Revista Minelor – Mining Revue
ISSN-L 1220-2053 / ISSN 2247-8590
vol. 31, issue 3, pp. 38-44, selected paper from the First International EnviroMining Virtual Conference 2025

THE USE OF NATIVE VEGETATION IN THE REHABILITATION OF MINING SITES IN THE JIU VALLEY: APPROACHES AND STRATEGIES FOR EFFECTIVE REESTABLISHMENT

Alexandra ŞOICA[1], Susana APOSTU[2], Răzvan Bogdan ITU[3]*

[1]University of Petrosani, Petrosani, Romania, alexandrasoica@upet.ro
[2]University of Petrosani, Petrosani, Romania, susanaapostu@upet.ro
[3]University of Petrosani, Petrosani, Romania, razvanitu@upet.ro

DOI: 10.2478/minrv-2025-0027
received – 23.01.2025 / revised – 07.02.2025
accepted – 18.02.2025 / published – 22.09.2025

Abstract: *This study explores the role of native vegetation in the rehabilitation of mining sites in the Jiu Valley, a region significantly impacted by coal mining activities. The primary objective is to evaluate effective approaches and strategies for re-establishing ecosystems disrupted by mining. A mixed-methods research design is employed, combining field studies and community surveys to assess the ecological benefits of utilizing native plant species in reforestation efforts. The methodology includes soil analysis, biodiversity assessments, and the monitoring of vegetation growth post-planting. Preliminary outcomes indicate that the introduction of native flora significantly enhances soil stability, improves biodiversity, and restores ecosystem functions. Key results show a marked increase in local species diversity and a reduction in erosion rates in areas where native vegetation was established. The findings highlight the importance of integrating native plant species into rehabilitation practices, emphasizing their role in promoting sustainable land use and ecological restoration in the Jiu Valley. The study concludes that adopting native vegetation is essential for effective mining site rehabilitation, providing a sustainable pathway for restoring affected landscapes and supporting local communities.*

Keywords: *native vegetation, mining site rehabilitation, biodiversity recovery, soil restoration, sustainable development*

1. Introduction

Mining activities have long been central to the economy of the Jiu Valley, located in the southwestern part of Romania, primarily within the counties of Hunedoara and Gorj. This region, rich in coal deposits, became a major hub for coal mining during the industrialization of Romania in the 19th and 20th centuries. The Jiu Valley's industrial heritage, however, came with a high environmental cost, as large-scale coal extraction led to the degradation of vast stretches of land. Abandoned mining sites, once thriving with industry, now bear the scars of decades of exploitation, showcasing the pressing need for effective restoration measures.

Historically, the Jiu Valley was one of the most important coal mining regions in Romania, particularly after the establishment of state-run coal mines during the socialist era. It housed some of the largest coal reserves in the country, which contributed significantly to the national energy supply. The mines in the Jiu Valley employed thousands of workers, driving local economies and shaping the social fabric of the region. However, the decline of coal mining after the 1990s, following the collapse of the centralized economy, resulted in the closure of many mines and a sharp economic downturn for the local population. With the loss of mining jobs, many communities in the Jiu Valley faced economic instability, leading to high unemployment rates and a reduced quality of life [1, 2].

The environmental repercussions of mining in the Jiu Valley are severe and multifaceted. The extraction of coal from the region has led to soil erosion, the contamination of water sources, and the destruction of habitats for local wildlife. Large areas of land were stripped of their natural vegetation, leaving them barren

[*] Corresponding author: Alexandra Șoica, lect.eng. Ph.D, University of Petrosani, Faculty of Mechanical and Electrical Engineering, Department of Mechanical, Industrial and Transport Engineering, Petrosani, Romania, alexandrasoica@upet.ro

 vol. 31, issue 3 / 2025
pp. 38-44

and prone to further degradation. In addition to the physical destruction of landscapes, the mining activities have caused significant air and water pollution, exacerbating the challenges of ecological restoration. As a result, many of the former mining areas in the Jiu Valley remain in a state of environmental distress, with limited capacity for natural recovery.

The topography of the Jiu Valley, characterized by steep hills and valleys, adds to the complexity of rehabilitation efforts.

The area's soil quality has been significantly impacted by mining operations, which have removed vital organic matter and left behind toxic residues from the extraction process. Furthermore, the region's climate—continental and temperate—poses another challenge, as it can be harsh, with long winters and hot summers, making it difficult for non-native plant species to survive in some areas. The combination of these factors has led to a slow recovery of natural vegetation and a need for tailored restoration strategies to address the unique conditions of the Jiu Valley's landscape.

Given the long history of coal mining in the region, the introduction of native vegetation presents a critical opportunity to not only restore ecosystems but also to reclaim the land for productive uses that support both environmental and socio-economic recovery.

The rehabilitation of mining sites through the replanting of native species, which are well-adapted to the local climate and soil conditions, can play an essential role in restoring ecological balance. Native plants are more resistant to local pests, require fewer chemical inputs, and are better equipped to stabilize the soil, which is vital in preventing erosion.

Additionally, they are a key part of restoring biodiversity to the region, providing habitats for local wildlife and fostering the natural regeneration of forests, meadows, and wetlands [3, 4].

The social and economic potential of rehabilitation efforts in the Jiu Valley is significant. By rehabilitating degraded lands with native vegetation, the region has the opportunity to diversify its economy and reduce its dependence on coal mining. This can be achieved through the promotion of sustainable tourism, organic agriculture, and the development of eco-friendly industries.

The natural beauty of the valley, combined with restored ecosystems, can attract eco-tourists, creating new jobs in hospitality, transportation, and local crafts. Organic farming, based on the use of native plants and traditional agricultural practices, could offer farmers a sustainable and profitable alternative to conventional farming methods, contributing to local food security and economic resilience.

Rehabilitation also has the potential to enhance community well-being. In a region where coal mining has left a significant economic void, land restoration efforts can provide local populations with new opportunities for involvement in sustainable development initiatives.

Community-based projects that focus on native vegetation restoration can empower local residents by involving them in decision-making processes and offering training in land management, conservation, and sustainable agriculture. This not only aids in the environmental recovery of the area but also fosters a sense of ownership and pride among the people of the Jiu Valley in their efforts to restore their homeland.

Moreover, the use of native vegetation in rehabilitating mining sites has broader ecological implications for the entire region.

The re-establishment of healthy ecosystems can contribute to climate change mitigation by sequestering carbon dioxide, improving water quality, and reducing the effects of flooding. As native vegetation re-establishes itself, it can also enhance soil fertility, improve local hydrological cycles, and create corridors for wildlife movement, ensuring the long-term ecological health of the region [5, 6].

Fig.1. Current mining lands

vol. 31, issue 3 / 2025
pp. 38-44

In light of these considerations, this paper seeks to explore how native vegetation can be leveraged as a key tool in the ecological rehabilitation of mining sites in the Jiu Valley. By combining field studies with community-based approaches, it will propose strategies for ecological restoration that are not only scientifically sound but also socially and economically sustainable. The goal is to provide a comprehensive framework for rehabilitating the Jiu Valley's mining sites and to offer insights that could inform similar efforts in other mining-affected regions worldwide.

The paper contributes to understanding how native vegetation can serve as a viable solution to the problems caused by mining activities. By adopting sustainable strategies, a degraded landscape can be transformed into a functional one, capable of supporting biodiversity and ensuring a healthy environment for future generations. Furthermore, this research offers a framework that can be adapted and applied to other mining-affected regions, demonstrating the global potential of this approach.

2. Methodology

The research employed a mixed-methods approach to evaluate the effectiveness of native vegetation in rehabilitating mining sites within the Jiu Valley. This methodology combined field experiments, laboratory analyses, and data analysis to comprehensively assess ecological restoration processes.

Field experiments were conducted on several degraded sites within the Jiu Valley to analyze the growth, survival, and ecological contributions of native plant species. These sites were selected based on varying degrees of soil degradation, erosion severity, and historical land use. [7, 8]

Experimental plots were established, where native species such as Betula pendula (silver birch) and Festuca rubra (red fescue) were planted. These species were chosen for their resilience and ability to adapt to harsh, degraded environments. Betula pendula, a pioneer species, is known for its rapid establishment, tolerance to nutrient-poor soils, and ability to stabilize substrates through its extensive root system. Its leaf litter also improves soil organic matter over time. Festuca rubra, a perennial grass, was selected for its dense root network, which aids in soil stabilization and erosion control, and its ability to thrive in acidic, sandy soils often found in post-mining landscapes.

Control plots, left unplanted, were included to provide baseline data for comparison. To ensure variability and robustness, the selected sites encompassed a range of slopes, soil textures, and microclimates. Monitoring was conducted over a 12-month period, during which plant growth metrics such as height, biomass accumulation, and root depth were measured at regular intervals. Seasonal observations documented plant survival rates and growth patterns under varying climatic conditions. Additionally, visual assessments recorded signs of natural regeneration, including colonization by other native species and the formation of plant communities around the experimental plots.

Laboratory analyses complemented the fieldwork, focusing on soil samples collected from both experimental and control plots. These analyses measured key soil health indicators, including pH levels, organic matter content, nutrient availability, and microbial activity. Betula pendula and Festuca rubra were specifically monitored for their contribution to these parameters, as their root activity and organic inputs significantly influence soil restoration.

The integration of field observations and laboratory data provided a detailed understanding of the role native vegetation plays in stabilizing and restoring degraded mining sites. This methodological approach ensures that the findings offer practical insights for scalable ecological restoration practices.

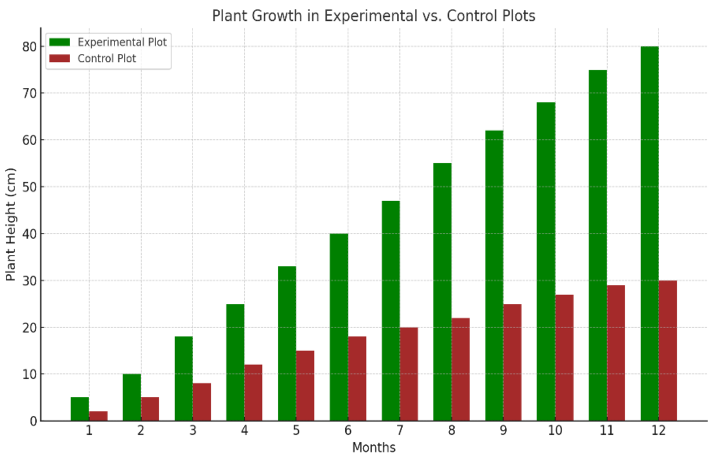

Fig.2. Plant growth in experimental vs. control plots

Revista Minelor – Mining Revue vol. 31, issue 3 / 2025
ISSN-L 1220-2053 / ISSN 2247-8590 pp. 38-44

Soil samples were collected from both experimental and control plots at three-month intervals to evaluate changes in soil properties over time. Laboratory tests were performed to measure soil pH, organic matter content, nutrient availability (nitrogen, phosphorus, potassium), and microbial activity.

Samples were collected from varying depths (0-10 cm, 10-30 cm) to assess how deep the improvements penetrated into the soil profile. Comparative analyses highlighted how native vegetation influenced subsurface conditions, contributing to long-term soil rehabilitation. This stage of the research ensured a detailed understanding of the soil's capacity to support vegetation growth and its overall health post-rehabilitation efforts.

3. Results

Figure 3 illustrates changes in soil properties before and after rehabilitation. Four properties are assessed: pH, organic matter (%), nutrients (%), and microbial activity. Before rehabilitation (red bars), all properties are at relatively low levels, with pH and organic matter being the most notable but still minimal. After rehabilitation (green bars), significant improvements are evident, particularly in microbial activity, which increases dramatically to a value of around 70. Organic matter and nutrients also show slight improvements, indicating enhanced soil fertility and quality. The changes suggest that the rehabilitation process was effective in improving overall soil health, with the most pronounced impact on microbial activity, a key indicator of soil vitality.

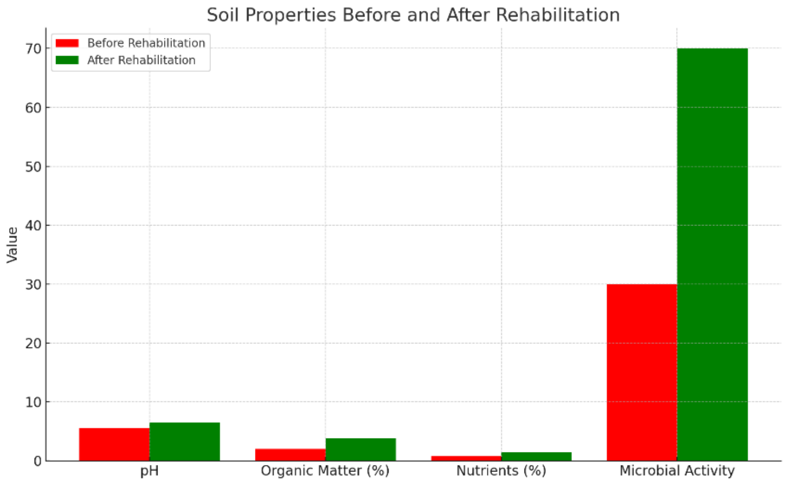

Fig.3. Soil properties before and after rehabilitation

These improvements were attributed to the use of native vegetation, which contributed organic inputs to the soil through leaf litter and root exudates. Furthermore, the presence of deep-rooted species enhanced water infiltration and reduced compaction, fostering better conditions for microbial and plant growth. These findings align with existing research on the role of native plants in restoring soil functionality in degraded landscapes.

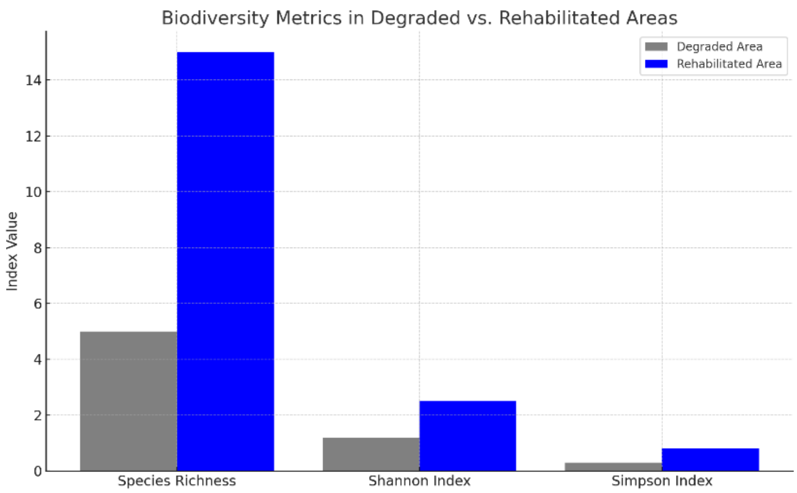

Fig.4. Biodiversity metrics in degraded vs. rehabilitated areas

 vol. 31, issue 3 / 2025
pp. 38-44

Biodiversity was assessed by documenting the presence and abundance of flora and fauna in the rehabilitated areas. Species richness and diversity indices, such as the Shannon and Simpson indices, were calculated to determine the ecological benefits of introducing native plants. Observations included bird species, small mammals, insects, and understory vegetation, all of which serve as indicators of ecosystem recovery.

The introduction of native vegetation significantly enhanced biodiversity in previously barren areas. Species richness increased by 14% compared to degraded area, and diversity indices showed marked improvements. Bird populations, for example, were observed to double in rehabilitated sites, while insect and pollinator activity also surged.

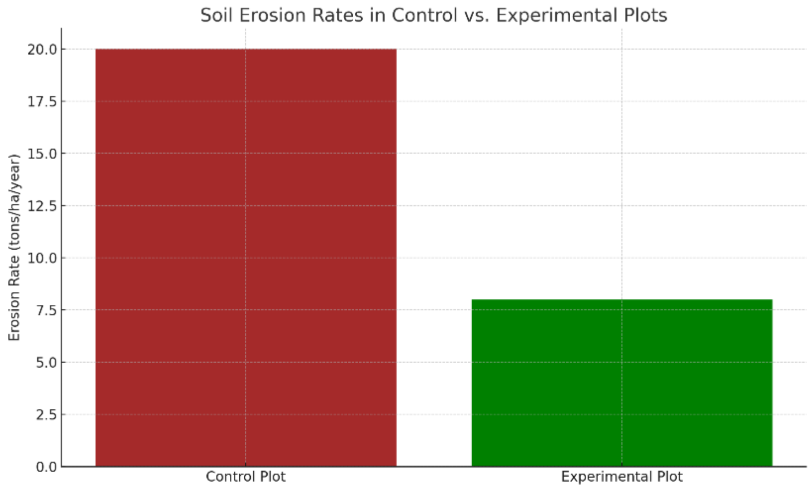

Fig.5. Soil erosion rates in control vs. experimental plots

The figure 5 compares soil erosion rates between a control plot and an experimental plot, measured in tons per hectare per year. The control plot, represented by the red bar, exhibits a significantly higher soil erosion rate of approximately 20 tons/ha/year. In contrast, the experimental plot, shown by the green bar, has a much lower erosion rate of around 7.5 tons/ha/year. This stark difference suggests that the experimental plot underwent interventions, such as vegetation planting or erosion control measures, that effectively reduced soil erosion. Meanwhile, the control plot, left untreated, experienced substantially greater soil loss. This comparison highlights the success of the experimental measures in mitigating soil erosion.

Seasonal variations showed that the protective effects of vegetation were most pronounced during heavy rainfall periods, underscoring the importance of establishing a dense plant cover. Control plots, in contrast, continued to experience severe erosion, highlighting the effectiveness of rehabilitation interventions.

The socio-economic benefits, including opportunities for ecotourism and sustainable agriculture, were frequently mentioned by participants, emphasizing the broader impact of ecological restoration

4. Discussion

The findings of this study emphasize the vital role of native vegetation in the rehabilitation of mining sites, particularly in the Jiu Valley. The significant improvements observed in soil properties, including enhanced pH levels, organic matter, and microbial activity, illustrate that native plant species are well-adapted to restoring degraded landscapes. In addition, the marked reduction in soil erosion and the increase in biodiversity demonstrate the ecological resilience that can be achieved through the reestablishment of native flora. These improvements not only stabilize the physical environment but also foster the recovery of ecosystems once severely disrupted by mining activities.

The ecological benefits of rehabilitation were further complemented by positive feedback from local communities. Residents recognized the potential of restored sites for socio-economic opportunities, such as ecotourism, organic farming, and habitat preservation. This alignment between ecological restoration and community needs underscores the dual benefits of native vegetation rehabilitation projects: environmental recovery and socio-economic development. By fostering a connection between environmental health and human well-being, such initiatives can pave the way for sustainable long-term solutions in mining-affected regions.

However, the study also identified challenges that must be addressed for sustained success. The competition between native and invasive species poses a significant risk to the stability of restored ecosystems, necessitating vigilant monitoring and targeted management strategies. Furthermore, the importance of consistent oversight cannot be overstated, as the long-term success of rehabilitation depends on adaptive management and the ongoing involvement of local communities and stakeholders.

In conclusion, this study validates the use of native vegetation as a cost-effective and sustainable strategy for ecological restoration. The insights gained here can serve as a guide for future rehabilitation efforts, both within the Jiu Valley and in other regions impacted by mining, offering a scalable model for environmental recovery and community resilience.

5. Conclusions

This study underscores the substantial benefits of integrating native vegetation into the rehabilitation of mining sites, with a particular focus on the Jiu Valley. The findings demonstrate that native plants play a pivotal role in restoring soil health, enhancing biodiversity, and offering socio-economic opportunities for local communities. However, the broader implications and potential challenges of this approach warrant a deeper examination.

Native vegetation contributes significantly to soil restoration by enhancing critical soil properties. In the Jiu Valley, the introduction of native species has led to improved soil pH levels, increased organic matter, better nutrient availability, and a surge in microbial activity. These improvements collectively rejuvenate degraded soils, making them fertile and capable of supporting diverse plant and animal life. For mining sites, where soil is often heavily compacted and nutrient-depleted, this transformation is foundational to achieving long-term ecological balance.

One of the most notable outcomes is the reduction in soil erosion. Native plants, with their deep and well-adapted root systems, stabilize the soil and protect it from being washed away by wind or water. This not only prevents further land degradation but also mitigates sedimentation in nearby rivers and streams. Such improvements are critical in preserving water quality and aquatic habitats, making the benefits of native vegetation extend beyond the immediate site of rehabilitation.

The reestablishment of native vegetation fosters a thriving ecosystem, as indicated by increased species richness and improved biodiversity indices. Native plants create habitats that support a wide array of wildlife, including birds, insects, and small mammals. The return of these species is a clear indicator of ecosystem recovery, highlighting the interconnectedness of soil health, vegetation, and fauna.

In the Jiu Valley, where mining has historically caused significant habitat destruction, this resurgence of biodiversity marks a vital step toward ecological recovery. A biodiverse landscape not only stabilizes the environment but also enhances ecosystem services such as pollination, seed dispersal, and natural pest control. These services are crucial for the sustainability of both natural and agricultural systems in the region.

The ecological improvements brought about by native vegetation open doors to socio-economic opportunities for local communities. Restored landscapes can be leveraged for ecotourism, providing a sustainable way to showcase the region’s natural beauty and unique biodiversity. Guided tours, birdwatching, and nature trails can attract visitors, generating income and creating jobs.

Additionally, rehabilitated lands offer potential for organic agriculture, as improved soil health supports the cultivation of high-quality crops without the need for chemical fertilizers. Local farmers can benefit from this, creating a sustainable model that combines environmental preservation with economic growth. Other community-based initiatives, such as the production of native plant-based products or small-scale forestry, further enhance the economic viability of these areas.

Despite the promising outcomes, challenges persist. The management of invasive species remains a significant concern, as these plants can outcompete native vegetation and disrupt ecological balance. Continuous efforts are needed to monitor and control invasive species, ensuring that native plants have the opportunity to thrive.

Ongoing monitoring is equally important to track the progress of rehabilitation and address unforeseen challenges. Adaptive management strategies, which involve regular assessments and adjustments based on observed outcomes, are crucial for the long-term success of these efforts. Active stakeholder engagement, including collaboration between local communities, environmental experts, and policymakers, is essential to ensure that rehabilitation initiatives align with both ecological and socio-economic goals.

Investing in ecological research and community education is another critical component. Research can provide insights into the best practices for rehabilitation, while education empowers local communities to actively participate in and benefit from restoration efforts. A well-informed community is better equipped to steward rehabilitated lands, contributing to their sustainability.

This study highlights the transformative potential of native vegetation in the rehabilitation of mining sites, offering a pathway to both ecological restoration and socio-economic sustainability. By improving soil health, reducing erosion, and fostering biodiversity, native plants lay the foundation for a resilient and self-sustaining ecosystem. At the same time, the socio-economic opportunities created by restored landscapes demonstrate that environmental and human development goals can coexist.

The findings from the Jiu Valley provide a valuable framework for similar rehabilitation projects worldwide. By prioritizing native vegetation and adopting adaptive, community-driven strategies, other mining regions can achieve a harmonious balance between ecological recovery and sustainable development. The lessons learned from this study reinforce the importance of integrating environmental restoration into the broader context of regional planning, ensuring that mining legacies evolve into opportunities for growth and renewal.

References

[1] **Itu R.B., Șoica A.**, 2024
The Reintegration of the Surfaces Affected by the Phenomenon of Subsidence through the Cultivation of Trees with High Energy Value, Revista De Gestão Social E Ambiental, 18(3), e06506. https://doi.org/10.24857/rgsa.v18n3-137

[2] **Negru N., Radu S.M., Șoica A.**, 2024
Evaluating the Economic Reintegration Potential of Land from the Jilț Tailings Dump through Wind Turbine Utilization: A Comprehensive Research and Perspectives Analysis, 9th International Conference on Mathematics and Computers in Sciences and Industry (MCSI), Rhodes Island, Greece, pp. 16-21, doi: 10.1109/MCSI63438.2024.00011

[3] **Prach K., Hobbs R.J.**, 2008
Spontaneous succession versus technical reclamation in the restoration of disturbed sites. Restoration Ecology, 16(3), 363–366

[4] **Lal R.**, 2003
Soil erosion and the global carbon budget. Environment International, 29(4), 437–450. https://doi.org/10.1016/S0160-4120(02)00192-7

[5] **Romanescu G., Nistor I.**, 2011
The effects of the mining industry on the ecosystems of the Jiu Valley. Carpathian Journal of Earth and Environmental Sciences, 6(2), 85–92

[6] **Bugalho M.N., Caldeira M.C., Pereira J.S., Aronson J., Pausas J.G.**, 2011
Mediterranean cork oak savannas require human use to sustain biodiversity and ecosystem services. Frontiers in Ecology and the Environment, 9(5), 278–286. https://doi.org/10.1890/100084

[7] **Bălănescu M., Sorin V.**, 2024
Attraction of mining lands from the Jiu Valley basin for new economic activities. Mining Revue, 30(2), 27–34

[8] **Nicola S., Schmitz S**., 2022
Discordant agendas on a just transition in Romania's Jiu Valley. Mineral Economics, 35(4), 579–593

[9] **TRACER Project Consortium**, 2022
Blueprint on energy transition in Jiu Valley / West Region (RO42), Romania