NOISE MEASUREMENTS AND NOISE DISTRIBUTION IN THE CITY OF SZEGED OVER A 6 YEAR TIME PERIOD

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Abstract
Measurements were carried out on selected points of Szeged to achieve a coarse noise distribution of the city. The measurements were aimed to obtain the environmental noise load values caused by traffic mainly. The original measurements were carried out in 2012 and they were repeated on the same location spots in 2015 and 2018.

Introduction

Almost all the information a man collects is acquired through sight and hearing (83% percent through sight and 11% through the hearing). These times more and more people live in big, crowded cities. This artificial environment when compared to the natural environment is too noisy. It can be even harmful to the hearing. It is a necessity to check from time to time that our environment is still within the healthy limits.
The normal hearing of a human ranges from 20 Hz frequency to 20000 Hz.[1]
The hearing is logarithmic. The industrial tools for noise measurements are based on sound pressure level and the data are given in decibel (dB).[2] It is given by Eq.1:

$$L_p = 20log_{10}\left(\frac{\Delta p}{p_0}\right)\ dB \qquad (1)$$

where Δp is the sound pressure fluctuation, and p_0 is the reference pressure fluctuation value (audition threshold); $p_0 = 20\ \mu Pa$.
Table 1 shows some common examples for easy comparison.

L(SPL) (dB)	*phenomenon*
0	audition threshold; mosquito at 3 m
10	human breathing at 3 m
30	theatrical stillness
40	living area at night; stillness of nature
60	office
70	street traffic at 5 m
90	noise in factory
100	jackhammer at 1 m; disco inside
120	train horn at 10 m
130	pain threshold

Table 1. Sound pressure level examples

85 dB or higher sound pressure level over a long-term exposure can cause hearing damage. The hearing damage is cumulative throughout the entire life like e.g. radioactive dosage.

The auditory sensation depends on the frequency of the sound strongly: at the same sound pressure level a 200 Hz sound feels much weaker than a 1000 Hz sound. The equal loudness curves are measured first by Harvey Fletcher and Wilden A. Munson in 1933. The measurements were reproduced in the time period of 2000-2003.[3][4][5][6]

The industrial noise meters use weighting curves to show similar responses to the human hearing. The A-weighting is used for auditory purposes. The C-weighting is almost flat; that can be used as the real physical sound pressure.[7]

Though +6 dB means twice the power, the human perception works in other way. If it is heard two times louder than it is +10 dB more.[8][9]

Also, in 2018, the measurements were extended to acquire samples of the CO_2 and CO levels of the air.

The atmospheric level of CO_2 is about 400 ppm by Mauna Loa Observatory, Hawaii (NOAA-ESRL) [10]; the normal value of CO_2-concentration at sea level is 250-350 ppm by industrial recommendations. [11]

Experimental

Figure 1 shows the different locations in Szeged where the measurements were carried out. Location 1, 3 and 5 are close to main roads in Szeged with heavy traffic. Location 2 and 6 are near less important roads, but sometimes they have heavy traffic. Location 4 is chosen to be far from any traffic; it is among housing blocks (sleeping area – no real daytime activity).

The measurements contain morning, mid-day and evening data for each location.

Out of curiosity the noise levels around the area of the Youth Days of Szeged (black area in the map) were measured, too. This festival is held in each August, and location 7 and 8 are used for it exclusively.

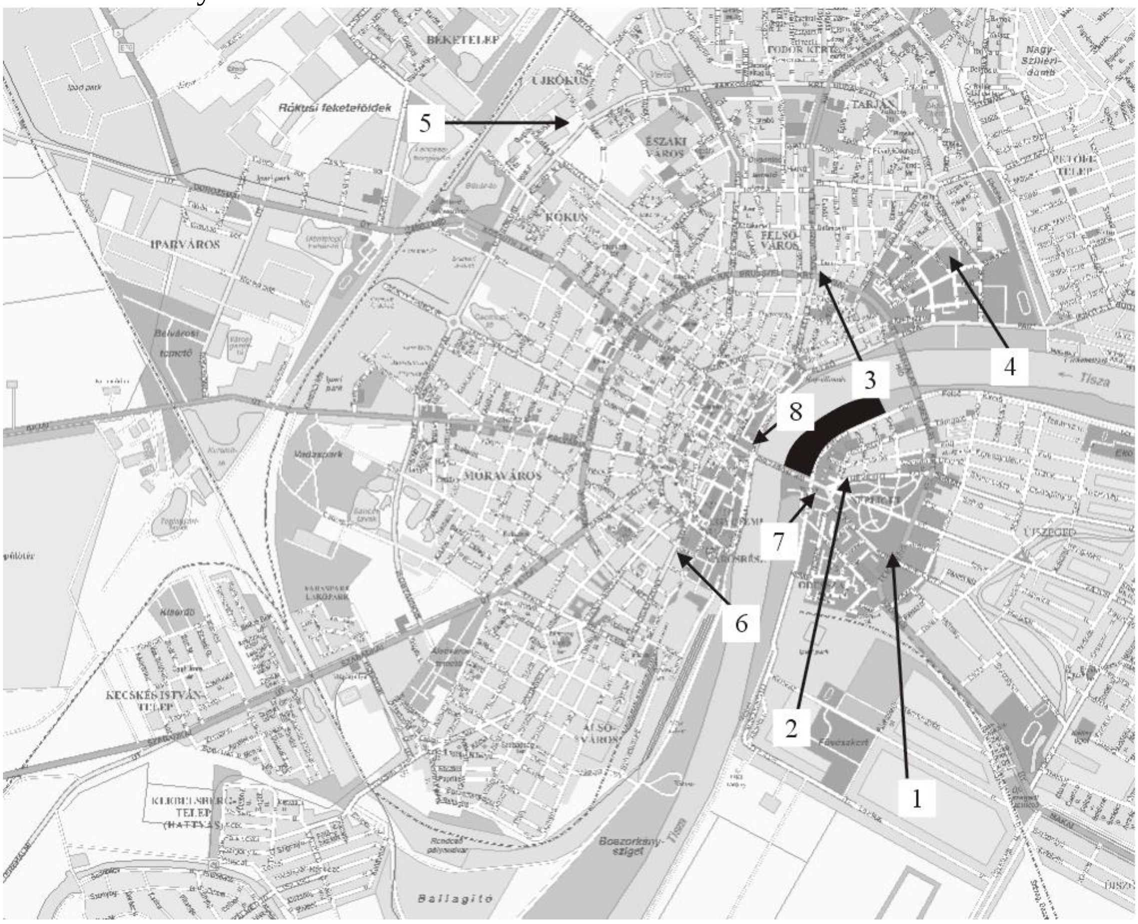

Figure 1. Locations of the measurements in Szeged

location	description (and GPS coordinates)
1	intersection of "Székely sor" and "Temesvári krt." (46^o 14.728’ N ; 020^o 09.842’ E)
2	close to the bridge (46^o 14.991’ N ; 020^o 09.605’ E)
3	intersection of "Római krt." and "József Attila sgt." (46^o 15.696’ N ; 020^o 09.479’ E)
4	near a housing block, "Csaba u. 43" (46^o 15.732’ N ; 020^o 10.116’ E)
5	school at "Rókusi krt." near Tesco (46^o 16.253’ N ; 020^o 08.290’ E)
6	school at "Boldogasszony sgt. 8" (46^o 14.759’ N ; 020^o 09.738’ E)
7	parking area at the bridge (46^o 14.933’ N ; 020^o 09.410’ E) – *only for YDS*
8	museum garden (46^o 15.124’ N ; 020^o 09.162’ E) – *only for YDS*

Table 2. Measurement location descriptions.

Results and discussion

The following tables show the current measured data for each location and all the previous values.[12] CO_2 and CO values are shown, too.

location 1	Year	*workday morning (7h-8h)*	*workday daytime (12h-15h)*	*workday evening (20h-22h)*
Sound level (dB)	2012	61.9 ± 5.2	55.5 ± 7.1	52.9 ± 6.8
Sound level (dB)	2015	64.6 ± 6.0	58.0 ± 8.0	52.2 ± 7.7
Sound level (dB)	2018	58.6 ± 7.6	56.1 ± 7.3	50.7 ± 7.0
CO_2 (ppm)		286 ± 3	189 ± 9	268 ± 6
CO (ppm)		0	0	0

Table 3. Measurements on location 1.

location 2	Year	*workday morning (7h-8h)*	*workday daytime (12h-15h)*	*workday evening (20h-22h)*
Sound level (dB)	2012	59.2 ± 7.3	57.4 ± 7.8	54.9 ± 8.1
Sound level (dB)	2015	60.7 ± 8.5	56.9 ± 9.9	55.6 ± 7.1
Sound level (dB)	2018	59.3 ± 7.7	60.1 ± 6.0	50.1 ± 6.4
CO_2 (ppm)		293 ± 17	193 ± 2	273 ± 20
CO (ppm)		0	0	0

Table 4. Measurements on location 2.

location 3	Year	*workday morning (7h-8h)*	*workday daytime (12h-15h)*	*workday evening (20h-22h)*
Sound level (dB)	2012	64.4 ± 3.4	63.4 ± 4.3	60.0 ± 4.9
Sound level (dB)	2015	67.5 ± 2.7	65.1 ± 4.0	60.1 ± 5.0
Sound level (dB)	2018	66.0 ± 3.7	64.9 ± 4.1	61.5 ± 4.7
CO_2 (ppm)		282 ± 15	174 ± 4	258 ± 5
CO (ppm)		0	0	0

Table 5. Measurements on location 3.

location 4	Year	*workday morning (7h-8h)*	*workday daytime (12h-15h)*	*workday evening (20h-22h)*
Sound level (dB)	2012	43.4 ± 2.1	50.0 ± 3.5	42.9 ± 2.9
Sound level (dB)	2015	44.6 ± 2.1	35.3 ± 2.7	42.1 ± 4.1
Sound level (dB)	2018	41.4 ± 2.5	42.5 ± 2.9	41.9 ± 0.9
CO_2 (ppm)		270 ± 7	169 ± 20	262 ± 8
CO (ppm)		0	0	0

Table 6. Measurements on location 4.

location 5	Year	*workday morning (7h-8h)*	*workday daytime (12h-15h)*	*workday evening (20h-22h)*
Sound level (dB)	2012	57.5 ± 2.9	49.3 ± 2.5	51.4 ± 3.2
Sound level (dB)	2015	52.1 ± 3.3	51.0 ± 3.3	49.0 ± 3.2
Sound level (dB)	2018	51.2 ± 2.9	52.4 ± 3.0	49.9 ± 3.1
CO_2 (ppm)		285 ± 12	189 ± 12	266 ± 6
CO (ppm)		0	0	0

Table 7. Measurements on location 5.

location 6	Year	*workday morning (7h-8h)*	*workday daytime (12h-15h)*	*workday evening (20h-22h)*
Sound level (dB)	2012	64.0 ± 3.4	59.6 ± 6.2	51.9 ± 8.3
Sound level (dB)	2015	62.9 ± 4.7	63.8 ± 4.6	60.2 ± 4.0
Sound level (dB)	2018	57.4 ± 7.6	60.3 ± 6.7	60.1 ± 3.9
CO_2 (ppm)		279 ± 7	218 ± 14	237 ± 3
CO (ppm)		0	0	0

Table 8. Measurements on location 6.

The measurements to check the noise levels of the Youth Days of Szeged are shown in table 9. The samples were taken in the time period of 22h-24h.

Youth Days of Szeged	Year	*location 1*	*location 2*	*location 7*	*location 8*
Sound level (dB)	2012	54.2 ± 6.1	59.0 ± 4.1	59.7 ± 2.4	64.9 ± 2.5
Sound level (dB)	2015	53.8 ± 7.2	60.6 ± 4.4	64.2 ± 2.3	61.3 ± 2.3
Sound level (dB)	2018	49.4 ± 4.3	58.8 ± 5.8	62.5 ± 1.6	64.4 ± 2.0
CO_2 (ppm)		254 ± 2	256 ± 11	247 ± 4	255 ± 3
CO (ppm)		0	0	0	0

Table 9. Measurements during Youth Days of Szeged.

Conclusion

The results show that Szeged is a good city to live in. It has a rather quiet acoustical environment. Even during festivals.

Surprisingly the structure of the city is very good for the air ventilation, too. The measured CO_2 values are quite low, despite the fact, that sometimes the measurements were carried out in ***1 m*** distance from the moving motor vehicles (e.g. location 2 and 6).

This work aims to measure the environmental load caused mainly by the traffic. Currently there is no real tendency in the data. Maybe later, when more and more electric vehicles will take part in the transportation some decrease could be found.

References

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