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Original scientific paper

Traffic Noise Levels in the City of Banja Luka

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Abstract: Noise pollution, as a major environmental problem, is present in Banja Luka. The measured values exceeded the level of noise allowed, which is a great problem. Evaluation of the noise levels was carried out in the streets in the area with health institutions. Objectives of this research were to evaluate the environmental noise pollution in the City of Banja Luka due to traffic noise and to compare the measured noise levels in the city with legislation and to establish the connection between noise and the number of vehicles. Correlation between the noise level and number of vehicles was positive and significant during the study period (r=0.89). It is confirmed that, with the increase of the number of vehicle, the noise level increases, i.e. the decrease in the number of vehicle decreases the noise level.

Key words: environmental noise, traffic, environmental protection.

INTRODUCTION

Noise is described as a sound without an acceptable musical quality, or as an undesirable sound. Noise occurs due to irregular vibration movements of solid bodies, liquid and gaseous fluids, whose oscillations are transferred to our ears. Industrialization had resulted in large migrations of population into cities, and that has caused insufficient planning in a city development. Traffic has also being developed intensively, there is an increased use of technical devices, and it all results in the increase in the number of noise sources, both in working environment and in the environment in general.

Noise pollution and air pollution are recognized as a major problem for the quality of life in urban areas all over the world. This problem has not been properly recognized despite the fact that it is steadily growing in developing countries (Barboza et al., 1995; Jamrah et al., 2006). Because of the increase in the number of cars and industrialization, noise pollution has also increased. Noise in cities, especially along main arteries, has reached up disturbing levels (Ozer at al., 2009). Urbanisation, economic growth and motorizsed transport are some of the driving forces for environmental noise exposure and health effects. Environmental noise is defined as the noise emitted from all sources except from industrial workplaces. The EU Directive on the management of environmental noise (Directive 2002/49/EC) adds industrial sites as sources of environmental noise (WHO, 2011). Noise, defined as 'unwanted sound', is perceived as a pollutant and one type of environmental stressor (Stansfeld, 2000). According to WHO guidelines, 40% of the population that lives in the European countries are exposed to equivalent sound pressure levels of more than 55 dB(A) daytime, and also about 20% of this population is exposed to the levels above 65 dB(A): WHO emphasised that noise pollution is an acute problem in developing countries [Berglund, 1999; Ehrampoush, 2012]. Country capitals such as Cairo, Paris, Beijing and Delhi represent four out of the five cities with the 10 highest scores for noise pollution (Mimi Hearing Technologies, 2017). Noise research in Banja Luka and neighboring municipalities is rare (Ilić et al., 2012; Janjuš et al., 2015; Janjuš et al., 2015), unlike air pollution (Ilić & Janjuš, 2008; Ilić & Preradović, 2009; Lammel et al., 2010; Lammel et al., 2010; Gasic et al., 2010; Lammel et al., 2011; Preradović et al., 2011; Ilić et al., 2012; Ilić et al., 2013; Ilić et al., 2014; Ilić, 2015). During the processes of planning and designing, and after the construction of new roads, it is

of major importance to determine the level of traffic noise which is going to occur or which has already occurred (Pozder, 2013).

Exposure to excessive levels of noise in industry may induce hearing loss. There is also an expectation that such an environmental stressor as noise may have deleterious effects on other aspects of health, apart from hearing (Stansfeld, 2000). In recent years, evidence has accumulated regarding the health effects of environmental noise (WHO, 2011). The influence of noise on human health and comfort can have negative effects on the psychological, physiological and physical functions of the human body (Hunashal & Pahl, 2011; Nawaz & Hasnan, 2013). For example, well-designed, powerful epidemiological studies have found cardiovascular diseases to be consistently associated with exposure to environmental noise (WHO, 2011). At least 1 milion healthy life years are lost every year from traffic-related noise in the western European countries. Even the incomplete 2012 noise mapping data shows that there are at least 10,000 cases of premature death in Europe and at least 43,000 cases of hospitalisation each year. In recent years, noise pollution has drawn interest of the researches worldwide due to its research on animals (Kight & Swaddle, 2011; Barber et al., 2010; Popper & Hastings, 2009), especially impact on birds (Parris & Schneider, 2008; Peris & Pescador, 2004).

OBJECTIVES

The primary aim of this study was to determine the noise pollution in the urban part of the City of Banja Luka (Republic of Srpska, Bosnia and Herzegovina (BiH)) by evaluating noise levels in the streets in the area with health institutions. The aim of this research is also to evaluate environmental noise pollution in the Citz of Banja Luka due to traffic noise and to compare the measured noise levels in the city with legislation and to establish the connection between noise and the number of vehicles.

MATERIAL AND METHODS

Study area:

Subject of the research is to determine the noise pollution in Banja Luka, which is located in the northwestern part of BiH and in one of the two entities in BiH. Banja Luka is located in Vrbas valley and is surrounded by hills 200-600 meters above sea level. Banja Luka is the second biggest city in Bosnia and Herzegovina with the population of 200,000. Situated in a basin 164 m above sea level, where the Dinaric Alps from the south descend into the Pannonian Basin in the north, Banja Luka has a temperate continental climate with the prevailing influences from the Pannonian plain. It belongs to the Central European Time zone (GMT +1) and. The average annual temperature reaches 10.7°C, the average January 0.8ºC, whereas the average temperature in July reaches 21.3ºC.

The present study on environmental noise pollution was carried out in Banja Luka in June 2014. Noise was measured at the measuring points in four streets and one roundabout (Pictures 1):

- S1 – Cara Dušana Boulevard,
- S2 – Jovana Dučića Street,
- S3 – Zdrave Korde Street,
- S4 – Sime Matavulja Street and
- S5 – roundabout (intersection Karađorđeva, Omladinska, Krajiških brigada Strrets and Cara Dušana Boulevard).

Picture 1. Location measurements (S1, S2, S3, S4 and S5) and sampling points (red points)

Noise measurements:

Measurements were performed with a 2260 Bruel & Kjaer type I sound-level meter and with tripod 140 cm. Calibration was performed using a 4226 Bruel & Kjaer calibrator. 7815 Noise Explorer™ was also used. Noise is measured by a sound level meter; which is an instrument which responds to sound in approximately the same way as the human ear and which gives reproducible measurements of sound level (Mato and Mufuruki, 1999; Jamrah et al., 2006). The equivalent continuous equal energy level (L_{eq}) is applied to fluctuating noise level. The L_{eq} is defined as the constant noise level that expands the same amount of energy as the fluctuating level over the same time period (Davis and Masten, 2004; Jamrah et al., 2006).

L_{eq} is measured for traffic noise along with the statistical levels L_1 and L_{10} which are the noise levels exceeded 1% and 10% of the time; respectively. Equivalent noise levels [L_{eq} (dBA)] were measured on one occasion, in one day interval (between 9 a.m. and 3 p.m.), one evening interval (between 6 and 10 p.m.) and two night intervals (after 10 p.m.). Three measurements lasted for 15 minutes daily (during three days) and were made at each measuring point on a sample during the day for each period day-evening-night, in accordance with the Directive 2002/49/EC of the European Parliament and of the Council of 25 June 2002 relating to the assessment and management of environmental noise, because the Rulebook on Allowed Limits for Noise and Hum Intensity (Official Gazette of SR BiH, 46/89) does not define an evening period. L_{day} [dB (A)] – is the A-weighted long-term average sound level determined over the day periods of a year, $L_{evening}$ [dB (A)] – is the A-weighted long-term average sound level determined over the evening periods

of a year and L_{night} [dB (A)] – is the A-weighted long-term average sound level determined over the night periods of a year.

The measurement of noise levels was performed in compliance with the Rulebook on Allowed Limits for Noise and Hum Intensity (Official Gazette of SR BiH, 46/89), i.e. Article 4 (external noise is measured at the level of 1.7 meters from the level of the terrain, at the distance of at least 3 meters from the noise reflecting obstacles).

Noise Levels Allowed

The highest equivalent levels of external noise allowed were determined in accordance with the purpose of the area (zone) and are provided in Table 1. of the Rulebook on Allowed Limits for Noise and Hum Intensity (Official Gazette of SR BiH, 46/89). In compliance with the purpose of the area monitored, the study area is located in the zones I (hospital, rehabilitation), II (tourism, recreation, recuperation), III (exclusively housing, child-bearing and educational and health institutions, public green and recreation areas) and IV (trading, business, housing and housing next to traffic corridors, warehouses excluding heavy transport).

Table 1. Allowed levels of external noise pursuant to the purpose of the area

Area (zone)	Area purpose	Highest level of external noise allowed (dBA)			
		Equivalent noise		Peak levels	
		daytime	nighttime	L_{10}	L_1
I	Hospital, rehabilitation	45	40	55	60
II	Tourism, recreation, recuperation	50	40	60	65
III	Exclusively housing, child-bearing and educational and health institutions, public green and recreation areas	55	45	65	70
IV	Trading, business, housing and housing next to traffic corridors, warenhouses excluding heavy transport	60	50	70	75
V	Business, administrative, trading, crafts, servising (utility services)	65	60	75	80
VI	Industrial, warehousing, servicing and traffic, excluding apartments	70	70	80	85

Statistical analysis

For statistical data processing while determining the interdependence and relationship between noise levels and vehicle number, were used EXCEL and SPSS statistical software tool. Descriptive statistic is presented as mean values±standard deviation (SD) for numeric variables. The association between parametric data was measured by Pearson's correlation coefficient.

RESULTS AND DISCUSION

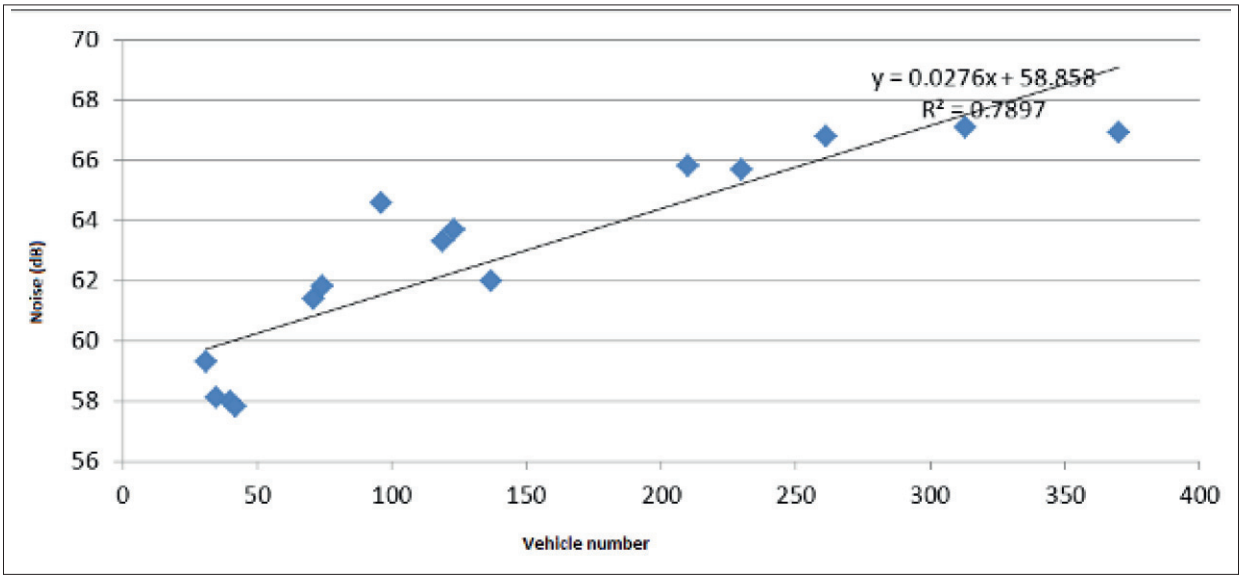
Measured average values of L_{eq}, statistical noise level L_1 ans L_{10} and the number of vehicles (min, max and average values) are shown in Table 2 for all locations.

Equivalent noise levels [L_{eq} (dBA)] were measured on one occasion, in one day interval (between 9 a.m. and 3 p.m.), one evening interval (between 6 and 10 p.m.) and two night intervals (after 10 p.m.). Three measurements (duration 15 minutes) were made at each measuring point on a sample during the day for each period day-evening-night.

Table 2. Values of L_{eq}, L_1 ans L_{10} (a-day, b-evening and c-night)

		S1			S2			S3			S4			S5		
		a	b	c	a	b	c	a	b	c	a	b	c	a	b	c
Leq	Min	65.7	64.6	58.3	64.9	62.9	60.2	62.2	57.1	58.6	59.8	56.7	56.9	66.3	65.9	62.5
	Max	69.9	66.4	65.4	67.7	66.8	64.1	66.2	58.9	57.3	64.6	61.1	58.4	67.9	67.6	63.9
	Average	67.1	65.7	62	65.8	64.6	61.8	63.7	58	58.1	61.4	59.3	57.8	66.9	66.8	63.3
L_1	Min	71.5	76	64.9	70.9	71	68.3	69.5	67.2	68.8	67.5	68.1	68.7	73.1	74.7	68.7
	Max	79.8	74	74.4	76.2	73	71.9	78.3	69.5	72.9	74.5	71	69.9	75.8	78.1	70.7
	Average	74.6	75	69.6	72.8	72.1	69.9	73.1	68.6	71.1	69.9	69.9	69.2	74	76.7	69.9
L_{10}	Min	67.8	67.9	60.6	67.7	66.2	63.2	64.9	61.6	61.4	63.1	59.4	59	69.2	68.8	64.4
	Max	73.5	69.7	68.6	71.1	67.3	67.8	66.1	62.6	63.3	68.1	63.5	64.4	70.9	70	67.6
	Average	70.1	68.9	65.6	68.8	66.8	65.4	65.4	61.9	62.3	64.9	61.7	61.6	69.9	69.3	66.2
Vehicle number	Min	300	210	118	197	88	71	100	30	33	65	24	36	363	224	106
	Max	325	253	163	224	105	76	157	55	38	81	40	46	380	300	134
	Average	313	230	137	210	96	74	123	40	35	71	31	42	370	261	119

Graph 1. shows the dependence of the noise level and vehicle number, as well as the equation describing this dependence. Correlation between the noise level and the number of vehicles was positive and significant during the study period (r=0.89). With the increase of the number of vehicle, the noise level increase, i.e. the decrease in the number of vehicles decreases the noise level.



Graph 1. Dependence of the noise level and the number of vehicles

All values L_{eq}, peak levels L_1 and L_{10} are slightly lower than the limit values or have been exceeded.

Because they are at all measuring points at the study area mixing two areas (zones) I (hospital, rehabilitation) and II (tourism, recreation, recuperation), III (exclusively housing, child-bearing and educational and health institutions, public green and recreation areas) and IV (trading, business, housing and housing next to traffic corridors, warehouses excluding heavy transport), it can be concluded that the noise level values in this area are alarming.

CONCLUSIONS

The results of the noise measuring in the tested downtown of the City of Banja Luka showed that the average noise levels and traffic frequency were unfavorable for health areas. The measured values exceeded the

level of noise allowed, which is a great problem. Evaluation of the noise levels was carried out in the streets in the area with health institutions.

It is proved that correlation between the noise level and the number of vehicles was positive and significant during the study period (r=0.89).

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