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ASSESSMENT OF TRAFFIC NOISE LEVELS IN THE CITY OF PILA

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Abstract

The last few decades have been characterised by the rapid development of technology and various industries around the world, as well as increasing levels of urbanisation. The development of technology has resulted in the emergence of many inventions, vehicles and equipment. This has resulted in many unforeseen consequences generating threats to the environment in which humans' function. One of these hazards is the noise emitted by vehicles. For this reason, environmental protection was created in response to threats to human existence (this work is to determine the level of noise resulting from traffic transportation in the city of Pila. In order to achieve the given objective in the city, sound values will be adopted and an acoustic map will be developed on their basis. A large amount of noise in the city of Pila is caused by road transportation, but from the results of the study it can be said that it is minimally exceeded only on two streets by less than five decibels and on three other streets where it is equal to the permissible noise value. The main places where the most noise is generated are two-lane roads and traffic lights and roundabouts. A lot of noise is generated when there are a large number of vehicles slowing down and starting in these places. A very big plus in the fight against noise in Pila is public transportation.

Keywords: communication transport; road transport; noise; environmental protection; acoustic map

1. Introduction

The last few decades have been characterised by the rapid development of technology and various industries around the world, as well as increasing levels of urbanisation. The development of technology has resulted in the emergence of many inventions, vehicles and equipment. This has caused many unforeseen consequences generating threats to the environment in which humans' function. One of these hazards is the noise emitted by vehicles. For this reason, environmental protection was created in response to threats to human existence [15].

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The main purpose of this study is to determine the level of noise resulting from traffic transportation in the city of Pila. Noise can have a detrimental effect on the lives of residents, causing many negative symptoms such as distraction, deterioration of perception, etc. In order to achieve the given goal in the city, sound values will be adopted and an acoustic map will be drawn up on their basis.

The problem of noise has been addressed in various publications. For example, [15] outlines the dangers of staying in areas with high noise levels and describes methods for studying noise levels. In contrast, [6] describes how noise is created and propagated. The book also includes thresholds that noise can exceed and methods for making noise measurements. Noise sources in motor vehicles are described in [2], and noise levels at drivers' stations under various conditions are described in [14]. The intensity of the traffic flow in some parts of the municipalities becomes disproportionately high, which contributes directly to the noise level [3, 24]. Car noise can affect the driver, passengers, and the environment, but also has a secondary social and economic impact [4]. In addition, the type of pavement affects the noise level of the vehicle, which in turn affects human health. In addition to the engine, exhaust system, and vehicle mechanics, music systems installed by the automobile owner themselves, with their volume level exclusively at his or her own choice, also contribute to noise production [19, 27]. The excessive loudness of music systems [16] not only harms the health of the driver but also prevents the driver from using auditory information content while driving, increasing the risk of a traffic accident [7, 8, 20].

Studies confirm that many large cities struggle with noise (which is primarily caused by traffic), exceeding the limits recommended by the World Health Organization (WHO) [1, 4, 5] and often at literally alarming levels [25]. The creation of conditions and greater support for alternative modes of transport in cities (such as walking and cycling) can significantly help reduce the level of noise pollution [22, 24]. Many studies point to the positive effect of using these options even in the wake of the Covid-19 crisis [9].

2. Materials and Methods

The research was conducted in the city of Pila, located on the Gwda River. Pila is located on the border of the Wielkopolska and West Pomeranian provinces. The city, thanks to is geographical location, is a very significant place on a national scale at the crossroads of transportation routes. Many roads and railroads leading from Pomerania to the southern directions of Poland intersect here, such as Poznań or Gorzów Wielkopolski and further to Germany, and from Szczecin to Bydgoszcz, as well as Toruń and Warsaw. All car noise is created by local and transit transport. Measurement points were placed at locations near which the flow of passenger and traffic vehicles is greatest throughout the city (Figure 1).

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Fig. 1. Location of measurement points in the city of Pila [12]

Noise measurements in the city of Pila were conducted mainly in spring and summer in two months, May and June. Noise measurements were made during the day from 6:00 am to 8:00 pm.

Measurements at the stated hours were also conducted according to the type of day (weekday, weekend), due to the characteristic traffic of vehicles. The measurements were performed on the basis of the Regulation of the Minister of the Environment on the requirements for conducting measurements of the levels of substances or energy in the environment by the managers of roads, railways, tramway lines and airport [23]. The measuring instruments were set at a height of 1.2 ± 0.1 m above the level of the road surface and were directed perpendicularly to the axis of moving road vehicles. For each measurement point, measurements were taken on one side of the city's arterial road at the same distance of 1 m from the edge of the road (Figure 2). In order to be able to make measurements, it is necessary to pay attention to the requirements of the regulation discussing atmospheric conditions, ambient temperature and wind strength and direction. At the time of the measurements, the air temperature was higher than 10°C, while the wind speed did not exceed 5 m/s and there was no precipitation. The noise measurements performed were made precisely under such atmospheric conditions in order to separate the results from atmospheric influences as much as possible. Noise measurements were made using a Habotest HT622B sound level meter (Figure 3). The technical data are shown in Table 1.

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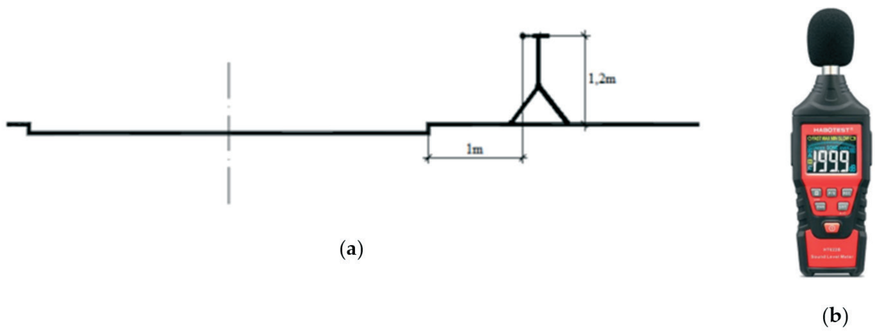

Fig. 2. Measuring device; (a) sketch of the location of the measuring device, (b) Habotest HT622B volume level meter [13]

Tab. 1. Habotest meter specifications [13]

Meter Specifications			
Sound pressure accuracy	±1,5 dB (94 dB/1 KHz), ±5 dB (94 dB/8 KHz)	Bar chart	Yes
Frequency response	30Hz–8kHz	Automatic/manual range selection:	Yes
Measurement range	30–130 dBA, 30–130 dBC	Under/Over range	Yes
Dynamic range: 50 dB	50 dB	Data storage: Yes	Yes
Measurement:	A/C	MAX/MIN	Yes
Dynamic properties	FAST: 125 ms, SLOW: 1 s	Power supply	3x battery AAA 1,5 V
Microphone	Polarized, capacitive	Dimensions	189x60x33 mm
Range	30–80 dB, 40–90 dB, 50–100 dB, 60–110 dB, 60–110 dB, 70–120 dB, 80–130 dB	Weight	About 180 g

Source: authors

According to the guidelines for acoustic mapping [13], maps are made for agglomerations with a population of more than 100.000. The guidelines for acoustic mapping also distinguish roads, railways and airports for which an acoustic map should be made. We are referring precisely to road sections with an annual traffic volume of more than 3 million motor vehicles and railway sections on which more than 30.000 trains move annually [18]. There is no railway section in Pila that meets the condition of 30.000 trips per year [21]. Measurements are also made for airports with more than 50.000 operations (departures or landings) per year.

The city of Pila does not meet any of the guidelines for preparing an acoustic map. Therefore, in order to carry out the study, the condition is adopted, which was determined in the creation of the acoustic map for the city of Poznan from 2017. Based on the acoustic map of the

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city of Poznań 2017 [17], which considers only roads with at least 3.000 cars per day. Roads characterised by less traffic than indicated do not pose a threat to the acoustic climate, as road noise extents then do not extend beyond the area of the road lane, and therefore do not cause exceedances of permissible sound levels. In order to determine the evaluation of the values of noise levels on the territory of the city of Pila, the results of measurements were compared with the permissible values specified in the Regulation of the Minister of Environment on permissible levels of noise in the environment of June 14, 2007 [23].

Noise level surveys conducted with a noise meter were performed on roads that exceed at least 3.000 trips per day. Roads on which there is less traffic than indicated create noise that does not go beyond the area of the road lane. Roads that meet the given indicator include thirty streets.

3. Results and Discussion

Noise measurements were made on the basis of short-term indicators. A given indicator applies to the determination and control of the conditions of use of the environment for one day. In order to make the measurements accurate, they were made as many as three times, on Tuesday, Thursday and Saturday from 6 a.m. to 8 p.m. The following tables will give the noise measurements at the measurement points for the days Tuesday, Thursday and Saturday and their average value is shown in Table 2.

Tab. 2. Average road noise obtained during the measurements.

Street	Average noise for Tuesday [dB]	Average noise for Thursday [dB]	Average noise for Saturday [dB]
Siemiradzkiego	57.9	51.5	54.4
Poznańska	61.3	69.3	69.2
Piastów	73.2	68.8	68.3
Okrzei	66.8	69.2	61.0
Podgórna	54.8	52.3	41.3
Mickiewicza	56.7	64.3	63.5
Wyspiańskiego	64.1	67.9	60.3
Konarskiego	48.9	51.2	43.6
Drygasa	53.9	48.6	51.4
Dzieci Polskich	65.1	71.2	62.9
Popiełuszki	60.5	56.8	45.9
Wolna	53.0	57.6	48.1
Niepodległości	66.2	71.4	66.1
Koszalińska	63.8	68.1	58.6
Paderewskiego	40.1	46.8	42.7
Wojska Polskiego	71.6	68.1	64.6
Jana Pawła II	67.8	74.2	66.5

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Tab. 2. Average road noise obtained during the measurements; cont.

Street	Average noise for Tuesday [dB]	Average noise for Thursday [dB]	Average noise for Saturday [dB]
Piłsudskiego	59.1	56.6	52.3
11-Listopada	52.9	50.6	52.2
Powstańców Warszawy	69.4	64.4	67.5
Powstańców Wielkopolskich	73.1	72.7	65.1
Dąbrowskiego	53.2	55.7	52.5
Śniadeckich	48.9	47.3	44.5
Bydgoska	61.3	67.8	58.7
Kossaka	60.5	57.4	55.5
500-lecia Piły	66.1	68.6	67.2
Głuchowska	69.8	66.5	62.0
Kusocińskiego	56.2	55.0	53.5
Podchorążych	59.1	63.5	55.9
Browarna	47.1	54.6	45.6
Okólna	63.2	58.7	67.7
Zygmunta Starego	65.7	67.2	73.2

Noise in Pila exceeds permissible standards only on a few streets, this applies to roads such as Piast Avenue, Jana Pawła II Avenue, Powstańców Wielkopolskich Avenue, Wojska Polskiego Avenue and Zygmunta Starego Street; the exceedances are minor, as they are at most five decibels more than the permissible value of sixty-eight decibels. Therefore, there are no noise-prone areas in the city. With the table given, it can be concluded that Pila is a quiet city.

3.1. Acoustic map of the city of Pila for traffic noise

The acoustic map consists of a descriptive component and a graphic component [11]. The descriptive component includes introductory information, tabular statements, and a summary and conclusions. The graphic component, consists of several types of acoustic maps, specifically, emission and immission maps, and exceedances. The emission map shows noise from individual sources (road noise, rail noise, air noise, etc.). An immission map is a map showing the acoustic condition shaped by one type of noise (road, air, streetcar, rail or industrial). An exceedance map identifies noise-prone areas, showing areas where noise exceeds the permissible sound level for a given noise source in the ranges from 0–5 dB, 5–10 dB, 10–15 dB, 15–20 dB and above 20 dB [10]. Acoustic maps are created at the behest of EU law. They are described by Directive 2002/49/EC of the European Parliament and of the Council of Europe of June 25, 2002, relating to the assessment and management of noise levels in the environment. This directive was introduced by the law of April 27, 2001. Environmental Protection Law, as amended. The Environmental Protection Law [26] requires the creation of acoustic maps for cities with more than 100.000 residents and for major roads with at least 3.000.000 car trips per year, railways with 30.000 trips per year, and airports with more than

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50.000 operations (take-offs and landings) [26]. Based on the above data, an immission map for road noise will be drawn up in the following section.

The immission map shows the noise generated by a given mode of transportation (Figure 3). The greatest noise in Pila is caused by road transport, but it is not as great as in larger cities with a population of more than 250.000, e.g., Poznań, Warsaw, Gdańsk.

The noisiest streets are marked in red and purple, these streets have traffic lights and are dual carriageways, so the most noise is generated there. Measurement points on the streets were within one metre of traffic lights, traffic circles and intersections.

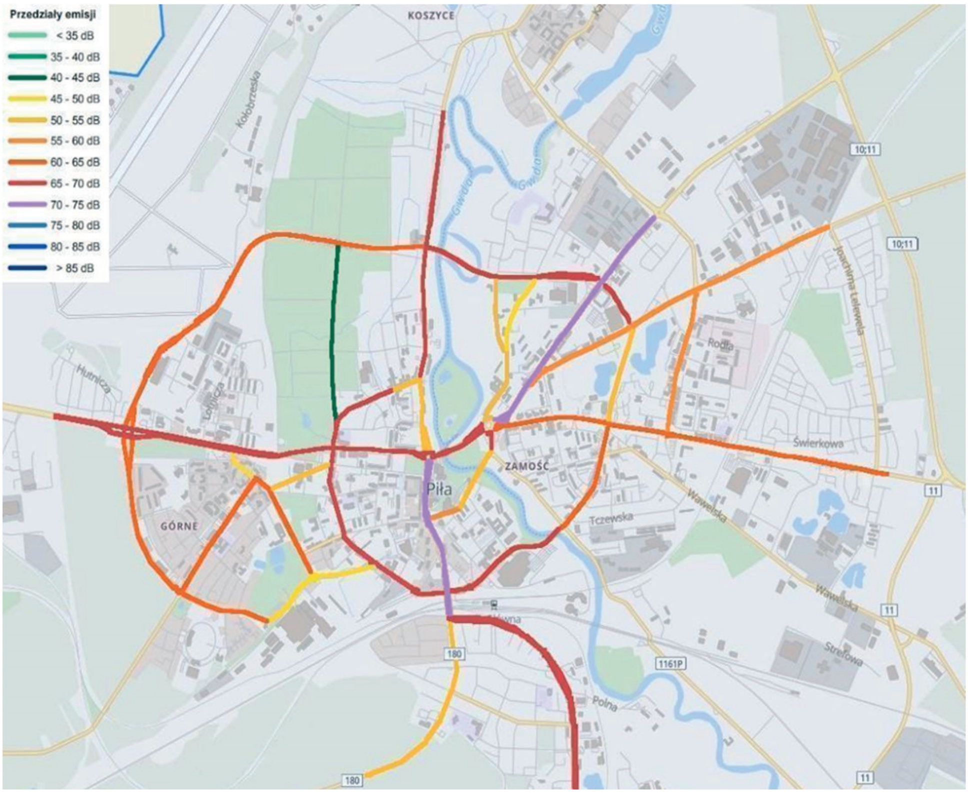

Fig. 3. Immission map for road noise [12]

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4. Conclusions

Noise is currently the most significant and widely present threat affecting the acoustic climate in most urban clusters. The harmful effects of noise on the human body cause negative effects on its health and functioning. Excessive noise negatively affects not only the organ of hearing, but also general health, including mental, emotional and somatic health.

A large amount of noise in the city of Pila is caused by road transport, but from the results of the study it can be said that it is minimally exceeded only on two streets by less than five decibels and on three other streets, where it is equal to the permissible noise value. The main places where the most noise is generated are two-lane roads and traffic lights and traffic circles. A lot of noise is generated when there are a large number of vehicles slowing down and starting in these places. A very big plus in the fight against noise in Pila is public transportation. Buses used in the city centre use hybrid engines, which produce less noise compared to regular internal combustion engines. Pila has a ring road along which much of the road transport moves without entering the city centre, so no more noise is created and no traffic congestion is created. Pila is a medium-sized city with a population of less than 100.000, so there aren't as many cars moving around the city.

On the basis of the surveys carried out, it can be concluded that noise in Pila exceeds permissible standards only on a few streets, this concerns such roads as Piastów Avenue, Jana Pawła II Avenue, Powstańców Wielkopolskich Avenue, Wojska Polskiego Avenue and Zygmunta Starego Street. However, these exceedances are minor, as they are at most 5 decibels more than the permissible value of 68.0 decibels. Therefore, there are no noise-prone areas in the city.

5. Acknowledgement

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