Geogr. Fis. Dinam. Quat.
30 (2007), 215-218, 3 figg., 1 tab.

GÁBOR LOKSA (*)

VARIATIONS IN MICROCLIMATE MODIFIED BY OPEN-CAST MINING: CASE STUDIES FROM HUNGARY

ABSTRACT: LOKSA G., *Variations in microclimate modified by open-cast mining: case studies from Hungary*. (IT ISSN 1724-4757, 2007).

Open-cast mining involves significant changes in topography and thus also influences the physical conditions of the atmosphere in the mining area and in its immediate surroundings. The paper intends to illustrate some of the interactions through findings from microclimate measurements in the pits of a lignite mining area of North Hungary. Implications for mining land reclamation are emphasized.

KEY WORDS: Open-cast mining, Microclimate, Land reclamation, Mátra Mountains (North-Hungary)

INTRODUCTION

At the first impression the interactions between open-cast mining (confined to the lithosphere) and meteorology (a science studying the atmosphere) do not seem very strong. However, if one considers that the solar energy which controls the physical processes of the atmosphere reaches the atmosphere through the mediation of the surface, the interactions are found to be essential. The ground surface, more precisely its material composition, structure, cover, morphology and colour is of great importance in meteorological processes. Open-cast mining continuously modifies these properties and the completion of extraction activities results in a final new surface.

The order of magnitude of climatic variation is generally proportionate to degree of surface transformation; therefore modifications at micro- and mesoclimatic scales due to mining are expected. The modifications affect the areas of mining activities and their immediate surroundings. Although the interrelationships between climate and mining discussed in this paper constitute only a small segment of the total climatic system and are embedded in the numerous environmental problems raised by open-cast mining, they still deserve attention, and it is useful to summarize related knowledge.

OPEN-CAST MINING AND METEOROLOGY

The relationships between open-cast mining and meteorology can be approached in two stages: during mining operations and after mine closure.

1. When a mining pit is deepened, an open air space with characteristic properties under extreme physical conditions is created (Baklanov 1986). The properties depend on pit depth and the quality of pit surfaces. The thermal conditions of the exposed bedrock and deposits on the bedrock are often different from those of original surfaces. Furthermore, air circulation conditions may also be modified. Consequently, the air space of a mine pit tends to warm up rapidly when insolation is intense, while cold air tends to accumulate in it when insolation is low or missing.

All these circumstances significant affect technical and hygienic conditions of mine operation. The larger temperature fluctuation in the pit than on natural surfaces may reduce the reliability of machines operating in the pit, while the reduced quality of stagnant air may raise hygienic problems. A high concentration of solid pollutants and gases released from deposits previously situated at greater depths and exposed by mining activities, is an additional pressure along with extreme temperature changes (fig. 1).

(*) *Institute of Enviromental and Landscape Management Szent István University. H-2103 Gödölló, Páter K. u. 1 - e-mail: loksa.gabor@kti.szie.hu*

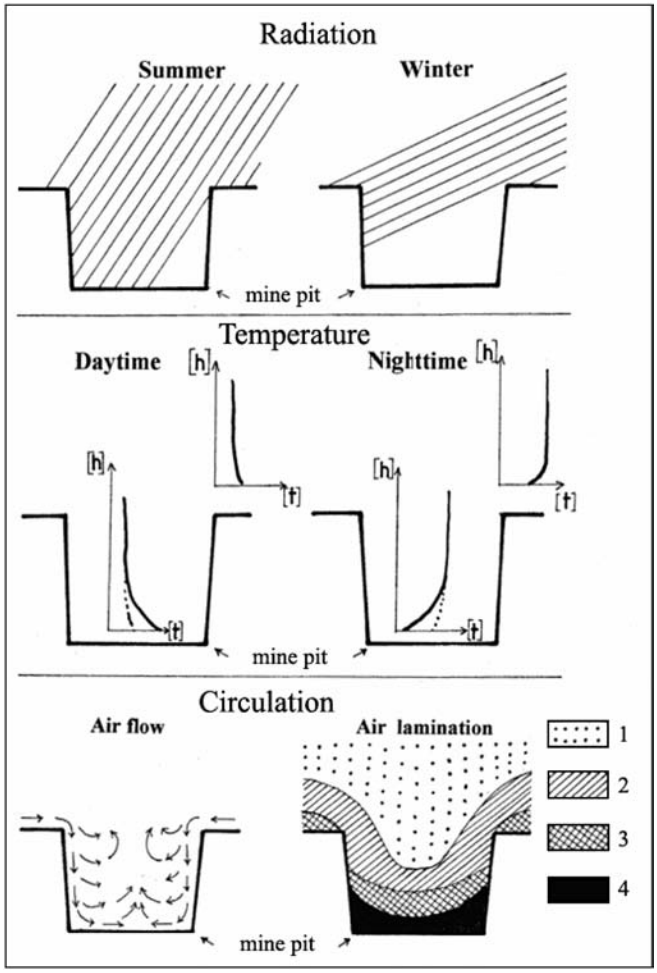

FIG. 1 - Microclimate during mine operation. 1) hotter air; 2) warmer air; 3) frost; 4) permanent frost.

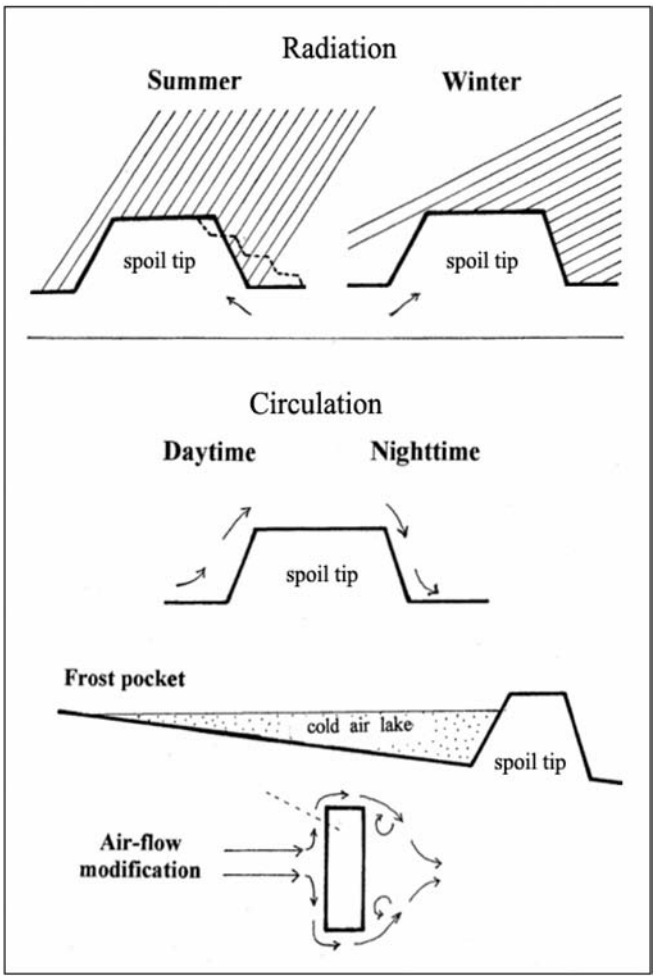

FIG. 2 - Microclimate after mine closure.

2. When mining activities are ceased, pit surfaces are usually left behind without treatment. An open or partly-backfilled mining pit, usually with a pond on its floor and spoil tips around it, has a topography different from the initial shape. While the pit modifies microclimate solely in its own air space, the spoil tips over the previous surface level can generate a new pattern of air circulation since they act as obstacles to air circulation (Hildmann & Wünsche 1996).

This problem deserves a closer investigation for several reasons. Most mines in Hungary are opened and operated in areas which are very favourable or at least suitable for agriculture because of soil conditions and meso/micro-climate of the area. When the surface is modified the value of the agricultural land is affected. Thus, the locally altered condition of atmosphere is an important factor influencing the land reclamation opportunities and future utilization of a mining area. The planning of the details of reclamation measures, including landscaping, the selection of the optimal vegetation type and species to be planted, as well as the maintenance of the reclaimed area, requires reliable information on the climatic situation and the consideration of the modified physical conditions of the atmosphere. Naturally, the figure describes extensive open-cast mining areas since enduring microclimate modifications are best observable there (fig. 2).

EXAMPLES FROM HUNGARY

In Hungary ca 15,000 quarries and mining pits are found which are partly landscaped and prepared for any new function after land reclamation. The above considerations can be illustrated by two examples from Hungary. In the case of the open-cast lignite mining works at the foot of the Mátra Mountains (Mátraalja) the significance of the topic can be underlined and both favourable and unfavourable consequences of relief transformation can be demonstrated (Strzyszcz, 1996).

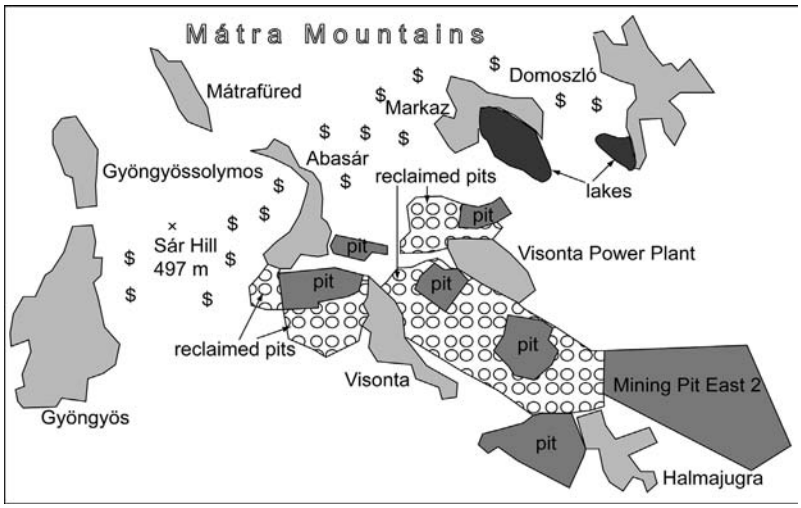

FIG. 3 - Lignite mining areas in the Mátra foothills.

1. The spoil tip accumulated near Abasár (fig. 3) obstructs the passage of cold air, ie. the night breeze coming from the Mátra Mountains and creates an artificial frost pocket. Since the site is located in a traditional viniculture region with fertile soils from the decomposition of volcanic rocks and long southern slopes with high insolation, the adverse change in microclimate hinders the reintroduction of viticulture following land reclamation.

2. Some kilometres' distance from there, possible microclimate modification was studied during the accumulation of a spoil tip near Halmayugra (fig. 3). Relying on measured data, we found a solution which resulted in the smallest alteration in local air circulation. Air motion is alleviated along the valley of the Bene stream, a minor water-course which flows from northwest to southeast, ie. parallel with the prevailing wind direction. This situation reduces the probability of the development of a frost pocket. As a consequence, the site endowments in the small gardens and farms established in the reclaimed area do not deteriorate considerably.

Microclimate measurements focused on air temperature were carried out in Northeastern Hungary, in the environs of Mining Pit East 2 in the surface mining region of Gyöngyösvisonta, at the eastern feet of Mátra Mountains (fig. 3). The measurements were made at the floor level of the mining pit hole, 80 m below its upper edge, at 131 m altitude. Air temperature was measured at 2 m height above the surface and near the surface. The readings were compared to data obtained at the upper edge of the mining pit. The measurements were carried out in every season, in weather situations most characteristic for the given season, both under clear sky and during cloudy periods over 4 years (1996-2000) in 46 campaigns, each of them covering a full day (24-hour period). The results obtained are summarized in table 1.

TABLE 1 - Results from microclimate measurements in the mining pit of Gyöngyösvisonta

Summer temperatures (clear sky)

		daily minimum (C°)	daily = maximum (C°)	daily variation (C°)	range (C°)
pit floor level	at 2 m	12.8-17.5	31.6-39.4	18.8-21.9	0.1-0.8(min) 0.1-1.1(max)
	near ground	12.7-18.7	31.7-40.6	19.0-21.9	
initial surface level	at 2 m	14.8-20.6	26.8-36.4	12.0-15.8	2.0-3.8(min) 3.0-3.1(max)

Summer temperatures (cloudy weather)

		daily minimum (C°)	daily = maximum (C°)	daily variation (C°)	range (C°)
pit floor level	at 2 m	13.7-16.5	26.4-31.2	12.7-14.7	0.2-0.9(min) 2.6-2.9(max)
	near ground	13.5-17.4	26.5-31.3	13.0-13.9	
initial surface level	at 2 m	14.2-19.6	23.8-28.3	8.7-9.6	0.5-3.1(min) 2.6-2.9(max)

Winter temperatures (clear sky)

		daily minimum (C°)	daily = maximum (C°)	daily variation (C°)	range (C°)
pit floor level	at 2 m	-18.8- -3.1	-7.2- -0.3	2.9-11.6	3.9-2.1(min) 1.1-1.3(max)
	near ground	-22.7- -5.2	-8.4- -1.6	3.6-14.3	
initial surface level	at 2 m	-16.1- -4.2	-5.0-0.8	5.0-11.1	1.1-2.7(min) 1.1-2.2(max)

Winter temperatures (cloudy weather)

		daily minimum (C°)	daily = maximum (C°)	daily variation (C°)	range (C°)
pit floor level	at 2 m	-1.2-6.1	9.2-11.3	5.2-10.0	0.2-0.4(min) 0.2(max)
	near ground	-1.8-5.7	9.4-11.5	5.8-11.2	
initial surface level	at 2 m	-0.2-7.2	11.8-14.3	7.1-12.0	1.0-1.2(min) 2.6-3.0(max)

CONCLUSION

Meteorological investigations are important both in the planning and implementation stages of land reclamation projects. The above examples clearly show that the survey of microclimatic conditions in open-cast mining areas can be useful both during the operation of the mine and subsequent periods when decisions on the further utilization of reclaimed land are made. Analysis of intricate relationships between anthropogeomorphology (in this case, landscape transformation by open-cast mining) and atmospheric physics (modifications in the properties of the air space in pits) can provide new viewpoints to be considered in the restoration of semi-natural environmental conditions in degraded areas and in the preservation of the ecological value of landscapes.

REFERENCES

BAKLANOV A. (1986) - *A method for evaluating the energy characteristics of the air in an open pit mine*. Journal of Mining Science 22. 1. 66-70.

International Council of Mining and Metals (2005) - *Good Practice Guidance for Mining and Biodiversity*. Environmental Resources Management Australia, Final Report 171.

HILDMANN E. & WÜNSCHE M. (1996) - *Lignite mining and its after-effects on the Central German landscape.* Water, Air, & Soil Pollution, 1-2, 79-87.

STRZYSZCZ Z. (1996) - *Recultivation and landscaping in areas after brown-coal mining in middle-east European countries.* Water, Air, & Soil Pollution 91, 1-2, 145-157.

(Ms. received 15 January 2007; accepted 30 November 2007)