LIGNITE EXPLOATATION IN IN LUPOAIA OPEN PIT AND ITS IMPACT ON ENVIROMENTAL WATERS

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ABSTRACT

The impact of extracting lignite in Lupoaia open pit over waters is local and regional, and temporary. The hydrographic network in Lupoaia open pit depends on the River Motru, with its afluents, the Ploștina and Lupoița Valley Rivers. The aquifers are to be found in the coal layers V-XII, mainly of sands formation.

The impact over water in Lupoaia consists of water pollution and of changes in both the quality and the quantity of gound and surface waters. The surface waters are polluted resulting in industrial wastewaters, household wastewaters and waste rainwater. The wastewater is polluted within maximum admitted limits. The quality of groundwaters is influenced and modified by extracting coal resulting in the extinction of some aquifers.

Environmental risks that can occur when extracting lignite are water floods, landslides, disasters which can be prevented by building guard channels around the open pit.

The actions for reducing the impact are, in general, accomplished through monitoring both the water pollutants and the morphological changes caused by extracting lignite. That is why wastewater treatment plants must function.

The impact of the activity in Lupoaia open pit over the hydrographic net of the area is to be observed during the entire extracting period,and monitoring this activity is highly demnaded by the European ennvironmental protection laws.

KEY WORDS: hydrographic net, impact over water, ground waters, wastewater, monitoring, pollutants, diminishing the impact.

1. INTRODUCTION

Water is absolutely vital to any form al life and to any social and economical activities, so its management is higly important for rational use and exploitation .[1]

Mining implies a large amount of water and this causes pollution to natural receivers or consumers. Water management means considerable problems for both water supplying and using in technological process, for water purification and for its dumping in natural rivers or creeks.[2]

The carboniferous basin Motru has numerous surface water and

groundwater sources , with the most important one: The Motru River.

The impact of exploting lignite in Lupoaia Mine can be seen in the changes of the hydrographic regime, in the chemical water impurity, and it affects both groundwaters and surface waters in the area.

The groundwaters and surface waters are polluted during the entire period of mining, leading to a long term breaking into the hydrodynamic balance.

The potential environmental impact is maintained over the entire periof of lignite exploiting and it determs a permanent vulnerability of waters.

2.THE HYDROGEOLOGICAL DESCRIPTION OF THE AREA

The hydrogeological conditions of the area of Lupoaia area are corelated with the formation of geological structures, consisting of a complex succession of clay and sand, intermingled by coal layers.[3]

The hydrographic net in the area of Lupoaia open pit is represented in figure 1.

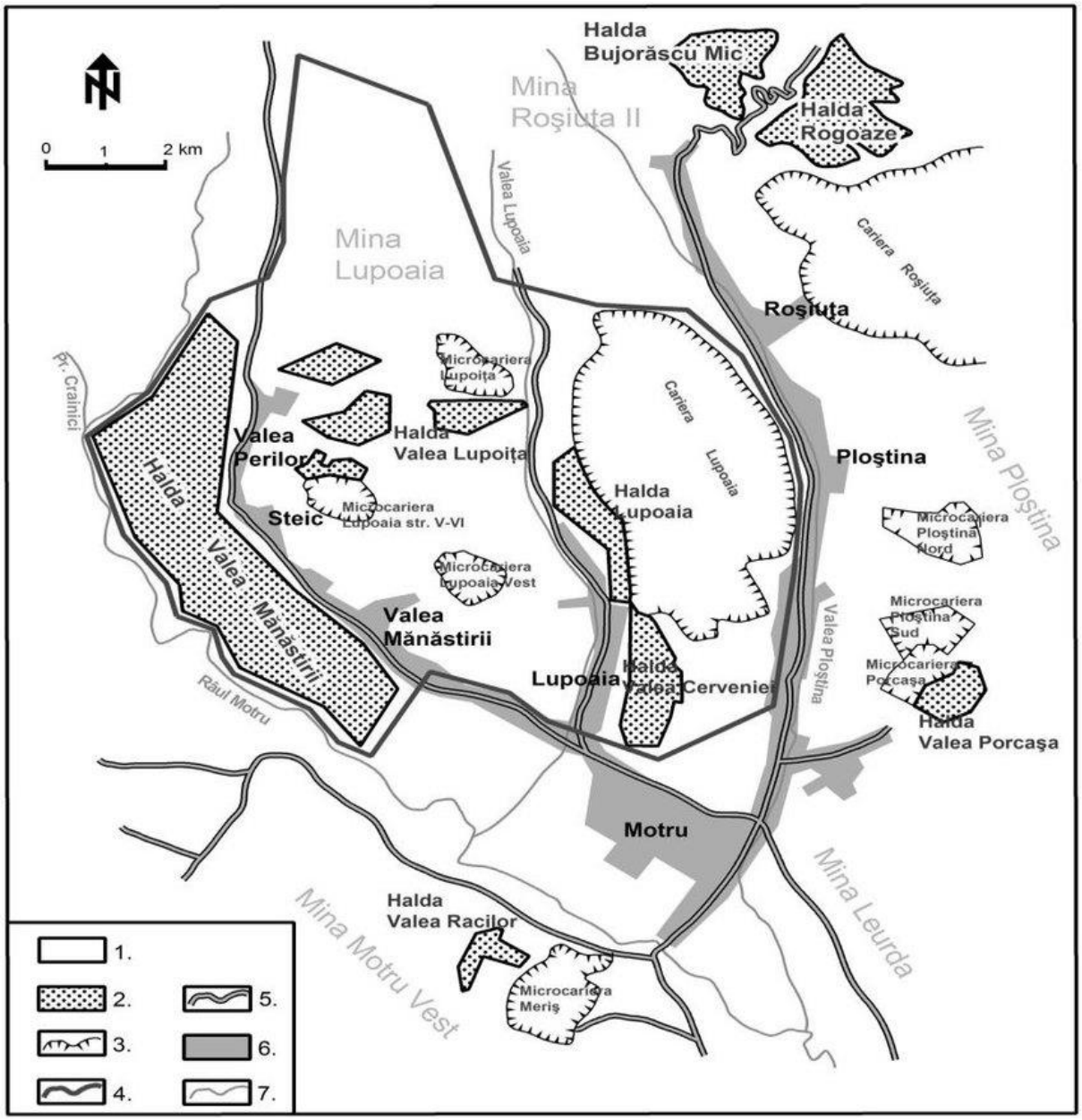

Figure 1. The Motru Mining Basin ,The Lupoaia Mining Camp ;
1. mining area; 2. sterile hatch; 4. mining abatements; 5. area limit; 6. roads;
7.hydrographic net

There are two types of aquifers in the area of Lupoaia open pit:

- surface water aquifers
- deep aquifers

Surface water aquifers are to be found in qauternary deposits, in slope deposits and in ejection cones.

Deep aquifers are located in pliocene deposits, and they can be found under pressure or by free level. Their supply source is representated by atmospheric rains that infiltrate deep in the sandy erosion area.

Aquifer horizons in the V-X levels interval naturally drains, as all the lignite layers emerge to the surface of all the slopes because of erosion.

The aquifer from the top of the V layer, is bench-shaped (1-5), separated by sandy clay, with 0.55 to 18,51 metres thickness. The sandy horizons consist of fine sands, dusty clay sands, that can be found on the top of the V layer, at a distance of 1.2 to 9,5 metres. The hydrostatic level is to be found between 198 metres and 224,5 metres, which leads to a low hydrostatic level, below the top of the V coal layer, and so it can be safely exploited.

The aquifer in the layers V-VI is a sandy horizon, varying from 0,3 metres to 8,5 metres, and it consists of dusty sands and sandy dust. The hydrostatic level can be found at 225 metre depth. The V layer is to found above the hydrostatic level.

The aquifer in the VI-VII layers consists of 1 to 4 benches of sandy horizon, lens-shaped. The thickness of the horizon is between 0,5 metres and 8 metres . The hysdrostatic level is under the VI-VII coal level, so it lead to the exploitation of this aquifer.

The aquifer covering the layer VII consists of sand with 0,5 to 20 metres thickness These horizons have constant draining.

The aquifer that is to be found between the VII-VIII lignite layers contains fine sands.

The aquifer horizons situated between the VIII-IX, IX-X, X-XII lignite layers consist of up to 10 metres thickness sands.

The aquifer horizons covering the XII layer consisted of lens-shaped sands, varying between 5 and 10 metres thickness.

The groundwater supllying systems in Lupoaia open pit area are:

- the village of Miculești, with to drilling systems, at 250 metres depth;
- the city of Motru, with the villages of Ploștina, Roșiuța, Horăști, Însurăței and Leurda;
- the commune of Cătunele, with its villages of Cătunele, Valea perilor, Steic, Valea Mânăstirii and Lupoaia.

The delimitation of the area for sanitary protection, according to a strict regim, for all the water sources were completed according H.G. nomber 930/2005.

The water net in the area of Lupoaia is subordinated to the Motru River via Ploștina Creek (hydrographic basin code VII.1.36.6) and tot the Valea Lupoița River (hydrographic basin code VII.1.36.5). The Motru River springs from the Vulcan Mountains, flows for 134 square kilometres and its basin area is of 1900 square kilometres.

In the area of Lupoaia Quarry , there are two waters, the Lupoița Creek and the Ploștina River, with the following afluents: The Black Valley, The Țigănele Valley, The Mărgelu Valley, The Cerveni Valley and Draga's Valley.

The regularization works operated over the Motru River, for exploiting coal, are:

- the completion of a section of 7980 metres, between the Ohaba River, downstream, and the guard channel, upstream;
- the completion of a 5740-metre dammed section, between the guard channel, upstream, and the Ploștina River, downstream;

- the aim of completing these sections is the protection from sterile tailings Motru City and Lupoaia.
- the technical solution consists of daviating the section via a double-trapezoid section, the width of the minor river bed = 50 mettes and the width of main river bed= 150 metres.

The functioning regim is continuous Q_{maxim} =1500 $m^{3/}$sec.

For the Ploștina Creek and for Lupoaia, the regularization has been completed on the length of 2100 metres and Q_{maxim} =150m^3 /sec and 113 m^3 /sec. The impact of exploiting per day results in reducing the groundwater supplies and the changing of the hydrodynamic regime. By reducing the groundwater supplies, flora and fauna are considerably affected, together with ground waters.

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3. ESTIMATING THE IMPACT

Waters protection remains a priority among worldwide issues due to the efforts people make to ensure the compatibility between the economical development, the rational usage of natural resources, keeping the ecological balance and improving the quality of this environmental factor. [4]

The impact of extracting coal in Lupoaia open pit consists of changes in both quantity and quality of ground and surface waters.

The impact on surface waters leads to:

- water diversion, remodelling, building canals and dams;
- creeks and rivers changes;
- extinctions of some creeks;
- hanges in the quality of some surface waters and of some creeks;
- surface water pollution caused by leaking fuil or other chemical substances used in mining.

The impact on groundwaters revolves in:

- changes in underground river courses;
- pollution of groundwaters by fuel leaks or residual water release;
- lowering the groundwaters level;
- changes in the quality of surface waters.

In Lupoaia open pit, the impact on waters is determed by:

- excavations and dumping leading to changes in the quantity of water in Lupoița Valley;
- changes in surface waters courses in Lupoița Valley and Ploștina;
- residual water evacuation that produces changes in surface waters quality;
- rainwater and drying water evacuation that changes the quality of surface water in Ploștina and Lupoița Valley;
- changes in underground courses regime;
- low working quotas determ the extinction of old aquifers and the appearing of new ones;
- lowering water leve land even discharging some creeks caused by lowering the piezometric level;
- excavating and transporting that modify both physical and chemical balance of groundwaters;
- erosion.

Also, the impact on water determs changes in the relief of the area, changes in groundwater levels and in increasing the qauantity of surface waters resulted from drainage activities.

We present you with the impact of the main operations developed in Lupoaia open pit over the environment ast it follows.

Firstly, the mining cam pis prepared by cutting down the trees and households decomissioning and fertile soil recovering, free of pollutants that are not to be overflown in waters.

The substances that are to pollute waters are fuels, lubricants and wastes used in machine operation. Another

source of pollution is the fecal matter from the authorized personel that wotk in the open pit.

In the actual mining stage, all the activities involved in extracting generate wastewaters, such as:

- fecal matter wastewater
- drying waters resulted from raining and infiltration in the open pit area.

Wastewater from the pit headquarter is drained into Lupoaia Creek after being purged in their own purging station.

The stage of closing and greening is accomplished by land modelling, using earthmoving equipment, and organic cultivation. These activities do not result in water pollution . The sole substances that are most likely to pollute are the fuels used to operate the machines, in an inappropriate usage.

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4. WATER POLLUTION SOURCES

The surface and groundwaters from the area we analysed are polluted by mining, but, according to A. N. M. P. Gorj , the maximum admitted concentrations are within the limits.

4.1. Surface waters pollution sources

Surface waters are polluted by raining wastewater washing the coal deposit, by housedhold wastewater and by industrial water used to moisten the material in the technological process.

4.2. Industrial wastewaters

The industrail wastewater is the wastewater from the open pit and from dumping that do not imply to be purged before being evacuated in rivers and creeks. The wastewater is polluted because of the suspsensions used in transporting the sterile when moistening the material inn the technological process.

The required water quantity for moistening is 20000 l/24 h, within the technological wastewater volume can be calculated by using the ecuation 1, according to STAS 1846/90 :

$$Q_u = 0,8 \times Q_s \ , \qquad (1)$$

in which

Q_s = the average technological water flow required per a day (m^3/day)

Q_u = the average volume of wastewaterper a day (m^3/day)

Q_u average per day = 0,8 x 20 m^3/day

Q_u average per day = 16 m^3/day

The daily moistening water quantity must be reduced by mounting filters responsable for absorbing dust from suspsension during the technological flow. The industrail waters are to be infiltrated into the sterile deposit and the infiltrations are decantered through the drainage systems mounted on the bottom of the deposit in the preliminary stage. [1]

The water supllying for moistening the material is accomplished by using water tanks.

4.1.2.Household wastewater

Household wastewater are resulted from mining in Lupoaia open pit. The fecal matter from the workers also pollutes water. In order to reduce surface water pollution, there were built collecting basin and channels, from where water is evacuated through the guard channels.

Purging household wastewater is accomplished in the station within the Lupoaia open pit by using an Imhoff aerator, followed by evacuating the water in Lupoița Creek.

The household wastewater is resulted during the mining process and its

quantity cannot be reduced; it only can be improved the profiency of the purging systems for a higher quality of the water evacuated, which is within the admitted limits.

The quality indicators of household wastewater are presented in table 1.

Table 1. The quality indicators of household wastewater

The quality indicators	U.M.	Measurements						Maximum admitted values NTPA 002/2005	The analysis method
		Household wastewater within the open pit			Drilling water				
		2019	2020	2021	2019	2020	2021		
1.Physical indicators									
Temperature	ºC	17	18	16	16	13	15	35	
2. Chemical indicators									
Ph	unităţi pH	6,3	6,1	6,1	7,08	6,8	6,5	6,5-8,5	SR ISO 10523-97
Suspensionj materials(MS)[2)]	mg/dm^3	58	62,5	84,23	13	11	7	35,0(60,0)	STAS 6953-81
Biochemical Oxygen consumption every 5 days (CBO5)[2)]	mg O_{2/dm^3}	11,10	11,80	15,56	-	-	-	25,0	SR EN 1899-2/2002
Chemical Oxygen consumption (CCO_{Cr}^-)2	mg O_{2/dm^3}	21,02	22,89	29,78	1,78	1.90	1,90	125,0	SR ISI 6060-96
Azot amoniacal (NH_4^+)[6)]	mg/dm^3	0,15	0,13	0,18	0,1	0,1	0,1	2,0 (3,0)	SR ISO 5664:2001 SR ISO 7150-1/2001
Nitrites(NO_2^-)[6)]	mg/dm^3	1,9	1,2	1,70	-	-	-	1(2,0)	SR EN 26777:2002
Sulphates (SO_4^{2-})	mg/dm^3	113	112	148	-	-	-	600,0	STAS 8601-70
Phenols entrained by water vapor (C_6H_5OH)	mg/dm^3	-	-	-	0,0001	0,0001	0,0001	0,3	SR ISO 6439:2001 SR ISO 8165/1/00
Synthetic detergents	mg/dm^3	0,1	0,9	0,15	-	-	-	0,5	SR EN 903:2003 SR ISO

									7875/2-1996
Chloride (Cl^-)	mg/dm^3	-	-	-	10,21	8,60	9,4	500,0	STAS 8663-70
Filtered residue at 105º	mg/dm^3	170	160	170	180	175	170	2.000.0	STAS 9187-84
Calcium (Ca^{2+})	mg/dm^3	-	-	-	68	81	84	300,0	STAS 3662-90 SR ISO 7980-97
Total ionic Iron (Fe^{2+}, Fe^{3+})	mg/dm^3	-	-	-	0,47	0,29	0,35	5,0	SR ISO 6332-96
Magnesium (Mg^{2+})	mg/dm^3	-	-	-	47	40	44	100,6	STAS 6674-77 SR ISO 7980-97

4.1.3. Rain wastewater

Rain wastewater is the rain water washing up the coal deposit and the open pit platfrom and contain pollutants as powders and petroleum products. The petroleum products can affect the surface water quality because of inappropriate storage and because of leakage. Water can also be polluted during machines fuel supplies.

4.2. Groundwater pollution

Because of the extraction process in Lupoaia open pit, groundwater sources have been polluted, determing modifications. (figure 2)

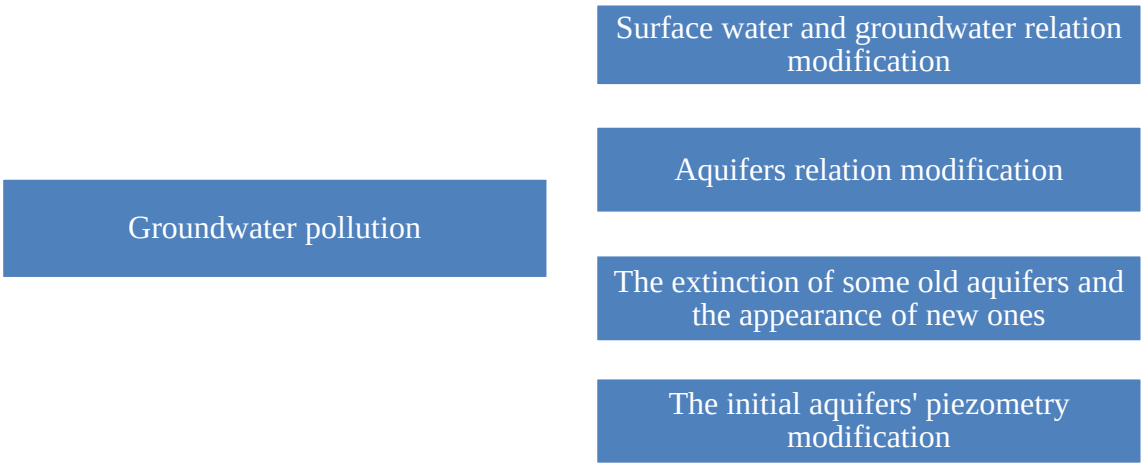

Figure 2. The pollution effects on groundwater

Future extinction of the work front will increase drainage influence on groundwater level in Lupoaia area. Since 1985, ICSITPML Craiova has conducted research and studies estimating the drainage influence, based on mathematic patterns, over the area. Analysing the evaolution of the drainage systems and comparing with the intial parametres of aquifers, observed in the drilling process, specialists succeded in simulating a drainage process in open pits in different locations or positions depending on the flow directions of groundwater sources. [1]

There are changes in groundwater caused by aquifers pollution and by their chemical composition modification. The aquifers are also affected by the excavating process and by charging the surface water with particles or impurities.

The work that is being done at the surface of the open pit, the petroleum material contamination , fertilizers and other pollutants cause reduction in the aquifers quality.

Besides chemical composition, there are also:

- pH decreasing;
- lowering the general piezometric level'
- the quality indicators deterioration;
- disruption in the aquifers continuity.

Total hydraulic restoration of aquifers would be possible only if the open pit were closed, and partial restoration could happen in case of heavy long-term rains.

Currently, a freatic aquifers restoration in Lupoaia open pit area has not been possible because of the short distance between the two pits, Lupoaia and Roșiuța.

Hydraulic aquifers restoration in the coal complex is very lew because of the quaternary formations, that do not allow water to infiltrate, and because of the sedimentary accidents.

The artesian aquifer is hydraulically restoring very quickly because its development is based on continuous fueling, and recent research have proven that drainage must be accomplished before the heart of the coal pit gets to the V coal layer.

From a hydrogeological point of view, by observing the the evolution of groundwaters levels in the body of the open pit, there were identified two-sandy-level aquifers, on different depths, as it follows:

- a surface level obvious in most of the drillings (FP1, HG1, HG2, FP5, HG4, HO2, HG5, HO3, HG8, HO4, HG7, HO5, HG6, FP3, FP4, FP7, G1, G2, G3), situated at 0.5 – 5.0 metres under the terrain level , reporting monthly changes in the depth (quota) of groundwater, caused by direct influence of rainwater or infiltrations, but also changes in the existance of a surface drainage, natural or directed; the waters are generally at a free level, captive at times, slightly ascending.
- a ground level, situated at 10-15 metres under the terrain level, intercepted by the drillings HO1, HG3 FP2, HO6, between +335,35m and +314,4 m. The monthly measurements also highlighted changes in groundwaters depth, but less obvious than in the case of surface waters level. [1]

The technogenic regime of groundwaters sustains the watering of surface aquifers, by direct and indirect infiltration from surface waters, and, as a consequence, by activating the global hydric balance within the depression boundaries.[3]

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5. RISK SITUATIONS

Regarding landslides and land stability, there are some compulsory measures to be apllied:

- following the technological norms of excavating and and dumping;
- following the geometrical elements of both work stages in an open pit and dumping area and final ones, by maintaining the general slope angle both in the pit and in the dumping area and by maintaining the slope angle during working and at thw final stage – according to geotechnical studies;
- permanent management of groundwater and rainwater within the mining area, by building step channels, guard channels, outlets for collecting and transporting pit and dumping waters and, respectively absorbing and collecting draining systems in zones where there are risks of landslides and high humidity;
- afforestating the working area.

In order to avoid water floods and landslides, field protection against the excesive water flow from the valleys in the mining area must be accomplished by bulding channels on definite steps or even outer from the exploiting area. Within the area, there are channels for guiding water on the outline of their platforms.

In addition, in order to provide transportation of the guard channels, periodical clearing works and vegetation removals are required.

Within the exploiting perimetre, solid suspensions settling, during heaving rains and afterwards, is highly sustained by collecting basins, called sumps. Conducting rainwaters and infiltrations to sumps placed in sites with the lowest levels is done by a local net of ditches, channels and drains.

Water evacuation from the heart of the pit and from the wide benches on the slopes of the excavating steps, outer the pit, is done by pomping stations blowing at the valleys nearby. At the stations from the pit heart, the pomping capacity is calculated so the water volume, granted by 2% accumulation, should be evacuated within maximum 24 hours (according the law).

In order to impiede pit floods, any activities conducting to partial or total damage in hydrotechnical water draining and collecting the torents works are forbidden.

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6. MEASURES OF IMPACT REDUCTION

In order to reduce the impact over water, permanent surface waters monitoring is required for registering quality and morphological changes, and groundewaters monitoring their qualitative and quantitative analyses.

There is also important the maintenance of the purging systems at their highest functional level within the pit.

The measures for reducing the impact over water due to preparing stages for exploiting, the exploiting the geological extracted material and also for the closing and greening period are:

The preparatory stage for exploiting:

- avoiding contamination with toxic substances;
- avoiding loosing fuels from the machines by periodical checking;

The geological material extracting stage:

- applying prevention measures and accidental pollution control, according to current norms;
- ensuring optimal operation of the purging systems within the headquarters of the pit in order to maintain water evacuation within limits;
- ensuring storage for waste material in order not to be dumped into surface waters;
- maintaining machines in optimum operation by periodical revisions;
- manipulating fuels in specially designed sites in order not to pollute water and soil;

- maintaining the guard ditches for collectin rainwaters.

The closing and greening stage in extracting lignite

- the appropriate storage of dangerous substances;
- periodical checking of machinery for avoiding accidental fuel leakage;
- performing operations in order to avoid floods on the slopes and in the valleys unaffected by mining during greening.

7.ENVIROMENT PROTECTION MEASURES

In order to avoid water contamination, there were established protection zones at the beginning water supplying works, considering all the factors, local, natural and atrophic, that can determ water contamination:

- geomorphological, geotechnical and geotectonic caracteristics of the site;
- hydrogeological structure and parametres of the layers sitauted above the captured aquifer;
- surface water quality, when they are hydraulically connected to the captured aquifer;
- capture exploitation regime;
- the punctual and diffuse sources of existing pollution;
- other caracteristics observed at the sites;

Water protection measures during exploiting:

- applying prevention measures and accidental pollution control, according to current norms;
- an optimum functioning of the purging systems within the pit in order not to break with the maximum water evacuating concentration;
- ensuring the compliance with the technical norms for installations exploitation;
- proetecting surface waters by not allowing any dumping of waste material into waters;
- ensuring an optimum functioning of the installations by periodical checking, according to specifications from the tecnical data sheets.
- ensuring collecting rain waters from all the pit functioning stages (opening, preparatory and exploitation).

In order to avoid pollution, there absorbing material will be used, placed in the most likely to be polluted sites, meaning the fuels, waste materials and lubricants storage areas. In order to also protect water in the area of Lupoaia pit, all the waste material and, fuels and oils must precollected in sealed or watertight tanks and periodically carried to specially designed storage areas and, finally, to an authorized waste storage.

A permanent monitoring of the pollutants is required, on both surface waters groundwaters by collecting samples from times to times, to be analysed at the labouratory. It is also required monitoring both qauntity and quality of the water evacuated from the pit resulting from freatic horizons, from raining and from fecal matter waterwaste.

During functioning, it is also required monitoring household wastewater and dewatering into their emissary, the Lupoița Creek and the Ploștina Creek.

The collected data must be compared to the admitted values in H .G no. 352 /2005.[7]

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8. CONCLUSIONS

The impact over water caused by extracting coal in Lupoaia open pit is a long-term one, local and regional, lasting the entire period of mining. This impact influences both the quanity and quality water by polluting of surface water and rainwater, by lowering the piezometric

levels, by reducing underground water supplies by changing the whole hydrodynamic regime. The impact over water lasts the entire pit functioning period determing a increased permanent vulnerability, by changing the natural balance and by polluting.

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