Noise control in urban parks in Cracow

Bartłomiej Chojnacki
AGH University of Science and Technology, Poland.

Janusz Piechowicz
AGH University of Science and Technology, Poland.

Magdalena Matys
AGH University of Science and Technology, Poland.

Kamil Piotrowski
AGH University of Science and Technology, Poland.

Summary

The main function of green areas located in urbanized zones is to provide places for relaxation and rest, both physical and mental for urban residents. Due to proper planning and management, city parks can provide a wide range of benefits to city inhabitants. Currently, the acoustic aspect is rarely taken into consideration when designing urban parks, and acoustic comfort is of great importance for the quality of rest. In various cities of the world, in the creation of quiet places in parks, innovative methods are used, which consist in proper management of the terrain, creating natural anti-noise protections and masking noise with the help of nature sounds. The authors have attempted to indicate the objective impact of these solutions on the improvement of the acoustic climate in the park and reference them to the city parks of Krakow. The paper will present the results of measurements of noise levels in city parks in Krakow and compare them to facilities where acoustic measurements were made in other cities in Poland and in the world. It was shown which factors have the most influence on the acoustic climate in green areas. Sound level A measurements were performed, statistical levels and noise nuisance indicators were also calculated. In the analysis of acoustic interactions, it is necessary to identify noise sources together with determining their parameters. The solutions to improve the acoustic climate of green areas are proposed and the benefits resulting from them are presented.

PACS no. 43.50.Gf

1. Introduction

Problems of noisy and quiet areas of the city are essential while urbanistic planning. Appropriate acoustic climate has a crucial meaning for an effective rest. This paper presents a conception of improvement of Jordan's Park in Cracow surroundings. The Park itself lies in AGH University of Science and Technology in Cracow close vicinity. Results of initial measurements in other urban parks have been presented. According to these results there were natural as well as artificial methods of shaping the soundscape proposed.

2. Background

Division of noise analysis into qualitative analysis and quantitative analysis is crucial to understand the soundscape planning. Carrying out only a quantitative analysis may lead to incorrect conclusions or unnecessary interference with environment. Additionally, there are no formal regulations concerning spatial planning which makes the case even more difficult. The process of sound information analysis should be carried out according to Schaffer's diagram which is shown in figure 1.

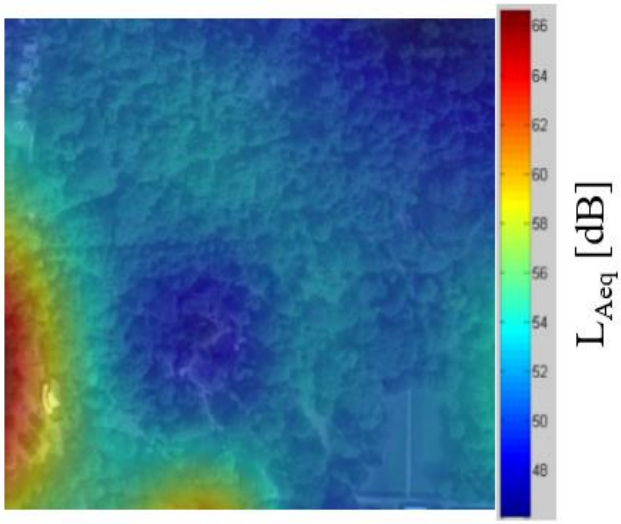
4 UNDERSTANDING – inside level : signs – outside level : meaning The emergence of *meaning* of sound, and notion of *references* of sound	1 LISTENING – inside level : indications – outside level : events *Emission* of sound	1 & 4 : objective
3 ATTENDING – inside level : perceptual qualification – outside level : sound quality *Selection* of certain aspects of sound	2 HEARING – inside level : inarticulate about features and contexts of sound – outside level : inarticulate about information of sound *Reception* of sound	2 & 3 : subjective
3 & 4 : abstract	1 & 2 : concrete	

Figure 1. Hearing modes for sound quality analysis, proposed by Schaffer [1]

In acoustic quality assessment of a city park we can connect the results of objective sound level measurement, qualitative indicators and subjective rating based on surveys. In urban environment the established building form and lack of possibilities to interfere with environment tends to be the problem [2]. We should also pay more attention to application of proper noise control methods which do not interfere with the city park's esthetics.

3. Previous studies and analysis methods

In the paper [3] there was a method presented to analyze the city park's soundscape dividing it into zones, carrying out the noise measurements and

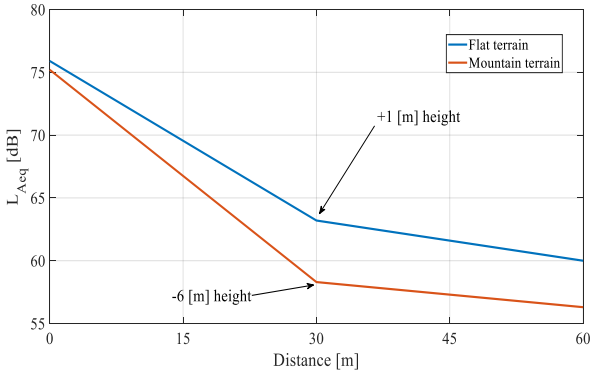


performing spectral analysis of the recordings.
Figure 2. Noise map of Holland Park, London

The crucial meaning of landform for silence zones (relax zones) and noise zones (playgrounds, places for playing sports) was pointed out. Prior to carrying out the measurements in Jordan's Park in Cracow there was literature research and field tests in city parks in London performed. The example of good relax (quiet) and active (noise) zones planning is Holland Park in London. In figure 2 there is a noise map presented which was created based on performed field measurements.

Holland Park is particularly wooded. In their works Engel [4] and Fricke [9] pointed out various types of dense vegetation, coniferous trees especially, as great natural acoustic screen. In the discussed object the isolation of playground (red area) from Japanese Garden was very well executed – at distance about 30 [m] the difference in measured noise levels reached about 18 [dB]. In limiting noise propagation zones landform is also very helpful [7].

Figure 3. Noise reduction with distance in two variants in Green Park, London



In the cased presented in figure 3 the difference between A-weighted sound levels can be observed depending on land form in the measurement spot – with constant sound source, when the measurements were performed in depression of the area with uneven terrain we can observe a 5 [dB] difference in relation with flat terrain measurements. The type and shape of the ground also is relevant (land, short grass, dense vegetation) [5][8].

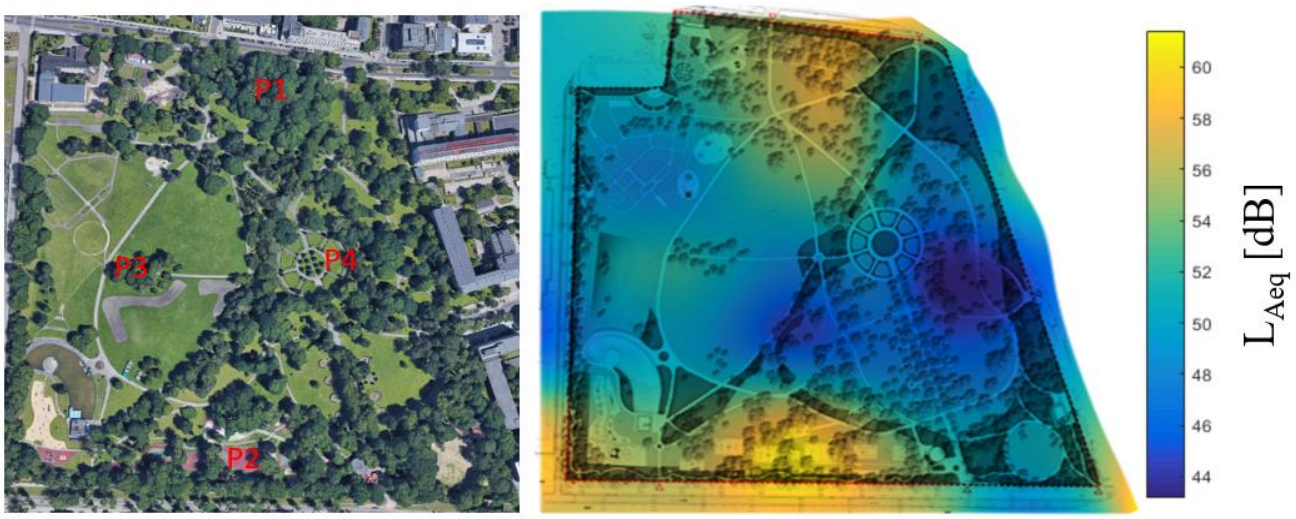


Figure 4. Noise map of Jordan's Park, Cracow

4. Soundscape of Jordan's Park in Cracow

While carrying out the research concerning acoustic situation in Jordan's Park, Cracow there was methodology used which is described in [3]. There were 15-minutes sound level measurements performed using SVAN Sound Level Meter and Analyzer. Based on results obtained there was acoustic model of given terrain created which was property calibrated (figure 4). In order to carry out a detailed analysis of Jordan's Park soundscape there were following zones differing in functionality and acoustic climate specified:

- P1 – the zone near to the Park's entrance with heavy traffic
- P2 – sport zone with a presence of sports Fields and neighboring tram rails
- P3 – recreational zone with large treeless area and lanes
- P4 – relax zone, monuments lane, qui et zone

Analyzing the acoustic situation which is show in figure 4 a significant difference between measured L_{Aeq} levels in particular zones. In Jordan's Park the sport zone and main entrance to the Park near the P1 spot are heavily wooded, which allows to dampen the noise accumulated in this area. The spot near the monuments lane is additionally fenced with dense hedge, which conducive to limiting noise in the relax zone. In figures 5 and 6 there are SPL Statistical Levels determined in key locations of the Park.

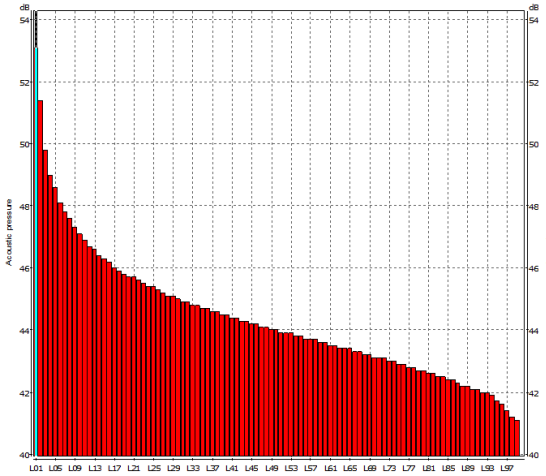


Figure 5. SPL Statistical Levels in P4

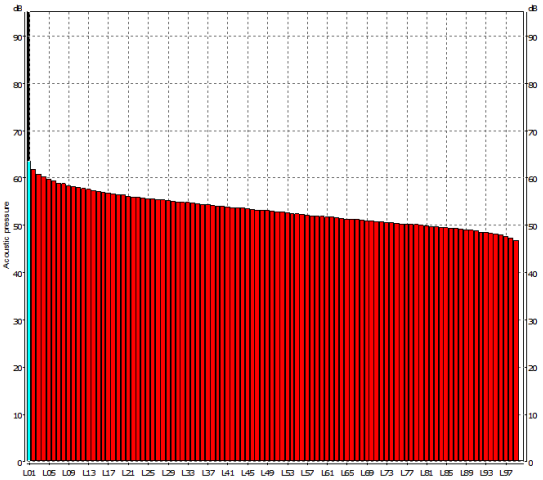


Figure 6. SPL Statistical Levels in P1

The use of Statistical Levels is a good tool to analyze the noise in a qualitative manner [11]. The P1 spot measurement results can be characterized as a constant noise of high level. The P4 spot measurement results, on the other hand, shown as a figure, tend to have an expotential shape with a steep slope. The quantitative analysis proves that even a short time interval of high-level signal would significantly increase the end result, especially concerning a short-time measurement.

5. Summary

Created noise maps based on measured L_{Aeq} levels are insufficient means of soundscape analysis. Performed research indicates a great usefulness of calculated statistical levels. Carrying out measurements with a small amount of sound level meters, the aggregate time necessary to perform such a measurement significantly lengthens, which requires shortening of the measurement time. It is so because the fluctuant acoustic climate in the area (which is connected with particular parts of the day) must be taken into account. The analysis with the use of statistical levels allows to omit the majority of random incidents. It is suggested to deploy further research using noise maps created based on statistical levels or to average the results into narrower section L15–L85. It would also be useful to perform surveys [6][10].

Acknowledgements

Project was supported with the financial support from AGH Rector's Grant 2016 for the Scientific Clubs of AGH "Żubr" Scientific Club.

References

[1] P. Schaeffer: Traité des Objets Musicaux, 112-117, Paris 1966.

[2] A. Farina: Soundscape ecology – principles, patterns, methods and applications, New York 2014.

[3] H. Li, H. Xie, J. Kang: The Urban Park Soundscapes in Mountainous Cities: a Case study in Chongquing, Internoise 2014, Melbourne.

[4] Z. Engel: Ochrona środowiska przed drganiami i hałasem, Warszawa 1993.

[5] J. Piechowicz, A. Ozga, D. Mleczko, C. Kasprzak, L. Stryczniewicz: Ekologia akustyczna na obszarach leśnych, Kraków 2015.

[6] J. Y. Jeon, J. Y. Hong: Classification of urban park soundscapes through perceptions of the acoustical environments, Landscape and Urban Planning 141 (2015) 100–111.

[7] V. Buccur: Urban forest acoustics, Springer-Verlag Berlin Heielberg 2006.

[8] T. Watanabe, S. Yamada: Sound attenuation through absorption by vegetation. J. Acoust. Soc. Japan. 1996;17(4): 175-182.

[9] F. Fricke: Sound attenuation In forests. J. Sound. Vib. 1984;92(1): 149-158.

[10] J. Wiciak, D. Mleczko, A. Ozga, G. Wszołek, J. Wierzbicki, J. Piechowicz, P. Małecki: Quietness in the soundscape of the Białowieża National Park, Acta Physica Polonica. A; 2015 vol. 128 no. 1-A: s. A-79–A-84.

[11] K. N. Irvine, P. Devine-Wright, S.R. Payne, R.A. Fuller, B. Painter, K. J. Gaston: Green space, soundscape and urban sustainability: An interdisciplinary, empirical study, Local Environment 14(2) (2009)