



AN ANALYSIS OF THE ENVIRONMENTAL NOISE LEVELS ON THE TERRITORY OF THE CITY OF NIŠ

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Abstract - *The communal noise level represents one of the key factors of life quality in urban areas. A continuous monitoring of the noise levels and the analysis of results have become a necessity when we discuss a possible recovery of those areas with high levels of noise pollution, and particularly those zones which were designed for specific activities. The city of Niš, Serbia, owing to the permanent long-term noise monitoring, possesses a database containing figures related to the noise levels at relevant locations in the city, which can serve as a basis for an analysis of the change of conditions, their tendencies in the future and recognizing factors which influence the danger of noise pollution.*

The paper involves an analysis of the noise level at a number of characteristic locations in the city of Niš during the previous three years.

1. INTRODUCTION

Noise pollution represents a major problem in the environment of most urban areas. However, the problem of noise has not been approached properly so far, and not enough attention has been paid to it in spite of the fact that it has a great impact on the quality of life of the endangered population. Reasons for such an approach could be found in the very definition of noise as a subjective experience of various external events, in its specific character, as well as in the difficulties connected to relating the causes with the effects it has on general health.

The results of medical studies have shown that noise can have very adverse effects on human health and justify the need for further explorations aiming at a better understanding and an improved control over noise. Namely, noise is treated as a serious health threat, with consequences ranging from anxiety to death and it is considered to be one of the main causes of stress, which has a psycho-social component. Practical effects of noise on people usually manifest themselves as unpleasant feelings, lack of concentration, sleep disorders and stress caused by ischemic heart disorders. It is extremely important to evaluate the impact which noise has on child health and development, as it can cause speech impairments and decrease learning capabilities.

Along with health issues, some recent studies in the field have also stressed various economic impacts of noise pollution. Besides the resources invested in preventing noise in populated areas near traffic arteries, airports, railroads and highways or other noise sources (e.g. industrial), recent studies have analysed the healthcare expenses related to treating disorders which emerge in noise-polluted areas.

Moreover, the level of communal noise pollution has a great economic impact on real estate prices in residential and business areas. Studies have shown that traffic noise cause a 5% drop in real estate prices on the average, and that the percentage can go up to 12% in the times of economic growth. This fact stimulated researchers from all around the world to dedicate more time to studying and defining the issue of traffic noise.

Traffic definitely represents the dominant source of communal noise and the main cause of disturbance and anxiety in people. Around 120 million people in the European Union are exposed to the levels of road traffic noise higher than 55 dB(A), whereas 50 million of them are exposed the levels of road traffic noise higher than 65 dB(A). If we take into consideration the fact that the level of noise of above 55 dB(A) causes unpleasant feelings, aggressive behaviour and sleep disorders, that permanent exposure to the level of noise of above 65 dB(A) can cause hypertension and that permanent exposure to the level of noise of above 75 dB(A) leads to higher stress levels, increases the number of people with heart disorders and can lead to hearing damage, it becomes clear that traffic planning and protecting inhabitants of urban areas from traffic noise require a far more serious approach.

The conditions related to noise pollution in the city of Niš are in many ways similar to conditions in other urban environments. Collecting information on traffic characteristics and updating it over a longer period has proven to be crucial to the evaluation and management of communal noise in an environment. Furthermore, measurement and evaluation of traffic noise are important activities which may result in the development of efficient methods for its control.

The city of Niš belongs to the group of medium-sized cities, with around 300,000 inhabitants. During the past decades it has been growing and taking up more territory, which has been followed by numerous changes in regard to urbanization, industrialization, having a larger traffic network and greater infrastructure. Recently, the city has been particularly exposed to an increased frequency of road traffic, which, in the given circumstances of traffic infrastructure, represents a crucial factor in the increase of noise pollution. Given the average age of cars in Serbia (11 years old) and the average age of public transport buses (15 years old), we can get a preliminary picture of the main sources of communal noise on the territory of the city of Niš. Conditions related to communal noise at specific spots in the city and their levels of noise pollution depend on a number of factors, such as: the

type of vehicles taking part in traffic, passing frequency of specific vehicles on specific roads during referential periods, road characteristics (its width, the number of lanes, whether it is a one-way or a two-way road, a boulevard, the type and quality of the surface, its slope), movement speed, presence of specialized or natural sound barriers (greenery along the road, parks, etc.) between the road and the area of interest.

Data on noise levels in the city of Niš have been systematically collected and analysed through the project of monitoring the noise level during a number of years. The obtained results give us an insight into the current condition of the noise level at specific locations, allowing us to compare them to previous measurement results and use this to evaluate tendencies related to possible changes in the future.

2. RESEARCH METHODOLOGY

The city of Niš, as a unit of local autonomy, represents a subject in the system in environmental protection from noise and, as such, and in accordance with the existing laws and regulations, has the authority over providing continuous control and monitoring of the noise levels in its environment.

Noise monitoring is performed by means of systematic measurement, examination and evaluation of noise indicators - physical dimensions which describe noise in an environment and which are related to the adverse effects of noise.

2.1 The elements of environmental noise level monitoring

For the purpose of the noise level monitoring on the territory of the city of Niš, continuous measurements of the sound pressure level are performed and they define its time dependencies at 11 measurement locations within all five city municipalities. The choice of measurement spots was done in accordance with location purpose zones, resulting in the selection of measurement spots which includes:

- Leisure and recreation areas, hospital zones, cultural and historical spots, large parks;
- Tourist areas, small settlements and villages, camps and school zones;
- Purely residential districts;
- Combined business and residential districts, combined commercial and residential districts and playgrounds;
- The city centre, craftsman, commercial and administrative areas with housing, zones along highways, main roads and city traffic arteries.

The locations of measurement spots as related to nearby objects and roads were defined in accordance with the SRPS ISO 1996 standard. The noise level monitoring on the territory of the city of Niš is organized on a monthly basis, for the referential time intervals: day (06:00÷22:00) and night (22:00÷06:00). The procedure of continuous noise level monitoring lasts for 12 months (the long-time interval).

The measurement time intervals were chosen in such a way that they encompass the whole cycle of noise level changes during the referential time intervals. One measurement interval lasts for 15 minutes. The day measurement interval is divided into three periods (09:00÷12:00, 13:00÷16:00 and 18:00÷21:00), whereas the night measurement interval is

divided into two periods (22:00÷01:00 and 02:00÷05:00), which means that during 24 hours there are five measurement periods. At each measurement spot, within one cycle/month, there is one measurement instance in each of the five measurement periods (table 1).

Table 1 *The dynamics of noise monitoring*

Long-time interval:	12 months (1 year)				
No. of series:	12 (monthly) - Three series of measurements for each of the 44 measurement points within 12 months				
Reference time interval:	Day 06:00÷22:00			Night 22:00÷06:00	
Time period:	09:00 ÷ 12:00	13:00 ÷ 16:00	18:00 ÷ 21:00	22:00 ÷ 01:00	02:00 ÷ 05:00
Measurement time interval:	15 min.	15 min.	15 min.	15 min.	15 min.

Monthly measurement dynamics involve defining the time dependencies of the current noise levels at 11 measurement spots within the defined measurement locations, which means 55 measurements of the noise parameters, accompanied by defining the traffic and road parameters. The procedure of noise level monitoring at each measurement spot is determined by the following measurement parameters:

- noise parameters (noise character, equivalent noise level, percental noise level, noise level time dependency);
- traffic parameters (passenger car frequency, light and heavy truck frequency, bus and motorcycle frequency);
- road parameters (the type and width of the road, the height of buildings along the road).

2.2 The aims of environmental noise level monitoring

The continuous noise level monitoring gives an insight into the actual noise levels in the environment on the territory of the city of Niš and, with all the data it provides, serves as the basis for putting into effect activities such as:

1. establishing and applying the measures and conditions for noise protection in those areas with noise levels above the limit;
2. acoustic zoning of the city's territory;
3. protection of "silent zones";
4. developing strategic noise maps;
5. developing a local action plan of environmental noise protection;
6. monitoring and controlling the implementation of environmental noise protection measures;
7. recognizing the problem of noise in spatial planning of the new and reconstructed settlements and other areas in accordance with the SRPS U.J6.205 standard.
8. providing and obeying the established technical rules which guarantee the quality of sound protection in accordance with the standard (the standards belonging to the group SRPS U.J6) in the process of building and issuing technical acceptance certificates for residential, investment and industrial objects, small enterprise objects and city infrastructure;
9. valorisation of residential areas with regard to the ways in which various ecological indicators can represent a risk to living conditions

3. RESEARCH RESULTS

The instrument made by Brüel & Kjær, Model 2250, was used for collecting the parameters for the purpose of noise monitoring. The detailed results of the noise monitoring for each analysed measurement spot in the period from 2009 until 2011 are given in the tables 2, 3 and 4, respectively. Using the obtained information, it is possible to perform a comparative analysis of the noise level at each analysed spot during the previous three years.

Table 2 *The noise monitoring results at the measurement spot 1*

Location and description of the measurement spot 1:		Nis / Dr Zoran Djindjic Boulevard / within the Clinical Center, in front of the Department of Internal Medicine - 15 m from the building and 4 m from the edge of the road;																			
Use of the space:		Hospital zone																			
Limited noise level for day and evening / night [dB(A)]:		50 / 40																			
Dominant source of noise:		Road traffic																			
The character of the noise:		Variable broadband noise																			
The parameters of the road:		Two-way, two-lane per direction, width 10 m, speed limit 50 km/h																			
Years of monitoring:		2009.					2010.					2011.									
Period of measurement:		09-12	13-16	18-21	22-01	02-05	09-12	13-16	18-21	22-01	02-05	09-12	13-16	18-21	22-01	02-05	09-12	13-16	18-21	22-01	02-05
No. of vehicles (15 min.)		361	305	339	172	36	357	445	296	154	38	320	365	265	128	23	320	365	265	128	23
Cars		9	5	1	0	0	6	4	2	0	0	4	4	2	0	0	4	4	2	0	0
Light-duty vehicles		1	0	0	0	0	1	1	0	0	0	1	1	0	0	0	1	1	0	0	0
Heavy-duty vehicles		13	15	15	6	0	14	17	12	7	0	15	15	14	7	0	15	15	14	7	0
Buses		5	9	7	6	1	2	12	11	2	0	2	7	5	1	0	2	7	5	1	0
Motorcycles		389	335	362	185	37	381	479	321	163	39	342	392	285	136	23	342	392	285	136	23
Total		77.2	73.5	75.1	75.5	68.1	79.5	77.8	78.3	75.5	68.3	82.4	85.0	84.9	79.5	71.1	82.4	85.0	84.9	79.5	71.1
LAFmax		47.0	47.9	48.6	40.8	32.6	47.9	50.7	49.5	41.5	34.2	52.4	55.0	50.7	44.1	36.3	52.4	55.0	50.7	44.1	36.3
LAFmin		78.7	74.9	76.7	78.2	69.3	81.1	80.3	79.8	76.6	69.7	79.5	82.2	80.7	76.9	68.8	79.5	82.2	80.7	76.9	68.8
LALmax		73.9	71.6	72.8	71.4	66.5	75.8	74.8	73.9	72.9	66.3	83.5	87.1	86.8	81.2	72.5	83.5	87.1	86.8	81.2	72.5
LASmax		47.8	49.1	49.8	41.9	33.3	49.1	52.0	50.4	42.4	35.3	53.6	56.3	51.9	45.1	36.9	53.6	56.3	51.9	45.1	36.9
LASmin		70.3	69.3	70.0	67.2	63.3	71.1	71.1	69.1	69.3	63.6	75.8	76.0	75.3	74.2	66.1	75.8	76.0	75.3	74.2	66.1
L1		66.5	66.2	66.9	63.3	57.6	67.0	67.7	66.6	65.4	59.7	70.7	70.7	70.9	69.6	61.5	70.7	70.7	70.9	69.6	61.5
L5		64.9	64.8	65.3	61.6	55.7	65.5	65.9	65.4	63.8	57.4	68.8	68.9	69.0	67.5	57.8	68.8	68.9	69.0	67.5	57.8
L10		60.3	60.8	61.1	55.8	43.7	61.4	61.5	61.2	57.8	44.3	64.1	64.6	63.9	59.3	44.2	64.1	64.6	63.9	59.3	44.2
L50		54.7	55.9	55.4	47.7	35.5	55.6	57.3	56.4	48.4	36.7	58.9	60.7	57.8	50.2	38.6	58.9	60.7	57.8	50.2	38.6
L90		52.7	54.1	53.2	45.8	34.4	53.4	56.0	54.9	45.4	36.1	57.3	59.5	55.6	48.7	38.0	57.3	59.5	55.6	48.7	38.0
L95		49.2	50.9	50.7	42.5	33.4	50.6	53.4	51.9	43.3	35.1	54.8	57.5	52.8	46.4	37.1	54.8	57.5	52.8	46.4	37.1
L99		62.1	62.0	62.4	58.4	51.9	62.9	63.2	62.5	60.5	53.0	66.4	66.9	66.3	63.9	54.1	66.4	66.9	66.3	63.9	54.1
Leq		12.1	12.0	12.4	18.4	11.9	12.9	13.2	12.5	20.5	13.0	16.4	16.9	16.3	23.9	14.1	16.4	16.9	16.3	23.9	14.1
Exceeding the limit level [dB(A)]					56		63		58		61		67		61		67		67		61
Rating noise level [dB(A)]					12		13		18		17		21		21		21		21		21
Exceeding the limit level [dB(A)]					16		13		18		17		21		21		21		21		21

Table 3 The noise monitoring results at the measurement spot 2

Location and description of the measurement spot 2:		Nis / Vozda Karadjordja Str./ within the school "Vozd Karadjordje", in front of the main entrance to the school - from 6 m, and 4 m from the edge of the road;														
Use of the space:		School zone														
Limited noise level for day and evening / night [dB(A)]:		50 / 45														
Dominant source of noise:		Road traffic														
The character of the noise:		Variable broadband noise														
The parameters of the road:		Two-way, two-lane per direction, width 10 m, speed limit 30 km/h														
Years of monitoring:		2009.					2010.					2011.				
Period of measurement:		09-12	13-16	18-21	22-01	02-05	09-12	13-16	18-21	22-01	02-05	09-12	13-16	18-21	22-01	02-05
No. of vehicles (15 min)		238	307	231	136	41	253	299	137	32	277	335	239	135	49	
Cars		3	3	1	0	0	4	2	0	1	4	2	1	0	0	
Light-duty vehicles		0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Heavy-duty vehicles		11	16	12	6	0	12	17	7	0	10	15	14	5	1	
Buses		4	9	8	7	1	3	13	1	0	3	14	7	1	0	
Motorcycles		256	336	252	150	41	274	330	146	33	295	365	261	142	50	
Total		84.4	82.7	84.1	83.2	77.3	82.2	85.3	79.5	77.1	83.9	93.7	87.0	87.8	77.7	
LAFmax		51.5	53.2	49.2	44.5	41.8	54.1	52.0	44.6	38.4	52.1	53.8	48.2	46.4	37.7	
LAFmin		85.8	83.7	85.6	84.6	78.3	83.6	86.6	81.1	78.5	82.4	92.1	85.6	85.7	75.1	
LAImax		81.5	80.7	81.7	79.7	74.7	79.9	82.4	76.8	74.1	84.2	93.4	86.8	87.7	78.1	
LASmax		53.3	54.7	50.3	45.4	42.9	55.6	53.4	45.5	38.9	53.1	55.3	50.0	47.7	38.3	
LASmin		77.4	77.5	76.3	74.5	68.7	77.3	78.5	74.2	70.5	76.7	80.4	79.3	77.3	71.3	
L1		71.9	73.4	71.1	69.8	65.1	72.1	74.0	70.2	66.4	72.1	73.2	73.4	70.9	67.4	
L5		69.7	70.7	69.2	67.8	62.7	69.8	71.3	68.4	63.5	69.7	70.7	70.8	69.0	64.5	
L10		64.8	65.3	64.2	61.9	49.8	64.9	65.6	62.2	48.5	64.6	65.9	64.6	62.7	51.5	
L50		58.9	60.5	57.9	51.7	44.2	60.3	60.4	52.2	40.3	58.6	60.6	57.9	53.5	42.3	
L90		57.4	58.8	55.6	49.4	43.6	58.8	58.3	49.9	39.7	56.8	59.0	55.8	51.5	40.9	
L95		54.2	55.8	52.2	46.1	42.7	56.6	55.0	46.4	38.9	54.0	56.1	51.6	49.0	39.4	
L99		67.4	68.0	67.0	64.9	58.7	67.4	68.6	65.0	59.3	67.3	70.9	68.6	66.8	60.4	
Leq		17.4	18.0	17.0	19.9	13.7	17.4	18.6	20.0	14.3	17.3	20.9	18.6	21.8	15.4	
Exceeding the lim. level [dB(A)]		63					63					65				
Rating noise level [dB(A)]		67					68					69				
Exceeding the lim. level [dB(A)]		17					18					19				
Exceeding the lim. level [dB(A)]		18					18					20				

Table 4 The noise monitoring results at the measurement spot 3

Location and description of the measurement spot 3:		Nis / Kralja Milana Square / the beginning of Milan Obrenovic street (pedestrian zone), in parallel with the residential-bussines building "Gorca" - 5 m from the building and 4 m from the edge of the road;															
Use of the space:		City center															
Limited noise level for day and evening / night [dB(A)]:		65 / 55															
Dominant source of noise:		Road traffic															
The character of the noise:		Variable broadband noise															
The parameters of the road:		Two-way, two-lane per direction, width 10 m, speed limit 50 km/h															
Years of monitoring:		2009.					2010.					2011.					
Period of measurement:		09-12	13-16	18-21	22-01	02-05	09-12	13-16	18-21	22-01	02-05	09-12	13-16	18-21	22-01	02-05	
No. of vehicles (15 min.)		278	324	249	115	29	273	360	262	89	23	314	357	233	117	18	
Cars		6	1	0	0	1	3	1	1	0	1	3	1	1	0	1	
Light-duty vehicles		1	0	0	0	0	0	0	0	0	0	1	0	0	1	0	
Heavy-duty vehicles		22	34	15	5	1	20	31	22	5	1	25	36	22	9	2	
Buses		3	7	5	5	0	5	8	9	4	0	4	13	7	3	0	
Motorcycles		310	366	270	125	31	302	401	294	99	26	346	408	263	130	21	
Total		89.3	85.9	84.1	89.5	81.0	85.7	85.0	90.1	84.7	88.0	87.2	86.2	87.7	87.3	81.6	
LAFmax		57.0	59.2	56.9	47.0	39.1	54.8	58.0	54.4	47.3	40.3	56.0	58.8	55.1	51.6	44.5	
LAFmin		91.7	87.7	86.8	91.0	82.4	87.3	86.0	91.9	86.0	89.3	84.5	83.3	84.0	83.7	79.6	
LAFmax		84.6	82.9	80.2	86.1	78.8	83.2	82.8	86.6	81.5	84.7	88.5	87.0	89.0	89.6	83.0	
LASmax		58.4	60.2	57.9	48.6	39.9	56.2	58.8	55.5	48.0	41.0	57.3	59.9	56.2	52.6	44.9	
LASmin		80.0	80.8	77.7	78.5	74.4	81.4	79.3	81.2	76.2	73.3	81.8	80.1	79.4	80.4	73.3	
L1		75.1	75.8	73.1	73.5	69.5	75.3	74.4	75.7	70.7	68.0	76.4	76.3	75.4	75.3	67.9	
L5		72.8	73.9	71.2	71.2	66.1	71.3	72.3	73.1	68.9	64.7	74.1	74.2	73.3	73.2	64.3	
L10		67.9	68.7	66.3	64.2	50.8	65.5	67.3	67.0	61.3	49.6	68.9	68.6	68.1	65.7	50.5	
L50		62.9	64.0	61.5	55.1	43.7	60.5	63.4	61.2	53.5	42.6	63.9	64.7	62.0	57.7	45.7	
L90		61.5	62.8	60.4	52.9	42.7	59.1	62.2	59.5	52.1	41.8	62.1	63.5	60.1	56.2	45.4	
L95		59.0	61.1	58.7	49.6	41.0	56.9	59.9	56.9	48.9	41.1	59.3	61.6	57.2	53.8	45.1	
L99		70.4	71.1	68.5	68.6	62.6	69.8	69.7	70.6	65.8	63.1	71.6	71.2	70.5	69.8	61.5	
Leq		5.4	6.1	3.5	13.6	7.6	4.8	4.7	5.6	10.8	8.1	6.6	6.2	5.5	14.8	6.5	
Exceeding the lim. level [dB(A)]		70		67		70		65		71		67		67		67	
Rating noise level [dB(A)]		5		12		5		10		6		12		6		12	
Exceeding the lim. level [dB(A)]		70		67		70		65		71		67		67		67	

4. THE ANALYSIS OF RESEARCH RESULTS

Based on the results of the noise monitoring on the territory of the city of Niš, this paper pays special attention to analysing the change in the noise parameters at three characteristic measurement spots during the previous three years (2009÷2011). The selected measurement spots are located in the vicinity of the main traffic artery going through the city centre and along which we find areas serving different purposes and having various contents. The characteristic which the three selected spots have in common is the intensity of traffic during the entire day, traffic being the main source of noise at these locations.

4.1 The analysis of the noise monitoring at the measurement spot 1

Dr Zorana Đinđića Boulevard is one of the busiest streets in the city of Niš, which means that the noise level in its vicinity is determined by the structure and the dynamics of road traffic. By comparing the results obtained at the measurement spot 1 in the previous three years and weighing them against the allowed values of the noise level at the given location, we can conclude the following:

- The equivalent noise level in the day and night measurement periods shows a trend of permanent growth year after year (figures 1 and 2);
- The equivalent noise level in the day and night measurement periods went beyond the allowed level of 50 dB(A) for the day measurement interval and 40 dB(A) for the night measurement interval, these limits being determined by the national regulation of areal contents and purposes (figures 1 and 2);

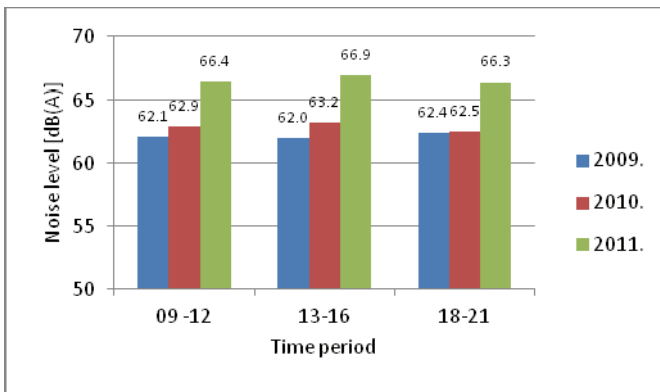


Figure 1 The trend of the change of the equivalent noise level in the day measurement periods at the measurement spot 1

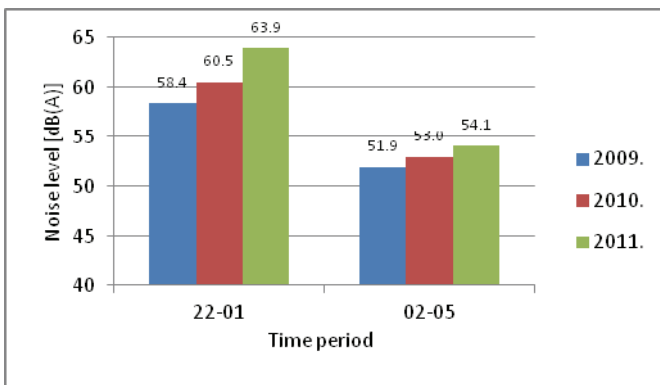


Figure 2 The trend of the change of the equivalent noise level in the night measurement periods at the measurement spot 1

- During all three years, the rating noise level for the day and the night measurement intervals went beyond the limit of the allowed noise levels at the given location (figures 3 and 4);
- The exceedings the limited noise levels were particularly noticeable during the night period and they got increased over time (figures 3 and 4);

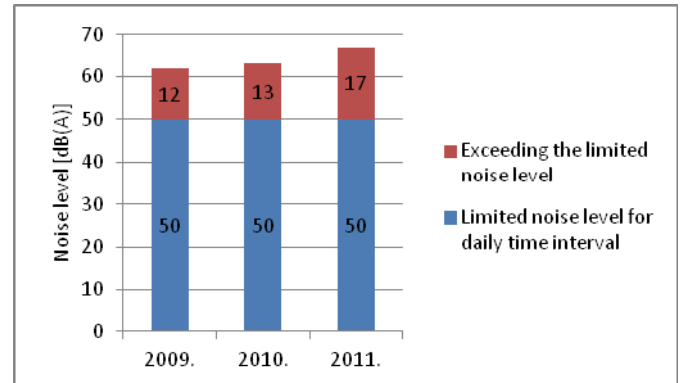


Figure 3 The trend of the change of the rating noise levels in the day measurement interval with exceedings the limited noise level at the measurement spot 1

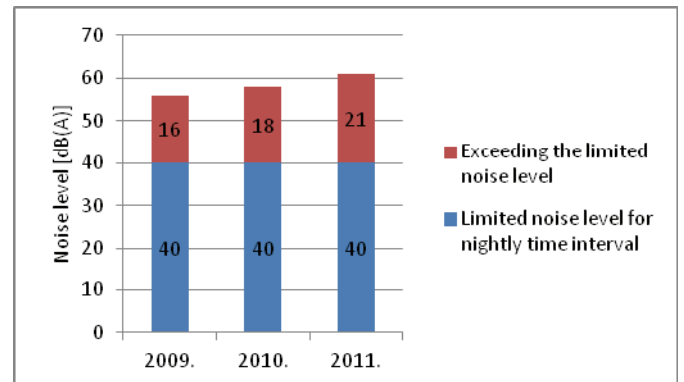


Figure 4 The trend of the change of the rating noise levels in the night measurement interval with exceedings the limited noise level at the measurement spot 1

- The structure and dynamics of road traffic had a dominant impact on the noise level at the given location;
- The structure of the traffic in dr Zorana Đinđića Boulevard predominantly involved cars (figures 5 and 6);
- A relatively small percentage of bus traffic significantly contributed to the general noise level at this location.

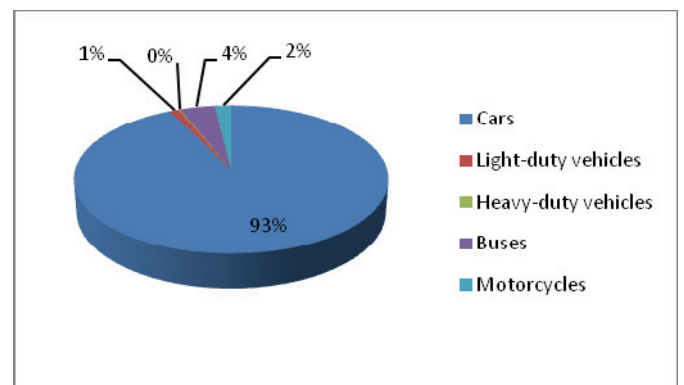


Figure 5 Vehicle structure in the day measurement interval at the measurement spot 1

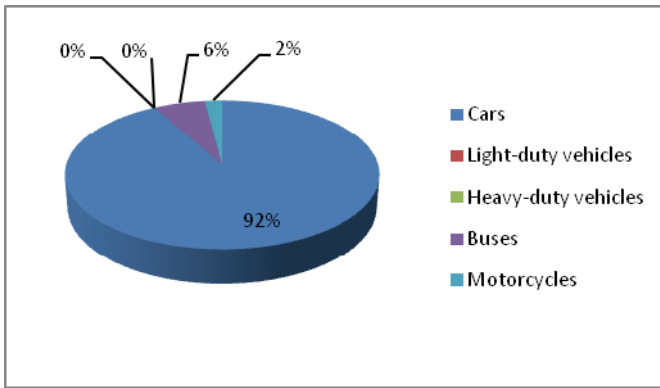


Figure 6 Vehicle structure in the night measurement interval at the measurement spot 1

4.2 The analysis of the noise monitoring at the measurement spot 2

Vožda Karadžića Street is an extension of dr Zorana Đinđića Boulevard. Similarly, it is a very busy road, which means that the noise level in the vicinity of the road is mostly determined by the structure and dynamics of the road traffic.

By comparing the results obtained at the measurement spot 2 in the previous three years and weighing them against the allowed values of the noise level at the given location, we can conclude the following:

- The equivalent noise level in the day measurement periods shows a trend of permanent in the previous two years (figure 7);
- The equivalent noise level in the night measurement period between 10:00 and 01:00 was chiefly constant, and its value varied in the period between 02:00 and 05:00 year by year, with no clear change patterns (figure 8);
- The equivalent noise level in the day and night measurement periods went beyond the allowed level of noise of 50 dB(A) for the day measurement interval and 45 dB(A) for the night measurement interval, these limits being determined by the national regulation of areal contents and purposes (figures 7 and 8);

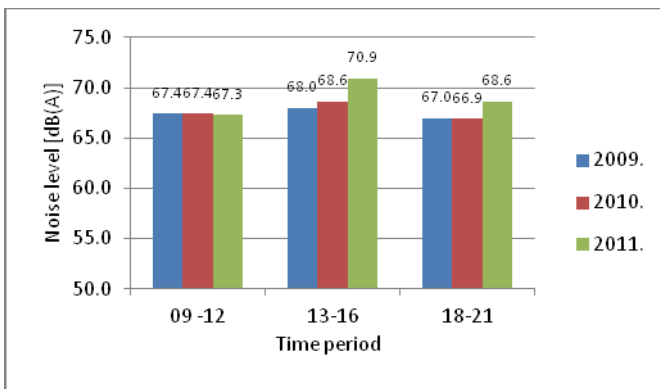


Figure 7 The trend of the change of the equivalent noise level in the day measurement periods at the measurement spot 2

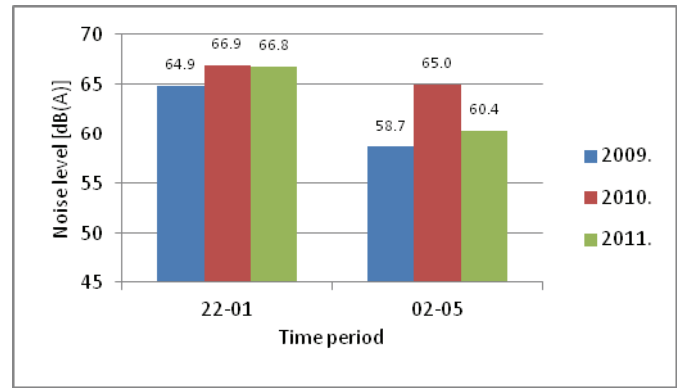


Figure 8 The trend of the change of the equivalent noise level in the night measurement periods at the measurement spot 2

- During all three years, the rating noise level for the day and the night measurement intervals went beyond the limit of the allowed noise levels at the given location (figures 9 and 10);
- Exceedings the limited noise levels are very high during both time intervals and are becoming more and more over time (figures 9 and 10).

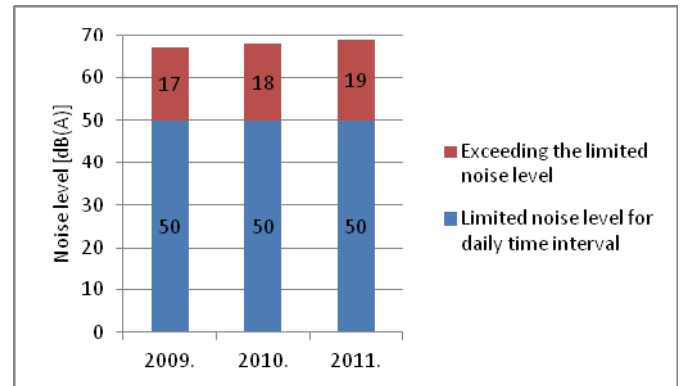


Figure 9 The trend of the change of the rating noise levels in the day measurement interval with exceeding the limited noise level at the measurement spot 2

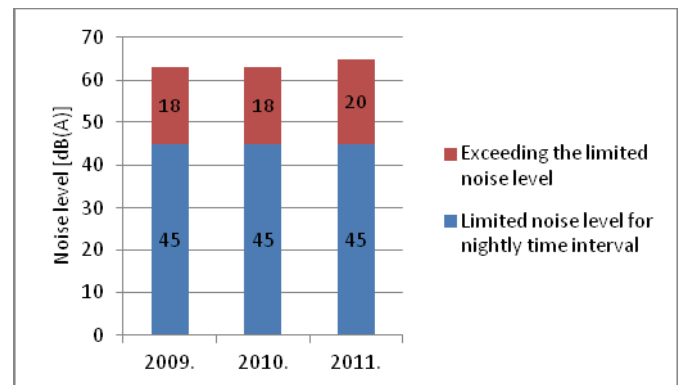


Figure 10 The trend of the change of the rating noise levels in the night measurement interval with exceeding the limited noise level at the measurement spot 2

- The structure and dynamics of road traffic had a dominant impact on the noise level at the given location;
- The structure of the traffic in Vožda Karadžića Street predominantly involved cars (figures 11 and 12);
- A relatively small percentage of bus traffic significantly contributed to the general noise level at this location.

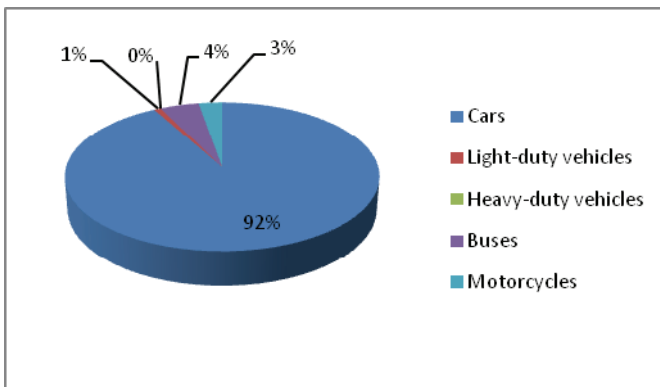


Figure 11 Vehicle structure in the day measurement interval at the measurement spot 2

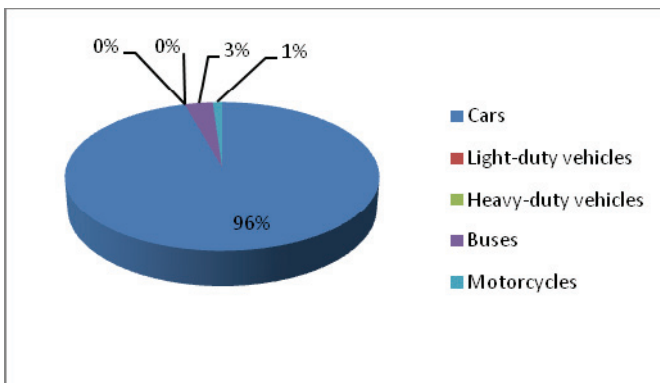


Figure 12 Vehicle structure in the night measurement interval at the measurement spot 2

4.3 The analysis of the noise monitoring at the measurement spot 3

Kralja Milana Square represents the very centre of the city of Niš. It is characterized by very intense communal activities, which are the consequence of the traffic in Vožda Karadžića Street and Generala Milojka Lešjanina Street, of the structure and the activity of pedestrians in the pedestrian zone in Milana Obrenovića Street, as well as other activities characteristic of the city core.

The noise level in the vicinity of the road is mostly determined by the structure and dynamics of the road traffic.

By comparing the results obtained at the measurement spot 3 in the previous three years and weighing them against the allowed values of the noise level at the given location, we can conclude the following:

- The equivalent noise level in the day and night measurement periods shows a trend of permanent growth year after year (figures 13 and 14);
- The equivalent noise level in the day and night measurement periods went beyond the allowed level of noise of 65 dB(A) for the day measurement interval and 55 dB(A) for the night measurement interval, these limits being determined by the national regulation of areal contents and purposes (figures 13 and 14);

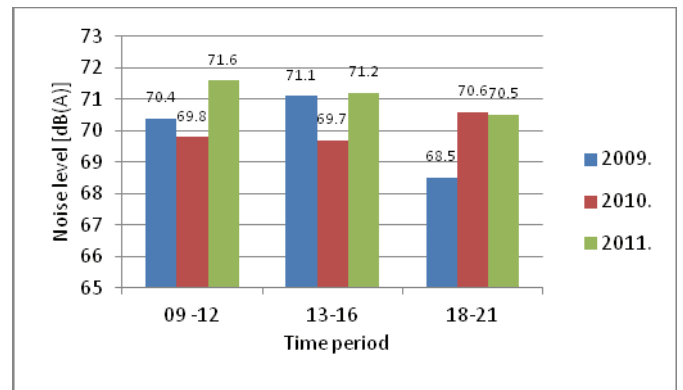


Figure 13 The trend of the change of the equivalent noise level in the day measurement periods at the measurement spot 3

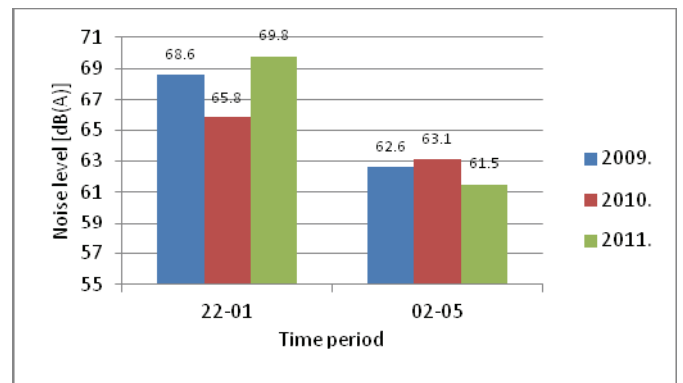


Figure 14 The trend of the change of the equivalent noise level in the night measurement periods at the measurement spot 3

- During all three years, the rating noise level for the day and the night measurement intervals went beyond the limit of the allowed noise levels at the given location (figures 15 and 16);
- The extent of exceeding the limited noise levels varied to a small degree year by year – the rating noise level at the given location was mostly constant. The exceedings the limited noise levels were particularly noticeable during the night period (figures 15 and 16).

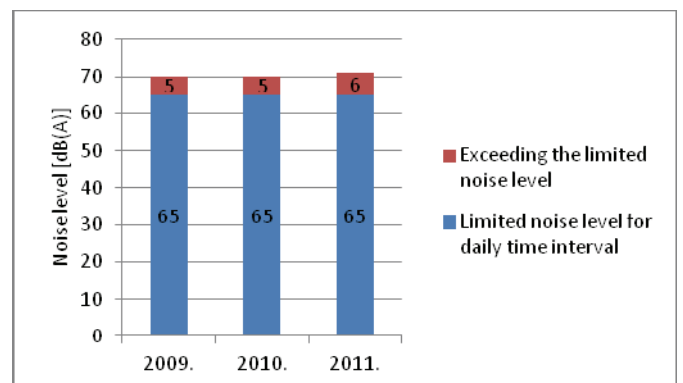


Figure 15 The trend of the change of the rating noise levels in the day measurement interval with exceeding the limited noise level at the measurement spot 3

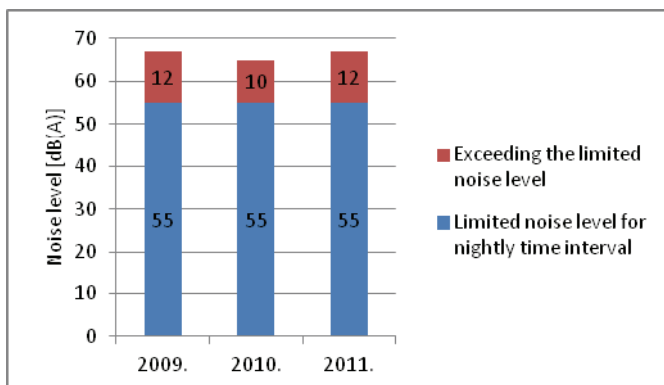


Figure 16 The trend of the change of the rating noise levels in the night measurement interval with exceeding the limited noise level at the measurement spot 3

- The structure and dynamics of road traffic had a dominant impact on the noise level at the given location;
- The structure of the traffic in Kralja Milana Square predominantly involved cars (figures 17 and 18);
- A relatively small percentage of bus traffic significantly contributed to the general noise level at this location.

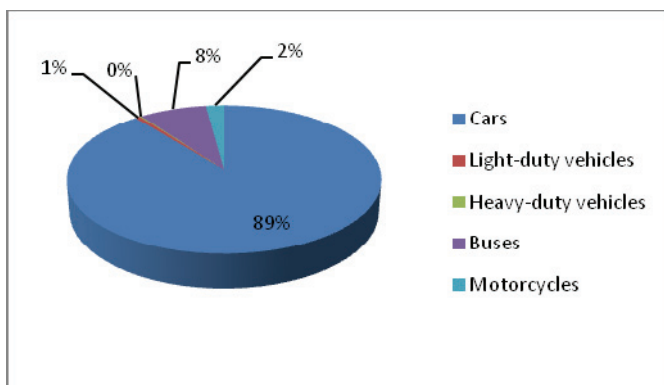


Figure 17 Vehicle structure in the day measurement interval at the measurement spot 3

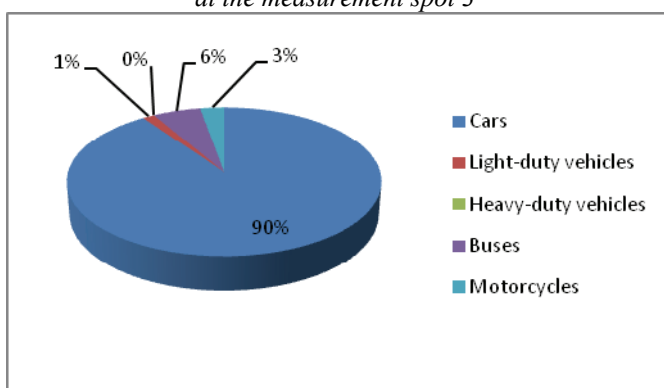


Figure 18 Vehicle structure in the night measurement interval at the measurement spot 3

4.4 A general analysis of the level of noise on the territory of the city of Niš

On the basis of the noise level monitoring results for the years 2009, 2010 and 2011, it is possible to create an overview of the noise levels on the territory of the city of Niš in the previous period. An essential piece of information in the process of evaluating noise pollution is the yearly percentage of the measurement spots (44 of them) with the associated referential level values – table 5, followed by the

yearly percentage of the measurement spots with the intervals of the exceedings the limited noise levels for specific measurement intervals in accordance with the areal contents and purposes (SRPS U.J6.205) – table 6.

Table 5 The yearly percentage of the measurement spots with the values of the rating noise levels within the specific range

Rating noise level [dB(A)]	2009.		2010.		2011.	
	day	night	day	night	day	night
40÷45	0.00	2.27	0.00	2.27	0.00	2.27
46÷50	2.27	9.09	2.27	6.82	0.00	0.00
51÷55	2.27	15.91	2.27	15.91	2.27	6.82
56÷60	20.45	38.64	20.45	45.45	4.55	27.27
61÷65	34.09	29.55	38.64	29.55	22.73	52.27
66÷70	38.64	4.55	34.05	0.00	59.09	11.36
>70	2.27	0.00	2.27	0.00	11.36	0.00

Table 6 The yearly percentage of the measurement spots with the intervals of the exceeding the limited noise level for the day and night measurement intervals

Exceeding the limited noise level [dB(A)]	2009.		2010.		2011.	
	day	night	day	night	day	night
no exceedance	41.00	7.00	41.00	7.00	41.00	7.00
1÷5	43.18	40.91	38.64	59.09	52.27	25.00
6÷10	9.09	38.64	9.09	34.09	18.18	47.73
11÷15	0.00	6.82	0.00	2.27	6.82	15.91
>15	2.27	2.27	2.27	2.27	4.55	9.09

5. CONCLUSION

The analysis of the noise monitoring on the territory of the city of Niš for the previous 3-year period (2009, 2010 and 2011) leads us towards the following conclusions:

1. Motor vehicle traffic largely influenced the noise levels at the examined locations;
2. The share of cars in the structure of vehicle was as large as 90%. A small percentage of buses which took part in the traffic had a strong impact on the noise levels at the examined locations;
3. The exceeding the limited noise levels were the gravest during the night measurement interval; One of the main reasons for this was the higher overall speed due to the lower traffic intensity;
4. The extent of the exceeding the limited noise levels at the examined locations had a tendency of growing with time – the rating noise levels were getting higher every year, which means that the exceeding the limited noise levels got bigger as well;
5. It is necessary to take serious provisions to cope with the problem of noise pollution at all locations which are proven to be endangered, first of all by preparing the required documentation and later on by urging the authorities to implement the concrete solutions.

ACKNOWLEDGEMENT

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