THE MANAGEMENT OF AREAS AFFECTED BY MINING INDUSTRY IN THE OLTENIA COALFIELD

*Constantin NISTOR**

Abstract The propose paperwork is following to elaborete a aplan of measures for management of grounds afected by minig activities of coal extraction from Oltenia. The study entity is extending between the rivres Olt and Danube and it is hold five basins of coal extraction : Berbesti, Rovinari, Jilt, Motru, Husnicoara, which is concentrated in 13 quarries, and it is affeted till now thousands of hectares of ground. We are focused of surfaces affected of coal extraction in open and underground mines. To touch this target ther is necessary many investigations by using specific methods based on up to data and information. The building of geographyc information sistem is the plan key which will be used during all objetives stages suppling up-to-date information. The data acquisition and actualization from many sources it is a base element into project develop, aspect for this it will be considering very important. Hazard identification and develop scenary of evolution, likelihood evaluation, it is a necesity to identify proplems areas and treatmet measures. Hazard dynamic asses and adjust of measures, depending of process evolution study and information flux is other step. Starting with signalizing afected areas and with potential hazard, it is wants to built a plan of reclaim and find solutions. The solutions need to request land use field before open the mines, economic and social requirement of community. The field reclaim must be done regarding of landscape reinstatement and economic and ecologic functionality to insurance a durable development.

Key words: minig management, anthropic relief, susceptibility, hazard, reclaim, rehabilitation

The mining industry has a strong impact on the environment, and its seriousness depends mostly on the extraction methods and the geological conditions (Bell, 2000). The mining activities have an important role in the local and national economy, but when they develop without control they induce a very high risk of soil erosion and severe problems of environment contamination (Coelho, 2007). The mining operations of small or large size are inherently environment destructive and produce large quantities of waste with negative impact on decades (Kitula, 2006). The environment problems occur as a result of the inadequate mining and lack of rehabilitation measures. Each mining activity has a potential impact, adverse for the environment, society, culture, health and local communities. Noronha, quoted by Kitula (2006), shows that the social and environment impact is more persuasive in the regions of new communities, where the mines were closed. The mining impact includes local population migration from the ancestral region, disregard and oppressions, as the result of the economic problems. Environmental impact of mining can never be zero, there is always a degree of uncertainty about the type and extension of impact that may arise. Risk Management plays a vital role in development because of inherent adverse consequence, that can’t be eliminated entirely without without turnig the mining into technically or economically non-viable operations (ERM, 2000).

Inferior coal mining in the region lying between the valleys Olt and Danube are concentrated in 5 production units: the coal fields Husnicioara, Motru, Jilț, Rovinari, Alunu and Berbeşti affected over 1 million hectares of land (Fodor, 2002). The influences on the landforms are direct, resulting anthropic landforms, very different from the natural ones, and even man-caused landforms inversions. The lignite quarries are located in hill regions and generate as they extend, real man-made depressions that spread over many kilometers. Given the hill landforms of this region, the only way to place the waste dumps was to put them on the existing negative landforms, along the local small valleys, on the local river beds.

Inferior coal exploitation in the region lying between the Olt Valley and Valley Danube is focused in five production units (Fig. 1), coal fields: Husnicioara, Motru, Jilț, Rovinari, Berbeşti, including 13 quarries and affected over 1 million hectares (Fodor, 2002). The influences on the landforms are direct, resulting anthropogenic landforms, very different from the natural ones, and even man-caused landforms inversions. The lignite quarries are located in hill regions and generate as they extend, real man-made depressions that spread over many kilometers. Given the hill landforms of this region, the only way to place the waste dumps was to put them on the existing negative landforms, along the local small valleys, and on the local river beds of major rivers.

**Ph.D Asistant University of Bucureşti, Faculty of Geography*

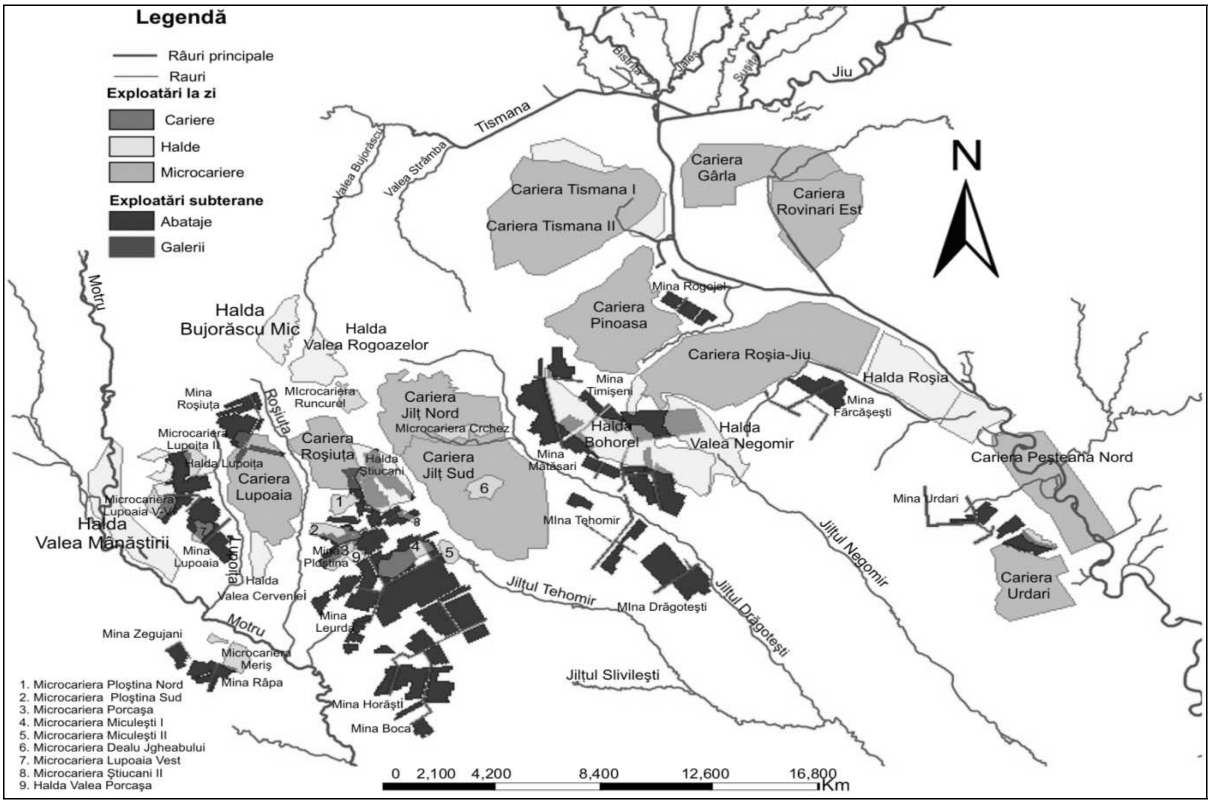

Fig.1; The repartition of mining activities betwen the arivers Motru and Jiu

Following this sudden change in the landscape area which provides support for all other elements of the landscape, there have been deep changes in the ecological level of the functionality of these reliefs on surfaces. Restoring the original ecological landscape in human personality is almost impossible, since the initial environmental conditions have changed irrevocably, thus seeking to ensure post-closure environmental functionality as close to the original.

We believe that a plan for management of degraded land bymining industry is a necessity, to meet requirements for decision making on land management, prevention and community information. Such evaluation and mitigation plans, the impact of mining on the environment from regional and national scale have been made at institutional level in most countries with extractive industry. For example in Slovakia, Environmental Impact Assessment of Mining Activities are still of years "90 part of the Slovak National Monitoring Network (Klukanova, 1999). In France was adopted nationwide Risk Prevention Plans (RPPs) for control risk arising from land movements (Mate 1999, quoted by Merad 2004).

This plan provided four types of information: an informative report of the natural phenomena, a hazard map, an evaluation of the situation, and a risk map. Because the evaluation methods based on a single data source, as the mine position plans, may be incomplete (they are useful only for small surfaces, where the data may be checked on the field), using the *multi criteria decision-aid* is the preferred approach (Merad 2004).

In order to manage properly the regions affected by mining, the U.S. Agency Environmental Protection Agency (EPA) has developed BASINS, (Better Assesment Science Integrating Nonpoint Sources), a specialized software that once installed is able to donwload by itself from various sources, for a selected region all the geographical and geological data, redesign information in a single projection.

The program has tools for modeling the affected region and and to calculate the rehabilitation costs. In Australia was developed by the Environmental Protection Agency, ERM (Environmental Risk Management), which is a set of rules and procedures binding measures to prevent environmental risks; they have to be adopted while the mining activity goes on and after that in order to recover the lands affected by mining. This approach has to be systematic and offers considerable benefits, including environment protection performance improvement.

We believe that management of degraded lands by mining activities should also include evaluation criteria, prevention focused on the following lines (ERM, 2000).

- Procedures and practices to identify hazards
- Consequence of these hazards
- Estimate the level of risk (quantitative or qualitative)
- Assessing the risk on the basis of relevant and objective
- Decisions about risk minimization and identification

Building a database update is the first step in ensuring an efficient management of land affected by mining activities. Develop methodologies and creation of digital database are time consuming and technically the most difficult part is to make and produce information (Walsby, 2007). In any management activity, the decision is based on information, regarding the operability of its access, interoperability (connectivity with different sources and on different subjects), quality information, updating of information. The only way of collecting and storing information that satisfies those demands is to build a Geographic Information System (GIS), which also offers information for spatial representation (Chacon et. Al. 2006).

Under this system can be integrated data of different formats: vector (numeric and alphanumeric, sizes, value, orientation, surface), raster (aerofotograme, satellite images, photos, documents, image synthesis), in different fields: geology, geomorphology, soil, mining, forestry. For efficiency this information can be represented in a single reference system (like Romanian Stereographic System), to enable it more easy integration of topographic data and technical service that is based on the same projection. Building a GIS is based on three areas: direct collection of information from the field by using specific equipment, allowing harvested in vector format (using GPS equipment, GPR, total station, drilling), acquisition of information from different manufacturers or owners (ortofotoplans of the area, satellite images), to collect the geological, topographic and technical date from the extracting units (usually in analog form and converting them into vector format). Information gathering is geared towards field verification and review the information for which there is uncertainty and obtain quantitative information about the presence of certain geomorphological processes (landslides, subsidence, collapse, excess water).

In order to evaluate the hazards in the region, we have to collect qualitative information on the intensity and frequency of such processes. Achieving this information implies field and laboratory investigations on the process dynamics and the lithological properties of the affected materials. The field investigations include GPS mapping at regular periods, using portable equipment and GPS stations. The measurements provided by the total station are difficult to make, but the data on process morphology and dynamics are very accurate.

Through the use of new tehnology to collect data are to increase the digital informations which can be process based of new methodologies and emphasize with a biger degrees of accuracy, the areas with potential hazards (Walsby 2007). For this aim we used geology data, the superficial deposits, including anthropogenic deposits classified in terms of geohazard, and there where its exists, validate data with the areas of ocurence. New methods combine the geological knowledges with topographic date and another informations, and each polygon is classified depending on potential of hazard (Walsby 2007). Informaţion about potential hazards were using in making the decisions about the location of civil and industrial buildings, the recovery of grounds affected by mining.

Making the necessary core drilling for the extraction of geotechnical analysis, interested primarily numerical parameters that can be modeled to identify the conditions for stability of the process and can be extrapolated to a wider area in the deterministic method.

Hazards for which are preconizate experiments on field and laboratory, are specified for affected regions of mining activities, overlapping both the natural and human forms: landslides, subsidences, rockfall, gully. The mining works, always can present a dangers for population and buildings, when pillars and galleries collapse. Such a rupture can cause the surface gradually slight negative movement called subsidence (Merad, 2004). In such a context, hazard and risk assessment tends to be a problem where information is uncertain. Method based on several criteria improves the safety of the finished product. In this approach (Merad, 2004), risk was separated into four classes, class 1 corresponding to the highest degree of risk and the lower class and classify 4 the most down. For the class 1 is enforced a permanent system of monitoring while for the class 4 there are enough topographic investigation. The subsidence resulted from manifestation of pits fall, is transmited on a surface over an area much broader than that occupied by the underground work (Bell, 2000). Subsidence also has a strong impact on groundwater; research on old work (Bell, 2000) showed that about 50% of the water from precipitation infiltrating through the network of surface cracks and then appears in the form of polluted water by a number of small springs.

This calls not only reporting areas with underground mining, but also a detailed mapping of areas affected by subsidence and likely to be affected with a real capacity to induce risk both directly and through other hazards (Bell , 2000).

G.I.S. data base realized will consitute the sourse of data for to realize simulation to determine the susceptibility of the region to certain process and in the last the identification of area with potential hazards.

Deterministic hazard assessment model is based on identifying factors contributing to their launch. Were identifing three causative factors: geology, topography and water, giving a value of each factor is given by the a set of the relative importance of each type of hazard. These data are then combined, assigning each polygon is a degree of susceptibility and classified by certain rules to form a map of susceptibility to hazards.

The probabilistic model of estimate the susceptibility uses the theories weights of evidencens and fuzy analysis (Bonham-Carter 1989, Klingseisen, 2006, Zahiri et of. 2005), identification of potential areas of occurrence by comparing conditions on a given surface with those of known areas. The difficulty of maps plotting is even higher, becouse in the past, during repeated mappings of industrial location were not specified potential hazard areas and their probability was amplified. Based on areas with different degrees of potential hazard, can be identified anthropogenic objectives (industrial and residential), with varying degrees of vulnerability. Where the degree of vulnerability is the highest will be asses the risk by calculating the potential losses which is exposed property.

Study on environmental issues to areas within degraded land due to mining activities are reflected in the extensive research programs practicality. Devising a methodology applied involves, first, a good knowledge of the structure and functioning of regional geomorphological to identify areas with conflicting state between components. In order to achieve a modern and efficient management of the territory is necessary to achieve a correlation characteristic data chosen, case study experiences on technical measures and rehabilitation of degraded areas within the minerals obtained from countries with experience in this field, such as Germany (Ruhr) (Bell et al., 2000), United Kingdom, Poland (Silesia Basin), Hungary (Miskolc region), Czech Republic, USA, Australia (Anderson, 2001) etc..

From highlighting areas of hazard and risk assessment, we can move sequentially to a rehabilitation strategy of land affected by mining. It is necessary to lay down the anthropic landscape function to avoid catastrophic effects during or after mining of minerals (Bell 1998, 1999 and Bennett, Doyle 1997). The lack of a management plan and its implementation solutions to reach a situation where land owners have been taken even before the completion of the dump and ensure stabilization measures. Major crops in the early years encouraged to persist, but the lack of productivity in the coming years and occurrence processes leading to land abandonment and their request or the issue of rehabilitation alternatives. How the alternatives are limited due to lack of space, the only measure of rehabilitation in which mining companies were limited reinsurance was to test stability by redistributing the material on the slope without drainage causes.

Fig.2; The micro-open mine Lupoița II, where frequently occurs landslides and rock fall

Fig.3 Field reclaim by reforestation, a good example for land recover - the dump Roşia Jiu

Measures envisaged for the rehabilitation plan of the land affected by mining concerns: mapping land affected by mining activities, the overall stability through support strips, drains, storm drain channels, identifying sources of pollution persist represented by technological equipment dismantled and abandoned, the stabilization of the geomorphologies process that undermine the stability of human constructions, reconstruction pedological cover by redistributing soil and providing conditions for their restoration, landscape planning, proposing solutions that combine economic needs with the assurance of stability, the alternating bands of trees with grass and cultivated land areas. Action plan should include measures to halt the development of geomorphological processes, ensuring the functioning of economic land degraded landscape and its reintegration (Ruthrof, 2000).

The situation of land affected by mining activities in Oltenia coalfield

For example coal basins from the western part of Oltenia, have large area occupied by small open mine and dumps closed, but unfortunately failed to be reintroduce in agricultural and forestry. In this situation are the quarry: Plostina North, Lupoița II, Miculeşti I, Ştiucani, the dumps, Lupoița, Ştiucani where mining activities have ceased and the land is in an uncertain situation. Current standards require mines to restore the affected land prior to the commencement stage of economic activities. Either this is not possible, since environmental factors are specific locations that change was irreversible. What is possible and recommended, are the restoration of environmental conditions from the new components: lithology, relief, hydrology, soil, vegetation. For a successful recovery better land degraded by industrial activities, it is necessary that revaluation plan to start a business there begins by tracking individual components. And since the work on these surfaces is stopped, it is necessary to find alternative solutions that substantially increase the price of work. The mistaken into consideration of each element of the environment, will result in compromising the final result, namely recovery of fertility. In a brief analysis of the environmental components, contained within the perimeters of the affected notes:

1. The lithology, is favorable, being composed by sedimentary rocks (clay, marl, sand, loess, waste coal), with a high degree of corruption, remove the alteration and genesis favorable soil formation. The presence of clay in excess, however, may create problems of instability, the lack of hydrogeological conditions and ensuring adequate slope.
2. The relief is represented by morphology of new man-made land, and must be interpreted three-dimensional by taking into account height and slopes obtained. For the affected areas from Oltenia, morphology waste dumps and abandoned small quarry constitute a problem, because very large slope angle does not guarantee stability of lithology formations. In some areas that small quarry preserve slope of 90 °, which constitute a permanent source of rock fall and landslides. Also the morphology obtained after the modeling process, has to ensure conditions for storm water runoff and drainage water infiltrate in rock mass. In most cases the dumps built in Oltenia not taken into account to create a superficial network of artificial drainage, and to act in the artificial aquifer to drain excess water from anthropogenic reliefs created. These shortcomings have led to the formation of surface water storage areas and water infiltrations onto the clay rock mass with the

consequent loss of stability. For example you can see the dump Ştiucani, Rogoaze, Monastery Valley, and the small quarry Lupoița II.

3. Hydrology, indicate the presence of surface water and in the body dump, necessary to conduct rock alteration processes, pedogenesis and ensure plant physiological functions. The most important is the water contained in the body of new deposits, which should be released gradually to the needs of plants. Or, for this approach, studies are currently not enough and strategies are missing.

4. Anthropogenic soils formed on the surface of the anthropogenic relief shows a skeletal structure, and lack of basal horizons. Because sedimentary rocks, which disintegrate relatively rapidly through physical and chemical processes at the surface to form a thick crust of alteration of approximately 0.5 meters, and in the top an organic horizon A. It was found that the clays and marls from hilly Oltenia contain high levels of phosphorus and potassium, a mineral base to ensure fertility. This leads to improved conditions for crops vegetation pilot of newly formed soils. Unfortunately soils initially present in these regions and were stored in separate heaps, after an interval of 15-20 years have lost their fertility properties and can't be used to cover the dumps.

5. Vegetation developed on the anthropic landscape is fundamentally different from the spontaneous flora of the region. Due to high productivity on these lands are developed in the first two or three years vigorous vegetation, consisting of less fastidious species. Even crops grown on these surfaces present in the first phase good results. Rapid depletion of soil nutrients and lack of a good structure, creates problems in dry intervals. It is advisable that on these lands to cultivate in the first phase pilot species that contribute to the enrichment of soil in organic matter and support the process of pedogenesis

Fig.4; Pioneer plants on the surface of dump Bohorel. Examples of cochineal (Phytolacca decandra) in May 2009

The above analysis shows that for surfaces where the mining activities have closed, the major problem is the lack of stability and for part of land the legal situation uncertain. Lack of stability may be solved by shaping the morphology of human construction, and reduce slope angles, by designing a superficial stream network and providing conditions for the realization of underground drainage. Uncertainty of land affected by mining is still a touchy subject, from which local communities can't benefit. In many cases the lands were occupied by former owners undocumented before stopping the mining activities and the introduction in rehabilitation programs.

These fields have been cultivated, the beneficiaries being encouraged byhigher yields from the early years.This has hampered the technical measures of rehabilitation, evry action being considered by the ancient and now the new owners as an abuse. Is the situation of dumps Monastery Valley, Rogoaze, Ştiucani, where former owners have established cultures even beforere moving the equipment. Satisfactory results were obtained in the case of forest plantations. For example the upper part of the the dump Bohore, the small quarry: Porcaşa, North Plostina, Roşia Jiu, where the released land were planted with pseudacacia. Pseudacacia species have adapted very well, but the lack of adequate solutions for rain water discharges led to water surface accumulation and the manifestation of the instability phenomena that have undetermined local trees. This is because trees with pivotal root have role of fixed deposit and disposal of water excess from the rock mass. We believe that the reforestation of areas affected by mining, is the most viable solution, although it may be alternated with other forms of recovery.

References

1. Bell F.G., Bullock S.E.T., Halbich T.F.J., Lindsay P. (2001)
Environmental impacts associated with an abandoned mine in the Witbank Coalfield, South Africa, International Journal of Coal Geology 45 2001 pag. 195–216

2. Coelho P., Silva S., Roma-Torres J., Costa C., Henriques A., Teixeira J., Gomes M., Mayan O., (2007)
Health impact of living near an abandoned mine – Case study: Jales mines, Int. J. Hyg. Environ.-Health 210 (2007) 399–402

3. Domínguez-Cuesta María José, Jiménez-Sánchez Montserrat, Berrezueta Edgar (2007)
Landslides in the Central Coalfield (Cantabrian Mountains, NW Spain): Geomorphological features, conditioning factors and methodological implications in susceptibility assessment, Geomorphology, 89, p. 358-369.

4. Ghosem M. K., (2001)
Management of topsoil for geoenvironmental reclamation of coal mining areas, Environmental geology (Environ. geol.), Springer, Berlin, ALLEMAGNE (1993) (Revue), vol. 40, nr. 11-12, pp. 1405-1410

5. Glade T., Anderson G. Malcom, Crozier J. Michael (2005),
Landslide hazard and risk, Publiser Willey.

6. Hack R., Price D., Rengers N., (2002)
A new approach to rock slope stability – a probability classification, Bulletin of Engineering Geology Environment, Springer-Verlag

7. Kitula A.G.N., (2006)
The environmental and socio-economic impacts of miningon local livelihoods in Tanzania: A case study of Geita District, Journal of Cleaner Production 14 (2006), pag. 405-414

8. Klukanova Alena , Rapant Stanislav, (1999)
Impact of mining activities upon the environment of the Slovak Republic: two case studies, Journal of Geochemical Exploration 66 (1999) 299–306

9. Merad M.M., Verdel T., Roy B., Kouniali S., (2004)
Use of multi-criteria decision-aids for risk zoning and management of large area subjected to mining-induced hazards, Tunnelling and Underground Space Technology 19 (2004) 125–138

10. Segumpta Mritunjoy, (2003)
Environmental impacts of mining: monitoring, restoration , and control, Lewis Publisher.

11. Walsby Jennifer Catherine (2007)
Geohazard information to meet the needs of the British public and government policy, Quaternary International 171–172 (2007) 179–185

12. Zahiri H., Palamara D.R., Flentje P., Brassington C. M., Baafi E., (2006)
A GIS-bassed Weight-of-Evidence model for mapping cliff instabilities associated with mine subsidence, Environmental Geology, Springer-Verlag 2006.

13. *** (1995)
Environmental Risk Management, Best Practice Environmental Management in Mining, Edited by Environmental Protection Agency Australia.