

## Assessment of the level of noise and chemical air pollution in two distinct urban areas

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Proceedings Paper

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### Abstract

In the paper are presented the results of tests on the evaluation of the level of noise and chemical air pollution in two distinct urban areas: an industrial area and an area characterized by heavy road traffic, with a focus on the novelty elements introduced by the regulations in force on the measurement and management of the level of ambient and industrial noise by periodically developing specific noise maps. The results of direct tests and noise maps developed in the case of the studied areas indicated higher values of the indicators measured near the road artery compared to the other measuring points, highlighting the influence of vegetation in urban areas to reduce noise levels and reduce air pollution.

**Keywords:** noise level, noise map, pollutants, industrial area

### INTRODUCTION

The environment is an essential element of human existence and is the result of the interference of natural elements with elements created by human activity. Ensuring a proper quality of the environment, protecting it as a necessity of survival and progress, is a matter of major interest and certain topicality [1]. Industrial development policy in recent years has aimed at transforming the industrial economy into an economy based on sustainable development interest in the protection of the environment in general and air in particular; special attention is paid to noise pollution in urban areas, due mainly to heavy road traffic and activities carried out in industrial areas [2-5].

Noise is a risk factor with harmful effects on the human body, which can lead to disorders not only of the hearing aid but also of other organs with effects on labor productivity but also on the general health of people [6-12].

At the European Union level the assessment and

management of ambient noise are regulated by Directive 2002/49/EC of the European Parliament and of the Council of 25 June 2002 on ambient noise assessment and management and Commission Directive (EU) 2015/996 OF 19 May 2015 laying down common noise assessment methods requiring the EU Member States to assess and manage ambient noise by regularly making strategic noise maps for road traffic noise sources and industrial activities as well as other types of noise. The two directives are taken up in the national legislation by Law 121/2019 thus creating a single legislative framework on ambient noise assessment and management [13-15].

Based on method standards [16-18] the noise level is determined in the frequency range 31,5 Hz – 8 kHz in 1/3 octave bands. For noise produced by road and industrial traffic, the average sound pressure level weighted on the weighting curve A is calculated according to the equation:

$$L_{Aeq,T} = 10 \cdot \lg \sum_{i=1} 10^{(L_{eq,T,i} + A_i)/10} \quad (\text{dB}) \quad (1)$$

where  $A_i$  – represents the correction corresponding to the weighting on curve A according to the standard IEC 61672-1,  $i$  - frequency band index,  $T$  – a corresponding

period.

All input values affecting the emission level of a source shall be determined at least with the accuracy corresponding to the uncertainty in the

level of the source emissions [13].

To calculate the uncertainty of measuring the noise level in the industrial zone, it is necessary to estimate the uncertainty of the measurement conditions. Thus, the determinations are made

$$u_{(sou)} = \sqrt{\sum_1^n \frac{(L_{mi} - \bar{L}_m)^2}{n-1}} \quad (\text{dB}) \quad (2)$$

where  $L_{mi}$  is the measured value representing a typical cycle of operation, expressed in decibels (dB),  $\bar{L}_m$  is the arithmetic mean of all  $L_{mi}$ , expressed in decibels (dB), and  $n$  is the total

$$u_L = \sqrt{c_L^2 u_L^2 + c_{res}^2 u_{res}^2} \quad (\text{dB}) \quad (3)$$

where:  $c_L$  is the sensitivity coefficient calculated for the measured noise level to be

$$c_L = \frac{1}{1 - 10^{-0.1(L - L_{res})}} \quad (4)$$

$c_{res}$  – is the sensitivity coefficient calculated for the measured size of the residual noise to be

$$c_{res} = \frac{-10^{-0.1(L - L_{res})}}{1 - 10^{-0.1(L - L_{res})}} \quad (5)$$

The uncertainty calculation also involves determinations of the residual noise level, measurements made at a distance large enough to eliminate or undetected the noise emitted by the tested sources [16].

For the noise level determined in the area with

$$u_{sou} = \frac{C}{\sqrt{n}} \quad (\text{dB}) \quad (6)$$

where  $n$  is the number of vehicles;

$C = 10$  for combined traffic as is the case with this study.

In this paper are presented the results of tests on the evaluation of the level of noise and chemical air pollution in two distinct urban areas: an industrial area and an area characterized by heavy road traffic, with a focus

## EXPERIMENTAL PART

### Location

Figure 1 shows the two areas studied and the points at which the measurements were made. It should be added that for noise measurements and acoustic map making, a higher number of

at distances small enough from the sources so that the variations in the sound pressure level are independent of the meteorological parameters according to equation 2:

number of all independent measurements.

The total uncertainty is given by the following equation:

determined by the equation:

determined with the equation:

heavy traffic, the equivalent leq noise level is determined by the direct counting of all vehicles (regardless of their type) passing through the vicinity of the measuring point. The number of vehicles allows the calculation of standard uncertainty:

on the novelty elements introduced by the regulations in force on the measurement and management of ambient and industrial noise levels by periodically developing specific noise maps.

measuring points were made both near the main sources and at two distances of 50 m each as required by the noise mapping program.

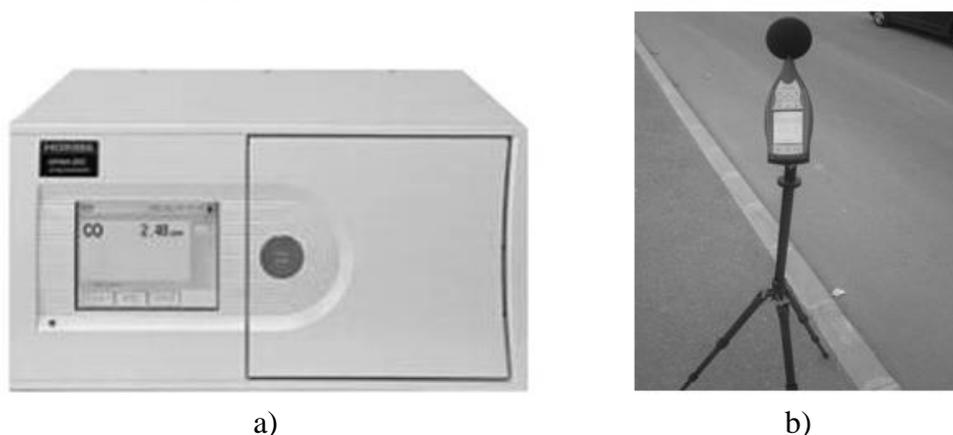


**Fig. 1.** Areas studied on noise level and concentration of pollutants in emissions (a) industrial noise zone; b) area with heavy road traffic (road intersection)

### Methods and equipment

The measurement of the noise level was carried out in compliance with the requirements of the method standard [16-18]: weather conditions for optimal measurements (stable meteorological conditions), calibrated measuring equipment before their use; thus, the meteorological parameters at the time of measurements were: ambient temperature 26°C, atmospheric pressure 1004 mbar; relative humidity 32%; wind speed 1.2 m/s, wind direction NE, nebulosity: clear skies. The noise level measurements for the industrial zone were carried out under operating conditions of the noise emission sources at maximum parameters. For pollutants determined at the emissions, 4 measuring points were established and the determinations were made under the standards of the method in force [19-21]. For the measurement of NO<sub>2</sub>, SO<sub>2</sub>, and CO at the emissions, the measuring equipment was placed

in the points shown in Figure 1 as follows: for the industrial zone at the limit of industrial property and the area with heavy road traffic (intersection) two points near the street and the other two at a distance of about 50 m from the street in the area with vegetation. The tests were carried out at a maximum activity time interval for the areas studied. Figure 2 shows the equipment with which the measurements were carried out: for pollutants in the surrounding air CO, NO<sub>2</sub> si SO<sub>2</sub> - automatic analyzers Horiba (Fig. 2a), which perform continuous measurements by the following methods: spectrometry in IR non-dispersive for CO, fluorescent for SO<sub>2</sub> and chemiluminescence for NO<sub>2</sub>; for the noise level was used Sonometer Light Brüel & Kjaer 2250 (Fig. 2b) provided with class 1 calibrator CAL 21 SOUND CALIBRATOR.



**Fig. 2.** Equipment for measurements (a) and noise level (b)

Noise level measurements were made over 10 minutes for each point and results were made to measurements representing the noise level in (dB) over the frequency range between 31.5 Hz and 8 kHz was used to make the noise map for the two areas studied. The values obtained were compared with the limits presented in the current legislation: SR 10009:2017 for the noise level, for the pollutants measured at the

emissions: NO<sub>2</sub> si SO<sub>2</sub> (1-hour measurements) - Law 104/2011; CO (30-minutes measurements) - STAS 12574-87 [22-24].

The results of noise measurements were used to make noise maps for both sites. For noise level mapping, the software was used as a software PREDICTOR 7810 Version 6.1 from Brüel & Kjaer.

### RESULTS AND DISCUSSION

Figure 3 shows graphically the values determined for the noise level in the industrial zone (Fig. 1a) and in Figure 4 the values of the

noise level measured at the points established for the characterization of noise pollution in the urban area with heavy road traffic (Fig. 1b).

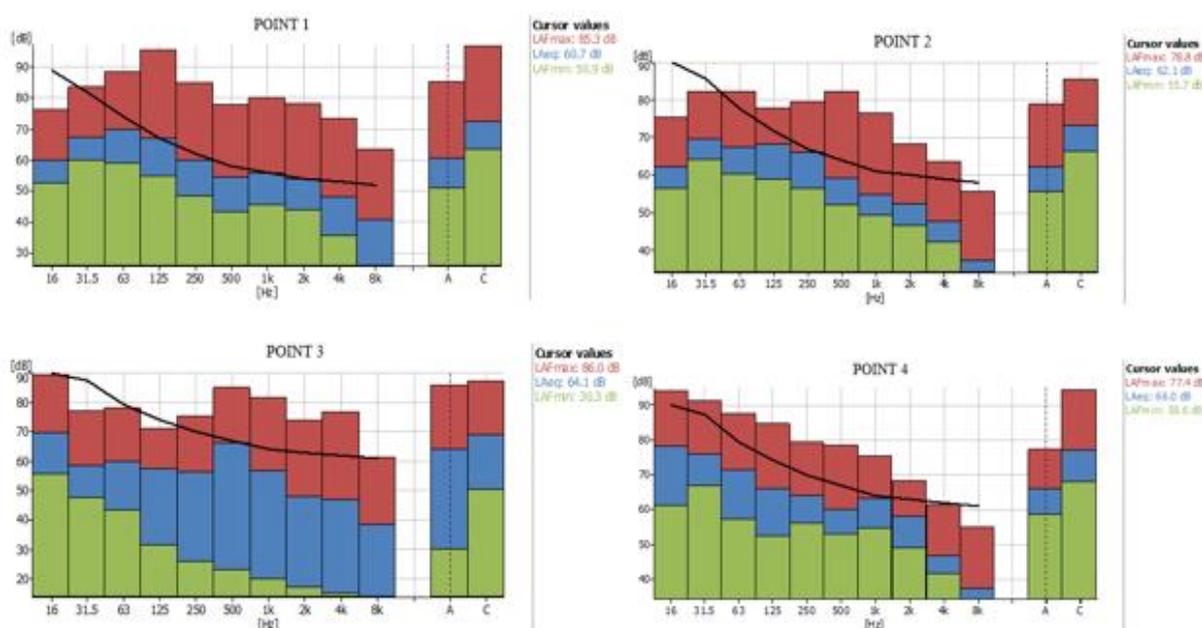


Fig. 3. Noise measurement graphs depending on the frequency at the 4 points

It is found that the values recorded in these points are: Point 1 – 60.7 dB; Point 2 - 62.1 dB; Point 3 - 64.1; Point 4 - 65.1. Note that these values are not corrected according to residual noise.

Measurements were made for residual noise to calculate the measurement uncertainty U (k=2)

$$L = 10 \lg(10^{L/10} - 10^{L_{res}/10}) \quad (\text{dB}) \quad (7)$$

After making corrections for the noise level measured according to the residual noise, values for the measured noise level between 59.2-63.8

resulting in values between  $\pm 4.2 \div \pm 4.8$ , as well as for making corrections depending on the measured noise level. Thus, because the difference between the measured and residual noise level is greater than 3 dB, corrections were required using the equation:

dB values that fall within the limits stipulated in the legislation.

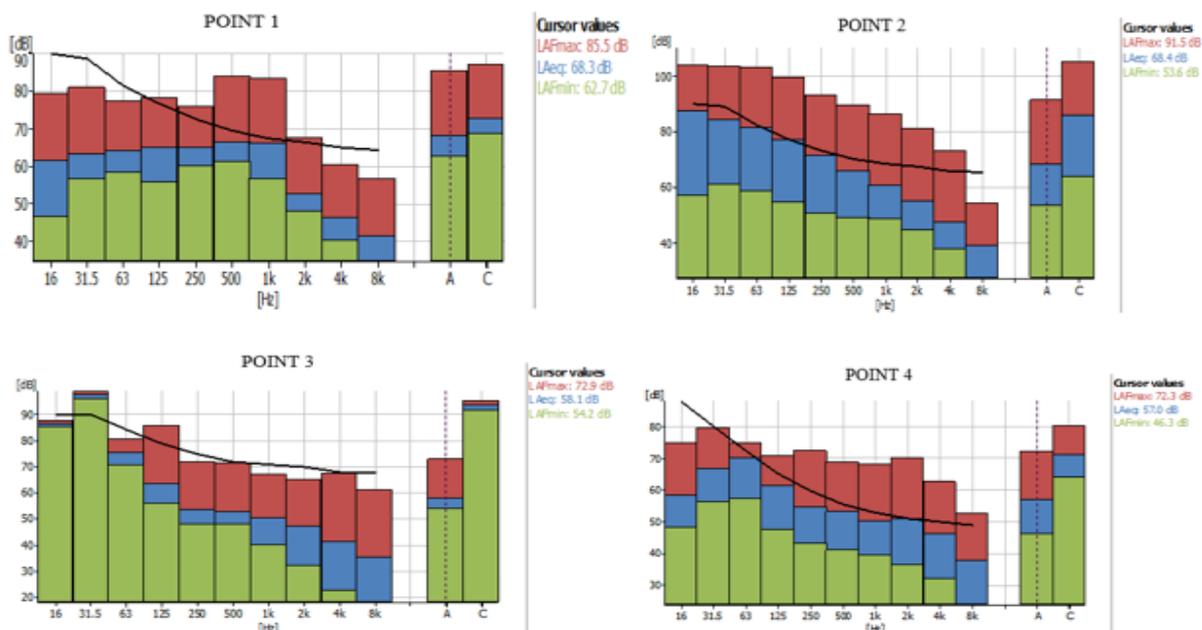


Fig. 4. Noise measurement graphs depending on the frequency at the 4 points

For the second area studied, noise levels between 55 – 62. The limit for the street of technical category II, the link is 70 dB and the value limit for the noise level near the dwelling is 50 dB [22]. The values recorded for the noise level are: Point 1 – 68.3 dB; Point 2 – 68.4 dB; Point 3 – 58.1 dB; Point 4 – 57.0 dB. And in this case, measurements were made for the residual noise both to calculate the measurement uncertainty  $U$  ( $k=2$ ) resulting in values between  $\pm 4.6 \div \pm 5.2$ , as well as for making corrections depending on the measured

noise level. After making the corrections, the noise level values became: Point 1 – 67.9 dB, Point 2 – 68.1 dB ; Point 3 – 55.8 dB; Point 4 – 54.9 dB. The conditions in which the measurements were performed, the peak period of the urban traffic, determined the obtaining of more values for points 1 and 2 because the measurements were performed near the street and points 3 and 4 are lower values that slightly exceed the limit. from the legislation for values of the noise level near the house.

by the noise map software used, values of the noise level at the edge of the studied area.

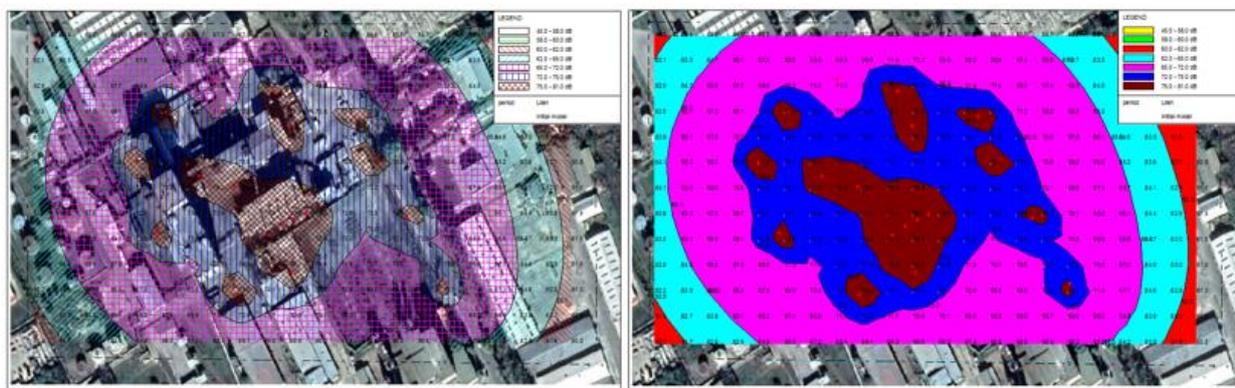


Fig. 5. Map regarding the dispersion of sound waves for the industrial area



Fig. 6. Noise level values recorded at the edge of the industrial area (a) hatched figure; b) colored figure

Thus, it is observed that at the edges of the studied area, the noise level reaches values between 60 - 65 dB. The limit for industrial premises and spaces with activities assimilated to industrial activities is 65 dB thus, the values at the limit of the studied area fall within the

limits provided in the legislation [22]. For the area with heavy road traffic, Figure 7 shows the noise map and Figure 8 shows the values calculated by the noise map software used, values of the noise level at the edge of the studied area.

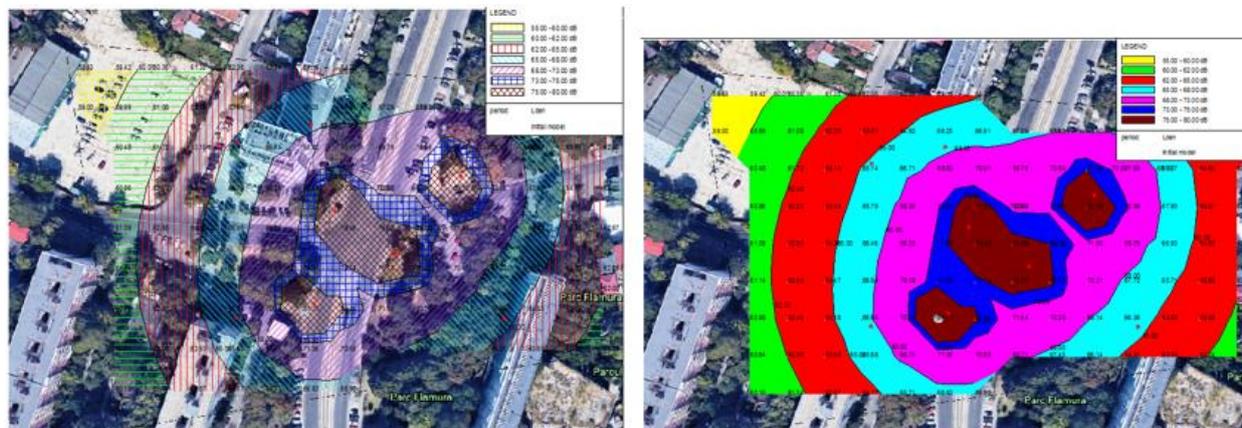


Fig. 7. Map regarding the dispersion of sound waves for the area with heavy road traffic



Fig. 8. The recorded values of the noise level at the edge of the area with heavy road traffic  
a) hatched figure; b) colored figure

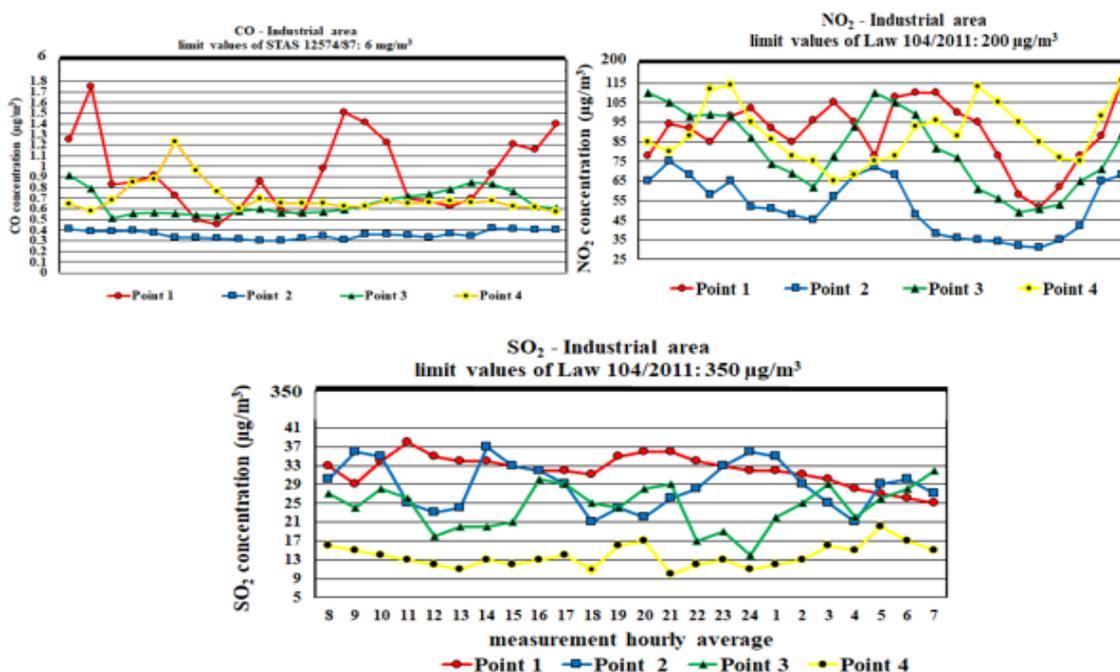


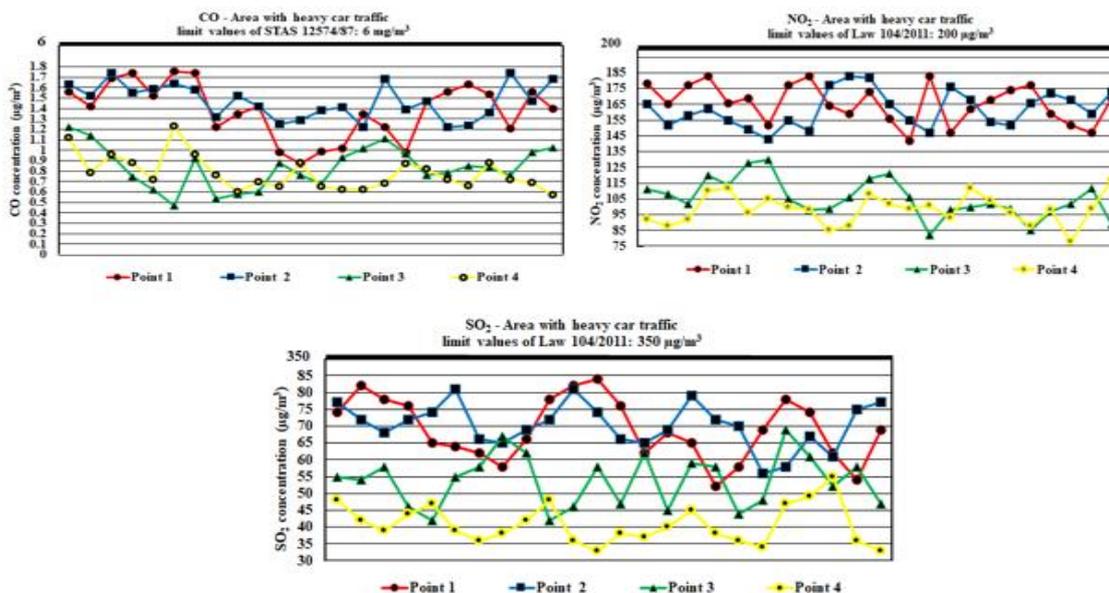
Fig. 9. Graphs of CO, NO<sub>2</sub>, and SO<sub>2</sub> measurements in the industrial area

For the pollutants determined at the immisions, their concentrations and the evolution in time are presented in Figure 9 for the industrial area and 10 for the urban area.

According to in force legislation, the limits for these pollutants are: CO – 6 mg/m<sup>3</sup> (30 min); NO<sub>2</sub> – 200 µg/m<sup>3</sup> (1 hour); SO<sub>2</sub> 350 µg/m<sup>3</sup> (1 hour). As can be seen from Figure 9, these

pollutants do not exceed the limits provided by law. A maximum value of  $1,8 \text{ mg/m}^3$  has been reached at point 1 and the lowest CO concentration was recorded at point 4. This is explained by the direction of the NE wind towards point 1. Anyway, on point 1 the highest values were observed for  $\text{NO}_2$  ( $115 \text{ }\mu\text{g/m}^3$ ) and  $\text{SO}_2$  ( $38 \text{ }\mu\text{g/m}^3$ ).

Higher values are observed for the pollutants determined at immissions for the second case, especially at points 1 and 2 located near the street where the noise level is also higher (Fig. 10). Points 3 and 4 show lower values for both  $\text{NO}_2$ ,  $\text{SO}_2$ , and CO pollutants and the noise level due to the attenuation caused by the vegetation curtain.



**Fig. 10.** Graphs of CO,  $\text{NO}_2$ , and  $\text{SO}_2$  measurements in the area with heavy road traffic

## CONCLUSIONS

The results of tests performed to assess the level of noise and chemical pollution with CO,  $\text{NO}_2$ , and  $\text{SO}_2$  highlight the following aspects:

In the case of the industrial area, points 3 and 4 present higher values for the noise level 64.1 dB, 65.1 dB because it is in the vicinity of noise sources (industrial fans). From air pollution, higher concentrations were obtained in point 1, located in the wind direction, values that fall within the limits imposed by the legislation.

In the case of the studied urban area with heavy road traffic, higher values were obtained both for the noise level and the chemical pollutants in points 1 and 2 points that are placed near the

street. For the other measurement points, the values are lower due to the vegetation area that attenuates both the noise level and the concentration of CO,  $\text{NO}_2$ , and  $\text{SO}_2$  in the ambient air.

It is recommended in this situation to increase the areas with vegetation in urban areas to reduce both the noise level and the chemical pollution of the air with compounds specific to traffic emissions. For the industrial area, the placement of attenuators or sound-absorbing barriers in the vicinity of noise emitting sources will reduce the level of noise pollution in the workplace and in the vicinity of industrial units.

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