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Improving the sound environment of the city park

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Abstract A city park is a place where, in an urbanized world, a person can experience nature. A park is the green lung of the city. The numerous trees and shrubs in parks improve the air condition, especially in densely populated agglomerations. It is a meeting place and allows you to spend time actively. The park allows recreation and relaxation for city residents. City parks are desirable, especially in city centres, densely populated and built-up places. Designing parks should meet people's needs. It is extremely important to properly select space elements that will positively affect the comfort of use. Apart from the obvious issue of taking care of the park's aesthetics, its flora and appropriate equipment, an important role is played by an appropriate acoustic climate. Hence, when designing open spaces such as city parks, the cooperation of specialists in many fields is important: landscape architects, town planners, people dealing with nature protection, artists, and finally, acousticians. This allows you to create a space that will meet the needs and expectations of residents. The paper shows the possibility of taking steps to correct the existing sound environment in selected places in the city park.

Keywords: soundscape, city park, sound environment.

1. Introduction

A city park is a place where people can experience nature in an urbanized world. It is the green lung of the city. The numerous trees and shrubs in parks improve the air condition, especially in densely populated agglomerations. It is a meeting place and allows you to spend time actively. It allows recreation and relaxation for city residents. City parks are desirable, especially in city centres, densely populated and built-up places.

The sound environment in urban areas is mainly shaped by road traffic. Noise from mobile sources, such as cars or trams, is integral to large cities, so excessive noise in cities and, at the same time, in city parks is becoming a common phenomenon. Generating additional, pleasant sounds to the environment makes it possible to mask unwanted sounds, which in turn may improve the acoustic climate [3, 4, 7, 9, 12].

2. Park Krakowski

One of the many city parks in Krakow is Park Krakowski, named Marek Grechuta Park [13, 16, 17], which is located in the city centre. It is particularly exposed to noise due to its relatively small area and its surroundings, with streets with particularly heavy traffic, such as Adam Mickiewicz Avenue, Królewska Street, Czarnowiejska Street and Szymanowski Street. These streets generate a high level of road and tram noise and reduce the comfort of using the park [1, 9, 15]. Additionally, Park Krakowski is equipped with a playground. The sounds coming from the playground also do not improve the acoustics of the park.

In work by Malec et al. [6], the authors referred to the acoustics of Park Krakowski. They made a comparative analysis of the impact of vegetation on the acoustic climate of two Krakow city parks - Błonia and Park Krakowski. The choice of these parks was motivated by the considerable diversity of plant cover and the proximity of both parks. In the case of Park Krakowski, a positive effect of the presence of leaves on trees on noise reduction was noticed. On the other hand, it was also found that in Park Krakowski, the sounds of nature were rarely recorded, and if the sounds of birds were heard in the spring season, then only in the area of the quietest streets. It was found that the sound landscape of both parks does not differ significantly from the rest of the city surroundings. The article emphasizes that it is advisable to revitalize two parks, especially Park Krakowski, with particular emphasis on reducing the sound level and designing appropriate acoustics, which would improve the comfort of using the park.

The article presents research on the acoustic climate of Park Krakowski and describes the designed acoustic solutions aimed at improving the acoustic environment in selected places of this park. The aim

of the activities undertaken was to create acoustically friendly zones, taking into account the sound level from the surrounding streets. These activities are designed to distract from traffic noise in two ways. The first is to lower the sound level in a selected park zone, and the second is to use additional masking sounds. The combination of these activities allows for minimizing the perceptible city noise.

3. Acoustic research in Park Krakowski

Acoustic measurements in Park Krakowski were carried out in the following seasons: spring (March, May) and autumn (October) [11]. Both measurements, in spring and autumn, were taken on Friday from 5 p.m. to 7 p.m. These are the city traffic rush hours, which means the most unfavourable noise conditions in the park's surroundings. Six measurement points (from P1 to P6) located in the park were selected (Fig. 1), and the measurements were taken at intervals of 15 minutes at each of the points, respectively. The results of the A-sound level measurements are presented in Table 1. Sound spectra were also recorded at the measuring points. Spectral characteristics were used to analyse the selection of sounds masking road noise.

Figure 1. Distribution of sound measurement points in Park Krakowski (P1 – P6).

The highest A-sound levels are found at points P1 and P3, which is related to the proximity of two streets with high vehicle traffic: Adam Mickiewicz Avenue and Czarnowiejska St. At points further away from these streets, such as P5 and P6, the A-sound levels are lower than 4 to 5 dB. Additionally, the acoustic parameters of the fountain located in the central part of the park were determined. The fountain is open from spring to autumn.

Table 1. The results of the A-sound level measurements at measuring points in Park Krakowski.

Measurement point	Autumn Sound level dB(A)	Spring Sound level dB(A)
P1	59.7	58.9
P2	56.3	57.3
P3	57.8	59.5
P4	55.0	54.3
P5	54.8	53.2
P6	54.3	55.0

4. Proposals of local solutions to improve the acoustic climate

For the purposes of analysing local solutions to improve the acoustic climate, an acoustic model of the Park Krakowski was built in the SoundPlan 8.2 software, the correctness of which was verified on the basis of the results of sound measurements carried out in the park and data on the structure of the vehicle stream on the surrounding streets. When performing acoustic measurements in the spring, the number of light and heavy vehicles passing by was determined. The NPB 96 model was used for road noise and the Schall 03-2012 model for tram noise. The terrain and the height of the buildings were taken into account in the simulation. The modelling result is presented in Fig. 2 in the form of A-sound level distributions on the park surface. The sound level distribution was presented at the height of 1.5 meters above the ground level, and the calculations were made in a computational grid of 5 m by 5 meters.

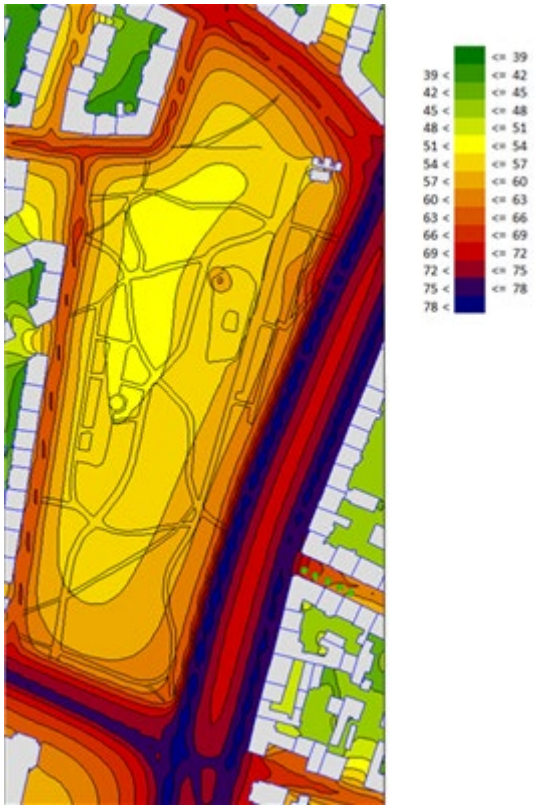

Figure 2. The A-sound level distribution in Park Krakowski (SoundPlan model).

When analysing the A-sound level distributions during the daytime (Fig. 2), it can be noticed that the values of sound levels in the park are in the range of 51 to 66 dB. The particularly acoustically unfavourable area can be found near the intersection of Adam Mickiewicz Avenue and Czarnowiejska Street. The lowest levels of A-weighted street noise are found in the central part of the park near Karol Szymanowski Street.

Taking into account the functionality of the park, we proposed three zones with a modified acoustic climate, marked with numbers from 1 to 3 in Figure 3. Zone 1 a spiral noise screen, zone 2 – is a group of water streams, and zone 3 – is a wooden path with abundant vegetation.

Figure 3. Park zones with a modified sound environment.

In the southern part of the park, due to the highest sound level A, we designed a spiral noise screen 2 meters high (1), which was to reduce the sound level reaching the observation point, with an entrance from the eastern side.

Figure 4 shows the forecast A-sound level distribution in this part of the park after applying an acoustic screen. In the presented calculation points, the difference in the A-sound level before and after the placement of the noise screen was from 2.8 dB at the P3 point to 4.9 dB at the P4 point. The calculations were made at the height of 1.1 meters because this height was estimated as the height of the human ears in a sitting position on a bench. In the calculation model, the grid spacing was set at 0.5 m × 0.5 m.

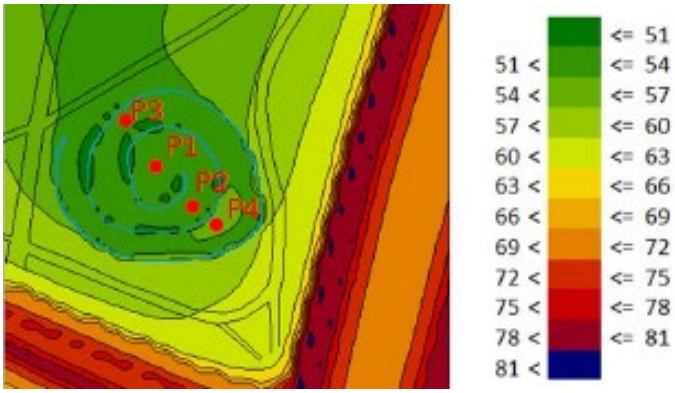

Figure 4. The A-sound level distribution in the southern part of the park, after adding a noise screen.

The next two zones are the result of activities aimed at reducing traffic noise and the introduction of masking sounds in selected zones. To the north of the screen, we have designed two fountains in the form of water taps, surrounded by a stone wall (2), which simultaneously reflects the sounds of the fountain inwards and insulates against road noise. Each fountain has four taps on opposite sides, and each tap pours an average of 5 litres of water per minute from a height of 60 cm. The A-sound level at the observation point near the fountains increased from 54.9 to 56.6 dB, but the spectrum of the sound pressure level also changed. The analyses were performed in frequency octave bands from 63 to 4000 Hz. After the local change of the sound environment, the difference in each analysed band was at least 3.3 dB(A).

The last and third element of climate improvement was the creation of a wooden path in the central part of the park surrounded by liana-like plants (3). The sound of footsteps on a wooden path generates pleasant sounds, which, combined with the reduced A-sound level caused by the placement of the plant path, results in a local improvement in the acoustic climate.

5. Conclusions

Park Krakowski is located in the centre of Cracow; on all sides, busy streets surround it, so it is not possible to completely silence the park. However, by taking appropriate acoustic measures, we can create local areas of the city park where traffic noise will not be annoying and will be less bothersome.

Shaping zones free from street noise is an important task for the proper functioning of the city park. Such activities are undertaken in many countries [1, 3, 7, 10, 15], as well as in Poland [2, 8]. As a result, it is possible to create a place where a city dweller will not be stressed by city noise. He can breathe in close contact with nature and read a fragment of a book or newspaper.

Actions to improve the acoustic climate could be further extended by placing a sound system which would generate natural sounds, for example birds singing or insect sounds. Also, natural sounds could be obtained by placing vegetation that would attract living organisms. As mentioned, Park Krakowski is named after Marek Grechuta, so the sound system in the park could also be used to generate his vocal compositions.

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Additional information

The author(s) declare: no competing financial interests and that all material taken from other sources (including their own published works) is clearly cited and that appropriate permits are obtained.

References

1. B. De Coensel, S. Vanwetswinkel, D. Botteldooren; Effects of natural sounds on the perception of road traffic noise, 2011.
2. K. Frączak; https://www.readyforboarding.pl/polska/ogrod-zmyslow-w-poddebicach.html (accessed on 2022.05.19)
3. Y. Hao, J. Kang, H. Wörtche; Assessment of the masking effects of birdsong on the road traffic noise environment; J. Acoust. Soc. Am., 2016, 140(2), 978
4. A. Kowalczyk; Preferencje dźwięków w krajobrazie (in Polish); Prace Komisji Krajobrazu Kulturowego, tom XI; Instytut Nauk o Ziemi UMCS, Komisja Krajobrazu Kulturowego PTG, Lublin, 2008
5. Life Urban Green Kraków; https://krakow.lifeurbangreen.eu/pl/green-areas/#/district/44 (accessed on 2022.05.31)
6. M. Malec, S. Klatka, E. Kruk, M. Ryczek; Próba oceny wpływu roślinności na kształtowanie krajobrazu dźwiękowego na przykładzie dwóch parków miejskich Krakowa; Acta Sci. Pol. Formatio Circumiectus, 2017, 16(2), 167–178
7. M.E. Nilson, J. Alvarsson, M. Radsten-Ekman, K. Bolin; Auditory masking of wanted and unwanted sounds in a city park; Noise Control Engineering Journal, 2010, 58(5), 524–531
8. Poddębice – Ogród zmysłów; https://poddebice.pl/polecane-ogrod-zmyslow (accessed on 2022.05.19)
9. E. Ozimek; Dźwięk i jego percepcja. Aspekty fizyczne i psychoakustyczne (in Polish); PWN, 2018

10. M. Piwonski, B. Schulte-Fortkamp; Audio-Islands am Nauener Platz – eine technishe Waliderung (in German); DAGA 2011 - 37. Deutsche Jahrestagung für Akustik, Düsseldorf, Germany, March 21-24, 2011
11. Rozporządzenie Ministra Środowiska w sprawie wymagań w zakresie prowadzenia pomiarów substancji lub energii w środowisku przez zarządzającego drogą, linią kolejową, linią tramwajową, lotniskiem lub portem (z dnia 16 czerwca 2011 r.); Dziennik Ustaw Nr 140, Poz. 824
12. R. Schafer; The soundscape: our sonic environment and the tuning of the world; Alfred Knopf, 1977
13. J. Torowska; Parki Krakowa, część I; Sponta, 2001
14. J. Więcek, M. Kucharczyk, M. Polak; Wpływ hałasu drogowego na ptaki (in Polish); Budownictwo i Architektura, 2014, 13(1), 75–86
15. J. Young Hong, J. Yong Jean; Designing sound and visual components for enhancement of urban soundscapes; The Journal of the Acoustical Society of America, 2013, 134(3), 2026–2036
16. A. Zachariasz; Park Krakowski znany i nieznany (in Polish); Teka Komisji Urbanistyki i Architektury, 1996, 28, 203–228
17. Zarząd Zieleni Miejskiej w Krakowie; https://zzm.krakow.pl/zzm/parki/222-park-krakowski.html (accessed on 2022.06.13)