Noise pollution in the Suceava Metropolitan Area. Interim research

Pollution bruit dans la Région Métropolitaine de Suceava. Recherche intermédiaire

Alina NISTOR[1], Bogdan NISTOR[2]*, Dumitru MIHĂILĂ[1], Petruț-Ionel BISTRICEAN[1], Mihaela ȚICULEANU (CIURLICĂ)[1] , Gina LAZURCA (ANDREI)[1]

[1] Department of Geography, "Ştefan cel Mare" University of Suceava, Romania
[2] Gymnasium School No.4 Suceava and Gymnasium School "Ion Creangă" Suceava, Romania

* Correspondence to: Bogdan NISTOR. E-mail: nistorbobo@yahoo.com.

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ABSTRACT: Noise pollution monitoring in the Suceava Metropolitan Area (SvMA) continued in 2021 and 2022 during two campaigns (named 3 and 4). Sound level meters type CEM DT - 805 were used. In campaign 3, the average noise level recorded the highest values (over 60 dB) at the points near the main traffic arteries, E85, B-dul George Enescu, 1 Mai, intersection E85 with DN29A. During weekends, the noise level decreased by 10-15 dB compared to weekdays. At all monitoring points, there were diurnal fluctuations in noise levels: increases during the day (07.00-19.00) due to heavy road and pedestrian traffic and decreases during the night (22.00-06.00) due to reduced human activities. The difference between daytime and night-time noise levels was 20-25 dB in urban areas and 5-10 dB in peri-urban areas. In the fourth monitoring campaign, with indoor and outdoor, day and night observations, the average indoor noise level (20-30 dB) was 10-35 dB lower than outdoor (30-55 dB). Maximum noise levels were below 85 dB indoors and below 105 dB outdoors.

KEYWORDS: average and maximum noise level, noise pollution.

RÉSUMÉ: La surveillance de la pollution sonore dans la zone métropolitaine de Suceava (ZMSv) s'est poursuivie en 2021 et 2022 au cours de deux campagnes (nommées 3 et 4). Des sonomètres de type CEM DT - 805 ont été utilisés. Dans la campagne 3, le niveau de bruit moyen a enregistré les valeurs les plus élevées (plus de 60 dB) aux points proches des principales artères de circulation, E85, B-dul George Enescu, 1er mai, intersection E85 avec DN29A. Le week-end, le niveau sonore a diminué de 10 à 15 dB par rapport aux jours de semaine. À tous les points de surveillance, il y a eu des fluctuations diurnes des niveaux de bruit: augmentations pendant la journée (07.00-19.00) en raison du trafic routier et piétonnier intense et diminutions pendant la nuit (22.00-06.00) en raison de la réduction des activités humaines. La différence entre les niveaux de bruit diurnes et nocturnes était de 20 à 25 dB dans les zones urbaines et de 5 à 10 dB dans les zones périurbaines. Lors de la quatrième campagne de surveillance, avec des observations intérieures et extérieures, de jour et de nuit, le niveau de bruit moyen à l'intérieur (20-30 dB) était inférieur de 10 à 35 dB à celui de l'extérieur (30 à 55 dB). Les niveaux de bruit maximaux étaient inférieurs à 85 dB à l'intérieur et à 105 dB à l'extérieur.

MOTS CLÉS : niveau sonore moyen et maximum, nuisances sonores.

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1. Introduction

Noise pollution is the continuous aggression to the health and comfort of the population, caused by various noises produced by road traffic, machinery, industrial or domestic appliances, inside or outside buildings, noises favored by their location, and constructive isolation. The discomfort created by noise causes a series of daily dysfunctions affecting daytime activities, rest, and sleep. The effects of noise are felt depending on the location of the dwelling, the level at which the apartment is situated, its location in relation to the source, the building materials, and the soundproofing equipment (https://www.eea.europa.eu/ro/articles/poluarea-fonica-este-o-problema).

In Romania, *Directive 2002/49/EC* of the European Parliament and of the Council has been taken over by *Government Decision No 321/, 2005,* based on which, in 2006, noise maps were made only for cities with more than 250 000 inhabitants (Brasov, Bucharest, Craiova, Constanța, Cluj Napoca, Galati, Ploiesti). From the data centralized by the European Commission in 2011, the highest percentage of the population affected by noise pollution was recorded in Bucharest (85%), Constanta (75%), Cluj-Napoca (64%), Brasov and Ploiesti (61%), Galati (55%), Timisoara (49%) (https://green-report.ro/cele-mai-recente-harti-de-zgomot-din-romania).

Order No. 152/558/1119/532 *of 2008* established noise limit values and their application when drawing up action plans for the indicators L_{den} (A-weighted long-term average sound pressure level as defined in SR ISO 1996-2:1995, determined for the sum of the day, evening and night periods of a year) in congested areas, industrial areas, main roads and railways, airports and railway stations (published in the *Official Gazette no. 531/15.07.2008).*

Government Decision no. 1260/2012 (published in the *Official Gazette no. 15/09.01.2013*) amended and supplemented *GD 321 14/04/2005,* which provided, for the preparation of strategic noise maps for cities with more than 100 000 inhabitants, railways, and airports, to identify inhabited areas where noise levels exceed the limits imposed by legislation, to draw up action plans with measures to reduce and protect the population against noise pollution. Unfortunately, public authorities and economic operators did not complete the maps and action plans by 30 September 2019, as required by the government decision.

Article 16 of *Order No 119/2014* stipulated that the limit values for noise indicators must be respected: during the daytime, the A-weighted equivalent continuous sound pressure level ($_{AeqT}$) measured outside the dwelling according to SR ISO 1996/2-08 at a height of 1.5 m above the ground, must not exceed 55 dB and the noise curve Cz 5, and during the night, between 11 pm and 07.00 am, the A-weighted equivalent continuous sound pressure level (L_{AeqT}) measured outside the dwelling according to SR ISO 1996/2-08 at 1.5 m above ground level, shall not exceed 45 dB and the noise curve Cz40 (*https://lege5.ro/Gratuit/gm2dambxgy3a/legea-nr-121-2019-privind-evaluarea-si-gestionarea-zgomotului-ambiant*).

According to the World Health Organization, exposure to noise levels below 50 decibels during the day is not harmful to the population, no matter how long or regular it is, conversely, continuous noise over 85 dB for more than 8 hours can be dangerous (*Environmental Pollution Centers, 2022*)

Noise pollution can cause a variety of health problems for people, including increased levels of stress, sleep disorders, insomnia, injuries, cardiovascular disease, type 2 diabetes, etc, cognitive impairment and low birth weight headaches, psychological disorders, lack of concentration at work, hearing loss, learning difficulties, stroke, stroke, hypertension and reduced quality of life (*Pantawane, Maske and Kawade, 2017, Wokekoro, 2020, Chand et al., 2022, Chauhan et al., 2021, Millar, 2020, Singh et al., 2022, Peris, 2020*).

Cardiovascular disorders are independent of sleep disorders. A previous study showed that 40% of people suffered from hypertension, while 15%, 67% and 61% of people suffered from cardiovascular disease, irritability, and, insomnia (*Gupta & Ghatak, 2011*).

When sleep disorders become chronic, they lead to mood changes, decreased performance and other long-term consequences for human health. Continuous noise of over 30 decibels disrupts sleep. For a good sleep, the equivalent sound level should not exceed 30 dB for continuous background noise, and individual noise events exceeding 45 dB should be avoided (*World Health Organization, 1995*).

Noise levels above 80 decibels are linked to an increase in hostile behavior as well as a decrease in helpful behavior. According to a study conducted in Katmandu, Nepal, the most important effects of noise pollution were on nervousness (29.1%), conversation problems (19.8%), amnesia (18.3%)%) and loss of concentration (12.8%). In addition, 54.8% of respondents considered ambient noise annoying, and 32.5% reported being very annoying (*Moteallemi et al., 2018*).

Noise is perceived as an element of stress or annoyance with negative effects on the body: the appearance of tension, nervousness, fear, sweating, and increased heart rate. Although stressors do not cause disease, they can aggravate other conditions *(Gille et al., 2017).* Exposure to excessive noise, either on a long-term or repeated basis, can cause hearing loss and tinnitus (a hearing disease) (*Platon et al., 2017*), but it can also be the effect of short-term exposure to extremely loud noise *(Hu and Zheng, 2008*). It is estimated that 22 million people in Europe suffer from high chronic discomfort, and 6.5 million suffer from severe sleep disturbance *(https://www.eea.europa.eu/ro/* highlights/number-of-europeans-exposed). That is why several studies on the effect of noise on human health have been carried out in Europe in recent years (*Cobzeanu, 2012*; *Cobzeanu et al., 2013; Recio et al., 2018; Simion et al., 2018; Radulescu et al., 2018; Cobzeanu et al., 2019; Abbasi et al., 2022; Petric, 2022).* Population perception of noise pollution was studied in the city of Cluj Napoca based on questionnaires, comparing 2000 - 2019 and 2007 -2017. The study shows that 75.2% of the respondents consider that noise in the city has increased in the last ten years, and 58% of them rated noise at level 4 or 5 on a five-point scale *(Popescu et al., 2013,* , respectively *Popescu, 2020).*

The main sources of noise are road traffic, economic, social, and cultural activities, plus everyday domestic activities. Population exposure to road traffic noise was analyzed in the city of Vaslui (9.87% of the total population) by using a model for generating noise levels and creating a spatial database of buildings and road networks in the study area. It was estimated that intersections within urban area with a high population density are characterized by noise levels 10 dB higher on average than the surroundings *(Sorea et al., 2019).*

Optimization of traffic flow along the main traffic arteries has been analyzed at an intersection in the center of Sibiu in order to reduce noise pollution. The noise level recorded values between 76.80 dB and 93.40 dB in the hourly interval 7.30 - 18.00, therefore a possibility of optimizing traffic flow by using Synchro Studio 7 software (calculation of intersection capacity) and reducing the noise level was suggested (*Deac et al., 2017).*

Noise maps play an important role in the management of environmental noise in assessing and measuring noise levels, dealing with complaints, noise mapping, and zoning, and limiting noise values. In the city of Voluntari, noise maps have been used to generate conflict maps and population exposure lists, that can help institutions managing roads to take measures to mitigate noise (*Covaciu et al., 2015)*. Assessment of road noise pollution in urban residential areas with impact on the population has recently been carried out in the cities of Pitesti *(Titu et al., 2022)* and Galati (*Drasovean et al., 2023).*

On 26 July 2019, in Romania, *Law no. 121/2019* came into force regarding *i)* the assessment and management of noise at national level through measures for its prevention and reduction, *ii)* noise mapping, *iii)* ensuring public access to information on environmental noise and its effects, *iv) the* adoption, implementation of action plans to keep noise levels below limit values (where these are not exceeded) and to reduce noise where exposure levels may cause harmful effects on human health. The development of the strategic noise maps was to be completed by 30 June 2022 so that by 18 July 2023, action plans with noise abatement measures could be drawn up, and if changes occur compared to the existing situation, these maps should be reviewed and redrafted, at least every 5 years.

The objectives of the study are to: i) record the mean and maximum values of noise levels at the inner and outer observation points; ii) identify sources of noise pollution; iii) highlighting the relationships between anthropogenic factors and noise levels; iv) comparative analysis of diurnal and weekly noise level recorded in urban and suburban environments.

2. Study area

Noise pollution research continued in 2021 and 2022 in the SvMA. In campaign 3, observations continued in 4 perimeters located in the municipality of Suceava and one in the peri-urban locality of Ipotești, and in campaign 4, in 29 perimeters located in the municipality of Suceava and the peri-urban localities of Șcheia, Salcea, Mitocul Dragomirnei, Mihoveni, and Tișăuți, inside and outside of housing (Table 1 and Table 2; Figure 1 and Figure 2).

Table 1 Noise monitoring points during measurement campaign 3 (12- 18.07.2021).

	Point 1	**Point 2**	**Point 3**
Obcini district	intersection B-dul 1 Decembrie 1918 (E85) - Str. Bistriței, Rompetrol; (47°38'07.6 "N, 26°14'02.4 "E)	intersection Gavril Tudoraș Boulevard - Corneliu Coposu Boulevard - Bistriței Street; (47°38'11.3 "N, 26°13'58.1 "E)	Slătioarei Street, C10, Sc. A; (47°38'12.9 "N, 26°13'54.5 "E)
George Enescu district	Profi parking lot; (47°38'37.3 "N, 26°14'22.1 "E)	Church of the Three Hierarchs; (47°38'38.7 "N, 26°14'19.2 "E)	the sports field of the Sports High School (47°38'40.6 "N, 26°14'18.1 "E)
Stefan cel Mare University	intersection University Street - Sofia Vicoveanca Boulevard; (47°38'24.9 "N, 26°14'48.1 "E)	in front of the E body of the University "Ștefan cel Mare" Suceava; (47°38'24.6 "N, 26°14'40.9 "E)	TPL Universitate station (47°38'29.1" N, 26°14'45.5" E)
Burdujeni district	Calea Unirii roundabout (DN29A - E58) (47°40'20.3" N, 26°16'45.5" E)	TPL Orizont station (47°40'19.7" N, 26°16'43.1" E)	TPL Orizont station (47°40'20.7 "N, 26°14'40.9 "E)
Locality Ipotești	DJ 208A, intersection Decebal Street - Tătărașii Noi Street (47°37'38.1" N, 26°16'19.1" E).		

Table 2 Noise monitoring points during measurement campaign 4 (7- 20.11.2022).

	Observation point	**Interior**	**External 1**	**External 2**
OB1	Obcini, Catena / Banca Transilvania	Suceava, Rulmentului Street, number 2, staircase A, 4th floor	Suceava, Rulmentului Street, number 2, staircase A, 4th floor	Suceava, Calea Obcinilor Street
OB2	Obcini, Army Block / I. Creanga School	Suceava, Slătioarei Street, no. 11, block C10, staircase A, 3rd floor, ap.14	Suceava, Slătioarei street, no. 11, block C10, staircase A	Suceava, Prefect Gavril Tudoraș Boulevard Street
GE1	Zamca, Philadelphia	Suceava, Zamca Street, number 51, staircase 1, 2nd floor	Suceava, Zamca Street, number 51, staircase 1, 2nd floor	Suceava, Zamca Street, number 51, staircase 1, 2nd floor

	Observation point	Interior	External 1	External 2
GE2	School 4 Sv - back	Suceava, Lazăr Vicol Street, no. 4, block E56 bis, 1st floor, ap. 8	Suceava, Lazăr Vicol street, no. 4, block E56 bis	
GE3	George Enescu, back Dorna towards Confecția	Suceava, Venus alley, number 2	Suceava, Venus alley, number 2	
GE4	George Enescu, Dorna, Sushi Master	Suceava, George Enescu Street, number 38, staircase B, 4th floor	Suceava, George Enescu Street, number 38, staircase B, 4th floor	
GE5	Dawn, sports field Computer science	Suceava, Zorilor street, number 15, block G23	Suceava, Zorilor street, number 15, block G23	
ZA1	Zamca, Profi area, near Strada Vișinilor	Suceava, Ion Neculce street, number 5, staircase A, 2nd floor	Suceava, Ion Neculce street, number 5, staircase A, 2nd floor	
ZA2	Cathedral, backwards CN Eminescu	Suceava, 6 Ion Neculce Street, block A-23, Sc.A, 4th floor	Suceava, 6 Ion Neculce Street, block A-23, Sc.A, 4th floor	Suceava, George Enescu Boulevard, Cathedral
ZA3	Zamca, middle, one way, traffic	Suceava, Visinilor Street, number 23, staircase A, 6th floor	Suceava, Visinilor Street, number 23, staircase A, 6th floor	
AR1	camin 4 USV, opposite Suceava Ambulance	Suceava, Scurtă Street, number 6, 2nd floor	Suceava, 6 Scurtă Street	
AR2	camin 4 USV, opposite Suceava Ambulance / Marami	Suceava, Strada Scurtă, number 6, 2nd floor	Suceava, Strada Scurtă, number 6, 2nd floor	Suceava, Intersection of Strada Scurtă and Bulevardul 1 Mai
AR3	USV boys' camp	13 University Street, Dormitory No. 2, 2nd floor	13 University Street, Dormitory No. 2, 2nd floor	13 University Street, Dormitory No. 2, 2nd floor
AR4	Alexander the Good, Jewish Cemetery	Suceava, Alexandru cel Bun Street, number 16, staircase B, 2nd floor	Suceava, Alexandru cel Bun Street, number 16, staircase B, 2nd floor	Suceava, Alexandru cel Bun Street, number 16, staircase B, 2nd floor
EC1	Centre, McDonalds - Mirouti	Suceava, Stefanita Voda street, number 10C	Suceava, 10 Luca Arbore Street	Suceava, Ana Ipătescu Street / Calea Unirii (McDonalds)
EC2	Mihai Viteazu, CAR Pensioners	Suceava, Alexandru Ienceanu street, number 3, block 3, staircase B	Suceava, Alexandru Ienceanu street, number 3, block 3, staircase B	Suceava, Mihai Viteazul Street, number 1
EC3	6 November - Mihai Viteazu (S.F. Marian Park)	Suceava, 6 November street, nr. 3	Suceava, 6 November street, nr. 3	Suceava, Mihai Viteazu street, number 8
IN1	Dormitory 7, USV ISJ Suceava	Suceava, Calea Unirii Street, number 15, 3rd floor	Suceava, Calea Unirii Street, number 15, 3rd floor	Suceava, Calea Unirii Street, number 15, 3rd floor
IN2	Dormitory 7, USV ISJ Suceava	Suceava, Calea Unirii, nr. 15, Dormitory nr.7 2nd floor, ISJ Suceava	Suceava, Calea Unirii, nr. 15, Dormitory nr.7 2nd floor, ISJ Suceava	Suceava, Calea Unirii, nr. 15, Dormitory nr.7 2nd floor, ISJ Suceava
BU1	Burdujeni, opposite Hotel Orizont	Suceava, Jean Bart Street, number 7A, staircase A, 2nd floor	Suceava, Jean Bart Street, number 7A, staircase A	Suceava, Jean Bart Street, number 7A, staircase A
BU2	Burdujeni Village, School 6	Suceava, Burdujeni Village, Stefan Luchian Street, number 2	Suceava, Burdujeni Village, Stefan Luchian Street, number 2	Suceava, Burdujeni Village, Stefan Luchian Street, number 2
BU3	Burdujeni train station, bus stop - station parking lot	Suceava, Nicolae Iorga Street, number 22, 1st floor	Suceava, Nicolae Iorga Street, number 22, 1st floor	Suceava, Nicolae Iorga street at the intersection with Jean Bart street, number 7
SFI	St. Elias New, Cemetery (above Obcini)	Sf. Ilie, Făgărașului Street, number 70	Sf. Ilie, Făgărașului Street, number 70	
SCH	Șcheia, towards Centura Road	Șcheia, 8, Fierăriei Street	Șcheia, Blacksmith Street	

	Observation point	Interior	External 1	External 2
MIH	Mihoveni	Mihoveni, 111 Main Street	Mihoveni, 111 Main Street	
MD1 MD2	Dragomirna Monastery	Mitocu Dragomirnei, Carutasilor Street, number 15	Mitocu Dragomirnei, Carutasilor Street, number 15	
PLP	after Plopeni School, on the right	Plopeni, 28 Văleni Street	Plopeni, 28 Văleni Street	
TIS	Tisauți, Church	Tisauti, Dumbravii street, number 12	Tisauti, Dumbravii street, number 12	

The area of study includes the municipality of Suceava, the city of Salcea, the municipalities of Scheia, Ipotesti and Mitocu Dragomirnei, located in Suceava Plateau, subdivision of the Moldavian Plateau. The relief is varied, fragmented in the form of plateaus, hills and hills, separated by the valleys of the rivers Suceava, Scheia, Bogdana, Dragomirna, Ipotesti. The average altitude is around 350 meters, with a maximum value of 527 m in Teisoara Hill. The climate is humid and cool, with Scandinavian-baltic influences. Average annual temperatures are between 7 – 8^{o}C, rainfall is high (600 – 700 mm / year).

In the study area live 156 575 inhabitants: Suceava 119 694 inhabitants (1 771 people / km^2), Salcea 9 513 inhabitants (158 people / km^2), Scheia 12 792 inhabitants (164 people / km^2), Ipotesti 9 346 inhabitants (409 people / km^2), Mitocu Dragomirnei 5 230 inhabitants (84 people / km^2).

3. Methods

The research methods used in this study were: *i)* documentation of the rigors of noise pollution research presented in the scientific literature, *ii)* identification in the field of the sources of noise pollution and the most suitable locations for monitoring, *iii)* monitoring of the minimum, average and maximum values of noise levels recorded at the observation points established in the field, indoor and outdoor, *iv)* graphical and cartographic transposition of the values of noise levels, *v)* comparative analysis and interpretation of statistical data, graphical and cartographic material.

The database was obtained in two research campaigns on noise pollution in SvMA.

Campaign 3 took place from 12 to 18 July 2021 in 5 observation perimeters (George Enescu district, Stefan cel Mare University - opposite Suceava City Hall, Obcini, Burdujeni - Orizont roundabout), each with 3 monitoring points and Ipotești with only one observation point. It comprised hourly daytime observations and hourly night-time observations every two hours. Each hourly observation lasted 12 minutes (6 minutes for the average noise level and 6 minutes for the maximum noise level). For both the main point (P1) and the auxiliary points (P2 and P4) the observations lasted 4 minutes. The observations for each hour, for the 3 points, started at the 54th minute of the hour and ended at the 6th minute of the next hour.

The campaign *aimed* to highlight the weekly and daytime noise regime near and away from the main roads.

Campaign 4 ran from 7 to 20 November 2022 in 29 observation perimeters. Observations were carried out for 2 weeks each day, grouped in the time intervals 01.00 - 03.00, 07.00 - 09.00, 13.00 - 15.00, and 19.00 - 21.00 (3 observations of 2 minutes for each noise parameter determined and for each point of the 58). The observations were carried out inside the dwellings and at two outdoor points (in front of the dwelling and at the street to which the dwelling had access).

In 15 of the 29 observation perimeters, we specify that at each hour, the observations lasted 12 minutes (6 minutes for the average noise level and 6 minutes for the maximum).

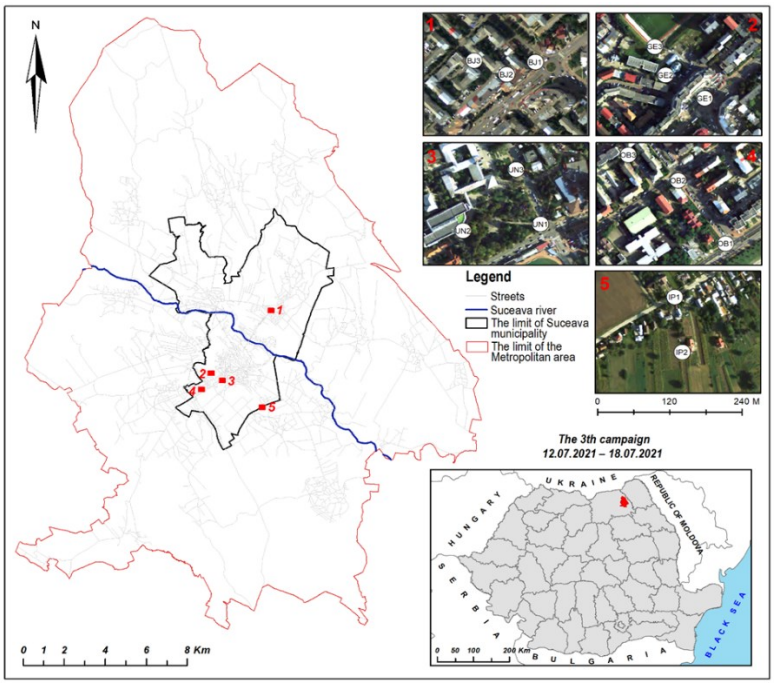


Figure 1 Location of the urban noise monitoring points in the SvMA during campaign 3 (12 - 18.07.2021) - which was conducted in 4 observation perimeters with 12 observation points (for each perimeter, one point was the main point plus two auxiliary points; 4 clusters of 3 points per cluster) located in the municipality of Suceava and one perimeter in the peri-urban locality of Ipotești, in the rural area.

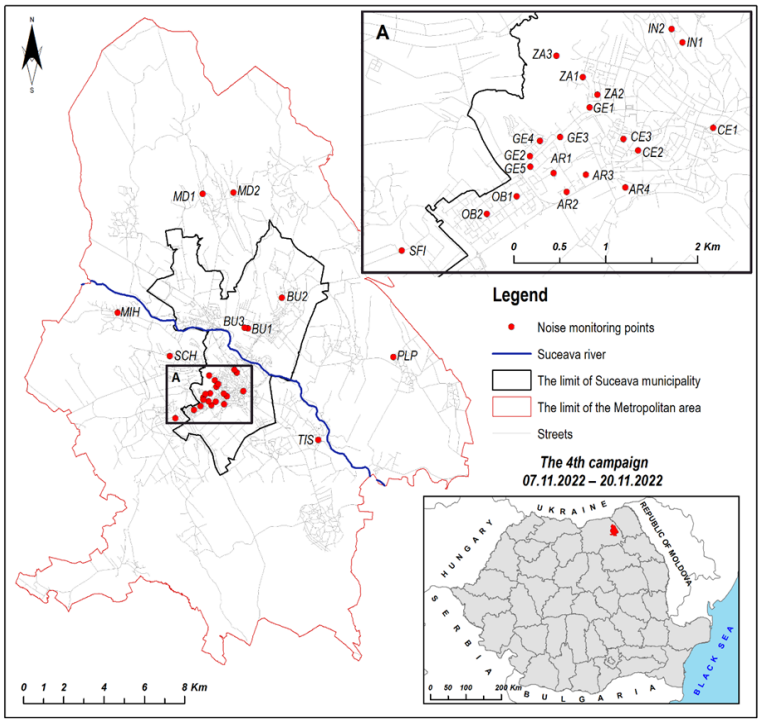


Figure 2 Location of SvMA urban noise monitoring points during campaign 4 (7 - 20.11.2022) - which took place in 29 observation perimeters with a total of 73 points (29 points inside houses and 29 + 15 inside houses) located in Suceava municipality and peri-urban localities.

For the inner point, they lasted 4 minutes; for the outer point 1, 4 minutes, and for the outer point 2, 4 minutes. In 14 of the 29 observation perimeters, we specify that each hour the observations lasted 8 minutes (4 minutes for the average noise level and 4 minutes for the maximum), for both the inner and outer points. Observations for each hour began at the 56th minute and ended at the 4th minute of the next hour. The monitoring points had a higher density in George Enescu, Centru, Areni, Mărășești, and Zamca districts, but also included Burdujeni district plus a number of peri-urban localities, so that they covered almost all points with a certain noise specificity in the SvMA.

The campaign *aimed* to highlight the daytime noise regime inside the dwellings, outside in front of the dwelling, and on the street to which the dwelling (apartment or individual house) connects.

In the third and fourth campaigns for monitoring the average and maximum noise levels, sound level meters of type CEM DT - 805 with an accuracy of ±1.5 dB were used.

4. Results and discussion

SvMA is in some places and, at some times, a noisy urban agglomeration. The main traffic arteries are important sources of noise pollution, therefore the average noise level was high at the observation points located in their immediate vicinity: over 60 dB on points 1 on George Enescu Boulevard - George Enescu District, from the intersection of 1 Mai Boulevard with University Street - Stefan cel Mare University, from E 85 - Obcini District, from the intersection of DN29A with E58 - Burdujeni (campaign 3) and over 50 dB on points 2, outside, located on Calea Unirii - USV Dormitory 7, George Enescu Boulevard - Zamca Cathedral, E85 - Obcini Catena Pharmacy, 1 Mai Boulevard - St John Suceava County Hospital, Mihai Viteazu Street - Petru Rareș National College (campaign 4). The average noise level exceeded 60 dB in the hourly intervals 07.00 - 09.00, 13.00 - 15.00, and 16.00 -18.00, because of values determined by heavy road traffic and economic and social activities. In SvMA, low values of the average noise level, below 40 dB, were recorded in peri-urban areas located far from the urban agglomeration: Ipotești (campaign 3), Mitocu Dragomirnei, Plopeni, Tișăuți, Sfântul Ilie, below 30 dB (campaign 4).

4.1. Weekly noise regime - for all points, campaign 3

In SvMA, the weekly noise regime is characterized by high average noise levels during the week due to the high population and car flows (Monday to Friday), which decrease slightly on the weekend due to reduced school and economic activities. The same weekend effect was also observed from the analysis of the weekly regime in the city of Iași, in 30 points located along different types of roads in the residential district of Sărărie - Ticau, in the months of August to October 2009. The results on the variation of noise levels during the week showed lower values on weekends following the same pattern for all three months, with lower values in summer and higher in autumn and during the weeks of September and October, as all school and economic activities were resumed *(Oiste et al., 2015).*

The average noise level recorded the highest values (over 60 dB) in four observation perimeters (Obcini District, George Enescu District, "Ștefan cel Mare" University and Burdujeni District), in the main monitoring points (P1), which were located near the main traffic arteries generating noise (E85, George Enescu Boulevard, 1 Mai Boulevard, E85 intersection with DN29A) from Monday to Friday. At the end of the week (Saturday, Sunday), due to the partial or total reduction of anthropogenic activities and the movement of the population outside the SvMA for recreational and tourist purposes, the average noise level values were lower (Figure 3. a - d).

In the observation perimeters Obcini, George Enescu, University "Ștefan cel Mare," Burdujeni, on all weekdays, the average noise level values gradually decreased from the main monitoring points (60 - 70 dB) - P1 to the auxiliary monitoring points P2 (50 - 60 dB) and to the auxiliary monitoring points P3 (40 - 50 dB), with increasing distance between the monitoring points and the main road traffic arteries (Figure 3. a - d).

In the case of the observation perimeter in the area of "Stefan cel Mare" University, during the whole week, the average noise level values recorded in P3 monitoring point were higher than in P2 monitoring point because P3 was located in the University TPL station, very close to the University Street, and P2 was located in front of the E Building of "Stefan cel Mare" University, further away from the noise generating sources (buses, cars, pedestrians). In the monitoring P3, lower average noise level values were recorded from Friday onwards because most of the students finished their courses, and their flow was much lower than during the week (Figure 3. c).

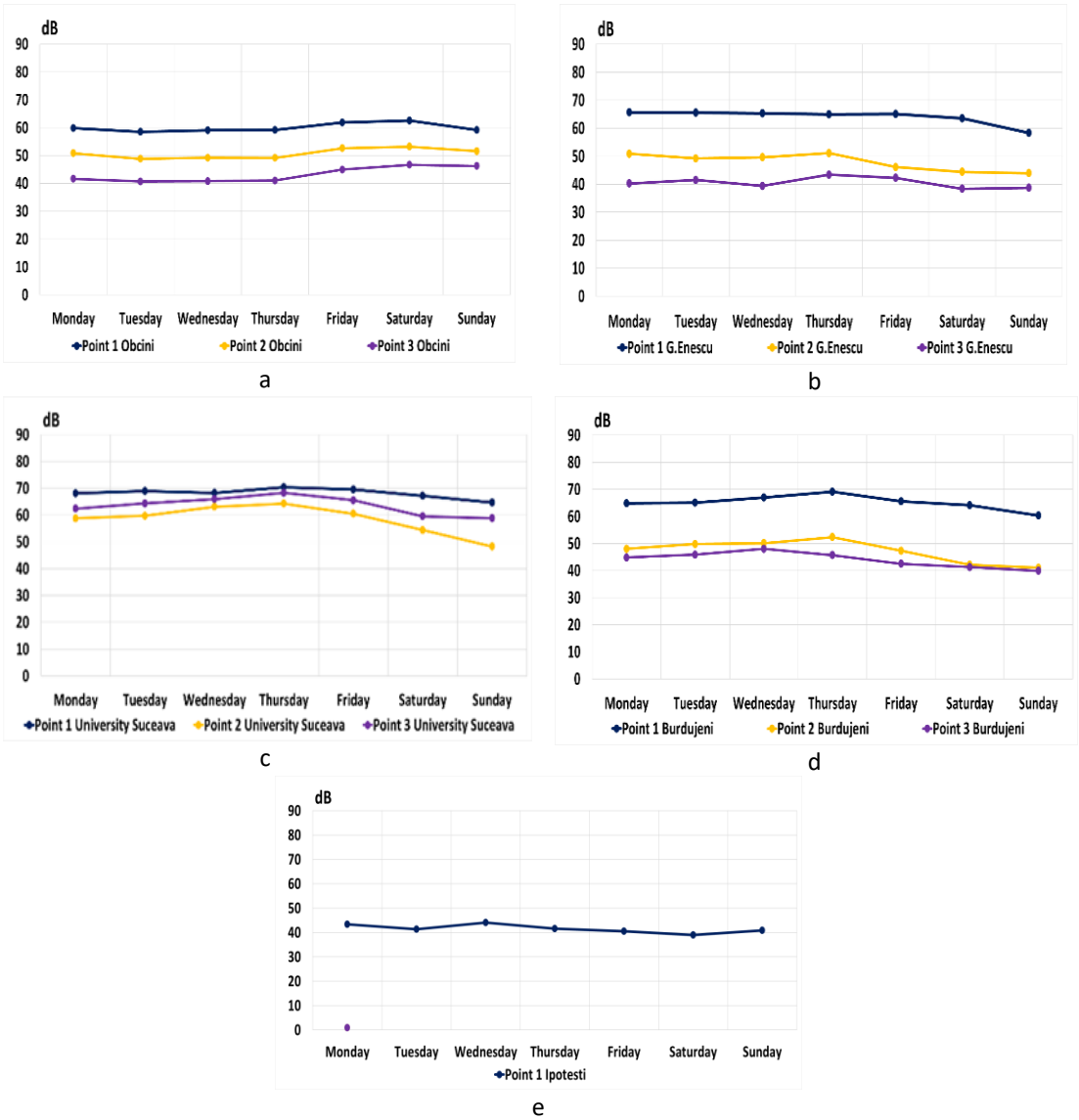


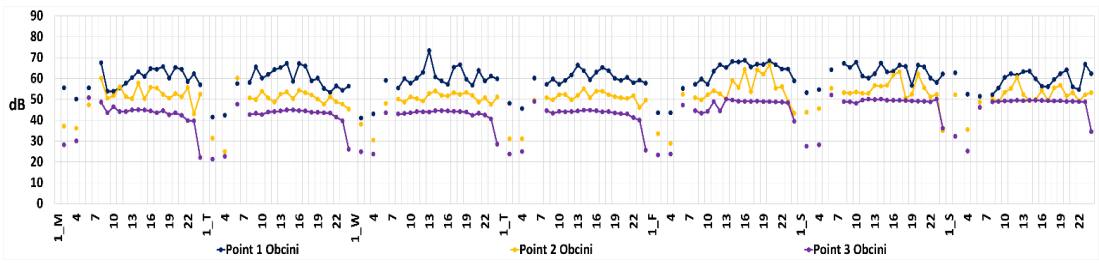
Figure 3 Weekly noise regime at points in the observation perimeters Obcini - a George Enescu - b, "Ștefan cel Mare" University - c, Burdujeni - d and Ipotești – e.

In Ipotești observation perimeter, the average noise level values remained between 40 and 50 dB from Monday to Sunday, with small fluctuations, because in the rural environment, anthropogenic activities are repetitive and do not constitute major sources of noise pollution (Figure 3. e). The analysis of Figures 3a- 3e allows us to outline the weekly noise regime in Suceava. The highest noise levels correspond to Wednesday, Thursday, and Friday, while lower values are registered on Saturday, Sunday, Monday, and Tuesday. Differences between weekdays and weekend days noise levels were 10-15 dB. If the analysis were extended over several weeks, perhaps this weekly pattern would emerge more clearly.

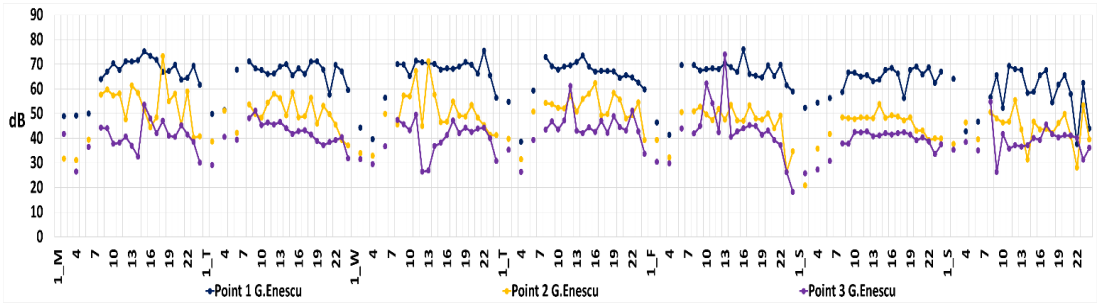
4.2. Weekly noise regime deployed per day for all points, campaign 3

In all *three monitoring points in Obcini district*, diurnal fluctuations in average noise levels were observed: increases during the day (between 07.00 and 19.00) due to road traffic and daily activities of the population and decreases during the night (22.00 and 06.00) due to the reduction or cessation of human activities. At the end of the week, from Sunday to Monday noise pollution was the lowest (Figure 4. a). In P3, the average noise levels remained constant during the day (40 - 50 dB) throughout the week without major fluctuations, as it was located in a car park between blocks and two secondary roads, away from heavy road traffic. At night, average noise levels decreased (20 - 30 dB) from 23.00 onwards, as human activities in the apartment blocks stopped.

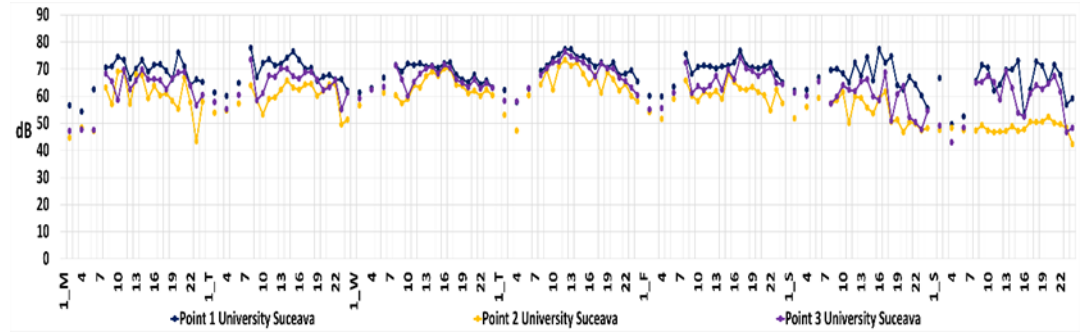
In *George Enescu observation perimeter*, the noise level recorded fluctuations in the average values during the day in all three monitoring points. The main cause was the variation in the intensity of traffic and human activities. Among the three monitoring points in George Enescu Boulevard perimeter, in monitoring point 1, the average noise levels were the highest during the day (70 - 75 dB) but also at night (not below 40 dB) from Monday to Friday. On the weekend, however, the values did not exceed the 70 dB threshold during the day, because the intensity of road traffic and the daily activities of the population did not reach the same degree of intensity (Figure 4. b). At monitoring point three, the noise level recorded at certain times of the day (Monday – Friday) increases in values, which exceeded 70 dB (Friday), the, consequence of the activities that took place at the Sports High School in the vicinity.



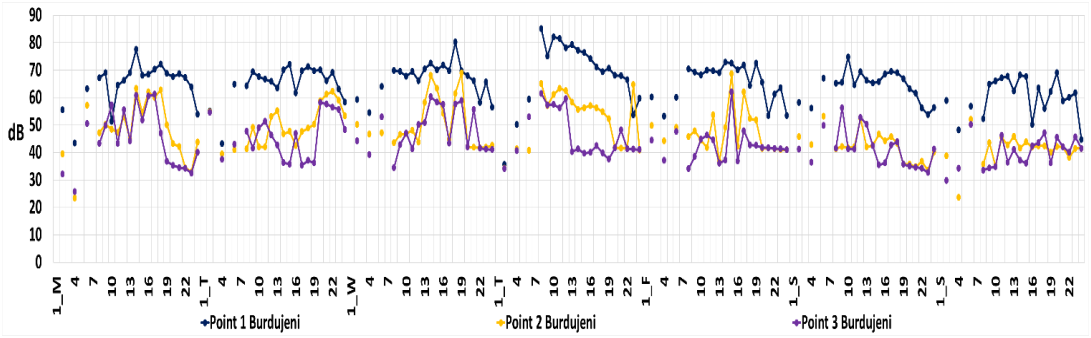
a



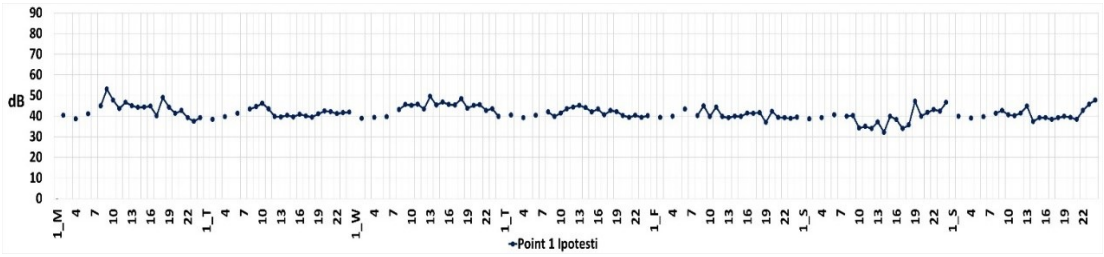
b



c



d



e

Figure 4 Weekly hourly and daily noise regime at the observation perimeters Obcini – a, George Enescu - b, "Ștefan cel Mare" University - c, Burdujeni - d and Ipotești - e

The noise level recorded high average values during the day (08.00 - 19.00) from Monday to Sunday, with a slight decrease towards the end of the week in monitoring points 1 and 3 in the *University perimeter*, as they were located close to the main traffic arteries (1 May Boulevard and University Street), constant sources of noise generated by road and pedestrian traffic. In monitoring point 2, located in front of the E building of the university, the average noise level recorded lower values on Saturdays and Sundays because the number of students attending classes was lower than during the week (Figure 4. c) .

In the three monitoring points in *Burdujeni observation perimeter*, the average noise level recorded high values during the day, from Monday to Sunday, between 08.00 and 19.00, with oscillations determined by variations in road traffic intensity, anthropogenic activities, and pedestrian flow (Figure 4.d). Diurnal variations are similar at monitoring points 1 and 2, as they are mostly influenced by road traffic, with a slight decrease towards the end of the week. At monitoring point 3, the oscillations of the mean noise level values were large, influenced by the activities and routines of the residents in the nearby blocks, as well as by the intense commercial activities on the ground floor. P3 was located away from the main streets, behind the tower blocks, and the lowest average noise levels (below 40 dB) were consistently recorded at night at this point.

In *Ipotești observation perimeter*, the average noise level values showed small variations from day (40 - 50 dB) to night (30 - 40 dB), during the whole week, the sources of noise pollution being insignificant (Figure 4.e).

The weekly daily noise regime was also carried out in Sărărie -Ticau residential district in the city of Iași from August-October 2009, only during the day (07.00 - 20.00), unlike our study, in which the noise level was also monitored during the night every two hours. The variation in noise levels during the week showed differences in both cities following the same pattern: high values in the morning and decreasing trends after midday. The main factor of noise pollution in both cases was the road traffic to which anthropogenic activities are added *(Oiste et al., 2015)*.

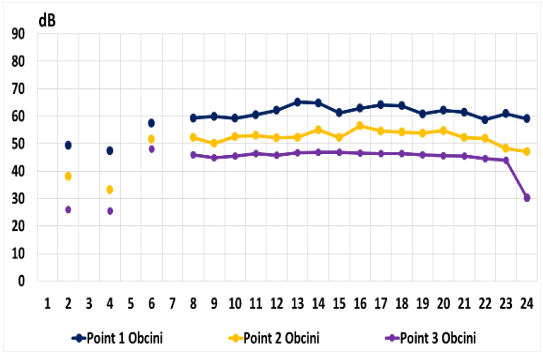
4.3. Diurnal noise regime - for all points (average/maximum values), campaign 3

In the *observation perimeter of Obcini district*, the average daytime noise level recorded high values in all three monitoring points during the hourly interval 07.00 - 22.00, with small fluctuations in points P1 and P2 due to road and pedestrian traffic. At point P3, the hourly mean values were more constant; the variations were small in the first part of the day (07.00 - 12.00), being caused by the activity schedule of pre-schoolers, pupils, and workers in different fields of activity. The average noise level at all three monitoring points showed a decrease in values from 23.00: P1 (from 60 dB at 24.00 to 48 dB at 03.00); P2 (from 48 dB at 24.00 to 33 dB at 03.00); P3 (from 30 dB at 24.00 to 27 dB at 03.00). In the morning, from 06.00, the average noise level at the three monitoring points was higher than during the night: P1 (59 dB), P2 (52 dB), P3 (48 dB) (Figure 5 a1). The maximum noise level of 94.4 dB was recorded at monitoring point P1 on 14 July at 13.00 due to heavy road traffic. On the other days of the week when we made the observations, the maximum values were between 77.7 and 88.8 dB. At the monitoring point P2, the maximum noise level (84.2 dB) was recorded on 16 July at 16.00, generated by heavy traffic at the roundabout where Gavril Tudoraș Boulevard intersects with Corneliu Coposu Boulevard and Bistriței Street (Figure 5 a2).

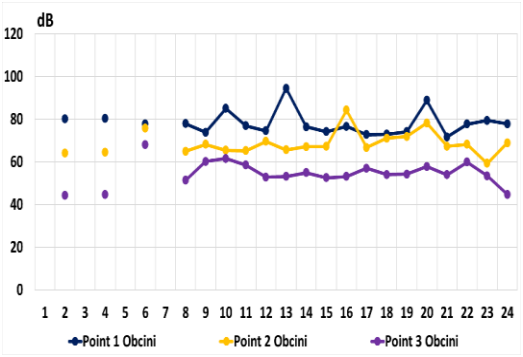
In the *perimeter of George Enescu district*, the average noise level recorded high values during the day (08.00 - 23.00) with fluctuations determined by road traffic at all three monitoring points: P1 (60 - 70 dB); P2 (45 - 55 dB); P3 (40 - 45 dB). During the night, starting at 23.00, the average noise level values decreased at all three observation points to 45 dB at point P1, 35 dB at point P2, and 30 dB at point P3 (Figure 5 b1). All three monitoring points between 08.00 and 16.00 recorded high noise level values, reaching maximum thresholds of 104.8 dB at 08.00 in P1 on 13 July, 88.1 dB at 13.00 in P2 on 14 July, and 80.6 dB in P3 at 13.00 on 16 July (Figure 5 b2).

In the *observation perimeter of Stefan cel Mare University*, the average noise level recorded high values during the day (08.00 - 20.00) in all monitoring points: P1 (70 - 73 dB); P2 (65 - 70 dB); P3 (59 - 63 dB) generated by road and pedestrian traffic on the main arteries (1 Mai Boulevard and University Street). From 22.00 to 08.00, the average noise level recorded lower values: P1 (58 - 68 dB), P2 (58 - 63 dB), P3 (52 - 58 dB) due to the reduction of road traffic (Figure 5 c1). Maximum noise level values rose to 96.4 dB in P1 at 09.00 on 12 July, to 78.9 dB in P2 at 12.00 on 15 July, and to 83 dB in P3 at 06.00 on 18 July due to increases in road traffic intensity (Figure 5 c2).

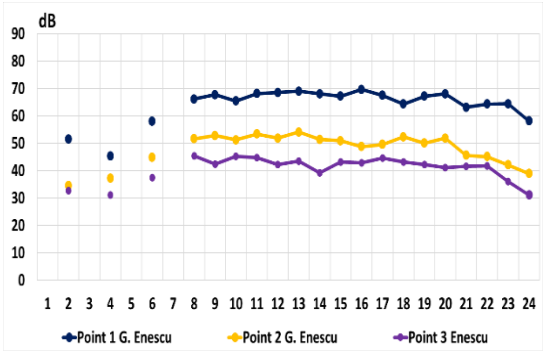
In *Burdujeni observation perimeter*, during the day (08.00 - 20.00), the noise level was high and varied between 60 and 77 dB in point 1 and between 50 and 58 dB in point 2. These points were located very close to the noise sources (Calea Unirii roundabout, intersection of DN29A and E58, and Orizont TPL station). This led to relatively high average noise values generated by night-time road traffic (e.g., at point P1 at 02.00, the noise level was 50 dB, at 04.00 48 dB, and at 06.00 58 dB) (Figure 5 d1). The maximum values of the noise level in the perimeter of Burdujeni district were due to the increase in road traffic and were 103.3 dB in P1 at 15.00 on 13 July, 74.9 dB in P2 at 19.00 on 14 July and 69.8 dB in P3 at 19.00 on 14 July (Figure 5. d2).



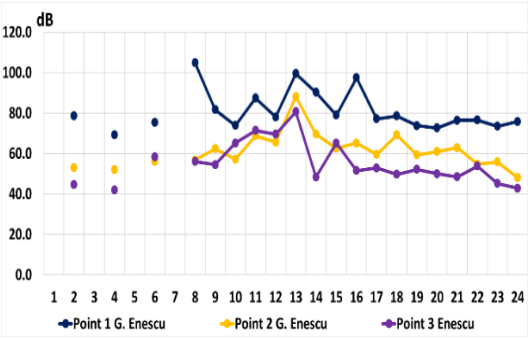
a1



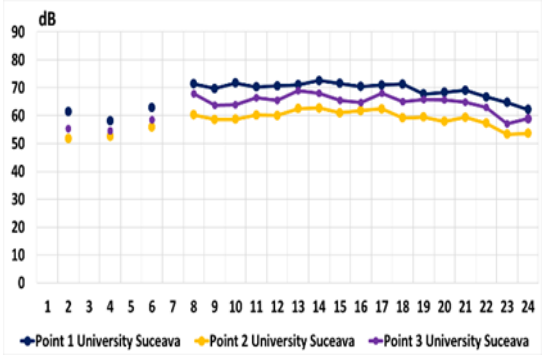
a2



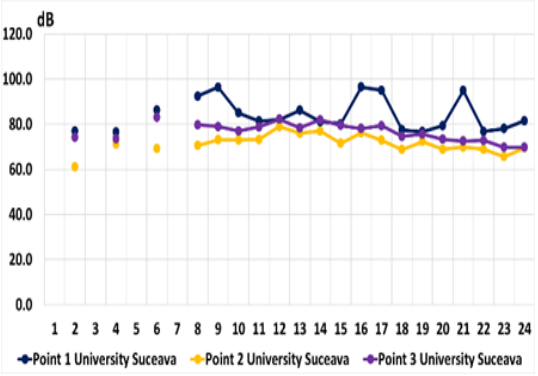
b1



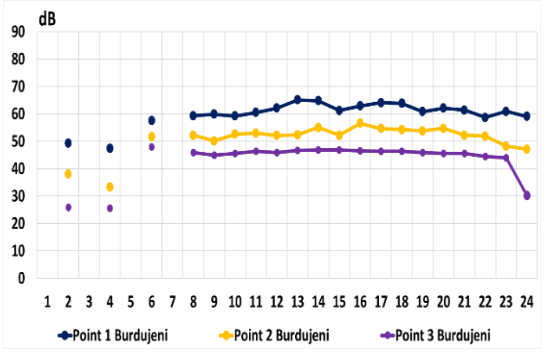
b2



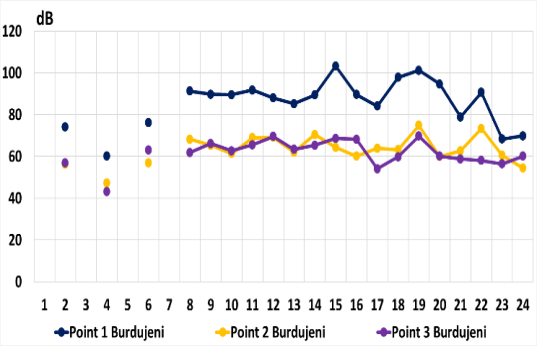
c1



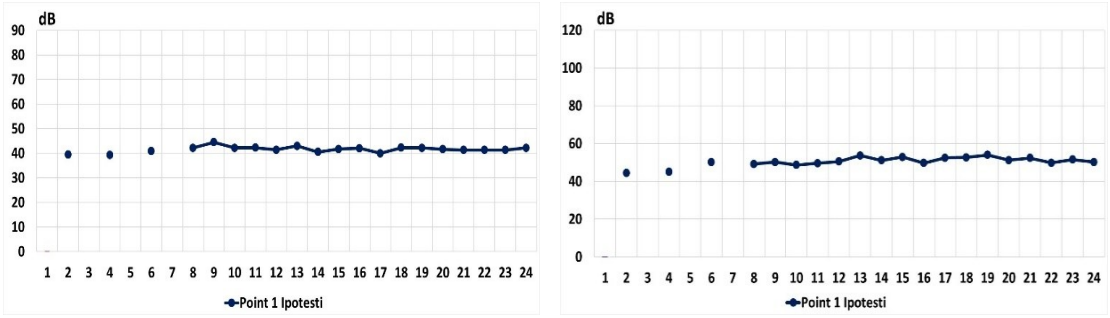
c2



d1



d2



e1 e2

Figure 5 Diurnal noise regime - at points in the observation perimeters Obcini - a1/a2, George Enescu - b1/b2, Universității - c1/c2, Burdujeni - d1/d2 and Ipotești - e1/2 on average noise values -1 and maximum values -2.

The average noise level values at *Ipotești observation point* were between 40 and 50 dB, both daytime and nighttime, being relatively constant during the day, with very few fluctuations, as there is no significant noise-generating sources (road traffic and intense anthropogenic activities) (Figure 5. e1). The maximum value of 53.7 dB was recorded on 15 July at 13.00, caused by road traffic noise in the locality (Figure 5. e2).

Following campaign 3, we can conclude that in the monitoring points P1 and P2 of the observation perimeters Obcini, George Enescu, University, Burdujeni, high values of the average noise level were recorded, which exceeded during the day and night the continuous sound pressure level (during the day it is recommended not to exceed 55 dB and during the night between 23.00 and 07.00 not to exceed 45 dB). The only observation point where the limit values were not exceeded was the locality Ipotești.

An analysis of the diurnal noise regime was also carried out in Sărărie - Ticau residential district in the city of Iași, but only during the day, in five hourly intervals: 07:00 - 8:00; 10:00 - 11:00; 13:30 - 14:30; 18:00 - 19:00; 19:00 - 20:00, for 10-minute measurements. High values of average noise levels were recorded in the third hourly interval (13:30 - 14:30), in the middle of the day, when the flows of cars, public transport, and population were high, the interval known as rush - hour, followed by the first hourly interval (07:00 - 08:00), when the main activities started, with a downward trend after the midday peak (*Oiste et al., 2015*).

4.4. Daily and weekly noise regime - for all points, campaign 4

The fourth campaign took place from 7 to 20 November 2022 in 29 indoor and 29 + 15 outdoor observation points. No studies have been carried out so far in our country to study the indoor/outdoor noise difference: day-night/morning, midday, evening, and midnight. Our study examines these issues for the first time. Observations were conducted in four 3-hour time periods (chosen to capture the most representative moments of noise levels over 24 hours), separated by 3-hour periods of no observations. The monitoring points can be seen in Figure 2.

The highest average daily noise *values* were recorded at observation point IN1 - Dormitory 7 / ISJ Suceava (37.9 dB average indoor and 62.2 dB average outdoor), located on the main traffic artery, Calea Unirii connecting the Centre of Suceava to Burdujeni and Iţcani districts, with heavy road traffic, where traffic jams were frequently recorded. The next observation point, SCH - Șcheia commune (32.2 dB indoor average and 40.1 dB outdoor average) was located on the outskirts of Șcheia, very close to the Suceava Bypass, the ZA3 - Suceava Zamca / Vișinilor observation point (29.9 dB indoor average and 43.1 dB outdoor average) was located in the Zamca district, one of the

populated districts of the city, on a one-way street with heavy traffic, especially at peak hours (Figures 6 and 7).

The lowest average daily values were recorded in observation points located in quiet perimeters or suburban districts: observation point AR1 - Dormitory 4/Short Street located in a quiet district (11.2 dB indoor average and 29.0 dB outdoor average); observation point GE3 - George Enescu/Venus Street located behind the Kaufland store on a low traffic street (16.4 dB indoor average and 16.8 dB outdoor average); observation point ZA2 - Cathedral with low traffic and one-way street (3.9 dB indoor average and 29.0 dB outdoor average); observation point BU3 - Nicolae Iorga Street/Burdujeni Railway Station located in a perimeter with low road traffic, especially at night (11.4 dB average indoor and 32.5 dB average outdoor); observation points TIS - Tișăuți, MD12 - Mitocu Dragomirnei and PLP - Plopeni located in suburban districts: without major pollution sources (15 - 18 dB average indoor and 21 - 26 dB average outdoor) (Figure 6 and 7).

For indoor observations, *average noise levels were higher* at all observation times at the monitoring points located near busy traffic arteries. For example, in the observation point IN1 - Dormitory 7 / ISJ Suceava, the noise level was 37.4 dB at 01.00 - 03.00, 39.3 dB at 07.00 - 09.00, 40.1 dB at 13.00 - 15.00 and 34.8 dB at 19.00 - 21.00. At the observation point ZA3 - Zamca / Strada Vișinilor, the noise level was 29.6 dB at 01.00 - 03.00, 29.7 dB at 07.00 - 09.00, 33.6 dB, 30.0 dB at 13.00 - 15.00 and 30.4 dB at 19.00 - 21.00.

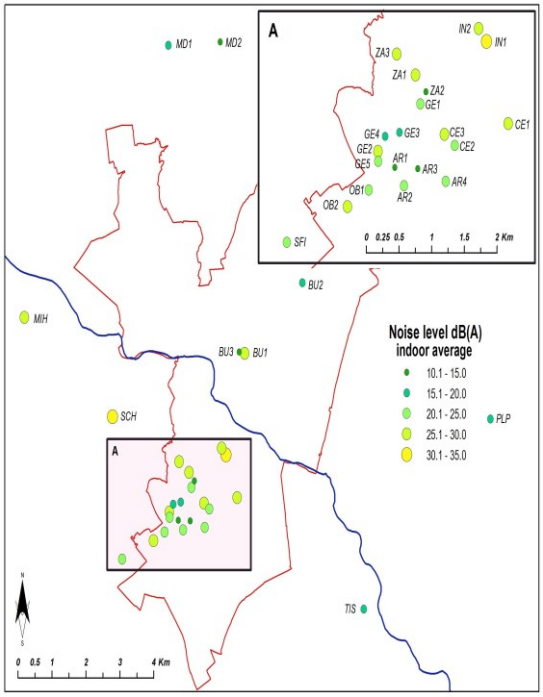


Figure 6 SvMA noise level - indoor environments.

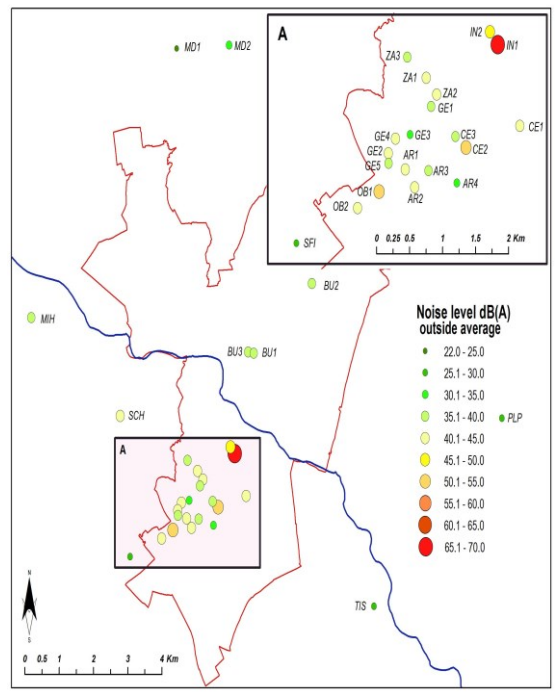


Figure 7 SvMA noise level - outdoor environments

Average noise levels were low during all observation hours at the observation points located in areas without significant sources of pollution. As examples, we chose the perimeter AR1 - Dormitory 4 / Short Street with a noise level of 4.8 dB at 01.00 - 03.00, 11.7 dB at 07.00 - 09.00, 14.0 dB at 13.00 - 15.00 and 14.7 dB at 19.00 - 21.00. Also, with low noise levels, we mention ZA2 - Cathedral (below 10 dB) and BU3 - Nicolae Iorga Street / Burdujeni Railway Station with noise levels below 15 dB (Figure 8 - 11).

For indoor observations, in the monitoring perimeters ZA3 - Zamca / Strada Vișinilor, SCH - Șcheia, the maximum values of noise levels were recorded for all hourly intervals.

For example, in ZA3 perimeter, the indoor noise level rose to 79.3 dB at night in the hourly interval 01.00 - 03.00, at 80.1 dB at 13.00 - 15.00, and in SCH to 84.5 dB in the same hourly interval and to 81.6 dB in the hourly interval 19.00 - 21.00. In the monitoring perimeter of Dormitory 7 - ISJ Suceava, the maximum indoor noise level values rose to 75.1 dB during the hourly interval from 07.00 to 09.00. In the monitoring perimeters Mihoveni and Obcini - Catena / Banca Transilvania, maximum noise levels of 80.8 dB were recorded in the hourly interval 07.00 - 09.00, respectively 77.4 dB for the interval 19.00 - 21.00 (Figure 12 -13).

The maximum values of indoor noise levels were recorded at monitoring points located inside buildings near access streets to public institutions, shopping centers, offices, educational institutions, and housing estates, or very close to the ring road, about 600 meters away, where heavy traffic and ambulances circulate.

For outdoor observations 1, the average noise level recorded high values at all observation hours in the perimeter of IN1 - Dormitory 7/ ISJ Suceava (it rose to 64.4 dB in the hourly interval 13.00 - 15.00). For the observation perimeters ZA3 - Zamca / Strada Vișinilor and Obcini - Catena / Banca Transilvania, the maximum noise level values rose to 50.3 dB in the hourly interval 13.00 - 15.00. Average noise level values at outdoor observation points 1 were lower in the monitoring perimeters AR1 - Dormitory 4 / Strada Scurtă, GE3 - George Enescu / Strada Venus, Tișăuți, Mitocu Dragomirnei, and Plopeni for night and morning observation hours (4.8 - 27.4 dB) (Figure 14 - 17).

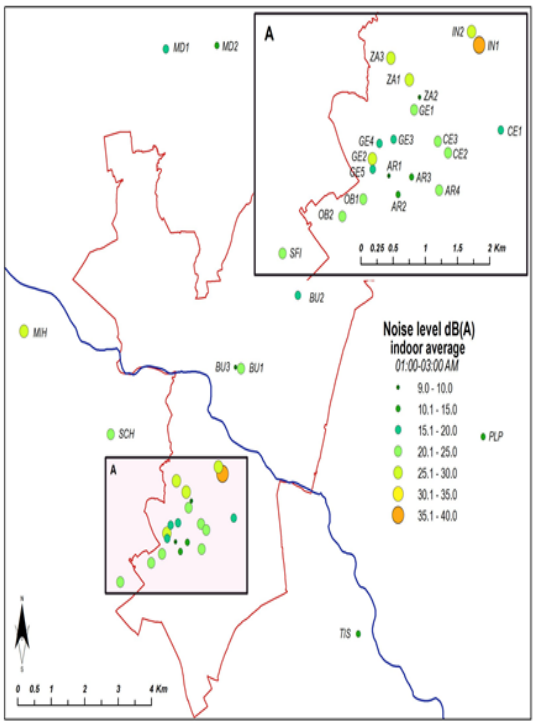


Figure 8 SvMA noise level - indoor averages (hourly interval 01.00 - 03.00).

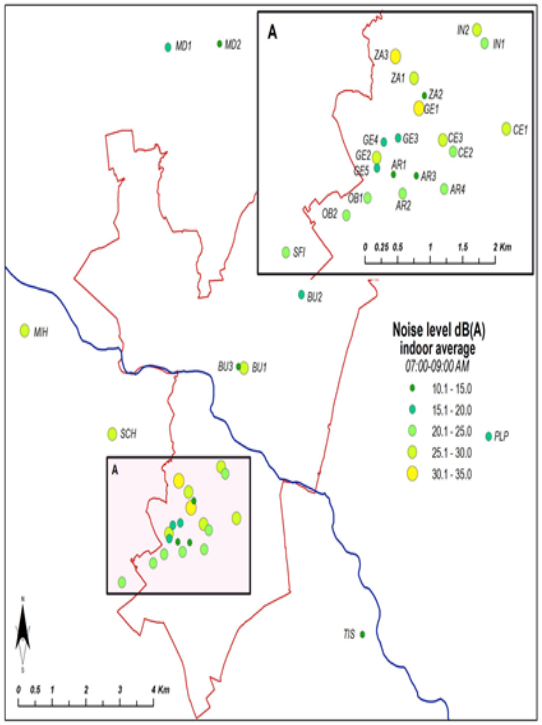


Figure 9 SvMA noise level - indoor averages (hourly interval 07.00 - 09.00).

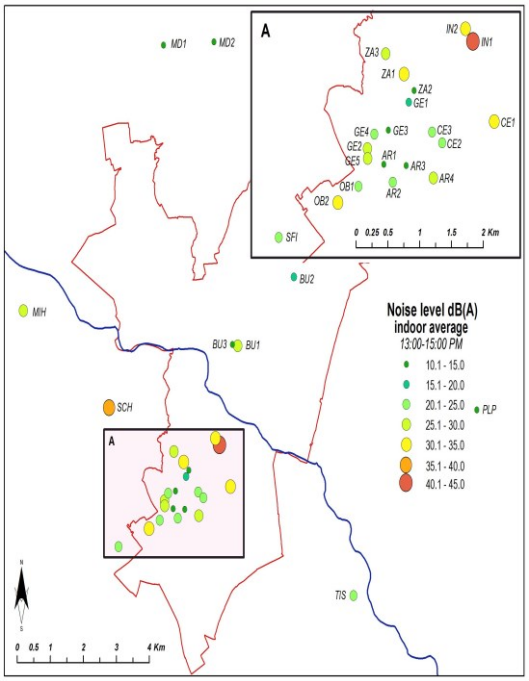


Figure 10 SvMA noise level - indoor averages (hourly interval 13.00 - 15.00).

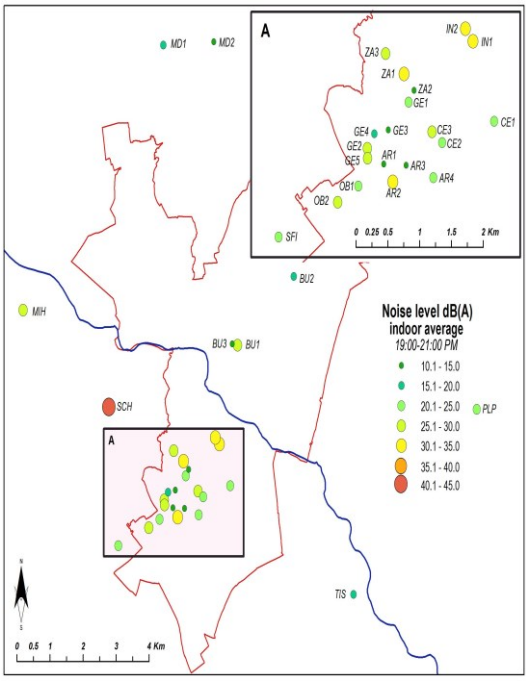


Figure 11 SvMA noise level - indoor averages (hourly interval 19.00 - 21.00).

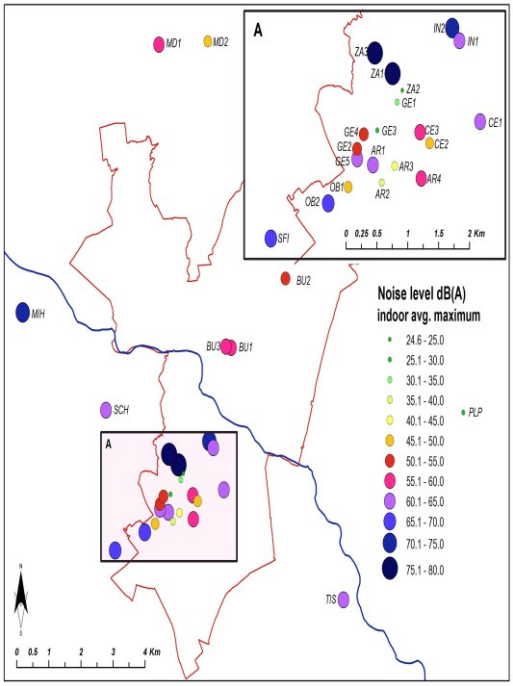


Figure 12 SvMA noise level - indoor maximum averages.

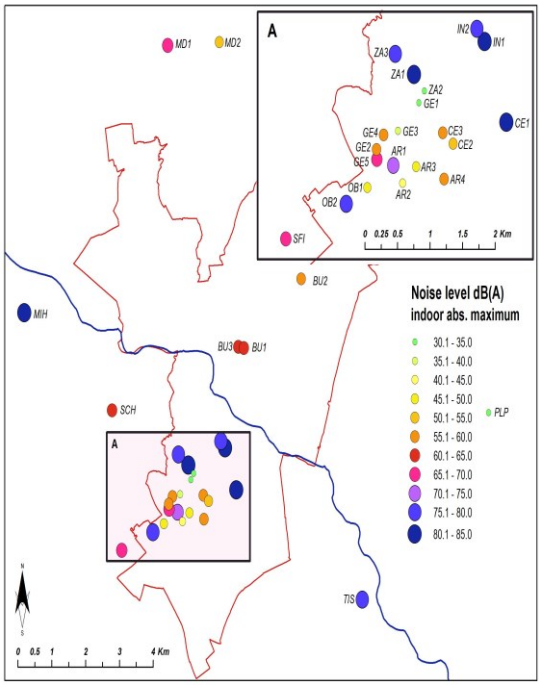


Figure 13 SvMA noise level - indoor absolute maximums.

The averages of the maximum noise values for the outside points 1 were calculated for Vișinilor Street - Zamca (one-way street, 4-storey blocks that do not allow sound to spread) for all hourly intervals: 01.00 - 03.00 / 88.8 dB; 07.00 - 09.00 / 87.8 dB; 13.00 - 15.00 / 87.8 dB; 19.00 - 21.00 / 87.8 dB.

For the points with outdoor observations 2, the average noise level recorded high values at all observations hours in point IN1 - Dormitory 7/ ISJ Suceava (65.0 dB in the hourly interval 01.00 - 03.00, 69.5 dB in the hourly interval 07.00 - 09.00, 70.7 dB in the hourly interval 13.00 - 15.00 and 67.4 dB in the hourly interval 19.00 - 21.00). For the observation point ZA3 - Zamca / Strada Vișinilor Transilvania, the maximum noise level values rose to 62.1 dB in the hourly interval 13.00 - 15.00.

The average noise level values in the outdoor observation points 2 were lower for all time intervals in the monitoring points Tisauti / Mitocu Dragomirnei / Plopeni (17 - 27 dB for the time interval 01.00 - 03.00, 24 - 28 dB for the time interval 07.00 - 09.00, 23 - 32.4 dB for the time interval 13.00 - 15.00 and 20 - 26.4 dB for the time interval 19.00 - 21.00).

The averages of the maximum noise levels at the outdoor observation points were calculated for the perimeters of School 6 Suceava for the interval 01.00 - 03.00 / 82.1 dB and McDonalds for the hourly intervals 07.00 - 09.00 / 91.8 dB; 13.00 - 15.00 / 91.9 dB; 19.00 - 21.00 / 90 dB (Figure 18). The noise peaks reached 90-95 dB at two observation points in the SvMA (Figure 19). During campaign 3, in George Enescu observation perimeter, the noise level, however, rose to 104.8 dB at 08.00 in P1 on 13 July.

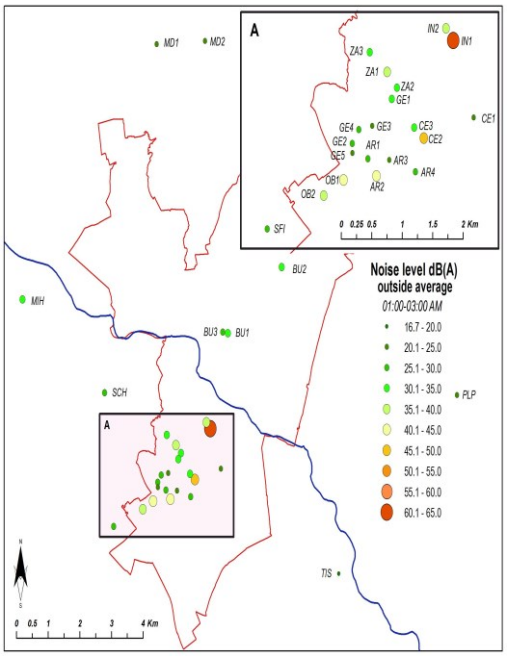


Figure 14 SvMA noise level - outdoor averages (hourly interval 01.00 -03.00)

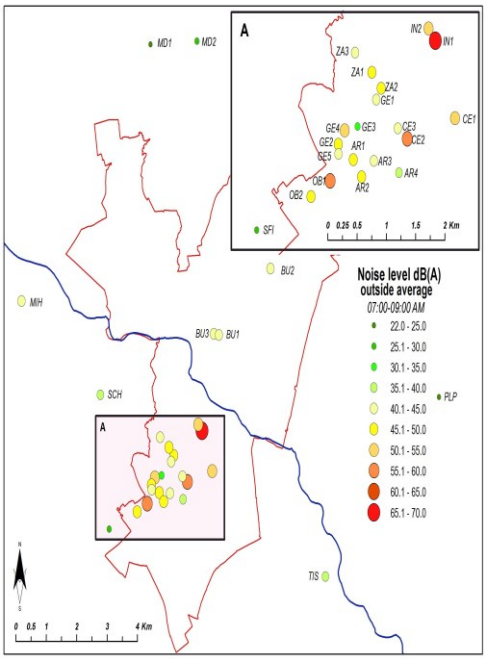


Figure 15 SvMA noise level - outdoor averages (hourly interval 07.00 -09.00)

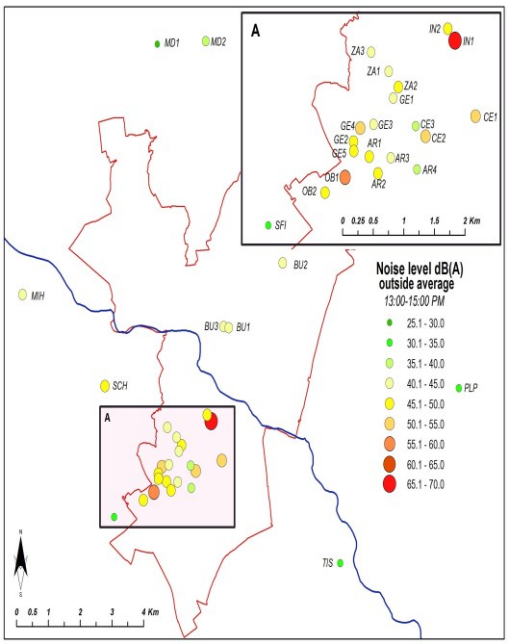


Figure 16 SvMA noise level - outdoor averages (hourly interval 13.00 - 15.00)

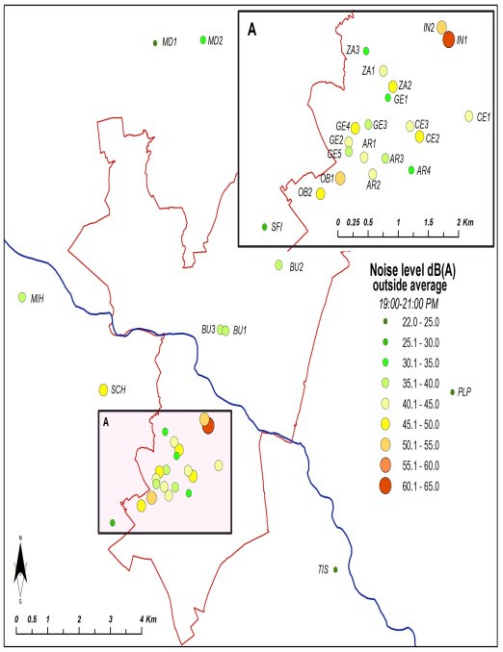


Figure 17 SvMA noise level - outdoor averages (hourly interval 19.00 - 21.00)

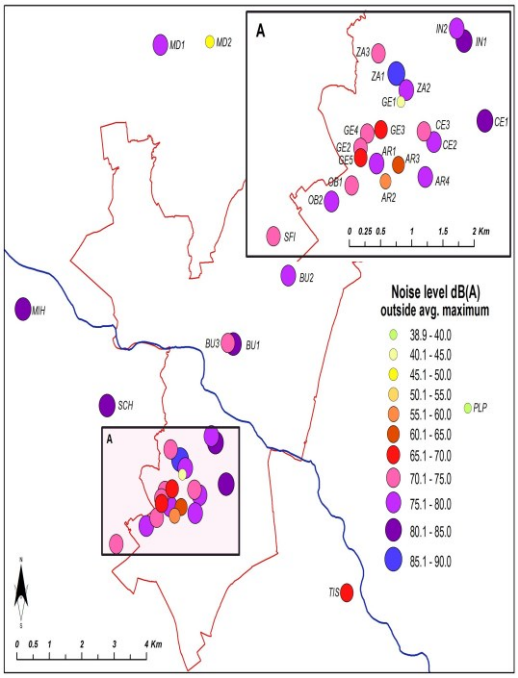


Figure 18 SvMA noise level - averages of outdoor maxima value.

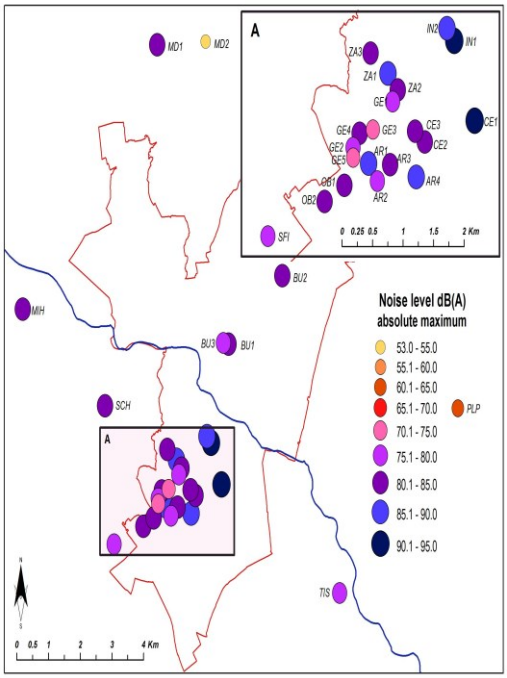


Figure 19 SvMA noise level - absolute maxima value.

The maximum noise level recorded high values in the center of Suceava, on Calea Unirii - County School Inspectorate, in crowded districts, crossed by road arteries with heavy traffic (Areni - 1 Mai

Boulevard, Zamca and George Enescu - George Enescu Boulevard), near intersections where there are frequent traffic jams during the day.

At the SvMA level, there are areas with high noise levels, corresponding to urban agglomerations where human activity is intense, and areas with low noise levels, located on the outskirts of Suceava, far from the hustle and bustle of the city (*Prisacariu, 2023*).

5. Conclusions

In the third monitoring campaign (July 12-18, 2021), several aspects were observed. *i) The* average noise level recorded the highest values (over 60 dB) in four observation perimeters (Obcini District, George Enescu District, "Ștefan cel Mare" University, and Burdujeni District) in monitoring points 1, which were located near the main traffic arteries generating noise (E85, George Enescu Boulevard, 1 Mai Boulevard, E85 intersection with DN29A) from Monday to Friday. At weekends, the noise level decreased in all monitoring perimeters. At the points located at the main arteries, the noise level was 5-20 dB higher than that of the buildings behind the first row and 10-30 dB higher than that of the buildings located further away. In the peri-urban area, the noise level was 5 to 30 dB lower in case of average values and 30 to 50 dB lower in case of maximum values. *ii)* In all monitoring points, there were diurnal fluctuations in noise levels: increases during the day (between 07.00 and 19.00.00) (25-35 dB indoors; 45-55 dB outdoors) caused by road traffic and daily activities of the population and decreases during the night (22.00 - 06.00) (20-25 dB indoors; 30-45 dB outdoors), depending on the reduction or cessation of human activities. Noise peaks rose during the day to 104.8 dB at 08.00 in P1 George Enescu on 13 July and to 103.3 dB in P1 Burdujeni at 15.00 on 13 July. The lowest values dropped in several observation perimeters to 24 dB. The average differences between noise levels at night and during the day are 5-10 dB in indoor areas, 20-25 dB in urban outdoor areas, and 5-10 dB in peri-urban outdoor areas. Maximum day-night noise differences reach 70-80 dB in urban areas while remaining within 15 dB range in peri-urban areas.

In the fourth monitoring campaign (7 - 20 November 2022), the highest average daily noise values were recorded at the observation point IN1 - Dormitory 7 / ISJ Suceava (37.9 dB average indoor and 62.2 dB average outdoor), located on the main traffic artery Calea Unirii connecting the Centre of Suceava to Burdujeni and Iţcani districts, with heavy road traffic, where traffic jams were frequently recorded. Inside, the average noise level is 25 to 30 dB lower compared to outside (in many quiet indoor spaces, it falls below 15 to 20 dB). The highest indoor noise levels were recorded at the monitoring points located in dwellings near access streets to public institutions, shopping centers, offices, educational institutions, and housing estates. The maximum noise level (84.5 dB) at indoor monitoring points was recorded in Șcheia in the hourly interval 13.00 - 15.00, the main cause being road traffic. In the outer points, the maximum noise level exceeded 90 and approached 95 dB.

Noise control and mitigation measures are of paramount importance. Technical measures to control noise pollution concern the identification of noise sources and the protection of human health, the home, and the space in which they operate, by finding measures that do not block daily activities. The production of noise maps for each city is a much-needed measure, as it can provide useful information to decision-makers in identifying urban districts with high noise pollution levels and the risk of long-term damage to people's health.

In the doctoral paper „Studies and research on reducing noise pollution produced by motor vehicles by organizing road traffic", engineer Andrei – Alexandru Boroiu (2017) proposed measures and solutions on reducing noise pollution in the cities of Bucharest and Pitesti, which have already been implemented: the location of a vegetable barrier, at 5 m distance from the road axis and at a height

of 1.5 m (noise level reductions of just below 60 dB have been achieved in the roundabouts); streamlining traffic by building passages (passage Prundu – Pitesti); equipping cars with silent tires (reduction of noise level by 4 dB); directing heavy traffic through road signs binding to the right, to, prior to the intersection of the Bridge of Vineyards, for vehicles entering the city over the Arges Bridge; improving traffic light cycles of the intersections with the Vissim program, an application consisting of a microsimulation of the road traffic in the central area (Bucharest, Pitesti).

To reduce the impact of noise on our lives, specialists in Otorhinolaryngology (ORL) recommend: individual hearing protection (the use of headphones or earplugs in noisy environments, such as concerts, concerts, etc, construction sites or even in heavy urban traffic, can help reduce noise exposure); noise insulation of the home (creating an effective barrier against external noise, ensuring a quieter resting and working environment); limiting exposure to personal devices (mobile phones, tablets and sound systems to levels not exceeding 60% from the maximum capacity can prevent damage to hearing); monitoring noise levels (using mobile applications that measure noise levels can be a useful tool to be aware of exposure to noise pollution and take precautions when necessary); education and awareness (informing and educating the community about the effects of noise pollution and about protective measures can lead to beneficial behavioural changes in the long run); community involvement in noise reduction efforts (planting green spaces for noise absorption and organizing events in designated areas that limit noise dissemination in residential areas) (*https://centrulmedicalmisca.ro/blog/combaterea-poluarii-fonice-sfaturi-de-la-specialistii-orl*).

Making decisions related to urban planning and supporting initiatives to reduce traffic noise contributes to creating a healthier and more pleasant urban environment for all.

References

Abbasi O.R., Ghajari Y.E., Asghar Alesheikh A. (2022). A spatiotemporal analysis of the impact of the COVID-19 outbreak on noise pollution in Tehran, Iran, Geospatial Health; volume 17:1114.

Boroiu A.A. (2017). Studies and research on reducing noise pollution caused by motor vehicles by the organization of road traffic. Doctoral thesis – summary, University of Pitesti.

Chand, P., Joshi, R., Maharjan, A., Joshi, P., & Joshi, S. (2022). Sound level exposure in the residential and peace zones of Kathmandu valley and its effects on human health. Scientific Reports in Life Sciences, 3(4), 27–52. https://doi.org/https://doi.org/10.5281/zenodo.7332209.

Chauhan, R., Shrestha, A., & Khanal, D. (2021). Noise pollution and effectiveness of policy interventions for its control in Kathmandu, Nepal. Environmental Science and Pollution Research, 28(27), 35678–35689. https://doi.org/10.1007/s11356-021-13236-7.

Chiru A., Covaciu D., Florea D., Timar J., Vlase S. (2009). Noise Mapping for Urban Road Traffic and its Effect on the Local Community, The 3rd Int. Conf. On Computational Mechanics and Virtual Engineering COMEC, 2 -30 October, Brasov, Romania.

Cobzeanu B., Butnaru C., Lungu A., Poenaru M., Hainăroșie R., Rădulescu T. (2019). Environmental noise: health and policy - an up to date minireview, Environmental Engineering and Management Journal, "Gheorghe Asachi" Technical, University of Iasi, Romania, March, Vol.18, No. 3, 749-755, http://www.eemj.icpm.tuiasi.ro/; http://www.eemj.eu.

Cobzeanu M.D. (2012). Implications of environmental and individual factors in genesis and management of advanced larynx neoplasms, Environmental Engineering and Management Journal, 11, 741-746.

Cobzeanu M.D., Palade O.D., Voineag M., Cobzeanu B.M., Ciubotaru A., Drug V.L. (2013). Environmental factors associated with dysphonia in professional voice users, Environmental Engineering and Management Journal, 12, 1265-1270.

Covaciu D., Florea D., Timar J., Dima D.S., Chiru A. (2015). Study of the noise generated by a major road in a city, Annals of the Oradea University, Fascicle of Management and Technological Engineering Issue #1, May 2015.

Deac C., Petrescu V., Gligor A. (2017). Reducing the noise pollution level along main roads in Sibiu, Romania by optimizing the traffic flow, MATEC Web of Conferences **112**, 09013 (2017) DOI: 10.1051/matecconf/20171120901.

Drasovean R.M., Simona Condurache-Bota S., Nicolae Tigau N., Gabriel Murariu G. (2023). The ambient noise level in the city of Galati and surroundings, Annals of "Dunarea de Jos" University of Galati, Mathematics, Physics, Theoretical Mechanics, Fascicle II, Year XV (XLVI) 2023, no. 2, DOI: https://doi.org/10.35219/ann-ugal-math-phys-mec.2023.2.07.

Gille L.A., Marquis-Favre C., Lam K.C. (2017). Partial and total annoyance due to road traffic noise combined with aircraft or railway noise: structural equation analysis, International Journal Environmental Research and Public Health, 14, 1478.

Gupta S., Ghatak C. (2011). Environmental noise assessment and its effect on human health in an urban area. International Journal of Environmental Sciences, 1(7), 1955–1965. https://doi.org/10.6088/ijessi.00107020050.

Hu B.H., Zheng G.L. (2008). Membrane disruption: an early event of hair cell apoptosis induced by exposure to intense noise, Brain Research, 1239, 107-118.

Millar H. (2020). What are the health effects of noise pollution? Medical News Today. https://www.medicalnewstoday.com/articles/noise-pollution-healtheffects, International Journal of Education and Life Sciences (IJELS), Vol. 2 No 2, 2024: 161-176.

Moteallemi A., Bina B., Mortezaie S. (2018). Effects of noise pollution on Samen district residents in Mashhad city. Environmental Health Engineering and Management, 5(1), 23–27. https://doi.org/10.15171/ehem.2018.04.

Oiste A.M., Mihai F.C., Chelaru D.A. (2015). Soundscape in North-Eastern Part of Iasi City (Sararie - Ticau District), Bulletin USAMV series Agriculture 72(1)/2015, DOI 10.15835/buasvmcn-agr: 11190.

Pantawane M., Maske M. K., Kawade M. N. (2017). Effects of Noise Pollution on Human Health. International Advanced Research Journal in Science, Engineering and Technology, 4(3).

Peris E. (2020). Noise pollution is a major problem, both for human health and the environment. https://www.eea.europa.eu/articles/noise-pollutionis-a-major Science Communication Unit, University of the West of England (UWE), Bristol (2015). Noise impacts on health, Science for Environment Policy.45(1) -15. DOI 10.2779/53698.

Petric D. (2022). Noise pollution and health, International Journal of Speech and Audiology 2022; 3(1): 08-10.

Platon S.N., Tudor A., Darabont D.C., (2017). Methods for reducing the risk of hearing loss in potentially explosive workplaces, Environmental Engineering and Management Journal, 16, 1341-1346.

Popescu D.I. (2020). Case Study of the Environmental Noise and its Perception in the City of Cluj-Napoca, Romania, Archives of Acoustics, Vol. 45, No. 4, pp. 625-631 (2020), DOI: 10.24425/aoa.2020.135250.

Popescu D.I., Moholea I.F., Morariu - Gligor R.M. (2013). Urban Noise Annoyance Between 2001 and 2013 - Study in a Romanian City, Archives of Acoustics, Vol. 38, No. 2, pp. 205-210 (2013), *DOI: 10.*2478/aoa-2013-0024.

Prisacariu A. (2023). Climatic, topoclimatic and microclimatic study of the metropolitan area of Suceava municipality - PhD thesis, University "Ștefan cel Mare" Suceava.

Radulescu L., Curocichin G., Buza A., Parii S., Meriacre T., Chiaburu Chiosa D., Butnaru C., Birkenhaeger R., Martu C., (2018). Efficiency of SNPs for the detection of 35DelG mutation in 50 cases with nonsyndromic hearing loss, Revista de Chimie, 69, 2273-2277.

Recio A., Linares C., Díaz J. (2018). System dynamics for predicting the impact of traffic noise on cardiovascular mortality in Madrid, Environmental Research, 167, 499-505.

Simion S., Kovacs M., Toth L., Ilie C., Gireada A. (2017). Workers exposure to noise in surface extractive industry, Environmental Engineering and Management Journal, 16, 1367-1372.

Singh B., Olds T., Curtis R., Dumuid D., Virgara R., Watson A., Szeto K., O'Connor E., Ferguson T., Eglitis E., Miatke A., Simpson C.E., Maher C. (2022). Effectiveness of physical activity interventions for improving depression, anxiety and distress: an overview of systematic review. British Journal of Sports Medicine; 57(18):1203-1209. doi: 10.1136/bjsports-2022-106195.

Sorea I., Stoleriu C.C., Ursu A., Urzica A. (2019). Assessment of the population exposed to road traffic generated noise. Case study: Vaslui Town, Romania, International Scientific Conference Geobalcanica, DOI: http://dx.doi.org/10.18509/GBP.2019.71 UDC: 504.6:534.322.3]:656.2(498).

Titu A.M., Boroiu A.A., Mihailescu S., Pop A.B., Boroiu A. (2022). Assessment of Road Noise Pollution in Urban Residential Areas-A Case Study in Pitești, Romania. Applied Science, 12, 4053., https://doi.org/10.3390/app12084053.

Wokekoro E. (2020). Public Awareness of the Impacts of Noise Pollution on Human Health, World Journal of Research and Review, 10(6), 27–32. www.wjrr.org.

World Health Organization (1995). Guidelines for Community Noise. Geneva: Stockholm University and Karolinska Institute.

Decision No 321 of 14 April 2005 on the assessment and management of environmental noise (published in the Official Journal No 358 of 27 April 2005).

Decision No 1.260 of 12 December 2012 amending and supplementing Government Decision No 321/2005 on the assessment and management of environmental noise (published in the Official Gazette No 15/09.01.2013).

Directive 2002/49/EC relating to the assessment and management of environmental noise.

Law No 121 of 3 July 2019 on the assessment and management of environmental noise, published in the Official Gazette No 604 of 23 July 2019.

Order No 152 of 13 February 2008 approving the Guidelines for the adoption of limit values and their application when drawing up action plans for the indicators L(zsn) and L(night) for noise from road traffic on main roads and in agglomerations, rail traffic on main railways and in agglomerations, air traffic at large and/or urban airports and for noise from areas in agglomerations where industrial activities are carried out, as referred to in Annex No. 1 of Government Emergency Ordinance No 152/2005 on integrated pollution prevention and control, approved with amendments and additions by Law No 84/2006 (published in the Official Gazette No 531 of 15 July 2008).

Order No 119 of 4 February 2014 approving the rules of hygiene and public health on the living environment of the population, Ministry of Health (published in the Official Gazette No 127 of 21 February 2014).

https://lege5.ro/Gratuit/gm2dambxgy3a/legea-nr-121-2019-privind-evaluarea-si-gestionarea-zgomotului-ambiant

https://centrulmedicalmisca.ro/blog/combaterea-poluarii-fonice-sfaturi-de-la-specialistii-orl