

RESEARCHES REGARDING THE POPULATION EXIGENCIES IN THE CONDITIONS OF RECOVERY AND REUSE OF THE REMAINING GAPS OF THE QUARRIES

Izabela-Maria APOSTU*, Maria LAZĂR**, Florin FAUR***

Abstract: The recovery of the remaining gaps of former quarries represents an important stage for the sustainable development of the environment, economy and society. This stage ensures the reduction of the negative impact of mining operations, which can't be avoided during exploitation but can be offset by the application of practices aimed at recovering the remaining gaps and their reintegration into the landscape. The establishment of the optimal direction and the final form of reuse of the remaining gaps can be achieved by applying methodologies that take into account a number of criteria which allow exclusion of inappropriate reuse forms. Among the most important criteria for determining the optimal form of reuse of remaining gaps is the criterion of population exigencies. The aim is to meet the needs of the population, taking into account the opportunities offered by the local conditions and the sustainable development strategy of the region. This paper presents the partial results of a survey which follows the requirements of the resident population of Rovinari Mining Basin in Romania.

Keywords: population exigencies, remaining gaps, reuse

1. Introduction

The decision-making process regarding the development of a mining area after the cessation of exploitation is a major challenge and responsibility for all decision-makers involved. The planning and use of degraded land of open-pit mining exploitation must take into account a whole range of requirements, ranging from the natural features of the site to the social and cultural structure and exigencies of the local communities [3].

The proper rehabilitation of the areas affected by open-pit mining activities must be clear. The multiple reuses of mining areas is a relatively new practice and involves overlapping the various uses and functions of the land, as long as they not only do not interfere with each other but also complement themselves [3].

An integrated approach of the planning and use of degraded land presumes involving all stakeholders in the decision-making process on the future of the land. It is necessary to identify and establish a land-use technically, socially and economically acceptable and ecologically non-degrading. Decisions regarding the land use must be implemented taking into account the physical, biological, aesthetic or economic requirements of those who will use them in the future [2].

According to the Rio Declaration, people have the right to a healthy and productive life, in harmony with nature.

This is reflected in the principle of respecting the requirements of the population, one of the fundamental principles of ecological planning [4].

2. Methodology for assessing population's requirements

Before undertaking any operation, it is necessary to draw up a list of exigencies and priorities for the sustainable development of communities. These practices favor the involvement of the population and lead to its effective participation in the planning process of the territory. The needs of local communities reflect individual needs and refer to housing, premises, productive areas, green areas, hygiene needs, mobility or resettlement in the territory, the quality of the environment, services and the complex image of the landscape or their requirements [2].

This aims at following the requirements and needs of the resident population regarding the type of reuse of a given remaining gap, taking into account the needs of the individual and the local communities, the importance of the socio-economic development of the region and the restoration of the environment, all these aspects being seen from the point of view of the respondent [1].

Evaluation of public opinion can be done on the basis of questionnaires, opinion poll, surveys, interviews or other research methods, conducted locally or regionally, depending on the area of influence (Figure 1). Such surveys can also be carried out at national level, but more concrete data are provided when conducted at the level of the studied region.

* Ph.D. Student, University of Petroșani

** Professor, Ph.D., University of Petroșani

*** Lecturer, Ph.D., University of Petroșani

Open-pit exploitation implies the appearance of a so-called remaining gap in the landscape. Choose or suggest the type of reuse of the remaining gaps, taking into account your needs and local communities needs, the importance of the region's socio-economic development and the restoration of the environment.

☐ Type of reuse no. 1

☐ Type of reuse no. 2

☐ Type of reuse no. 3

....

☐ Type of reuse no. n

Fig. 1. Example of opinion poll

Prior to requesting the opinion of local communities, it is important to study the possibilities of reuse and to determine the opportune variants. These variants can then be subjected to public opinion, avoiding the occurrence of errors, such as obtaining answers that make reuse inappropriate reuse impossible to achieve depending on the conditions.

There are many directions for the reuse of the remaining gaps of former quarries, but the optimal choice of reuse type must take into account many aspects so as to achieve the objectives of sustainable development at a regional level, namely environmental protection, security and safety, health and well-being of the human communities as well as economic and social development.

The remaining gaps of former quarries can be filled with water, thus taking up various functions, from industrial to recreational, or can be used to store different types of waste, from house hold to industrial waste [2]. These are the most common types of reuse of the remaining gaps, but depending on their characteristics and opportunities, the remaining gaps are also used in many other forms such as: forestry, fruit growing, museums or other cultural attractions, circuits for extreme and off-road sports, film or music scenes etc. Also, a remaining gap offers multiple possibilities of combining the uses, this practice having particular cumulative advantages (Figure 2).

Quarry lakes	Waste deposits	Others
☐ pisciculture	☐ household	☐ silviculture
☐ lake for recreation	☐ industrial	☐ pomiculture
☐ water tank for		☐ museums or other
☐ irrigation		☐ cultural attractions
☐ potable/industrial		☐ circuits for extreme
☐ water tank		☐ and off-road sports
☐ retention basin for		☐ film or music scenes
☐ rainwaters, torrents		☐ etc.
☐ etc.		

Fig. 2. Reuse types of the remaining gaps

Taking into account the fact that there are many variants of reuse of the remaining gaps, in order to obtain more precise results, it is recommended to apply the following methodology with a view to establish a hierarchy of opportunities for reuse according to the requirements of the population:

- establishing the optimal reuse variants and their number (n);
- conducting the opinion poll;
- questioning the local communities in the studied region regarding the type of reuse of the remaining gap after its recovery;
- analysis of the answers obtained after conducting the opinion poll;
- ranking of population requirements (establishing a hierarchy) [1].

When pursuing the position of a certain type of reuse in the hierarchy of population requirements, for which it is desired to establish an appropriate score for the assessment of the reuse opportunity (e.g. the opportunity of flooding of the remaining gap, the opportunity of building of a waste deposit in the remaining gap, the opportunity of cultivating fruit trees, etc.) of a remaining gap according to an established evaluation scale (evaluation intervals) at a certain time, the methodology described below will be followed.

The score always varies between the limit values of the evaluation scale established at a certain time, the lower limit describing the inopportunity of reuse for that purpose and the upper limit describing the major opportunity of reuse for the desired purpose.

Regardless of the number of proposed reuse variants, there are 3 situations:

1. The analyzed type of reuse occupies the first position in the hierarchy of the population requirements - in this situation, for evaluation, the remaining gap will receive the maximum score (the upper limit of the evaluation scale/interval).
2. The analyzed type of reuse occupies the last position in the hierarchy of the population requirements - in this situation, for evaluation, the remaining gap will receive the minimum score (the lower limit of the evaluation scale/interval).
3. The analyzed type of reuse ranges between the first and the last position in the hierarchy of the population requirements - in this situation, to determine the score and the opportunity of the reuse, the following method will be applied:

- establishing the position of the analyzed reuse variant in the hierarchy of the population's requirements (p_{vr}).
- determining the value of a constant, k, (1):

$$k = \frac{p_{max}}{n-1} \quad (1)$$

where:

P_{max} - maximum value of the evaluation scale (or the upper limit of the evaluation scale);

n - the number of the optimal reuse variants offered in the questionnaire;

- the final score will be determined by applying the following calculation relation (2):

$$P_f = (n - p_{vr}) * k \quad (2)$$

where:

p_{vr} - the position of the analyzed reuse variant in the hierarchy of the population's requirements regarding the reuse of the remaining gap;

P_f - the final score, which can be used to evaluate the opportunity of reuse of the remaining gap in a certain direction opportunity (e.g. the opportunity of flooding of the remaining gap, the opportunity of building of a waste deposit in the remaining gap, the opportunity of cultivation of fruit trees etc.) [1].

3. Assessment of population requirements regarding the reuse types of the remaining gaps and the opportunity of flooding - Case study: Rovinari Mining Basin

The assessment of the population's requirements regarding the reuse of the remaining gaps and the opportunity of flooding of the remaining gaps in Rovinari Mining Basin was carried out taking into account the partial results obtained by conducting an online opinion poll, at a regional level, on a number of 109 persons. The questionnaire includes 5 questions regarding the choice of reuse type of the remaining gaps in the Rovinari Mining Basin, taking into account the needs of the individuals and the local communities, the importance of the socio-economic development of the region and the restoration of the environment, all of these aspects being seen from the respondent's points of view [1].

In order to choose the type of reuse of the remaining gaps in the 5 mining perimeters in Rovinari Mining Basin, five options were offered: waste deposit, quarry lake, agriculture, forestry, industrial museum or other cultural attractions (Figure 3). The response variants were determined by studies, analyzes and documented at the level of Rovinari Mining Basin and regarded the geological and geomorphological conditions, hydrological and hydrogeological conditions, the climate conditions, the stability of the permanent slopes of the remaining gaps, the use of adjacent lands and the regional development strategy [1].

Choose the type of reuse of the remaining gap, taking into account your needs and the local communities needs, the importance of the region's socio-economic development and the restoration of the environment.

☐	Controlled waste deposit (household waste, street waste, industrial waste etc.)
☐	Quarry lake (for recreation, swimming, irrigation water tank etc.)
☐	Silviculture
☐	Agriculture
☐	Industrial museum or other cultural attractions

Fig. 3. Model of the questionnaire

The responses were analyzed and the following observations were made:

- the respondents had different opinions on the type of reuse of the degraded land by the open-pit mining exploitations in Rovinari Mining Basin;
- the hierarchy of the population's requirements on the type of reuse of the remaining gaps in Rovinari Mining Basin was carried out and the results were centralized in Tables 1-5:

Table 1. The hierarchy of population's requirements regarding the reuse type of the remaining gap of Tismana quarry

Rank	Type of reuse	%
1	Quarry lake (for recreation, swimming, irrigation water tank etc.)	61.5
2	Forestry	23.9
3	Industrial museum or other cultural attractions	7.3
4	Agriculture	4.6
5	Controlled waste deposit (household waste, street waste, industrial waste etc.)	2.8

Table 2. The hierarchy of population's requirements regarding the reuse type of the remaining gap of Rovinari quarry

Rank	Type of reuse	%
1	Controlled waste deposit (household waste, street waste, industrial waste etc.)	71.6
2	Forestry	16.5
3	Quarry lake (for recreation, swimming, irrigation water tank etc.)	6.4
4	Industrial museum or other cultural attractions	5.5
5	Agriculture	0

Table 3. The hierarchy of population's requirements regarding the reuse type of the remaining gap of Pinoasa quarry

Rank	Type of reuse	%
1	Forestry	80.7
2	Controlled waste deposit (household waste, street waste, industrial waste etc.)	8.3
3	Agriculture	4.6
4	Quarry lake (for recreation, swimming, irrigation water tank etc.)	3.7
5	Industrial museum or other cultural attractions	2.8

Table 4. The hierarchy of population's requirements regarding the reuse type of the remaining gap of Roşia de Jiu quarry

Rank	Type of reuse	%
1	Industrial museum or other cultural attractions	44.0
2	Forestry	23.9
3	Quarry lake (for recreation, swimming, irrigation water tank etc.)	14.7
4	Agriculture	13.8
5	Controlled waste deposit (household waste, street waste, industrial waste etc.)	3.7

Table 5. *The hierarchy of population's requirements regarding the reuse type of the remaining gap of North Peșteana quarry*

Rank	Type of reuse	%
1	Quarry lake (for recreation, swimming, irrigation water tank etc.)	74.3
2	Forestry	10.1
3	Agriculture	6.4
3	Industrial museum or other cultural attractions	6.4
4	Controlled waste deposit (household waste, street waste, industrial waste etc.)	2.8

- according to the recorded answers, the population believes that for the sustainable development of the region, after the cessation of the lignite exploitation activities, the following directions of reuse of the remaining gaps of the former quarries in Rovinari Mining Basin match best the interests pursued:
 - in the case of Tismana mining perimeter - 61.5% of the respondents chose the option "Quarry lake (for recreation, swimming, irrigation water tank etc.)";
 - in the case of Rovinari mining perimeter - 71.6% of the respondents chose the option "Controlled waste deposit (household waste, street waste, industrial waste etc.)";
 - in the case of Pinoasa mining perimeter - in the proportion of 80.7%, the respondents chose "Forestry";
 - in the case of Roșia de Jiu mining perimeter - 44% of the respondents chose "Industrial museum or other cultural attractions";
 - in the case of North Peșteana mining perimeter - 74.3% of the respondents chose the option "Quarry lake (for recreation, swimming, irrigation water tank etc.)" [1].

At the level of Rovinari Mining Basin, an assessment study was carried out on the opportunity of flooding the remaining gaps from former quarries.

Depending on the type of reuse that is of interest under the assessment of the opportunity of flooding the remaining gap, namely "quarry lake (for recreation, swimming, irrigation water tank etc.)" and the position of this variant in the hierarchy of the population's requirements (the position of the "quarry lake" variant is highlighted in Tables 1 - 5 in blue background), the opportunity of flooding the remaining gaps within Rovinari Mining Basin was assessed. For the final assessment, taking into account the requirements of the population, there were established intervals with values ranging from 0 to 3, 0 showing the inopportunity of flooding, and 3 the high opportunity of flooding of the remaining gaps, as follows:

- $[0 \div 0.75]$ - inopportunity of flooding;
- $(0.75 \div 1.5]$ - low opportunity of flooding;
- $(1.5 \div 2.25]$ - medium opportunity of flooding;
- $(2.25 \div 3]$ - high opportunity of flooding.

The final score was calculated based on the (1) and (2) calculation relationships and the results are shown in Table 6.

Table 6. *Assessment of the opportunity of flooding the remaining gaps of former quarries within Rovinari Mining Basin [1]*

Mining perimeter	Number of reuse variants, n	The position of "quarry lake" variant in hierarchy, p_{vr}	Const, k	Score, P_f
Tismana	5	1	0.75	3
Rovinari		3		1.5
Pinoasa		4		0.75
Roșia de Jiu		3		1.5
North Peșteana		1		3

According to the final score that gives details on the opportunity of flooding the remaining gaps of the quarries within Rovinari Mining Basin, the following results can be extracted: the remaining gaps of Tismana and North Peșteana quarries display a high opportunity of flooding, Rovinari and Roșia de Jiu display a low opportunity of flooding, while Pinoasa shows inopportunity of flooding.

These results were observed within Rovinari Mining Basin. Approximately 70% of the respondents live in the town of Rovinari or its surroundings (surrounding villages), while the other 30% of the respondents know the area and the situation of Rovinari Mining Basin, so their responses were also been taken into account.

4. Conclusions

Population is one of the most important decision-making factors when it comes to the planning and reuse of areas affected by mining. Knowing and respecting, as far as possible, the needs and demands of the population regarding the direction of reuse of degraded land ensures a sustainable future development of the region and numerous social, economic, cultural, and ecological benefits.

According to the results of the opinion poll on the population's exigencies regarding the choice of the type of reuse of the remaining gaps in Rovinari Mining Basin, most of the population wants the remaining gaps of Tismana and North Peșteana

quarries be reused as quarry lakes, Rovinari as a waste deposit, Pinoasa for forestry, and Roşia de Jiu as an industrial museum or other cultural attractions.

The assessing of the opportunity of flooding the remaining gaps within Rovinari Mining Basin according to the methodology established in this paper shows that the remaining gaps of Tismana and North Peşteana quarries display a high opportunity of flooding, Rovinari and Roşia de Jiu display a low opportunity of flooding, while Pinoasa displays inopportunity of flooding.

References

1. Apostu, I.M.

Methodology for assessing the opportunity of flooding of the remaining gaps of quarries (in Romanian), Doctoral Research report no. 2, Petroşani, pp. 51-70, (2018).

2. Lazăr, M.

Rehabilitation of degraded lands (in Romanian), Universitas Publishing House, ISBN 978-973-741-161-7, Petroşani, pp. 236-284, (2010).

3. Lazăr, M.

Researches regarding the stability and ecological reconstruction of mines affected areas (in Romanian), Empowerment thesis, Petroşani, pp. 112-113, (2016); http://www.upet.ro/doctorat/abilitare/Lazar%20Maria/9%20-%20Teza%20de%20abilitare_Lazar%20Maria.pdf.

4. Lazăr, M., Faur, F., Dunca, E.C., Ciolea, D.I.

New methodology for establishing the optimal reuse alternative of degraded lands, Environmental Engineering & Management Journal (EEMJ), Vol. 16, No. 6, pp. 1301-1308, (2017); (https://www.researchgate.net/publication/319454791_New_methodology_for_establishing_the_optimal_reuse_alternative_of_degraded_lands).

Reviewer:

Prof.PhD.Eng. Mircea GEORGESCU
UNIVERSITY OF PETROŞANI