Survey on the Process of Environmental Impacts of Opencast Mining

József PÁJER[a*] – Imre BERKI[a] – Zoltán GRIBOVSZKI[b] – Péter KALICZ[b] – András POLGÁR[a] – Katalin SZABÓ[a]

[a] Institute of Environmental and Earth Sciences, The University of West Hungary Faculty of Forestry, Sopron, Hungary,

[b] Institute of Geomatics and Civil Engineering, The University of West Hungary Faculty of Forestry, Sopron, Hungary

Abstract –The surface of Hungary is covered by a number of quarry pits that were made out of mining cultivation. Concerns have become more intense over possible environmental loads and there are different professional standpoints regarding the adjudication of the situation. The target of the project is to identify the impact area of the opencast mining, and systematize these impact factors and develop a check-list that supports the forecast of the impact factors.

Keywords: opencast / mining / environmental impacts

1. INTRODUCTION

The opencast mining is a very offensive influence on the natural environment, the state of the environment was developed, depends on the duration, the method of the mining and on the quality of the exploited raw material. The demand for building materials has increased in the last 15 years, several new mines have been opened in the western Transdanubian region. More and more cases of unauthorised and illegitimate mining activities have occurred. It follows that, the surface of Hungary is covered by a number of quarry pits that were made out of mining cultivation. This is attributed to the former permissive regulations of mine-opening, as well as the change of the ownership after the change of the regime.

Such activities can also, on occasion cause significant disturbance to wildlife and lead to loss or deterioration of valuable natural habitats. (European Commission 2010) Concerns have become more intense over possible environmental loads and there are different professional standpoints regarding the adjudication of the situation.

2. THE TARGET OF THE SURVEY

The target of the project is to identify the impact area of the opencast mining, exploring the factors that influence the impact range of the impact factors, keep in mind the preservation of the natural environmental requirements.

Systematize these impact factors, and develop a check-list, that supports the forecast of the impact factors.

[*] Corresponding author: jpajer@emk.nyme.hu, H-9400 Sopron, Bajcsy Zs. Str. 4.

3. METHOD OF THE SURVEY

The survey is based on a 5 years of returning monitoring that allow of the aerial photography, and the local collection of data.

The research took place on 20 allocated sampling areas, in the course of which we made ecological, hydrological and soil tests. However experiments were made on other minesides as well. According to the impact parameters 8 impact processes were identified. The impact area was examined by using pairs of aerial photos about the mining areas. During the examination different types of impact processes were identified.

Gérce (alginit), 2005 Gérce (alginit), 2011

Figure 1. The change of the enviromental state of the alginit mine Gérce

The examination eludes the ecological processes of the mines, where we experienced that the direction of the natural succession and the range of the constantly changing biological diversity depends on many different factors. However there are some basic determining factors such as the water supply of the area, the kind of vegetation coverage of the area before the mine-opening, and the type of the exploited raw materials.

4. RESULTS

4.1 The Hydrological Effects of Surface Mining (Focusing on the Gravel Mining Impacts onto Groundwater Resources).

Removing of the surface covering topsoil (confining) layer and the exploitation of the mineral resources, which is generally gravel in the West-Transdanubian region, causes long lasting effects. The original, better protected state of the groundwater resources generally decreases after mining activities. If the level of the groundwater exceeds the new ground surface (after the mineral exploitation) a mine lake will arise on the area. In the followings we try to analyze what can be the influence of mine lakes on the surrounding groundwater resources.

4.1.1 The effects of gavel mine lakes onto the groundwater resources

Gravel mine lakes (and the surrounding groundwater) is much more sensitive (than the original groundwater body) against the surface pollutions because of the removal of the protection cap layer. Lakes have a very intensive connection with the neighbouring groundwater bodies therefore any pollution in the surface water body of the lakes endangers also the groundwater resources.

If the gravel mine lakes can be found on a sensitive area (from geological point of view), any kind of change appearing as a negative component in the water balance demands a detailed examination.

High evaporation rate of the mine lake surface has also a considerable effect on the water balance of the neighbouring area. The surrounding groundwater level can be depleted (compared to the original state) as a result of higher evaporation induced groundwater withdrawal of the lake in dry periods. The surrounding groundwater quality may be in a danger also, if groundwater withdrawal happens near the lake and its surface water body is in the recharge area of the water exploitation.

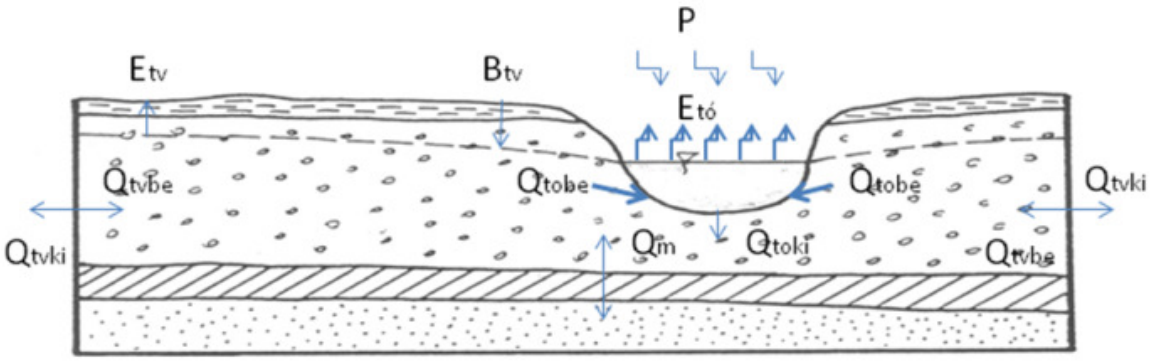

Figure 2. The connection of groundwater and mine lake.

The water balance equations of the lake and surrounding groundwater in permanent case:

Lake: P + Qtobe = Etó + Qtoki
Groundwater: B - Etv ± Qtv ± Qto ± Qm = 0 (±Qto = Qtoki - Qtobe)
Total Water Balance: B - Etv + Cs - Eto ± Qtv ± Qm = 0 (Eq. 1.)

Where: P: precipitation; B: infiltration; Eto: evaporation from the surface of the lake; Etv: evaporation from the groundwater; Qtv: groundwater (in the aquifer) input and output across the border of the area; Qtobe: groundwater input into the lake; Qtoki: lake water output into the aquifer (in case of humid climate can be the case); Qm: groundwater exchange with deeper layers.

4.1.2 Numerical modeling

Because of the complexity of the problem the analytical solutions (the lake is handled as a long channel or a well) give only approximate results. So as to get more accurate solution we have to use the method of numerical modeling (Kovács 2004). In case of mine lake (Bükk I.) was examined as an example of numerical modeling. We used Processing Modflow model environment for calculations.

4.1.3 The building of the numerical model and the results of the analysis

The numerical model aquifer was a homogeneous gravel layer. We used permanent model. The evaporation was taken into consideration as 400 mm/years (0,001 m^3/m^2/day). In case of the cells of the free water surface an enormous hydraulic conductivity (100 000 m/days) was used, that makes easier to handle the lake region (Savanyú, 1996). For the surrounding gravel layer cells with more orders of magnitude lower hydraulic conductivity (100 m/days) was given (Léczfalvy 2004). So as to handle the magnitude differences in the neighbouring cells on the lake shore region (to ensure the numeric stability of the model), hydraulic conductivities were changed gradually in two steps (in two cell rows) in that area.

With the above described geometry and parameter set of the numerical model about 2 km from the lake the groundwater depletion becomes insignificant. Near the lake (about 2-300 m distance) the maximum groundwater level depletion was estimated about five centimeters by

Modflow. This value is less than the depletion estimation of the analytical solutions in case of the same mine lake: the lake is handled as a long channel: more than 15 cm depletion in 3100 m wide region along the channel; or as a well (according to geometry more realistic): more than 15 cm depletion around in a 140 m wide zone the lake. It has to be note that using non permanent model in a dry summer periods the groundwater depletion can be more significant than the above mentioned ones.

4.2 Succession In Opencast Mines

The area of the gravel mines are increasing every year with 600 hectares in Bavaria. Most of these mines are opened in lowlands (Jürging 2003).

Opencast mining is an intensive disturbation which eliminates the living world for a certain time. As result of opencast mining a more diverse abiotic condition has been established compared to the earlier surface. The bigger the surface of the opencast mines, the more intensive are its effect on the living world of the surrounding landscape.

4.2.1 Seeds from outside

As seed sources of the succession in the opencast mines mainly the surrounding vegetation exists. The distance of the seed sources is very different depending on the plant species. Although no robinia exists in the surroundings forest of mines still it could colonise numerous of the disused mines from (a) long distance.

The weeds (vegetation) growing up on the soil gangue are developed from the seedbank of the soil gangue and as the nearest seed sources play an important role in the succession in the mine basin.

There are fallows in many cases in the space surrounding the mine basin. These fallows are covered mainly by weeds with numerous alien species. There is a desirable situation, if the mine is bordered by a nature closed forest. In this case the disused mine were colonised with no only weeds, invasive herb species, but the autochton trees have a good colonising success also, and the succession reach the schrub-forest climax in a short time.

4.2.2 Succession in the different minetypes

The succession is developing toward the rock-grass, or scrub-forest depending on the different drier site condition *in the rock mines* than in the surrounding areas.

Sand mines were opened not in lowlands, therefore cannot form lakes in it. The biodiversity of this sand mines cannot reach the biodiversity of the gravel mines due to lack of mine lakes. In sand mines there is moisture and nutrient deficiency therefore not only the high stalk of weeds, but the grass species exist in the early phase of the succession. Only a few native tree species can colonise the sand mines due to pure site condition, on the other hand the robinia having a high tolerance to moisture- and nutrient deficiency covering big parts of the sand surface.

The crumbling process of the mine wall to slope is occurring gradually relative quick in the sand mines. The succession of the plant and animal species attached to the mine wall and slope is determined and influenced by this crumbling process of the wall. In the relative young part of wall in sand mines there are brooding holes of some protected birds.

More and more slighter slopes have been developed from the mine wall in the older part of the mines, and only a short wall remains above the crumbling slope. Fox and badger hollow their holes in this crumbling slope since they can already move on the crumbling slope. The brooding holes of the riparian birds is deteriorated partly by covering of the lower-, than the middle part of the wall by crumbling, partly the funier predatory, which can reach the upper part of the wall on the crumbling slope

The wetland in a *claymine* will be overgrown by water plant and marsh forest quicker, than in the case of gravel mine, therefore the clay as substrat is more adequate for the succession, than the gravel. The shallow depth of the water in lakes of clay and gravel mines is an added factor for the succession *(fig. 3.)*. The excavating mining is a general method only in case of mining from the gravel mine lakes.

Figure 3. Littoral zone of a shallow minelakes

The large quantity gangues resulted mainly by *gravel mining* is unfavourable from point of view of ecology and nature conservation. Since the weeds and alien species remain a longer time due to slower succession, than in the wet mine basin. There are hardly any invasive species in the wetland vegetation of the mine basin. The shallow water area and the higher number of islands in the mine lakes are, the higher is the biodiversity of the lakes. Shallow water is the precondition of the riparian vegetation, which provide for example nesting place of waterfowl. In the mosaic-like wetland bush willows and other wet forest association are dominated neighbouring from drier sites.

Table 1. The relative naturalness of the vegetation depending of some main factors

	The vegetation of the earlier surface			
degree of moisture	**nature-close dry grass and forest**	**nature-close flood plain forest and grass**	**degradeted grass, and forest, hobbygarden**	**arable land, fallow**
dry	rockmine			gravelmine
	gravel-and sandmine		Sandmine	sandmine
			claymine	Claymine
wet		gravelmine		gravelmine
	Claymine			claymine

increase of the naturalness

increase of the naturalness

5. SUMMARY

As result of the succession, the biodiversity of the opencast mines is higher, than the biodiversity of the surrounding agricultural area. As step stones the vegetation of mines facilitate the migration of plant and animal species in the agricultural landscape.

According to the *Table 3.* the relative naturalness of the investigated mines are depending mainly on the earlier plant cover, the moisture content and the type of rock material.

The project produced 1 BSc study Kreiter Á. „Environmental impacts of abandoned clay mines" and 2 MSc study Török G. „Factors of abandoned outcrop mine's environmental loads" and Kisvárdai M „Environmental aspects and possibilities of post-exploration of leave-off clay mines", 1 started university subject „Impact research of opencast minig" and 1 PhD project Szabó K. „The influential factors of environmental state of leaved-off opencast mines" in the topic of the survey.

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