Environmental Noise Management in the Area of Opencast Mines

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Environmental noise constitutes a threat regarding disturbance and deterioration of quality of living. There are numerous sources of environmental noise, among others mine objects, traffic roads etc. In Serbian practice open cast mines are commonly in vicinity of residential areas, which is the case of the Field C open cast coal mine and the Barosevac settlement. More complexity is added to noise management in such conditions through additional noise sources, not directly linked to mine objects and activities, such as local or regional roads. This paper describes an approach to noise management for the purpose of environmental noise impact reduction, from both traffic and industrial sources, related to the project Environmental Improvement Project in Kolubara Mine Basin in Barosevac settlement, as a part of acquisition of new Excavator-belt Conveyor-Stacker (ECS) system.

Key words: *environmental noise, noise mapping, opencast coal mine*

1. INTRODUCTION

Higher noise emissions into the environment (both working and natural natural) are inevitable during technological processes in coal production and processing. Also, noise constitutes a threat regarding damage to and in worst case loss of hearing capability. One of the means and most basic approach for overcoming this problem is noise mapping, or determination of noise zones in accordance with Directive 2002/49/EC [1] and the Law on Protection from Noise in Environment ("Official Gazette of RS", no. 36/2009 and 88/2010) [2].

This topic was subject of research of many authors. An empirical model for calculation of noise distribution from different sources was developed by Sensogut and Cinar [3, 4]. They used it in Tuncbilek open cast mine, in Turkey. The model is based on large amount of data, obtained from 312 measuring stations for monitoring noise on mentioned open cast mine.

Research of Degan et al. [5] was directed to identification of simplified but efficient technique for measurement and analysis of noise impact in vicinity of mine (open cast).

Pathak et al. [6] developed technique for noise forecasting originated from operation of specific groups of mining machines. This technique can be used for assessment of comprehensive sound field in vicinity of open cast mine.

Research of Lilić et al. related to open cast mine, resulted in developed noise mapping model for the purpose of definition of measures for reduction of negative noise impact in immediate vicinity of open cast mine [8, 11].

2. BASELINE CHARACTERISATION

In this paper the authors presented an approach to environmental noise management related to project Environmental Improvement Project in Kolubara Mine Basin - Part A – Procurement and Erection of ECS system for Field "C".

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At the start of the mentioned Kolubara Mine Basin project implementation, the Faculty of Mining and Geology, University of Belgrade, was engaged to perform baseline noise measurement in the Baroševac settlement. Measurements were performed on two locations in period from 15.06.2013 to 19.06.2013. Locations of measuring points are shown in Figure 1. First one was at the family house owned by Radosav Pantelic, with coordinates N44^{0}23.926' and E20^{0}22.236' and the second one was at the family house owned by Goran Nikolic with coordinates N44^{0}24.006' and E20^{0}21.852'. The terrain around the measurement points is of urban characteristics with open space, covered with low vegetation, and without barriers for sound propagation, as it could be seen on Figure 1. Background noise at this point originates from the traffic at the main road Stepojevac-Arandjelovac and from different activities usual for this type of settlement.

Figure 1- Locations of measuring points (Google map)

The results of continuous 24-hour noise measurements on the locations for the purpose of baseline characterisation are given in the table 1. It is obvious that some recorded noise levels listed in table 1 exceed prescribed limit values for environmental noise according to the Act [2].

All noise measurements, presented in the table 1, was conducted by using handheld analyzer, type 2250 (Bruel&Kjaer) which technical characteristics fulfill the requirements from standards defining environmental noise measurements.

3. MEASUREMENT OF ENVIRONMENTAL NOISE

Part A of the project Environmental Improvement in Kolubara Mine Basin included Procurement and Erection of ECS system for Field "C". For the current status of work on the project noise measurements were performed on the same two locations in period from 21.05.2016 to 24.05.2016.

Results of noise measuring are also given in table 1. The measurement setup included sound recording, to analyze noise events with high level of noise.

Recorded noise levels during the day and night periods, as given in table 1, exceed limit values for environmental noise for evening and night, as prescribed by the Act [2].

During the environmental noise measurements, indoor measurements were carried out in a house on the measuring point 1. The noise level measured in the house at the measurement point 1 during the daytime as prescribed by the Act [2].

Table 1. Applicable noise levels at measuring points and limited value of noise

Measurement period	Measuring Point 1, (dB(A))				Measuring Point 2, (dB(A))			Limited value of noise, (dB(A))
	2013.		2016.		2013.		2016.	
Day	60	**61**	**61**	**63**	55	59	**63**	60
Evening	**64**	58	60	58	57	56	60	60
Night	**55**	**54**	**58**	**57**	**54**	**54**	**64**	50

4. DEVELOPMENT OF NOISE MAPPING MODEL

First step in creating a noise mapping model is identification of noise sources. In this case these are:

- excavator and stacker,
- drive stations of belt conveyors,
- belt conveyors.

Data on noise levels from above mentioned sources, in form of L_{Aeq}, are obtained by noise measurement and they are used as base for development of noise map presented in this paper.

Additional noise source at this location is regional road Lazarevac-Arandjelovac (Figure 2). Noise originated by the traffic along this road was also taken into consideration during development of the model [9].

Mapping software SoundPlan was used for development of noise model. Methodology of noise mapping stipulates validation of sources, which was performed with existing measurements in vicinity of the sources. Model validation was done with noise measurements at points presented in table 1. Results of noise measurements at same points are indicating levels in span from 57 dB(A) to 63 dB(A) at MP1, and 60-64 dB(A) at MP2. Such conditions are corresponding to the results of modelling. Model validation results are shown on Figure 3, together with data acquired by measurement at individual noise sources and at sensitive receptors (residential objects, MP1 and MP2).

Based on performed measurements and input data for modeling, it is concluded that most dominant individual source of noise on new ECS system on Field C open cast mine are drive stations of belt conveyors. Accepted level of equivalent noise, for the purpose of modelling, at drive stations is 86 dB(A). Noise at the stacker is significantly lower, and it is accepted at level of 74 dB(A). Somewhat lower noise was on the belt conveyor, which is accepted at level of 72 dB(A) for the modelling.

Figure 2 - Disposition of Field "C", road Arandjelovac-Lazarevac and Barosevac willage

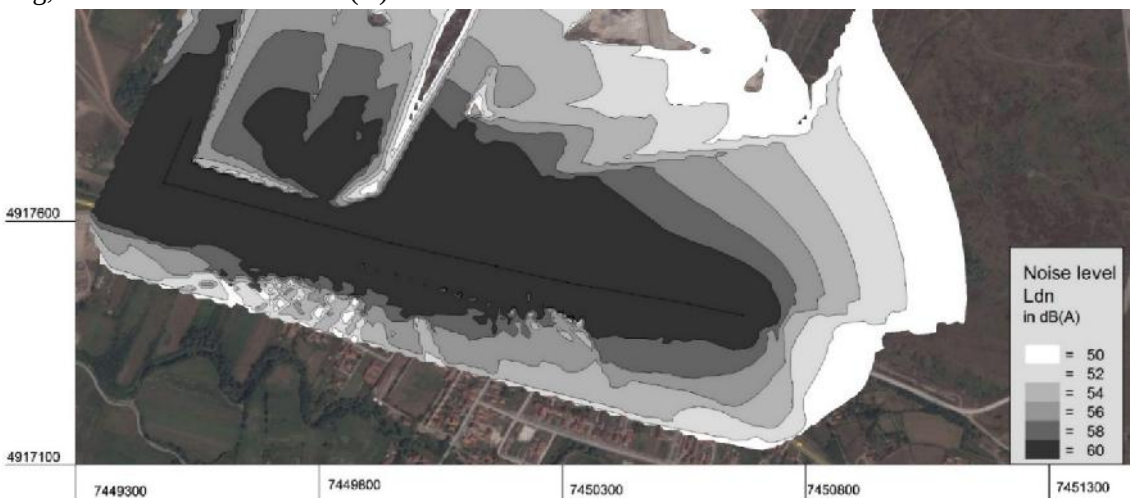

Figure 3 - Noise levels in vicinity of new ECS system at open cast mine "Field C" – initial condition (base condition)

Results from the model validation process and from field measurements showed that marginal parts of Baroševac settlement (parts closest to the mine) will be in zone with equivalent noise in range 59-62 dB(A) (during day, evening and night). According to the Act [2] noise level in zone 4 (which is suitable for exposed objects) must not exceed 60 d(A) for day and evening and 50 dB(A) for night. Model suggests that daily operation of the mine with existing traffic along the regional road Lazarevac – Aranđelovac, will generate exposure of mentioned parts of settlement to noise levels higher than allowed during the day and night.

5. SUGGESTED MEASURES FOR NOISE SUPPRESSION AND ABATEMENT

Measures for noise reduction was implemented on all drive stations of belt conveyors, resulting in reduction by 10 dB(A) in relation to initial value, in order to examine possibilities for improvement of environmental quality. It is possible to lower noise level by 11 dB(A) applying covering-enclosing of drive station [10]. Modelling results, after reduction of noise from drive stations by 10 dB(A), are shown on Figure 4.

It is obvious that applying the measure will result in sufficient noise reduction and ensures compliance with requirements from the Act [2] for day and evening, but not during the night. In the night period noise is still above the limit of 50 dB(A).

Having in mind proximity of regional road and traffic intensity along the road as well as its contribution to the overall noise additional modeling is performed in order to establish the impact of individual components of ECS system in relation to intensity of night traffic along the section of regional road Lazarevac – Aranđelovac.

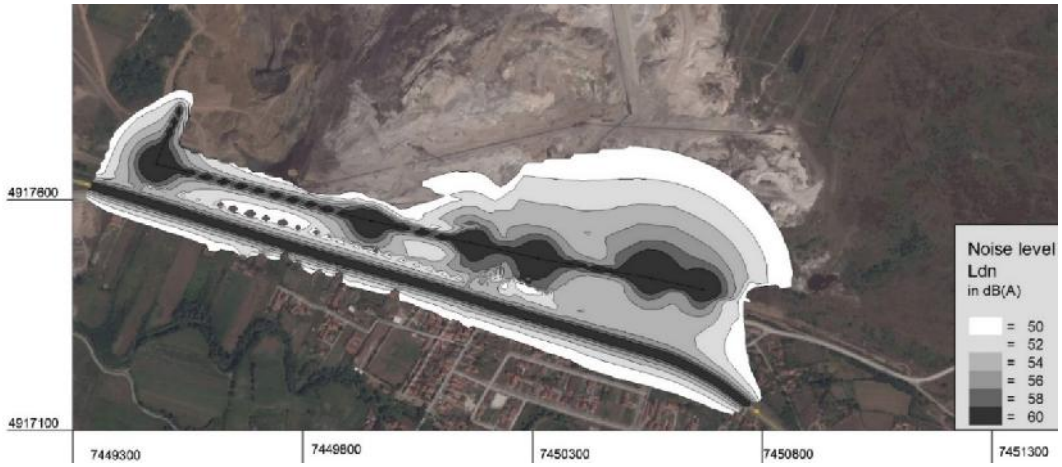

Figure 4 - Noise levels at in in vicinity of new ECS system at open cast mine "Field C" after reduction of noise on drive stations along the new ECS system

Modeling of operation of new ECS system, with implemented measures for noise reduction along the Baroševac settlement, excluding traffic noise is shown on Figure 5.

As it can be seen on Figure 5, operation of new ECS system with implemented measures along the route through Baroševac, is in accordance to the requirements of Act for night operation - below 50 dB(A).

Based on that we can concluded about significant impact of the road on overall noise level affecting the settlement during night (Figure 6).

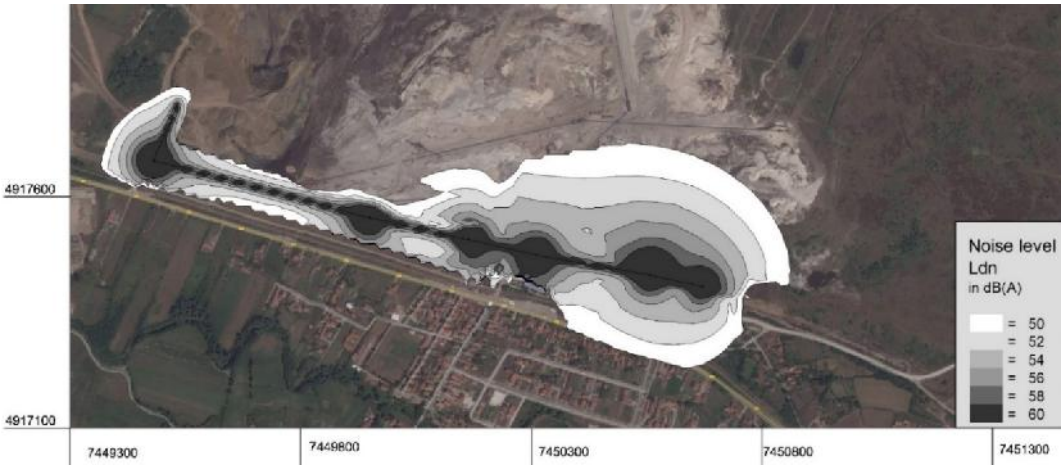

Figure 5 - Modelling results of new ECS system operation without the traffic noise from regional road Lazarevac - Aranđelovac

Figure 6 - Noise modelling results of combined operation of new ECS system and night traffic along the regional road Lazarevac – Aranđelovac

In favor of improving the noise environment is a fact that part of regional road Lazarevac – Aranđelovac will be relocated as development of "Field C" open cast mine takes place, therefore it importance will be reduced.

Hence, it is confident to conclude that operation of new ECS system, with suggested measures for noise reduction at drive stations of belt conveyors, will be in accordance to the Act.

6. CONCLUSION

Environmental noise constitutes a threat regarding disturbance and deterioration of quality of living. There are numerous sources of environmental noise.

Case study presented in the paper describe issues in Barosevac settlement which is exposed to noise emitted from Field C open cast mine and a regional road. In Serbian practice open cast mines are commonly in vicinity of residential areas, which is the case of the Field C and the Barosevac settlement.

Higher noise emissions are inevitable during technological processes in coal production and processing. Since coal production process can't be stopped, as well as traffic along the mentioned road, it is difficult to make a conclusion which source has higher impact on neighboring housing and to what extent.

However, it is necessary to establish prominent source in order to plan measures for noise reductions in the environment within the noise management action plan.

Noise mapping is a tool which give us such potential and it is efficient way for assessment and management of noise, both in design and operational stage.

Modelling results for above-mentioned conditions are indicating that covering of drive stations along the route of belt conveyors, parallel to the Baroševac, noise level to neighboring parts of settlement can be successfully reduced to value bellow 60 dB(A), even bellow 50 dB(A), thus meeting requirements of Act [2] during the day, evening and night period. It should be mentioned that noise from the section of regional road Lazarevac – Aranđelovac has significant role to exposure of parts of the settlement along the route of the new ECS system.

7. ACKNOWLEDGMENT

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REZIME

UPRAVLJANJE BUKOM U ŽIVOTNOJ SREDINI NA PODRUČJU POVRŠINSKI KOPOVA

Buka u životnoj sredini predstavlja realnu opasnost sa stanovišta uznemiravanja i pogoršanja kvaliteta života. Brojni su izvori buke u životnoj sredini, da napomenemo samo neke: rudarski objekti, saobraćajnice i sl. U Srbiji su površinski kopovi često u neposrednoj blizini stambenih objekata, što je slučaj i sa površinskim kopom uglja „Polje C“, koje je u neposrednoj blizini naselja Baroševac. Problem upravljanja bukom u takvim situacijama se usložnjava postojanjem dodatnih izvora buke, koji nisu u direktnoj vezi sa rudarskim objektima i aktivnostima, kako na primer lokalnih ili regionalnih saobraćajnica. U radu je opisana mogućnost upravljanja bukom, koja potiče od industrijskih izvora i okolnog saobraćaja, u cilju smanjenja njenog uticaja na životnu sredinu.

Ključne reči: *buka u životnoj sredini, mapiranje buke, površinski kopovi uglja*