OPTIMIZATION METHODS OF URBAN RAIL TRANSPORTATION AND POPULATION EXPOSURE CALCULATION

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ABSTRACT – Noise is a major source of dissatisfaction in residential areas. There are many noise sources in the urban areas, but only some of them can be taken into consideration for noise mapping and noise reduction action planning. These are: road traffic, railway traffic, airports and industry. The research paper intends to make the optimized noise map of the rail transport of Tg. Mureş city. The local authorities mentioned that they would like to reduce in the future the rail noise. Therefore it was made some investigation and resulted that one optimization could be that along the rail line where the buildings are close to one another, noise barriers could be mounted, reducing the rail noise in this way with 5 – 10 dB (A). Another optimization is welding the rail joints and reducing the speed limitation to 50 km/h along the urban area resulting a 2 dB (A) reduction.

INTRODUCTION

Noise is a major source of dissatisfaction in residential areas. There are many noise sources in the urban areas, but only some of them can be taken into consideration for noise mapping and noise reduction action planning. These are: road traffic, railway traffic, airports and industry – see references [3],[5],[1]. In order to know the effect of these noise sources on the population and buildings, we have to know as much as possible about the sources and propagation. The analysis can be done using specialized software. The result is a noise map – a map representing the noise levels as surfaces or contour lines. The input data for the simulation software are a base map and specific properties of the sources (road segments, railway segments, industrial sources and others).

POPULATION EXPOSURE CALCULATION

Population calculation could be done easily if for each building along the railway is known the number of inhabitants (stored as metadata). From the noise map is possible to identify the exposure of each façade of the building to each noise level (Figure 2). The grid cells are colored according to the equivalent noise level (intervals of 5 dB). The exact noise value is stored as Z coordinate of the cell; adding this value as metadata is not a good idea because the very high number of cells will make the execution of any other command very slow. The first step is to find all the intersections between the building contour lines and the squares representing the grid cells in the noise map. Only the x, y coordinates are used to calculate the intersections, because z is the noise value. For each intersection found the value of the noise associated to the respective grid cell is added to a list – the black list in Figure 1. This list is added to the building object in the drawing as metadata.

```
Command: rent
Select object: (("type" . "casa") ("oameni" . 238) ("lz" 61.1 60.29 60.48 58.3
61.69 59.0 58.07 61.44 54.24 54.91 50.14 58.7 61.63 55.09 57.94 61.87 54.83
61.34 54.0 57.34 54.66 56.86) ("id" . 851) ("h" . 15.0) ("categ" . "locu")
("aria" . 1451.08))
```

Figure 1. *Metadata associated to a residential building along the railway*

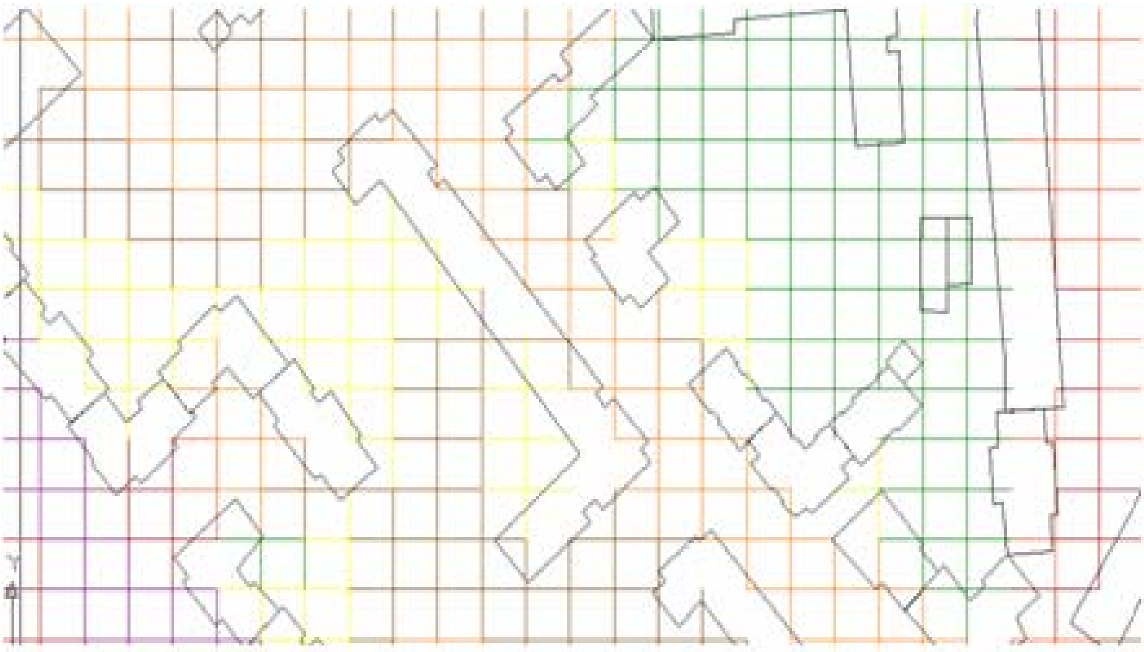

Figure 2. *Exposure of the facades [4]*

In the second phase, it is calculated the number of inhabitants exposed to each 5dB interval of noise level, then these values are added to the list of exposed people (see Figure 13).

```
Command: !lexp
((30 0) (35 0) (40 0) (45 0) (50 64.9091) (55 86.5455) (60 86.5455) (65 0) (70
0) (75 0) (80 0) (85 0))
```

Figure 3. *People exposed to different noise levels, calculation result*

The tables bellow represents the number of people exposed to the noise generated by the rail transportation [4].

Table 1. *Population exposure for Lden*

	Noise level dB (A)										
	<35	35-40	40-45	45-50	50-55	55-60	60-65	65-70	70-75	75-80	80-85
Nr. of people exposed to noise	19272	18939	11557	2861	1824	976	212	8	0	0	0

Table 2. *Population exposure for Ln*

	Noise level dB (A)										
	<35	35-40	40-45	45-50	50-55	55-60	60-65	65-70	70-75	75-80	80-85
Nr. of people exposed to noise	25669	5549	2153	1449	437	49	1	0	0	0	0

Table 3. People exposed to noise at silent façade for Lden

	Noise level dB (A)										
	<35	35-40	40-45	45-50	50-55	55-60	60-65	65-70	70-75	75-80	80-85
Nr. of people exposed to noise	96	54	34	0	0	0	0	0	0	0	0

Table 4. People exposed to noise at hospital façade for Lden

	Noise level dB (A)										
	<35	35-40	40-45	45-50	50-55	55-60	60-65	65-70	70-75	75-80	80-85
Nr. of people exposed to noise	81	87	54	15	12	6	0	0	0	0	0

Table 5. People exposed to noise at hospital façade for Ln

	Noise level dB (A)										
	<35	35-40	40-45	45-50	50-55	55-60	60-65	65-70	70-75	75-80	80-85
Nr. of people exposed to noise	38	44	12	10	0	0	0	0	0	0	0

Table 6. People exposed to noise at schools silent façade for Lden

	Noise level dB (A)										
	<35	35-40	40-45	45-50	50-55	55-60	60-65	65-70	70-75	75-80	80-85
Nr. of people exposed to noise	284	230	104	24	30	20	0	0	0	0	0

RESULTED CONFLICT AND DIFFERENCE MAPS

Using the noise maps and the conflict maps is possible to identify the hot spots and also the quiet areas, and to estimate the number of annoyed people for Lden and Lngt. The quiet areas are defined as areas of at least 4.5 hectares with a maximum noise level of 55 dB (A).

The colours used in the conflict maps are: green for a noise level with maximum 5 dB (A). lower than the limit; red is for a noise level with maximum 5 dB higher than the limit and blue is for a noise level of more than 5 dB (A). over the admitted limit. Based on the conflict maps as shown in Figure 4 and Figure 5 the number of people exposed to high noise level, the local authorities should propose action plans for reducing the noise level and its effect on the population. Taken into consideration the proposed measures, new noise maps can be created and, again, the number of people exposed to high noise levels can be ascertained. From the initial and the estimated noise maps it can be generated the difference maps, like the one shown in Figure 6 and Figure 7. The colour scale of difference maps is for intervals of 1dB (A).; in the given example orange means no change (0 dB (A).), green means a gain of 3-4 dB (A).

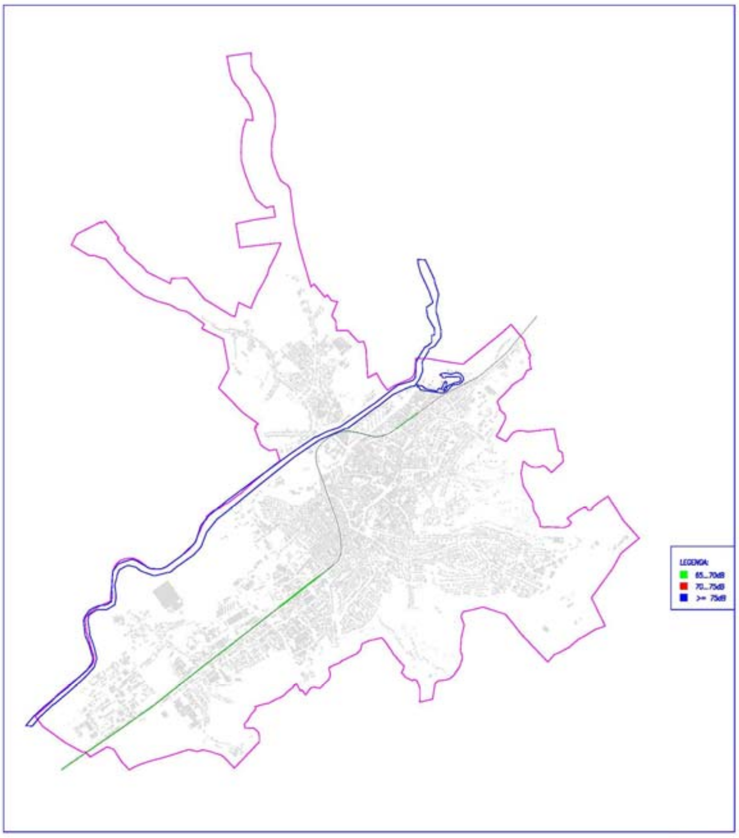

Figure 4. *The resulted urban rail conflict noise map for Lden indicators*

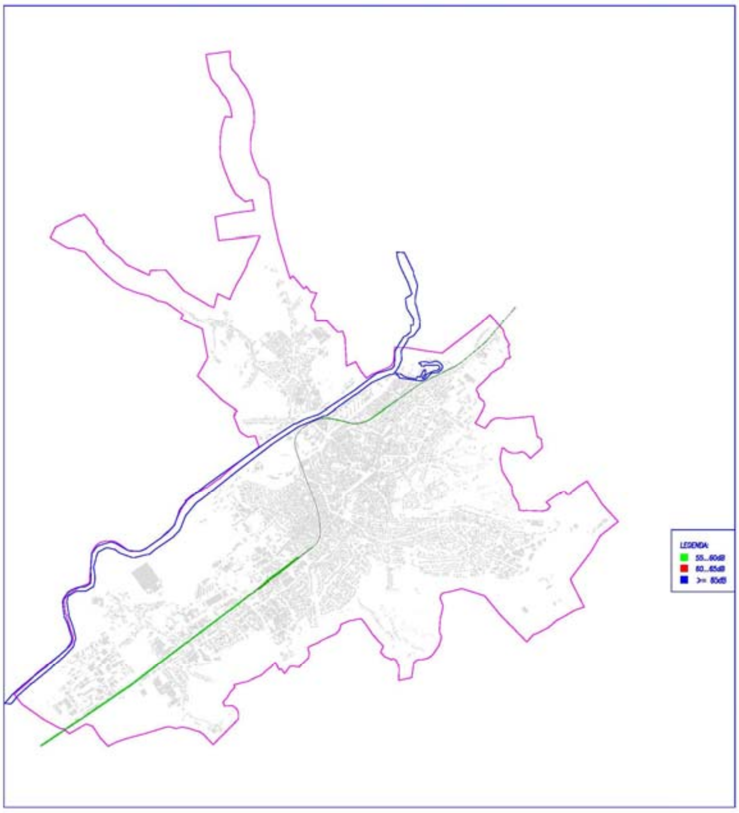

Figure 5. *The resulted urban rail conflict noise map for Ln indicators*

Figure 6. *The resulted urban rail difference noise map for Lden indicators*

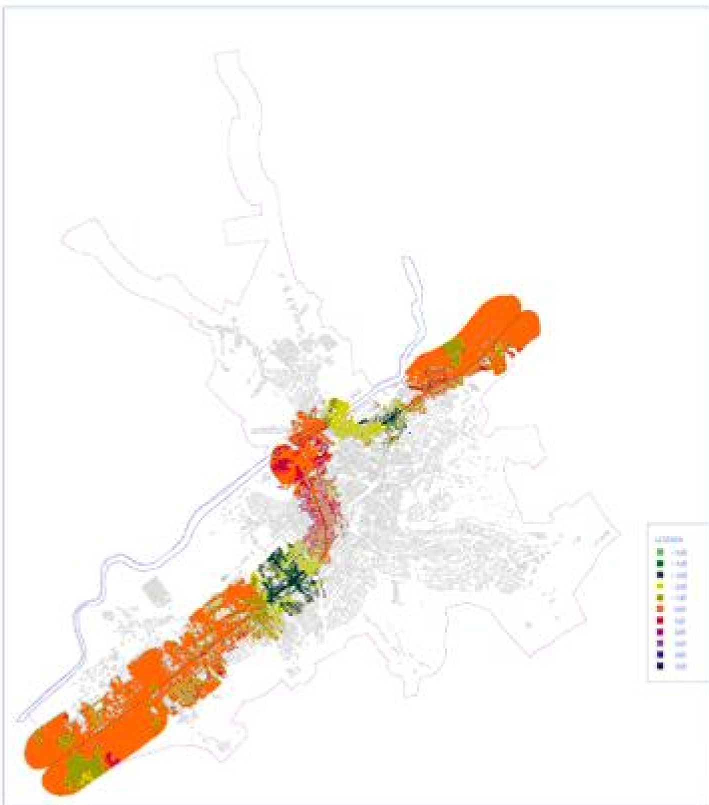

Figure 7. *The resulted urban rail difference noise map for Ln indicators*

CONCLUSSION

As you can observe in the conflict maps above at Tg. Mureş city has one line of rail emission. The resulted noise maps shows a relatively normal noise level; the limits for Lden it is 70 dB (A) and for Ln it is 65 dB (A). The local authorities mentioned that they would like to reduce in the future the rail noise. Therefore it was made some investigation and resulted that one optimization could be that along the rail line where the buildings are close to one another, noise barriers could be mounted, reducing the rail noise in this way with 5 – 10 dB (A). Another optimization is welding the rail joints and reducing the speed limitation to 50 km/h along the urban area resulting a 2 dB (A) reduction.

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