PREVENTION AND MONITORING ENVIRONMENTAL IMPACT OF OPEN PIT COAL MINING ACTIVITIES

I.L. OLTEAN, T. GOLDAN, C. M. NISTOR
University of Petrosani
Address corresponding: goldan_t@yahoo.com

Abstract. *Many types of changes are distinguished as a result of mining: degradation of land and vegetation, change in the natural topography whith results in restrictions in the possibilities of using the land for othe purposes, changes in composition and quality of water causing water pollution, changes in air quality and finally changes in the geotechnical conditions of the rock. The impact varies with local conditions of the specific site of mining. The majority of mining methods have disadvantage removing of immense volumes of soil for mining mineral deposits. Because the materials disposed in refuse dumps are physical-chemically heterogeneous and extremely diverse in terms of mineralogical composition (sand, gravel, clay, marl), over time there have been many occurrences of instability phenomena. Moreover, in mining activity are produced numerous noises which may irreparably affect the environment.*

Key words: *prevention, monitoring, environmental,impact, mining, activities,open pit.*

INTRODUCTION

The changes created by mining activity differ from one open pit to another.

The opencast mining has a considerable impact. Depending on the mining method used, mining activities can produce environmental degradation. The coal found in dumps may combust sponateously and produce smoke and sulphurous fumes. To reduce the risk of ignition, dumps are compacted and covered with layers of soil. Mining dumps are source of solid and liquid waste.

Coal mining activity changes local area by introducing mining dumps, change the course of rivers, produces soil contamination, deterioration of the ecosystems and migrate native residents. Also must be removed large volumes of soil to gain access to the coal resource, that create problems in restoration after closing the mining activity.

Open pit coal mining will produce negative environmental effects such deforestation, land subsidence, water and air pollution, dust, noises, poisonous gases, and mine waste. Contamined water has a major impact in agriculture.

The main environmental impacts of open pit mining activities is land degradation and erosion.

MATERIAL AND METHODS

Before starting the coal extraction there were performed the following workings: decommissioning of existing buildings, clearing the terrain, topsoil removal, preliminary excavations, achieving access routes, building production facilities and necessary annexes, building coal deposits, etc.

There were also conducted hydraulic water works like: diversion of watercourses; execution of dumps guard channels; flood embankment; shielding aquifer formations; arrangements for correcting torrents; water drainage and collection channels.

Simultaneously with the opening trenches execution there were built mounting platforms for technological equipment, slopes to access high capacity machines and for the location of belt conveyors.

Mining methods applied mainly have been those with transportation of the waste rock at dumps. They are used in all conditions and in any terrain configuration or lignite deposit settlement, whose inclination is in the range 5-8 °.

Tailings disposedd in landfills comes from the work of outcropping and sterile intercalations between the mined out lignite strata.

Observations on such dumps can be quantified as it follows below:

- the presence of uneven subsidence areas, which allows accumulation of rainfall and runoff in the body of dumps and results in the change of state of consistency, with negative effects on the stability;
- the occurrence of the thixotropic or liquefaction phenomenon during therainfall season, which leads to increased instability of dumped rock by reducing the shear strength;
- the increased humidity due to excess moisture leads to small size superficial slips of landfill slopes steps without affecting the overall stability of the;
- tilt slopes greater than 30 ° are crossed by ravines created by water flow.

Following the periods of excessive moisture, the presence of clays resulted in rocks swelling, leading ultimately to destabilize some of dumps.

Above realities combined with constructive deviations from the designed geometry of waste dumps favors the appearance of instability phenomena or reactivation of older, previously existing ones.

Humidity content in a dump is a fluctuating parameter influenced by time of sampling, height of dump, stone content, amount of organic carbon, and the texture and thickness of litter layers on the dump surface. During the winter, the humidity content of 5% was found to be sufficient for the plant growth. During high summer, humidity content in dumps was reported to be as low as 2-3% moisture content of all the dumps was 5%.

Following the periods of excessive moisture, the presence of clays resulted in rocks swelling, leading ultimately to destabilize some of dumps.

Being loosened structures consisting of carbonaceous clay, sandy clay, dusty-marly sand and argillaceous sand, heaps are characterized by a great susceptibility to triggering geomorphological processes, of which the most common are runoff and gully, shallow landslides of steps and slopes, aslo their collapse, wind erosion, natural and anthropogenic compaction.

RESULTS AND DISCUSSION

After closure open pit mining activities it is necesarry a monitoring management. Monitoring, evaluation and adaptive management is critical in mine rehabilitation (figure 1). Monitoring should also be used to determine the effectiveness of rehabilitation. Monitoring would become more complex over time, and together would demonstrate rehabilitation success.

Monitoring in an open pit should not only concentrate on surface movement, but systems should also be installed to monitor sub-surface movement. The timely collection and interpretation of the data, followed by distribution of the results, forms the complete slope monitoring system.

Measures commonly adopted to increase stability are draining surface water and groundwater, reducing the slope escarpment, covering them with plantations, building retaining walls.

In order to prevent instability of the surface land is used primarily the aquifer formations dewatering, process allowing that the water is drained and evacuated for operation under normal conditions. These works resulted in lowering the groundwater levels in areas with large extension.

Through the surface water drainage it is minimized the process of alteration of rocks properties. In this respect is necessary the surface land leveling and building drains for surface water leakage.

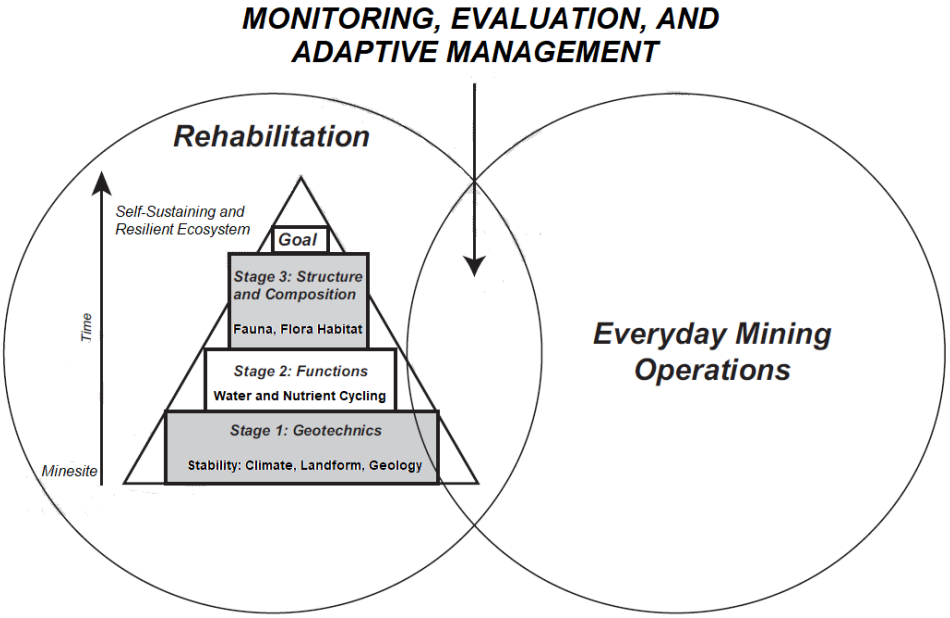

Figure 1. Monitoring, Evaluation and Adaptive Management after mining operations.

The underground drainage system lowers to groundwater levels, reducing pore water pressure and hydrostatic pressure in rocks's cracks.

Leveling – which fall under mining units obligations – must create the conditions required to carry out the regeneration of soil fertility and plant cultivation or conditions for building and development purposes.

Creating plantations and afforestation are other measures with positive effect aimed to stabilize landslides, being applying after surface land leveling and provision of surface water drainage.

Another measure for landslide stabilization is to reduce slope gradients in order to achieve stable conditions.

Landscape and soil degradation involve a reduction in ecosystem functions and services. Thus, decisions about sustainable landscape management must consider the restoration of essential ecosystem services.

Restoration of coal mining landscapes has become an important area of focus with the presure to reduce coal combustion, since coal combustion is a major contributors to the total anthropogenetic emissions of 35 Gt CO_2/yr. Restoration of these lands is critical to ecosystem functions and services.

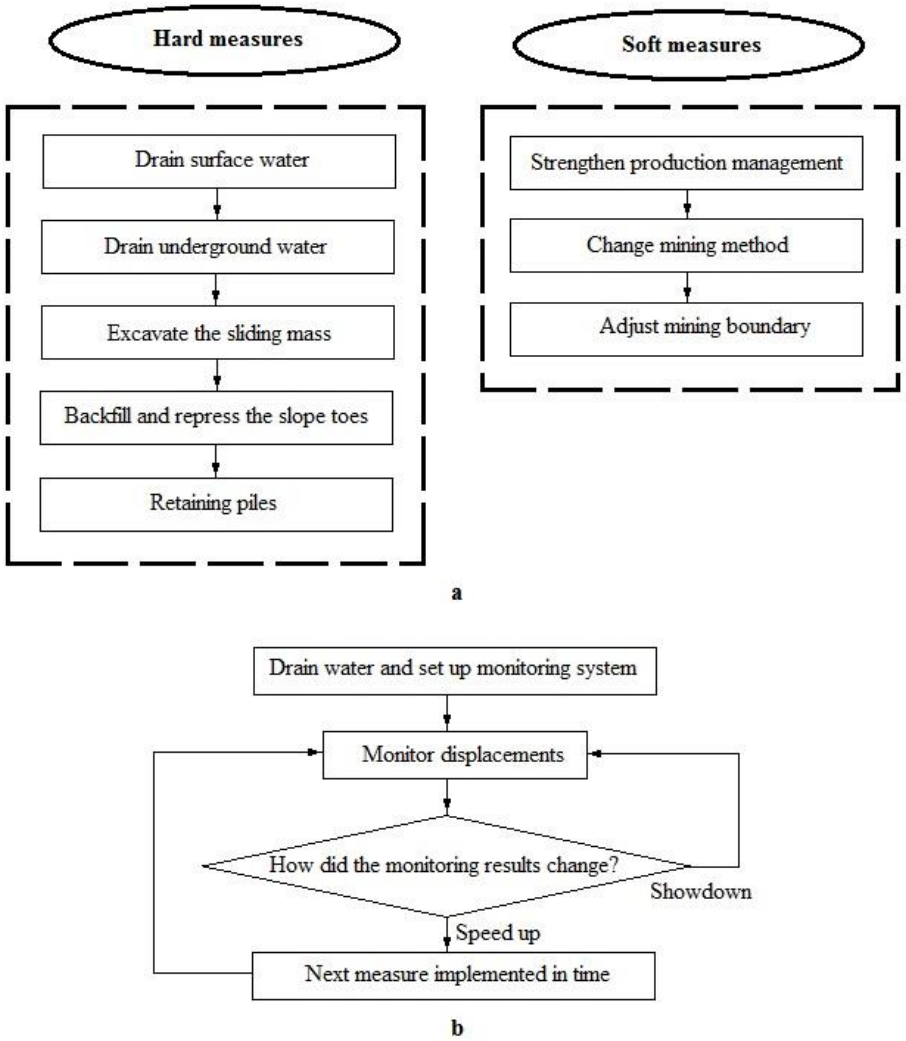

Figure 2. Control measures and design procedures to landslides control:
a – measures for landslides control; *b* – design procedures.

CONCLUSIONS

The effects of the open pit mining activities on the environment may by highlighted only after several years. Large areas of land are temporary disturbed. The environment is affected by mining activities in various forms: poisonous gases generated after massive blasting operations, vibrations and noises generated during coal transport with heavy vehicles, soil erosion, surface water and groundwater pollution. The topography of land is changed after closure mining activity, vegetation and fauna are affected, and include impacts on local biodiversity.

Environmental degradation is generally caused on the mining method and technology chosen in open-pit. The source of waste and considerable pollution is mining dumps. Also, the pollution of surface water and groundwater is caused by mining operations.

Workings performed for extracting coal in open pits are large-scale developments and can lead to significant degradation of the surrounding terrain and waste dumps resulting from this activity.

Measures to ensure slope stability dumps can be qualified as "hard" or "soft". A first measure consist in respecting working technology, followed by dewatering, and drainage of surface water and groundwater, land leveling and creating plantations

All these measures requires continuous monitoring, which is a problem often neglected, most often due to limited financial resources or lack of communication between the involved parties.

BIBLIOGRAPHY

1. AKPINAR, N., KARA, D., UNAL, E**.,** Post surface mining land use planning. Turkey XIII. Mining Congress, 10-14 May 1993, İstanbul: Chamber of Mining Engineers of Turkey, 1993.
2. BHATTACHARYA, A., ROUTH, J., JACKS, G., BHATTACHARYA, P., MORTH, M., Environmental Assessment of Abandoned Mine Tailings in Adak, Vasterbotten District (Northern Sweden). Applied Geochemistry, Volume 21, 2006, pp.1760-1780.
3. BELL, F.G., DONELLY, L.J., Mining and Its Impact on the Environment. Oxon, England: Taylor&Francis Group, 2006.
4. DRAKE, J., GREENE, R., MACDONALD, B.C.T., FIELD, J.B., PEARSON, G.L., A review of landscape rehabilitation frameworks ecosystem engineering for mine closure, International Conference on Mine Closure 2010, ed. Andy Fourie, Mark Tibbett, Jacques Wiertz, Australian Centre for Geomechanics, Perth, pp. 241-249.
5. HANCOCK, G.R., The Use of Landscape Evolution Models in Mining Rehabilitation Design. Environmental Geology, 46, 2004, pp.561-573.
6. HENDRYCHOVA, M., Reclamation Success in Post-Mining Landscapes in the Czech Republic: A Review of Pedological and Biological Studies. Journal of Landscape Studies, Volume 1, 2008, pp.63-78.
7. HERBEI, M.V., HERBEI, R., SMULEAC, L., SALAGEAN, T., Using Remote Sensing Techniques in Environmental Management. Bulletin of UASMV Cluj-Napoca, Agriculture, vol.73, no.2, 2016.
8. KAVOURIDES, C., PAVLOUDAKIS, F., FILIOS, P., Environmental protection and land reclamation works in West Macedonia Lignite Centre in North Greece current practice and future perspectives. In: Ciccu R. (ed.) SWEMP 2002: Proceedings of the 7 th International Symposium on Environmental Issues and Waste Management in Energy and Mineral Production, SWEMP 2002, 7-10 October 2002, Cagliari, Italy. University of Cagliari; 2002.
9. KUTER, N., Reclamation of degraded landscapes due to opencast mining. http://dx.doi.org/10.5772/55796.
10. MAITI, S.K., GHOSE, M.K., Ecological restoration of acidic coal mine overburden dumps- an Indian case study. Land Contamination and Reclamation, 13(4), pp.361-369.
11. MIAO, Z., MARRS, R., Ecological Restoration and Land Reclamation in Open-Cast Mines in Shanxi Province, China. Journal of Environmental Management, Volume 59, 2000, pp. 205–215.
12. PECHAROVA, E., BROUMOVA-DUSAKOVA, H., NOVOTNA, K., SVOBODA, I., Function of Vegetation in New Landscape Units After Brown Coal Mining. International Journal of Mining, Reclamation and Environment, 25(4), 2011, pp.367-376.

13. SAHU, H.B., DASH, S., Land Degradation due to Mining in India and its Mitigation Measures. Proceedings of the 2nd International Conference on Environmental Science and Technology, IPCBEE vol.6, February 26-28, 2011, Singapore: IACSIT Press; 2011.
14. SENGUPTA, M., Environmental Impacts of Mining: Monitoring, Restoration, and Control. USA Lewis Publishers, 1993.
15. SHEORAN, V., SHEORAN, A.S., POONIA, P., Soil reclamation af abandoned mine land by revegetation: a review. International Journal of Soil, Sediment and Water, vol. 3(2), 2010.
16. SKLENICKA, P., KASPAROVA, I., Restoration of Visual Values in a Post-Mining Landscape. Journal of Landscape Studies, Volume 1, 2008, pp.1-10.
17. TONGWAY, D., Part 3:Interpretation of the data. In 'The LFA Monitoring Procedure: A monitoring procedure to assess rehabilitation success'. CSIRO Sustainable Ecosystems Presentation, 2005.