general plan of landscaping, drawn up, discussed and approved by the local communities and law enforcement, on which are planned and carried out all the works.

The solutions proposed for re-use, relatively new in our country, point at the use on a more extensive scale of fields to be given back to the economic circuit, including afforestation of then land surfaces on the slopes which do not allow carrying out agricultural works with mechanized equipment safely.

Cultivation of energy crops, planting Paulownia tree or photovoltaic panels installing are some of the solutions proposed for land use on the heaps of debris, a part being already included in the pilot programs.

Recreational recovery is similar to naturalistic recovery, it has in view the recreation of the natural cadence of the degraded landscape, including specific measures for nature protection. It is suitable for the surfaces in mountainous areas and it is done in case of slopes of a quarry surrounded by natural forested mountainsides or along water courses.

Recreational recovery brings furthermore the achievement of some specific structures. It is recommended for land located near urban centers, when, for example, for the rehabilitation of the remanent holes, the most appropriate form is filling the holes with water. This phenomenon happened naturally to Campu lui Neag, without human intervention. In this case, the foreign element into the landscape, which is water, became a catalyst in the formation of a new organization of landscape, which can be exploited in the interest of the community in the future.

In the process of rehabilitation for the area Campu lui Neag is important to create a long-term project, feasible and economically profitable, which helps the region to develop.

We can conclude that recreation and leisure recovery is the most suitable for the region taken into consideration, namely Campu lui Neag.

References

- [1]. **Arad, S., Arad, V., Chindriș, Gh.**
Environmental Geotechnics, Polidava Deva Publishing House, 2000.
- [2]. **Arad, V., et al.**
Geotechnical construction for environmental protection, Focus Publishing House, Petroșani, 2001.
- [3]. **Băraia, O.**
Scientific Report: *Research regarding the regeneration of areas affected by mining, by proposing a model of planning and sustainable development of such area. Case Study: Jiu Valley - Campu lui Neag*, Petroșani, 2013.
- [4]. **Dican, N.**
Modern solutions for returning to the economic circuit the dumps and lands degraded by mining activities, in Berbești mining basin, PhD Thesis, Petroșani, 2013.
- [5]. **Lazăr, M.**
Environmental rehabilitation, Universitas Publishing House, Petroșani, 2001.
- [6]. **Fodor, D., Baican, G.**
The impact of mining on the environment, Infomin Publishing House, Deva, 2001.
- [7]. **Mills, S.**
In service of the wild: Restoring and reinhabiting damaged land, Beacon Press, Boston, Mass, 1995
- [8]. **Nimară, C.**
Research regarding the landscape reintegration of anthropic areas in Petrosani mining basin, PhD Thesis, University of Petrosani, Petroșani, 2011.
- [9]. **Rebega, L., E.**
Sustainable Tourism Development in Sibiu, PhD Thesis, University of București, București, 2011.
- [10]. **Zaharia, C.**
Recovery and capitalization solutions of lands from waste dumps Poiana Mare, Șesul Șerbanilor and Galbena in Câmpu lui Neag area, dissertation Thesis, Petroșani, 2013.
- [11].***
Society for Ecological Restoration International and IUCN Commission on Ecosystem Management, 2004. *Ecological Restoration, a means of conserving biodiversity and sustaining livelihoods*. Society for Ecological Restoration International, Tucson, Arizona, USA and IUCN, Gland, Switzerland.
- [12].***
Project - *The study of aquatic ecosystems formed between the waste dumps and their impact on groundwater*, (theme no. 3 cod CNCSIS 888, registration no. given by CNCSIS 25GR/11.05.2007), Univ. „OVIDIUS” Constanța, 2008.
- [13].***
<http://ecofuture.ro/afacere/>
- [14].***
<http://www.icasbv.ro/wpcontent/uploads/2012/06/rezultate22.pdf>
- [15].***
<http://wikimapia.org>