Geoecology in mining hazards

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Abstract: - Mining operations deals with issues connected to frequent geoecological hazards. The manuscript is addressed to researchers as well as designers or specialists involved in mining process with a view to introduce the geoecological perspective for mining sector and to present an efficient method for intervention in wet landslides hazards, as a case-study. By reconsidering the concept of impact and redefining of landscape, economic, social skills and inabilities determined by the new environment, both in theory and technical engineering applied to mine closure, the authors consider landscape ecology as a good approach in evaluation of the severity of mining operations impact as a general method. In the same time it is presented a case study for a common natural-technical hazard phenomenon, as a wet landslide.

Key-Words: - Geoecology, Mining, Hazards, Landslide, Landscape, Inabilities, Abilities

1. Introduction

For reaching the mineral resources, necessary in economic development, extractive activities, whether mining or oil, affects natural balances.

Mining is an important human activity for exploitation of earth's mineral resources [1], but generates the inability of diverse elements for both geographic landscapes, by remodeling the terrains, and environment, by interaction with natural equilibrium established between organisms and their surrounding environment.

Due to operations, mining activities generates inabilities for living environment [3], by:

- deforestation,
- stripping of soil
- large amounts of mining deposits;
- wide range of pollutants usage;
- water retention or removal,
- landscape changes,
- inadequate living conditions.

Thus, extractive activities are associated with potential living impacts on human health; most publicized to an increasingly aware public, focusing on invasiveness nature of mining. [7]

Mass-media increased the pressure on the authorities for adopting policies and measures embodied in restructuring processes for extractive activity, on the whole operational lifecycle, without considering geoecological aspects that include both natural and technical elements. [9]

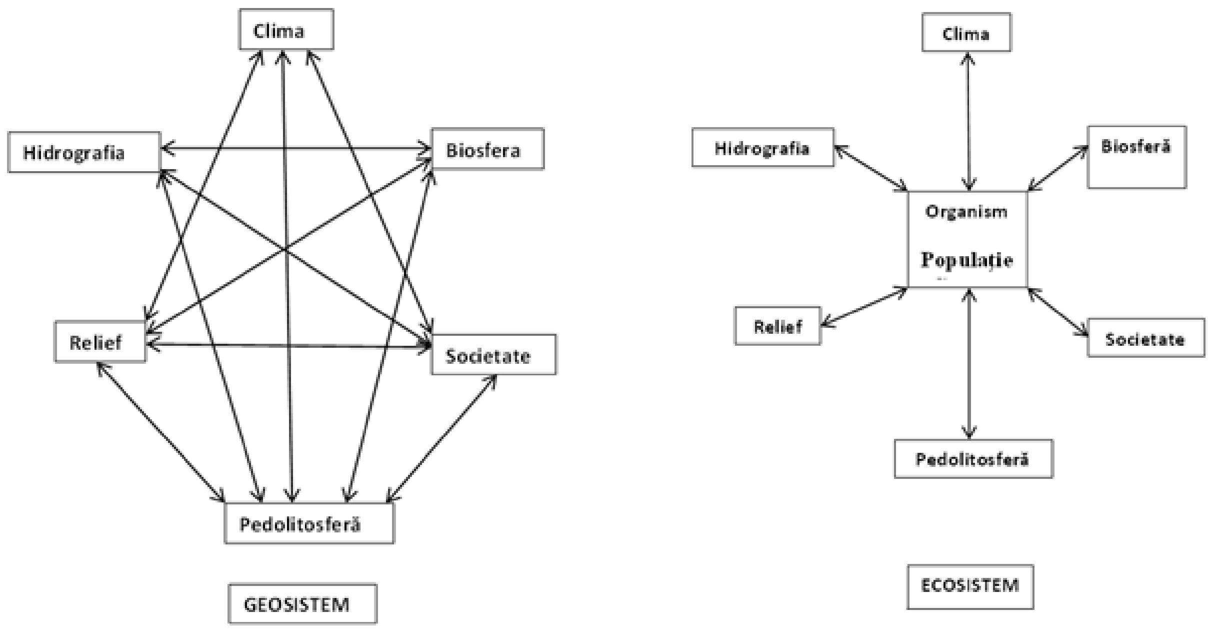
Geoecology is a science about earth (geo-sciences); the concept derived by assembling three Greek words: Ge-earth, Oicos - house and Logos - study. [9]

Mining Geoecology enables analysis of dynamic combinations for natural (biotic, abiotic) and anthropic (technical) factors occurring within a territory where natural resources are extracted. Therefore, it is necessary to integrate information's provided by geography, ecology and mining. [9]

The inevitable approach between ecology and geography reached very large areas of intersection, respectively defining the concepts of mining "Ecosystem" and "Geosystem" (Bertrand, 1978).

The difference between the two concepts is the fact that the Geosystem, as an object of physical geography (Mac, 1990), has a spatial character, while the Ecosystem has a functional character, because the Ecosystem has a small number of structural and relational connections, that can be observed in Figure 1.

Fig.1 Geosystem vs. Ecosystem [9]



In terms of spatial scale, geographical subdivisions are:

- the Geosystem, which corresponds to a territorial complex, well individualized, focused on dynamic overview of it,
- the Geofacies, which insists on physiognomy of the landscape, and
- the Geotop, which is the lowest level of the spatial scale.

The Geosystem consider the geographical complex and its dynamics, occupying areas from tens to hundreds square kilometers. [2]

The Geofacies will reflect the features of local ensemble and corresponds to a homogeneous area, characterized by its own physiognomy, whose spatial extent will be lower (one to tens square kilometers).

The Geotop represent the lowest level of analysis (under one square kilometer).

For the geographical purposes, the environment is an expression, a manifestation of the quality of the Geosystem as a dimension of its load with life resources.

Therefore, analysis of the geographic area (physiognomy) will provide most of the information's required for assessing the effects of invasive activities, while the hygienic-sanitary analysis provides the details necessary to clarify the technical and administrative aspects, the best practices.

Given the spatial extent, most mines can generate the inability of landscapes considered Geotopes or Geofacies.

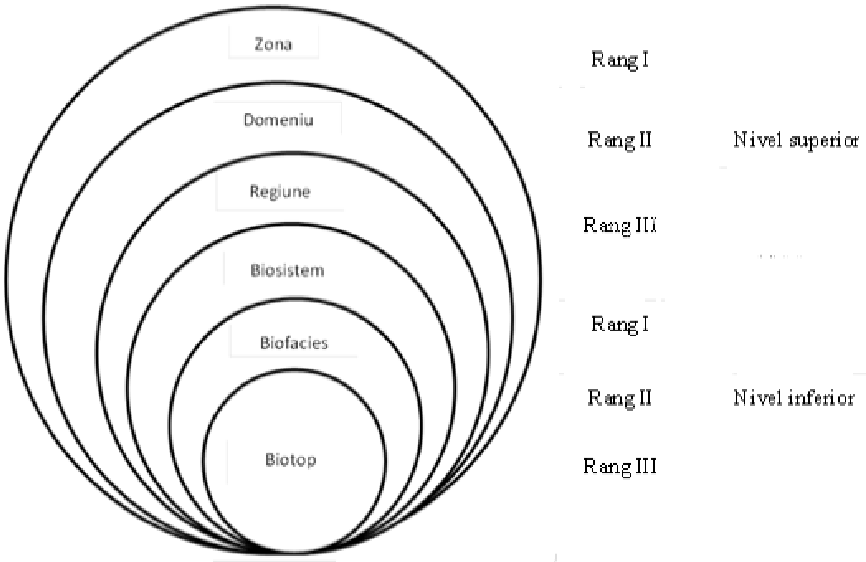
By monitoring Geoecological indicators mining perimeters evaluation simplifies because geoecology is a "geographical approach" where the impact of extractive activities is analyzed in different "spatial scales", defined in physical-geographical units referring to the "structure", "physiognomy (landscape)" and "dynamics" of the main units of the systems.

In mining Geoecology, for instance, if a mountains, forest, soil form a Geosystem, the various homogeneous landscape units within, as watershed, specific forest type (coniferous), plain or meadow, can be considered as Geofacies.

The latter for their part can be split in very small spatial units from few square meters to one square kilometer, such as Acid Rock/Mine Drainages (ARD/AMD), mine works, mining deposits (dumps) and tailing ponds or hazardous effects (as landslides), can form Geotopes.[5]

In this context the **Zone**, **Domain** and **Region** are ranks (I to III) of superior taxonomic level and the **Geosystem**, **Geofacies** and **Geotop** are ranks (I to III) of inferior level, of the same geographical space, as in Figure 2.

Fig.2 Geographical space [9]



The homogeneity of each unit increases in inverse proportion of its analysis decreasing scale. We note that the analysis addressing to environmental problems requires prior knowledge of the geoecological structure and after that bio ecological structure. (C. Troll, 1938)

2. Problem formulation

Mining operations deals with issues connected to a frequent hazard – landslides, caused by natural-technical inabilities of the perimeters.

Generally, waters encountered during mining operations, like springs or swamps, which are not well managed in the sense of being drained and exported outside the perimeter, can create failures for mining deposits, as tailings ponds and dumps, operated in this conditions. In such situation was a coal mine were the materials excavated, overwhelming consisting in clays, formed an interior dump that closed the downstream part of the open pit. Once the water pumping were stopped initial hydrogeological conditions started to recover. [5]

This led to increase the volume of seepage water provided by underground pressured aquifer, because the natural clay shield has been pierced by mining workings.

This technical inability helped the initiation and maintains the landslide phenomenon in the quarry, as can be observed in Figure 3. [6]

Fig.3 Wet Landslide

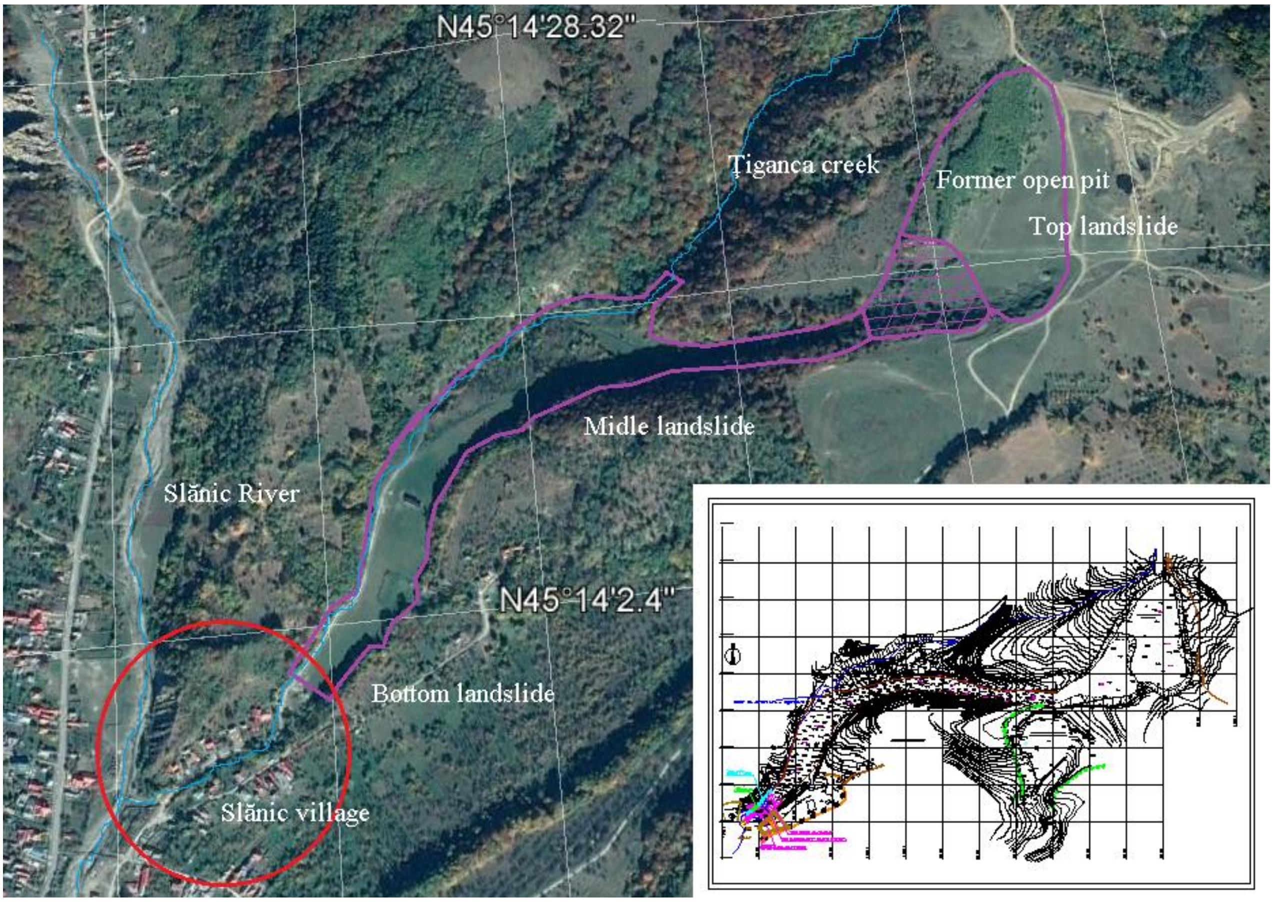
In this context, rain water that circulates through slope's cracks creates synergic natural inabilities by providing permanent accumulation in landfill and continuous supply of the slip phenomenon.

Slipped soil, saturated with water, gradually became a wet landslide flowing downstream the valley with a speed greater than 1.5 m/day, occupying up to 0.3 square kilometers of the landscape (Geotop). (Ilie, 2006)

The volume of material involved in the wet landslide was over 1,000,000 cubic meters, resulting total blockage of the valley, with 1.5 km long (Figure 4). [6]

The wet landslide destroyed all the properties encountered along its flow and creates inabilities on the "structure" and "physiognomy" of landscape and modified the „dynamics" of the geotopes, but its influence in both geofacies and geosystem was reduce. [5][11]

Fig.4 General View



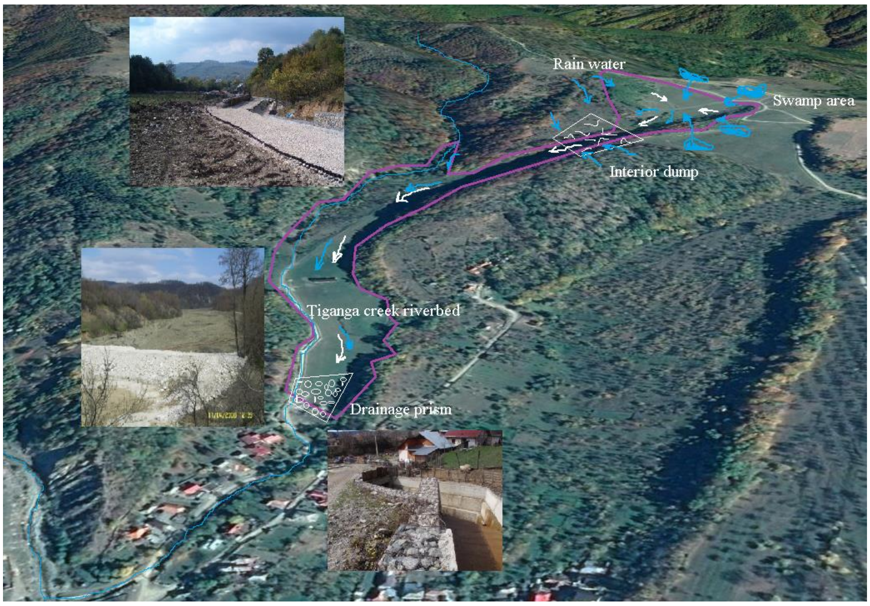
3. Problem solution

The technical solution, in respect with the natural environment preservation and minimum anthropic intervention, was to build a special drainage installation, like a wedge prism, made by crushed stones filled in compacted thin layers (with height growing downstream), placed in-front of landslide.

The wedge prism was designed to not oppose an important resistance, in order to enable continuously gravitational movement of the material filed on it [11]; linear movement (laminar) was converted in a circular motion (rotation with translation), both horizontally and vertically, which caused more water discharge and accelerate recovery of the terrain. [5]

In these conditions, the slipping material turned quickly into a stable compacted natural ground; its solid consistency opposed to the motion and restored the natural balance of the terrain. [10]

Fig.5 Intervention and final view



4. Conclusions

Although the image of the hazardous phenomenon had a major public impact, after a correct geoecological evaluation followed by a precise engineering for intervention's work (figure 5) the landscape recovered and returned to its natural state.

Environmental inabilities were removed within a relatively short time (three years) after which the new environment, developed on the Geotop of the former landslide, turned into grazing area integrated in the landscape, as is seen in figure 6.

Due to the small scale of affected area (under one square kilometer), the natural abilities for rapid recovery, in spite the emotional impact generated to the moment that natural-technical inabilities of the landscape happened, the hemorobic index is *almost natural* (Dierschke, 1984**)** or *β – oligohemerobic* in terms of Grabherr (1997) scale.[9]

Fig.6 The new Landscape

References:

[1] Buia, G., Rădulescu, M., *Geoecologie şi management ecologic,* Ed. Focus, Petroşani, (2002), p.248;

[2] Drăguţ, L., *Geografia peisajului*, Ed. PUC, Cluj-Napoca, (2000),

[3] Fodor, D., Baican, G., *Impactul industriei miniere asupra mediului*, Ed. INFOMIN, Deva (2001);

[4] Iliaş, N., Offenberg, I., Gâf-Deac M., Bălăiu, I., Purcaru-Stamin, I., *Cercetări privind reducerea impactului de mediu generat de apele de mină poluate cu aplicabilitate la depozite de reziduri miniere din domeniul energetic*, FOREN, Costineşti, (2016);

[5] Iliaş, N.. Offenberg, I., *Mining dumps & Wet landslides*, Congresul balcanic minier - Balkanmine 2015, Petroşani, (2015), p 12-23;

[6] Ilie, M - *Lucrări de stabilizare a alunecării de teren, punerea în siguranţă, modelarea şi ecologizarea zonelor afectate la cariera Slănic Nord, jud. Argeş*, GEOCONSULTING, 2006;

[7] Jinescu, V., Avram, I., Iliaş, N., Radu, S.M., Offenberg, I., ş.a., *Pagini din istoria dezvoltării României. Construcţia de echipamente, maşini şi instalaţii pentru proces industriale* (I), Ed. AGIR, (2018);

[8] Mac, I., *Peisajul geografic. Conţinut şi semnificaţie ştiinţifică*, Ed. Terra XXII, (1991), p. 1-4;

[9] Offenberg, I., *Management de mediu și geoecologie în sectorul minier*, Ed. Impressum, Chișinău, (2018);

[10] Offenberg, I., ş.a., *Sistem de intervenţie în curgerile de teren*, ICSTI Conference, Roma, (2012);

[11] Offenberg, I., ş.a., *Romanian experience in post closure monitoring of mining perimeters - Intervention in wet landslides*, ICSTI Conference, Moscova, (2013);

[12] Troll, C., *Landscape ecology (geoecology) and biogeocenology: a terminological study*, GeoForum no. 8, (1971), p. 43-46;