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TRAFFIC NOISE IN SMALL URBAN AREAS

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Abstract: *Traffic noise is often perceived as one of the biggest environmental problems. In order to implement effective measures against the traffic noise the information about its distribution – noise maps - is imperative. Current regulations as much as scientific efforts focuses large metropolitan agglomerations, although two-years (2010-12) research study in Stip (about 50.000 inhabitants) implicate excessive noise levels in the major part of city. Directed monitoring and mapping using SoundPLAN 7.1 Noise and Air Pollution Modeling Software, point to traffic as the principal community noise source, directly linked with measured noise levels. The paper presents road traffic noise measurement and mapping results in small but dynamic city of Stip, pointing to growing concern about noise levels in similar environments all over South Eastern Europe.*

Key words: *traffic noise, excessive, urban area, noise level.*

1 INTRODUCTION

Noise is one of the major environmental issues of modern world originating from a wide variety of sources, including traffic (air, road, rail), industrial facilities, or social activities [1]. In the European Union about 40% of the population is exposed to road traffic noise with an noise level exceeding 55 dB(A) daytime, and 20% are exposed to levels exceeding 65 dB(A) [16]. When all transportation noise is considered, more than half of all European Union citizens is

estimated to live in zones that do not ensure acoustical comfort to residents. At night, more than 30% are exposed to equivalent noise levels exceeding 55 dB(A), which are disturbing to sleep [16]. Noise pollution is also severe in cities of developing countries. It is caused mainly by traffic and alongside densely-travelled roads equivalent noise levels for 24 hours can reach 75-80 dB(A). In contrast to many other environmental problems, noise pollution continues to grow and it is accompanied by an increasing number of complaints from people exposed to the noise. The growth in noise pollution is unsustainable because it involves direct, as well as cumulative, adverse health effects [9] [10].

2 FACTORS THAT DETERMINE ROAD TRAFFIC NOISE LEVEL

Approximately 60-80 percent of the noise level in cities comes from vehicles. Noise penetrates into the residential areas, public buildings and other personal environment [2]. The traffic flow was continuously increasing during the last decade; herewith traffic noise has increased approximately by 10-12 dB(A).

The noise of road vehicles is mainly generated from the engine and from frictional contact between the vehicle and the ground and air. In general, road-contact noise exceeds engine noise at speeds higher than 60 km/h. The quality of road pavement is also a factor increasing the noise level in the city. The vehicle speed and traffic flow intensity influence the noise level greatly. The motor vehicle intensity is the main factor of the community noise level in the city [3].

Fig. 1 and Tab. 1 shows tyre/road noise generation in dependence of different porous surfaces.

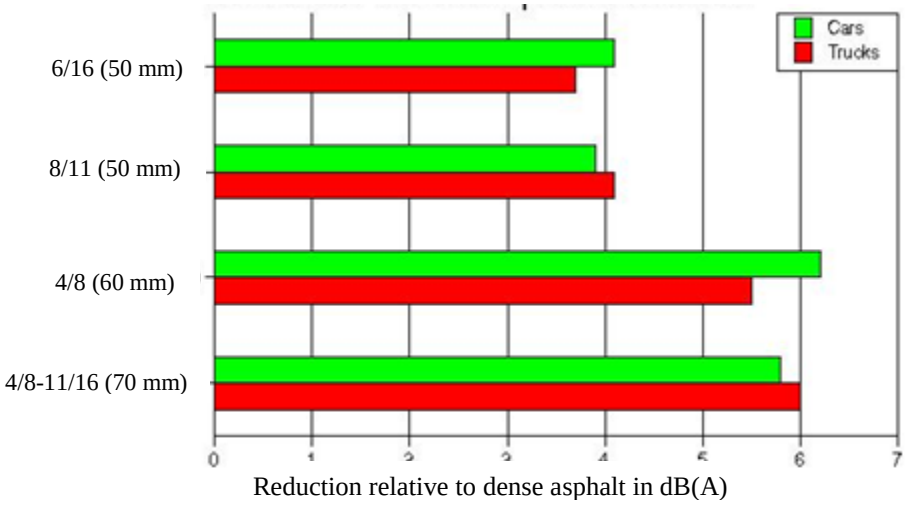

Fig.1 *Noise reduction of 4 types of porous road surfaces relative to dense asphalt concrete*

Tab.1 *Noise absorbance ability of different types of porous road surfaces*

Surface type	Stone size grading	Thickness[mm]	Frequency of max. absorbance in Hz	Max.absorbance %
Dense	0-16	-	-	-
Porous	6-16	55	840	89

Porous	4-8	60	810	95
Porous double layer	4-8 (top)	25 (top) 40 (bottom)	600	92
Porous	8-11	50	900	87

Fig.2 shows noise reduction dependence of different porous asphalt and different vehicle speeds.

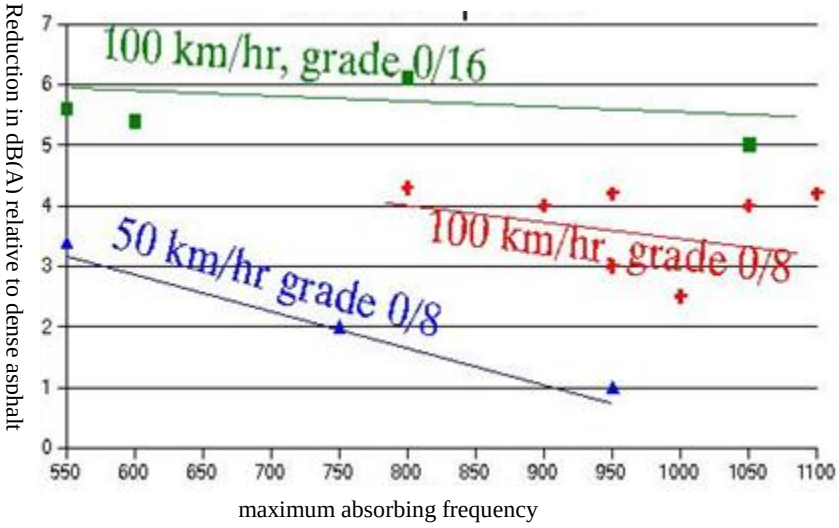

Fig.2 *Noise reduction of porous asphalt for different vehicle speeds*

3 METHODS AND MATERIALS

Two-years monitoring (2010-2012) covers 24 hours continuous noise level measurements on strategic measurement points according to Regulations for locations of the measurement stations and measurement points ("Official Gazette of Republic of Macedonia " No.120/08) expressed by the noise indicator for day-evening-night (L_{den}) in dB (A).

Measurements were performed in 1/3 frequency octave band according to ISO 1996-2:1987 with Sound Level Meter, Class 1: IEC 61762, type CR: 831C and Carrying Case SK: 250 at a height of 4 m in the vicinity of buildings and most exposed facade to the noise source [14]. Data from measurements are logged at intervals of 1 s for whole measurement period and processed with specialized Deaf Defier 3 Software of Cirrus Research Plc. Version 3.3.04.

Using SoundPLAN Noise and Air Pollution Modeling Software, noise dispersion model (noise maps) were generated for entire Stip urabn area .

Indicator for noise disturbance during the day (L_d) covers the period of 12 hours, from 7 am to 7 pm (7-19) [12], Indicator for noise disturbance during the evening (L_e) covers the period of 4 hours, from 7 pm to 11 pm (19- 23) [12] and Indicator for noise disturbance during the night (L_n) covers the period of 8 hours, from 11 pm to 7 am (23 - 7) [12]. These time slices are defned as a Emission time slices in the SoundPLAN Manager (Fig.3) .

Fig.3 *SoundPLAN Manager*

Road traffic noise was predicted according to the French national computation method 'NMPB-Routes-96 (Fig.3) (SETRA-CERTU-LCPCCSTB)', referred to in 'Arrêté du 5 mai 1995 relatif au bruit des infrastructures routières, Journal Officiel du 10 may 1995, Article 6' and in the French standard 'XPS 31-133'. For input data concerning emission, these documents refer to the 'Guide du bruit des transports terrestres, fascicule prévision des niveaux sonores, CETUR [12].

Roads in the acoustics and air pollution modeling are used as a line source. The road master alignment is entered with X and Y coordinates and the elevation of the road surface above sea level [15]. The width of the road and the distance of the emission bands are defined in the tab index card PROFILE in Road properties window (Fig.4). The elevation of the emission band is computed automatically from the elevation of the road surface according to the used standard.

Assumption for traffic data [6] [7]:

- The road traffic includes all types of vehicles such as light vehicles, small vehicles, heavy vehicles and light trucks
- The noise is emitted from the centre line of roads.
- The type of road surface is same in the entire study area and it is assumed to be asphaltic concrete.
- The road surface of study area is flat without any undulations in ground surface.

The road traffic noise levels can be predicted from the traffic flow rate, the speed of the vehicles, the proportion of heavy vehicles, and the road properties (Fig.4 and Fig.5).

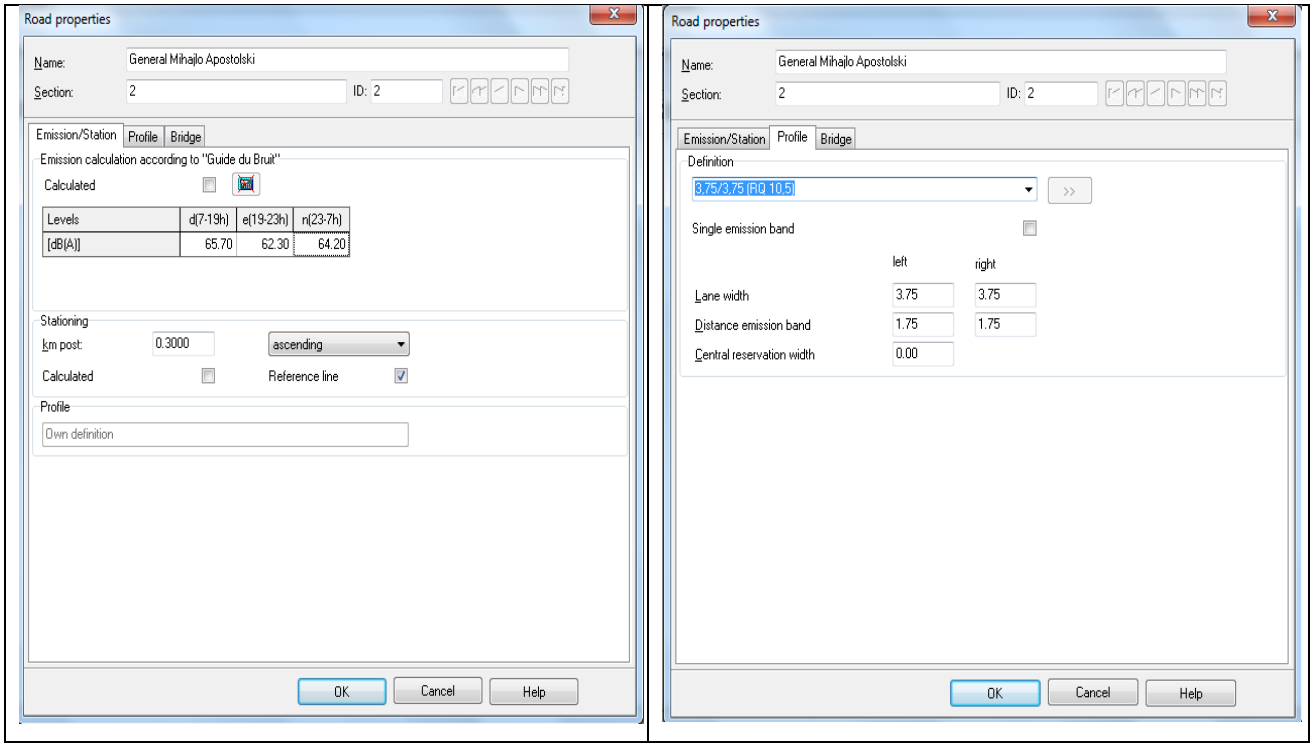

Fig.4 *Road properties Widows in SoundPLAN Software*

The dialog for the entry of the traffic volume is the same for nearly all standards; only the number of vehicle types can vary (Fig.5).

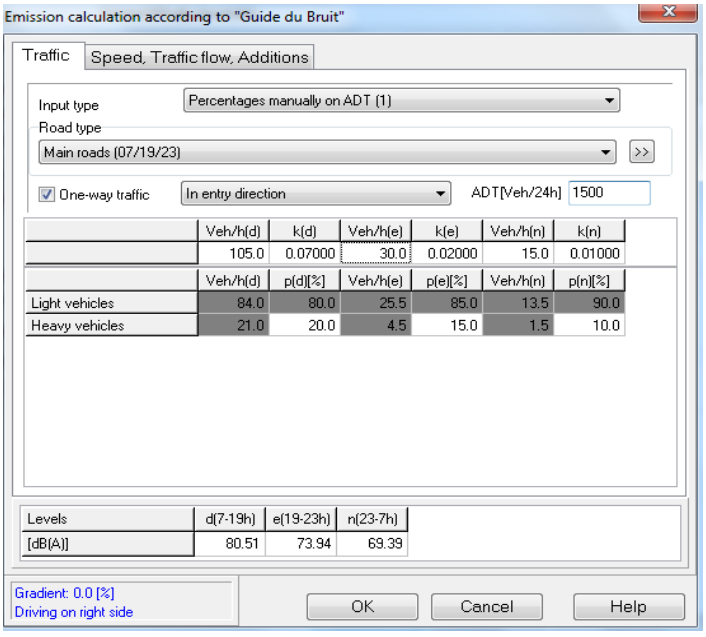

Fig.5 *Traffic flow, vehicle speed and emission calculating according to given standard*

4 RESULTS AND DISCUSION

Results from research study in framework of PhD thesis [8] showed that the equivalent noise level in Stip exceeded noise level limits for all noise indicators (L_d, L_e, L_n). The highest noise levels were found at main crossroads, because of intense traffic flow and slow permeability (Fig. 6). The average equivalent daily noise level (7 am – 7 pm) one of the main city boulevards shown on Fig.6 was 61.4 dB(A) (allowable noise level 55 dB(A)) [13], the evening level (7 pm – 11 pm) was 59.2 dB(A) (allowable noise level 55 dB(A)) [13], and night (11 pm – 7 am) level was 58.8 dB(A) (allowable noise level 45 dB(A)) [13]. The daytime noise level peak was 72.5 dB(A), the evening 70.1 dB(A), and night – 65.1 dB(A).

Those results showed that the daily and evening noise level exceeded the limits from 5 dB(A) to 7 dB(A) accordingly , while the night noise level from 12 dB(A) to 18 dB(A) above allowable level. Software generated conflict maps for daily (Fig.7) and night noise level (Fig.8) [8] clearly indicates dramatic noise pollution of residential areas surrounding the boulevard.

According to the data of two-years monitoring, 35 % of Stip urban area falls into a noise discomfort area, mainly the area close to the main streets. Approximately 30 % of city population were exposed to above 57 dB(A), and about 25 % of them live in central part of Stip. Such noise level leads to serious annoyance and sleep disturbance [1] [5]. Many studies illustrate a link between exposure to noise and negative effects on public health. Noise may severely impair quality of life (disrupt sleep, interfere with speech intelligibility), or possibly giving rise to both social and psychological problems [4]. Such type of disturbances can also create risk of cardiovascular conditions [11].

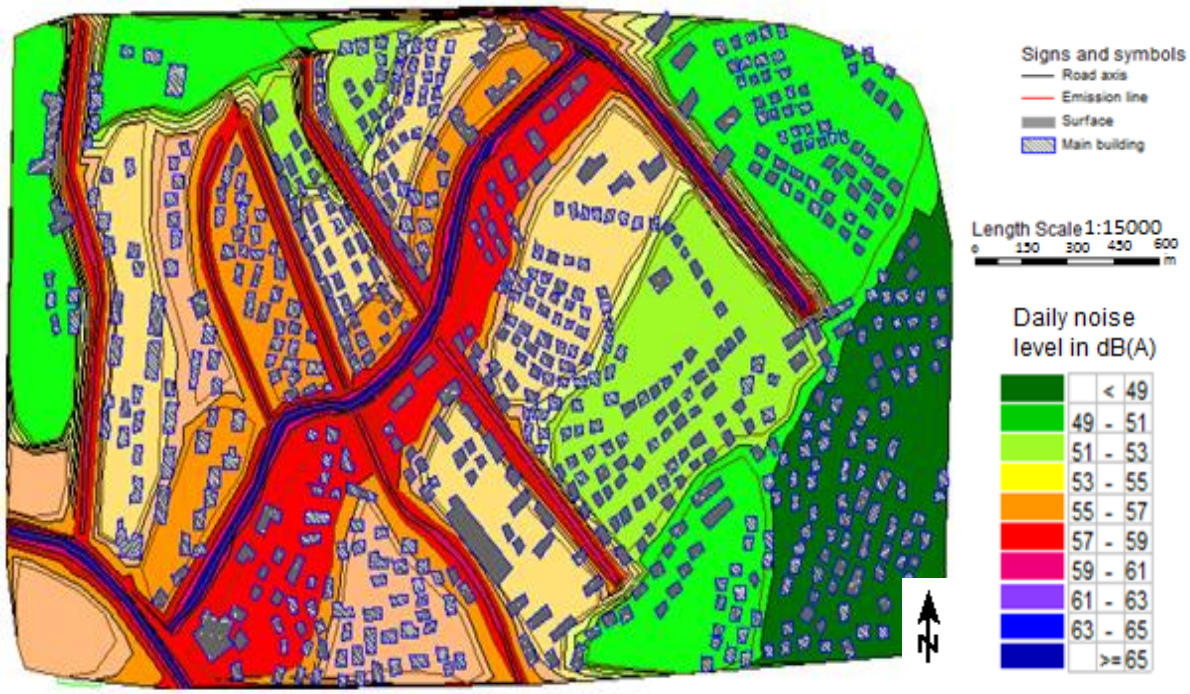

Fig.6 *2D noise map for part of Stip exposed on intense road traffic*

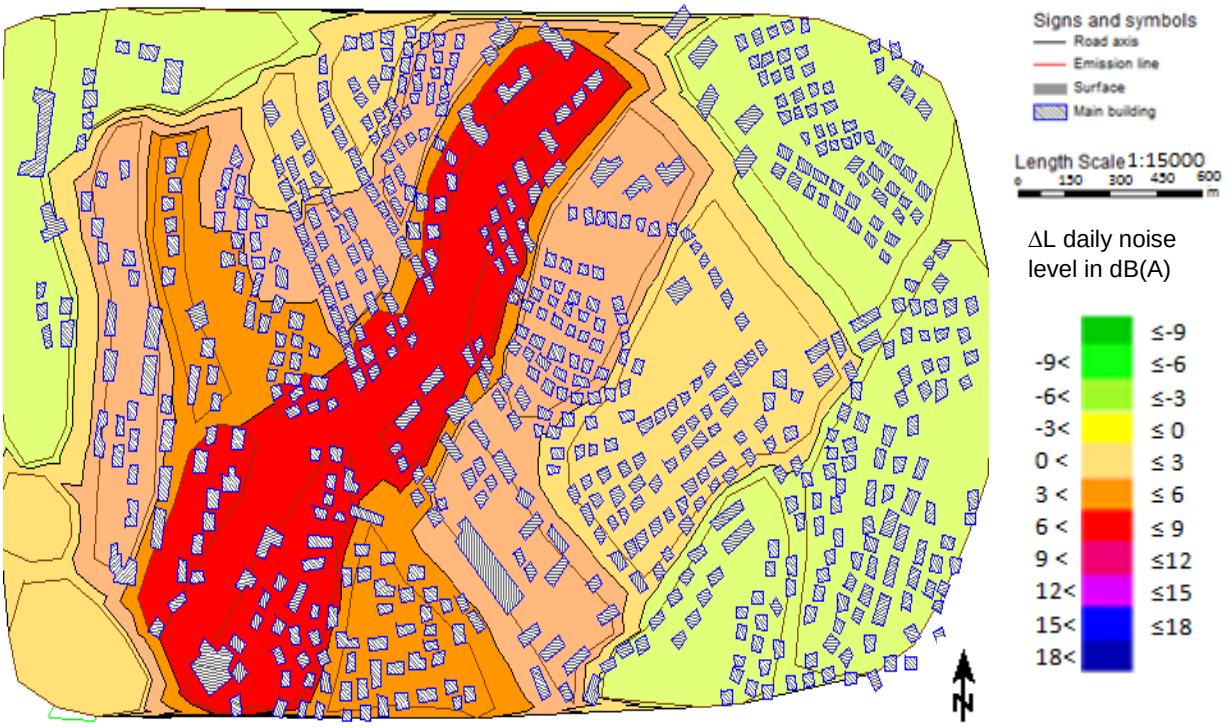

Fig.7 *2D conflict map of daily noise level for part of Stip exposed on intense road traffic*

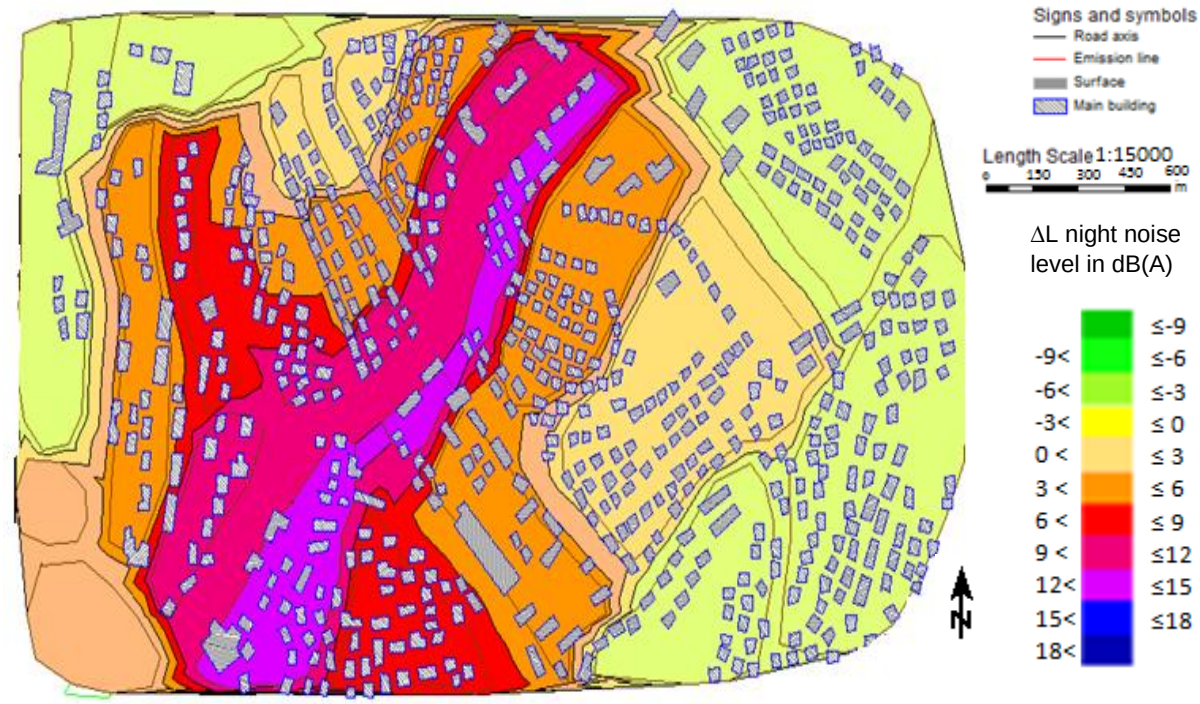

Fig.8 *2D conflict map of night noise level for part of Stip exposed on intense road traffic*

5 CONCLUSIONS

Major part of Stip urban area where administrative, commercial and cultural activities take place, is heavily affected by intensive traffic flows. Traffic jams have become an endemic feature even in such small urban areas due to insufficient street capacity. The major parts of residential buildings situated in the central urban area are directly exposed to excessive traffic noise.

There are various factors that contribute to increase of noise levels. As consequence of fast development and improper spatial planning, the densely-travelled roads are developed in a close proximity of residential and public service buildings, directly leading to excessive noise pollution. What is most concerning our research shows small but wide spread increase of noise levels in year to year basis, clearly indicating steady increase of overall noise pollution.

Strategic approach to noise pollution control in small urban areas is crucial and should start with proper noise measurement and mapping program. If properly enforced, a series of effective and applicable control measures are available, starting from limitation of vehicles access, speed limits reduction, tires quality specification or even changes in road material. Low-noise behavior of drivers should be encouraged as well, by advocating defensive driving manners.

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