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THE PRESSURE EXERTED ON THE NATURAL ENVIRONMENT IN THE OPEN PIT EXPLOITATION AREAS IN OLTENIA

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Abstract. The Interdisciplinary Centre for Advanced Researches on Territorial Dynamics has completed a series of studies on the impact that the growing number of coal mines in open pit has on the natural environment. The study at hand aims at spatially projecting the lacks in the equilibrium of the natural environment, an indispensable stage in designing the strategies for territorial development. The growth of the coal mining industry brought, besides economic advantages, a major pressure on the components of the natural environment and important lacks of equilibrium which calls for specific strategies in territorial management. The open pit mining represents an act of real aggression on the environment which leads, shortly, to an intensification of the erosion processes and to a high pollution caused by suspended and deposit particles. The delay in implementing the plans for rehabilitating the damaged soil led to the amplification of the corrosion processes and, as a consequence, the growth of the fitting up costs. The studies use information drawn from Mehedinti and Gorj Agencies for Environment Protection, and from field research.

Key words: coal mining, environment, pollution, open pit exploitation, suspended particles.

1. INTRODUCTION

Sustainable development strategies must be elaborated so that they could respect the environment, in order to harmonize the globalization and the location processes, frequently classified as contradictory (Ianos et al. 2009 and Fekete, 2006), their success being assured by the awareness among the population (Szigethy, 2007) and the recovery of the affected areas (Makhelouf, 2009).

One of the most obvious acts of aggression on the environment is the degradation of the landscape as a result of exploiting and processing the raw material for obtaining the final product, the coal. A great part of the material which resulted from the mining activities is laid under the form of sterile waste heaps, occupying vast areas and showing a marked degradation of the local landscape aesthetics. In Bosnia, for example, the most part of the degraded soil which resulted from coal mining is situated in Tuzla Basin, where 8460 hectares of land have been completely ruined (Salih et al., 2007).

Environment pollution determined by the coal exploitation could represent a serious threat to the population state of health from the communities situated nearby to the exploitation areas, (Hendryx, et al, 2008, 2009). The exploitation and the coal burning are the main environmental source of pollution in many world countries (Changcun et al., 2009).

Another major problem that arose because of coal mining is related to the registered changes in the structure of soil use. A research conducted by Feng et al. (2008) emphasizes the great impact that the mining activities performed in the open pit had on the balance of the natural environment. An analysis carried out in the Mentougou area shows that the region of agricultural fields has been reduced with 2534 hm^2 from 1995 to 2001 (from 7229 hm^2 in 1995 to 4695 hm^2 in 2001) (Feng et al. 2008).

Coal mining has also an influence on the underground water resources and especially on the rain water draining regime. Some changes can appear in the chemical structure of the underground waters which can make them become unfit to drink or harmful for

the health of the local people. The infiltration of the rain water, which washes the open pit coal, reaches the ground water layer and modifies its pH index, consequently raising the concentration of the harmful substances for the human body. In the same way, the topographic alterations which resulted from open pit exploitation can produce important modifications of the base level and can cause a deep corrosion of the surface. In a study dedicated to the Damodar coal basin, Tivary & Dhar (1994) rose the awareness on other types of environmental pollution due to coal mining activities, like suspended particles (especially in the case of mining in the open pit), transformation of the land into desert and pollution with the substances resulted from the burning of the coal such as CO_2, CO, H_2S, etc. For example in the area mentioned above, they identified that the values of the SO_2 şi NO_X particles ranged between 287.1 – 1911 μg/m^3 64.4 – 129.6 μg/m^3, 75 - 89 μg/m^3, and the concentration of CO was situated somewhere between 1620 - 1850 μg/m^3 (Tivary & Dhar, 1994).

In many circumstances it has been noticed that the vegetation is also influenced. The suspended dust particles that are a result of the process of coal mining are carried by the air currents and are being placed on the leaves of the plants, thus impairing the completion of photosynthesis and respiration functions. In a study carried out in Russia on the green algae from Vorkuta mining area, in the east-European part of the Russian tundra, the researchers concluded that the number of species of algae decreased from 27, in the areas unaffected by mining activities, to 19 in the areas where mining was performed. Thus, the total number of green algae (including the species Xanthophyta), according to studies by the same authors, varied between 100–120 x 10^3 (cells/g dry soil) in the areas that are unaffected by pollution and 0.5–50 x 10^3 in the polluted areas. The authors conclude by admitting that these algae are a better marker of identifying the level of pollution resulting from mining activities than measuring the degree to which plants and moss blossom in the respective areas (Patova & Dorokhova, 2008).

Table 1. World Health Organization air quality guideline values

Pollutant	**Value**	**Average time**
Carbon monoxide	100 mg/m^3	15 min
	60 mg/m^3	30 min
	30 mg/m^3	1 h
	10 mg/m^3	8 h
Ozone	120 μg/m^3	8 h
Nitrogen dioxide	200 μg/m^3	1h
	40 μg/m^3	annual
Sulphur dioxide	500 μg/m^3	10 min
	125 μg/m^3	24 h
	50 μg/m^3	annual
Benzene	$6x10^{-6}$ (μg/m^3)$^{-1}$	UR/lifetime[1]
Dichloromethane	3 mg/m^3	24 h
Formaldehyde	0.1 mg/m^3	30 min
PAHs[2]	$8.7x10^{-5}$(ng/m^3)$^{-1}$	UR/lifetime[1]
Styrene	0.26 mg/m^3	1wk
Tetrachloroethylene	0.25 mg/m^3	24 h
Toluene	0.26 mg/m^3	1wk
Trichloethylene	$4.3x10^{-7}$(μg/m^3)$^{-1}$	UR/lifetime[1]
Arsenic	$1.5x10^{-3}$(μg/m^3)$^{-1}$	UR/lifetime[1]
Cadmium	5 ng/m^3	annual
Chromium	0.04 (μg/m^3)$^{-1}$	UR/lifetime[1]
Lead	0.5 μg/m^3	annual
Manganese	0.15 μg/m^3	annual
Mercury	1.0 μg/m^3	annual
Nickel	$3.8x10^{-4}$(μg/m^3)$^{-1}$	UR/lifetime[1]

Source: Morris P., Therivel R. (2001), Methods of Environmental Impact Assessment, p. 148.

[1] *UR =high risk of developing cancer following a lifetime exposure*
[2] *Specifically benzo[a]pyrene*

The economic activities, an implicit consequence of the growth of demand on the national energy market, have been and still are the main element of the pressure on the way in which space is being organized. Hence, mining activities are those that have placed the heaviest pressure on space, affecting over 30.000 hectares.

2. MATERIALS AND METODS

The degradation of the environment in the mining areas in the district of Gorj evinces a high degree of specificity due to socio-economical conditions that imposed a speeding rhythm regarding the rehabilitation of the damaged lands. The analyses showed great delays in the process of rehabilitation of the lands that were formerly part of the agricultural and forest circuit.

Studies completed in the district of Gorj focused especially on the mining activities that are performed in open pit and started from field research and records of the Gorj Agency for the Environment Protection, related to the international standards of the lowest value of a polluting agent that can cause health problems. These values have been established by the World Health Organization, and they are presented in table no.1.

The European Union has established its own quality standards in 1980 regarding the admitted concentration of air polluting agents. The limits for the initial values were set by the European Union in 1980 (revised in 1989), initially, for sulfur dioxide and suspended particles, lead (Pb) in 1982, nitrogen dioxide (NO_2) in 1985 and ozone (O_3) in 1992. In September 1996, the European Union decided to review this list and to complete it with a series of new polluting agents. Thus, the new and revised list can be seen in table no 2.

For each pollutant the generative source had been identified:

- Particles (dust, smoke PM_{10} and $PM_{2,5}$) : the main sources that have been identified are: thermo-electric power stations that use solid or liquid fuels, the house heating systems, constructions, mining, cement industry;

- Sulfur dioxide: the main sources are thermo-electric power stations that use solid or liquid fuels, waste cremators, house heating systems etc.;

- Nitrogen oxide and its composites: the main sources are: thermo-electric power stations that use solid or liquid fuels, waste cremators, house heating systems;

- Toxic micro-pollutants (TOMPs), like **PAHs, PCBs, dioxin.** The main cause is coal burning;

- Toxic metals, like **cadmium**, which is generated by coal burning, exhaust fumes;

- Greenhouse gases (CO_2, CH_4), for carbon dioxide the main cause is fuel burning, and for methane the main sources are coal mining industry, gas leaks.

Table 2. E.U. air quality limit values
Further Daughter Directives will be issued to specify limit values for other pollutants

Pollutant	Target date	Measuring Period	Limit value
Lead	2005	annual	0.5 µg/m3
Nitrogen dioxide	2010	hourly	105 ppb (200 µg/m3), no more than 18 exceedance per year
		annual	21 ppb (40 µg/m3)
PM10	Stage 1 2005	daily	50 µg/m3, no more than 18 exceedance per year
		annual	40 µg/m3
	Stage 2 2005	daily	50 µg/m3, no more than 7 exceedance per year
		annual	20 µg/m3
PM2.5	Action level 2005	daily	40 µg/m3, no more than 14 exceedance per year
Sulfur dioxide	2005	hourly	132 ppb (350 µg/m3), no more than 24 exceedance per year
		daily	47 ppb (125 µg/m3), no more than 3 exceedance per year

Source: Morris & Therivel (2001), Methods of Environmental Impact Assessment, p. 149.

Quantifying the lacks of balance in the natural environment was achieved by spatially projecting the evolution of the forest areas during the extension of the open pit mining. Topographic maps and satellite images obtained through the use of ArcGis 9.3 platform were used. This allowed for a precise evaluation of the impact of mining activities on the natural environment components.

A great deal of attention was paid to the erosion processes that are highly developed in the areas where mining activities, especially those in the open pit, are performed. There, the alterations of the hydro-geological components were found to be really significant.

3. RESULTS

Coal mining determined, in the first place, a change in the typological profile of land use and an intensification of the slope processes, as a result of insufficient or delayed works of improvement.

Modifying this typological profile and lacks of balance in the natural environment caused by coal mining has been analyzed for Motru, Jilt, Rovinari and Husnicioara basins.

Motru basin is mostly situated on the left bank of the river Motru and occupies the hillside area that develops from the valley of this river to the peaks which separate Motrului basin from Jiltului basin. The extension of mining activities into the underground, and especially in the open pit, led to major alterations in the environment. The complex improvements meant to rehabilitate the area have proven to be insufficient.

A major effect of the extension of mining activities is the reduction of the forest areas and the alteration of the hydro-geological regime which led to the amplification of the slop processes. The heaviest pressure on the environment is to be felt in the area where the open pit mining is performed, where coal mining presupposes the open pit exploitation on vast areas. Thus, the opening in 1972 of Lupoaia exploitation meant heavy cutting of trees after 1980 (Fig. 1), a process that is going on even today, in the east of Lupoita village, where mining activities have penetrated a wooded area.

An area highly affected by coal mining is Rosiuta, a space where mining activities started in 1969, with the opening of Rosiuta I mine and with the purpose of mining one thousand tones of earth coal from the X layer. Surface works have been accomplished almost in their entirety using the equipment from the existing precinct by resizing them, the area being of use for the Rosiuta II open pit and mine.

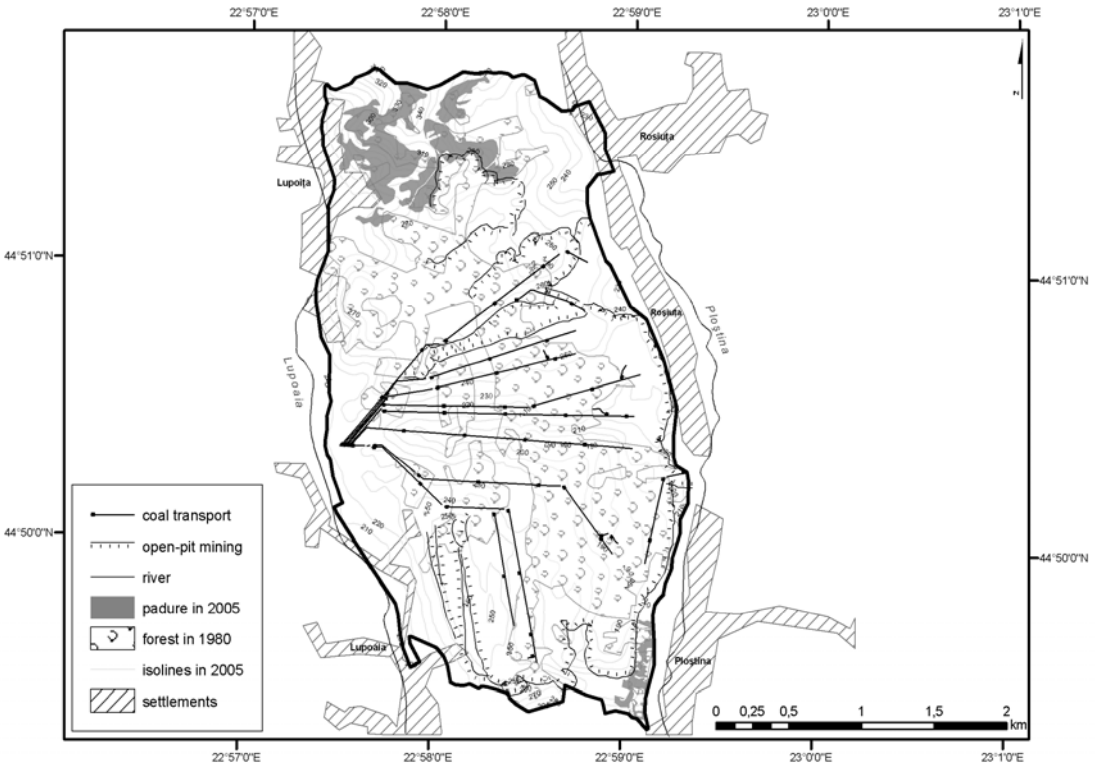

Figure 1. Reduction of wood areas around Lupoaia open pit

The sterile is gathered around Bujorascu Hill (Rogoazelor basin, Bujorascu Mic basin) and Stiucani basin where it has been brought using lines of conveyor belts.

Their impact on the environment can be translated into reducing vast areas covered by forests (Fig. 2) as a result of the intensification of open pit mining, moving of households from Valea Stiucani (17 households), and deviating the district road between Tg. Jiu and Motru in the windings around Valea Bujorascu. The extension of mining activities and storage area is a result of a series of proposals of decision-making persons. Thus, through the environment agreement GJ – 7/17.02.2005 the clearing of over 1 hectare of wood has been approved for the expansion of waste heap Valea Rogoazelor. In the same year the environment agreements GJ – 10 and GJ – 11/17.02.2005 have permitted the cutting down of 2 hectares of wood for the enlargement of Valea Bujorascu waste heap, and environment agreements GJ – 17, 18, 19/5.04.2005 approved the cutting down of over 3 hectares for the extension of the working area.

Jilt basin comprises, besides Matasari, Dragotesti, Tehomir ans Cojmanesti mines, two exploitations, Jilt Sud and Jilt Nord, that put a great amount of pressure on the natural environment, the complex works for the improvement of the affected land being insufficient.

For the earth coal mining activities that are now being performed in the area, 354 households, 2 churches and 2 graveyards from the village of Croici have been moved. The extension of the open pit so as to comprise Tehomir mine will lead to new demolishing activities in the village of Cojmanesti.

For the exterior waste heap in Valea Bohorelu, a heap which will be continued by the one of Jilt Nord exploitation (Fig. 3), the entire Bohorel village, the church and the graveyard will be evacuated, and over 10 hectares of wood will be cut (according to environment agreements GJ – 41,42/12.10.2005). For this dump heap they have agreed to re-build a forest area of over 35 hectares (according to the environment agreement GJ – 46/7. 11. 2005).

Extending Jilt Nord exploitation meant cutting down vast areas covered in woods (Fig. 4) and the start of intense slope processes. In 2005 alone approvals were won (through the environment agreement GJ – 16/21.03.2005) for the clearing of over 6 hectares of forest in order to extend this exploitation.

In Rovinari basin the most obvious lacks of balance in the natural environment have been identified in the areas of Garla, Tismana I and II, Rovinari Est, Rosia de Jiu, Pestena Nord and Sud, Urdari and Pinosa exploitations. These regions have undergone hydro-technical works for the protection of the exploitations, especially those in the meadow area, and of the exterior sterile dumps, which caused a deep alteration of the initial natural environment.

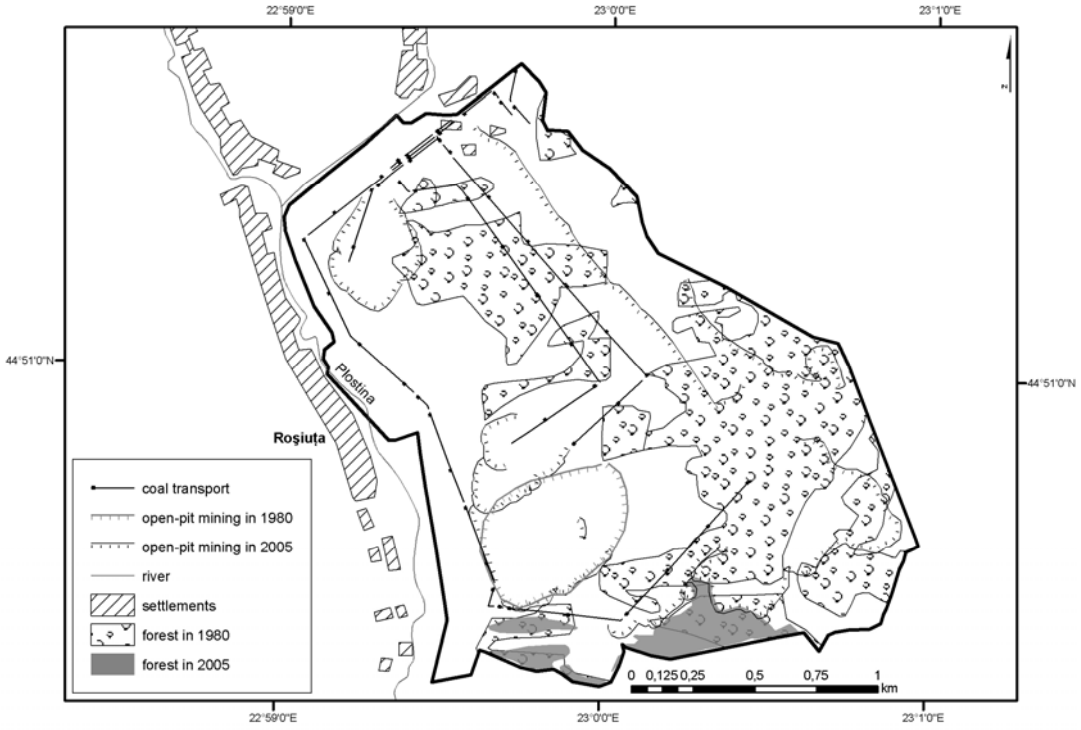

Figure 2. Reduction of wood areas around Roşiuţa open pit

Garla is one of the old objectives of Rovinari basin. The technological flux is visible only in the region surrounding the exploitation, the damping of the sterile being performed inside. The surface works that have been accomplished, access roads, lines of conveyor belts, will keep on serving the exploitation, while other facilities will not be needed in the near future. The exterior dump waste, situated in the eastern part, was leveled, being cultivated at present almost in its entirety. There are important problems raised by the suppression and reconstruction of the households in Poiana village, in Rovinari colony (Poiana).

For Tismana I, a series of surface improvements have been performed, part of which met the needs of the exploitations when the production intensified, while others had to be amplified.

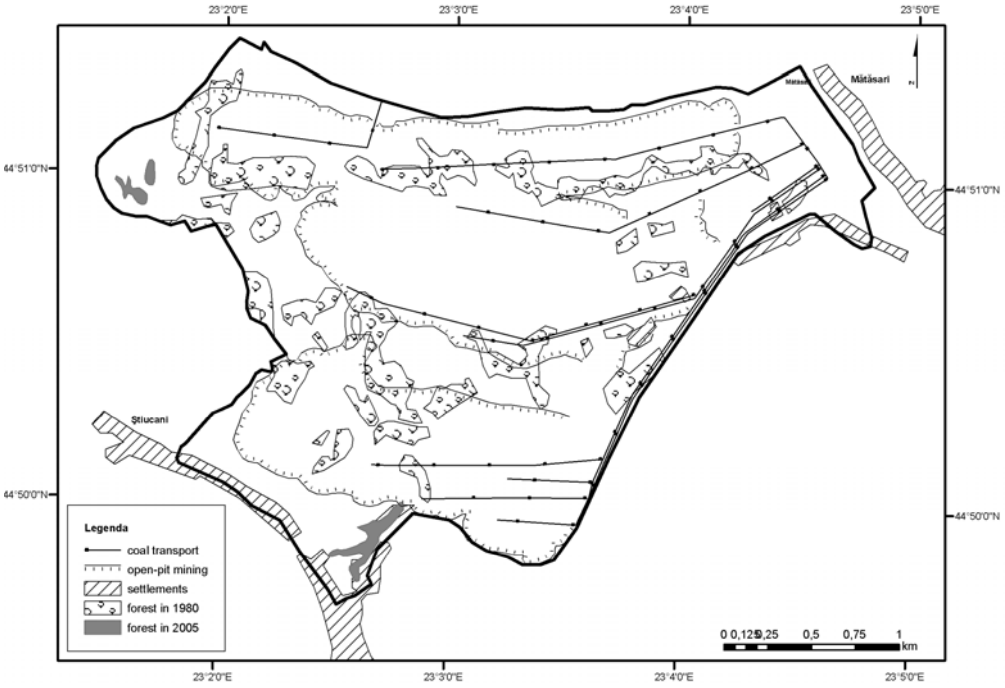

Figure 3. Reduction of wood areas around Jilt-Sud open pit

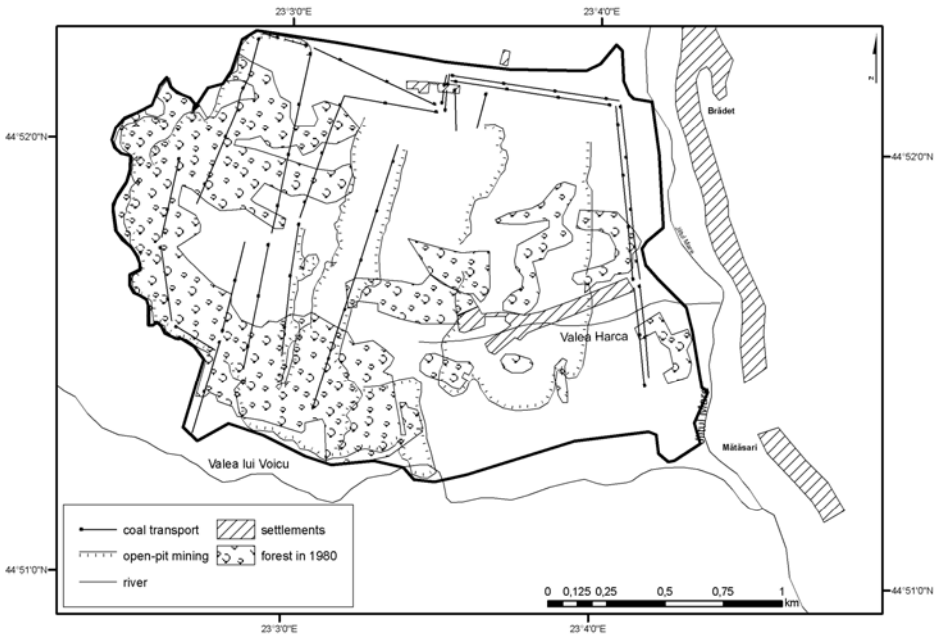

Figure 4. The reduction of forest areas around Jilt Nord open pit.

For the same reason, roads have been built – roads to be circulated by the technological equipments, roads needed for the maintenance of the conveyor belts, access roads to the assembly platforms – and on the northern side of the open poit a new platform for the equipment assembly has been raised (situated inside the open pit region).

Tismana exploitation has witnessed a significant extension, in 2005 alone there being approved the cutting down of trees from over 35 hectares of forest, for the extension of the exploitation area (by the environment agreements GJ – 35, 36, 37, 38/29.08.2005).

In Rovinari Est, there are being performed works necessary for the use of the pit – a secondary precinct, a platform for equipment assembly, roads for the maintenance of conveyor belts and hydro-technical protection works for the open pit. The dumping of sterile is done inside the pit so that the new areas of land will be affected only through the moving forward of the mining field.

Approvals were won for Rovinari, after 2005, for the extension of the open pit mining with over 42 ha (GJ–22, 23, 24, 25/22.04.2005), and, under these circumstances, the schedules for the rehabilitation of the damaged lands have not been settled.

Through the environment agreement GJ – 20/5.04.2005, an approval to extend the exploitation with over 40 hectares has been gained, without establishing the clear terms of the land rehabilitation program.

Field research and data from Gorj and Mehedinti Agency for Environment Protection showed frequent exceeding of maximum admitted limits for suspended and deposit particles. The high values are the result of the multiplying effect of emissions from other sources like burning fossil fuels in the electrical plants in the area.

The analysis of the main indicators of the quality of the environment has been based on the data gathered with the help of the environment monitoring system in the districts of Mehedinti and Gorj and on the basis of field research.

Using the measures performed by Gorj Agency for Environment Protection, it has been noticed that, in many places in the district, over 75% of the daily average concentrations exceed the limit value (50 μg/mc), and over 60% exceed the limit value to which it is added the tolerance margin (66.67 μg/mc).

Field research has highlighted the massive pollution in Motru-Rosiuta, Rogojelu, Timiseni areas, pollution which can be noticed even without specific equipment. In these regions the frequency to which the admitted maximum concentrations are exceeded is over 50%. The highest exceeding of the admitted maximum concentrations was registered in Rosiuta, where works for arranging a large-size sterile dump are being performed. Transporting the sterile towards the dump, alongside with coal minning in the working field, add to these elevated values.

Husniciara Vest – Valea Copcii area can be placed into the high risk zones category, the indicator of suspended particles showing elevated values because of the coal dust from the earth coal loading point and the inadequate infrastructure of the transportation system. The high values are determined also by the transportation of the coal in uncovered trucks, especially on short routes.

Monitoring the evolution of slope processes in the areas where mining activities are being performed, for a period of two years, highlighted the main impact that they have on the dynamics of these processes and their nature as restrictive elements for development.

All the mining fields show a high degree of fragmentation of their relief, by their secondary valleys (temporary draining valleys, dales, ravines), a permanent tendency to become deeper, to branch (a stressing of the fragmentation density) and a regressive moving forward of sources in spite of peaks among basins of different ranks. The rock layer is highly favorable to the development of natural denudation processes, intensified by the human interventions on the protective vegetal layer and on the soil and relief.

Research concluded for the coal open pits area showed the degree reached by the slope processes. Thus, in Husnincioara, at the same time with the development of coal open pit exploitations and cutting down of trees from vast areas, the slope processes have intensified, endangering the access road towards the mining points and the administrative buildings of Oltenia National Company for Earth Coal.

A less favorable situation is present in the central-west part, where erosion processes have affected over 40% of the agricultural fields (Negomir, Slivilesti, Dragotesti, Damarinesti), exceeding 60% in the case of agricultural fields near Matasari and Motru localities.

4. CONCLUSIONS

The extension of mining activities performed in the open pit led to major lacks of balance in the natural environment, over 30 000 ha of land that show a chaotic, deranged relief, made out of rock mixes, wanting in vegetation, heavy affected by the erosion process and looking like a “moon landsaft”, or, as the Russian specialists have defined it, “an industrial

waste land"

In order for the tillable characteristics of the soil, that is about to be degraded by the mining activities, not be lost and to create the premises for obtaining a richer, more stable and of a better quality production and for reducing the period of time before the dumps are reintroduced in the agricultural circuit, it is necessary that the surface layer of the soil be excavated selectively. The procedure is applicable only to the bio-active layer that contains at least 0, 5% humus.

In the diagnosis performed on the status of the geo-systems in the region one might individualize certain areas and critical points which may contribute to the adopting of future development strategies, adequate for this territory.

A large area situated in the central-north part, highly affected by coal mining on the surface and underground, an area which is formed of the regions whose condition demand a clear intervention aimed at reestablishing the damaged balance. Of these areas, the one near Motru stands out. It has two critical sub-regions: Rosiuta and Lupoaia, the only regions where coal is extracted on the surface, which have determined not only changes in the functionality of the initial natural landscapes, but also their replacement with highly anthropic landscapes (that is naturally degraded). The higher part of Jilt basin is another critical area in which at least two sub-regions draw attention: Jilt-Sud and Bohorel-Negomir dump, whose height must not exceed 380 m in order to harmonize with the hills in Jilt basin.

5. AKNOWLEDGEMENTS

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