



A STUDY OF THE EMOTIONAL RESTORATIVE EFFECT OF DIFFERENT NATURAL SOUNDSCAPE

Dorota Młynarczyk^{1*}

¹ AGH University of Science and Technology, Poland

ABSTRACT

Stress, the pace of life, and related problems with psychological restoration have become a growing challenge. Many psychologists point to the positive therapeutic qualities of natural soundscapes. However, there is a need for an objective soundscape classification for psychological research. The presented paper shows the analysis of the restorative properties of different natural soundscapes. The research included determining the acoustic, ecoacoustic, and psychoacoustic parameters, conducting psychoacoustic tests with the use of virtual reality tools, and statistical analyses. Based on the results of the research, a guide to soundscape parameters that have a key impact on their perception as relaxing or stress-relieving was created. The guide describes which soundscape parameters and what their values are crucial for their positive restorative evaluation.

Keywords: *insert natural soundscape, restorative effect, sound and wellbeing.*

1. INTRODUCTION

The presented paper shows results of study on restorative effect of natural soundscape on human wellbeing. It has long been widely known that spending time in nature and looking at green plants helps people reduce stress levels, relax, and unwind. In recent years, there has been an increasing amount of research conducted on the relaxing effects of nature sounds and their impact on the restorative process. The development of new virtual reality

**Corresponding author: first.author@email.ad.*

Copyright: ©2023 First author et al. This is an open-access article distributed under the terms of the Creative Commons Attribution 3.0 Unported License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

technologies has significantly expanded the scope of such research and the possibilities for applying the findings in practice. The findings from Alvarsson et al. indicate that nature sounds aid in the recovery from sympathetic activation following a psychological stressor [1].

During the 24th International Congress on Acoustics in 2022, a series of presentations were delivered, exploring the concept of soundscape and its influence on human beings. Recent findings suggest that the rhythmic sounds of nature promote optimal breathing, mask noise, enhance attention, and contribute to the creation of healthier and more conducive working environments [2]. These insights support the development of smarter design solutions for workspaces [2]. Auditory experiments were conducted to examine the impact of the perceptibility of birdsong sounds on annoyance caused by residential noise. [3]. The article [4] presented the relationship between the acoustic environment and humans, which was clearly noticeable, despite all three studied soundscapes being natural and free from noise pollution.

2. PAPER LENGTH AND FILE SIZE

2.1 Acoustic measurements and ambisonic recordings

The research was conducted using ambisonic recordings and measurements of sound pressure levels taken at various natural locations between 2018 and 2022. The measurements were carried out using a Class 1 sound level meter, the Svan 979. The ambisonic recordings were captured with a Zoom VR recorder.

2.2 Parameters

A series of indicators were determined for comparative analysis: basic classical acoustic parameters, psychoacoustic parameters – loudness, sharpness or roughness – and soundecology indicators such as: ACI (acoustic complexity index), NDSI (normalized difference

soundscape index), Bio (bioacoustic index), ADI (acoustic diversity index), AEI (acoustic evenness index). The values of the calculated parameters were then compared with the results of subjective auditory tests.

2.3 Psychoacoustic tests

Listening tests, based on soundwalk guidelines, were conducted in the auralization laboratory of AGH University, utilizing virtual reality tools, specifically the Oculus Quest 2 virtual reality headset.

During the listening test, respondents were asked a series of questions summarized in the standard [5,6]. These included questions “to what extent do you agree or disagree that the present surrounding sound environment is monotonous, vibrant, uneventful, eventful, calm, chaotic, pleasant, and annoying. Participants responded by selecting a value on a five-point Likert scale. In addition, the declared well-being of respondents was recorded.

The article presents sample results from the evaluation of three recordings. All recordings were made in nature spots. The first one contains birds squeaking in their nests against a background of stream and wind noise. The second is very quiet interrupted only by wind noise. The third is much louder, having been made next to a rushing river with a waterfall.

3. RESULTS

Table 1 summarizes selected values of ecoacoustic indicators for the first and second spots. It is worth noting that the high NDSI values in both spots indicate that signals containing no anthropophony. Slightly higher values of the ACI and Bio coefficients indicate more bird activity at the first spot compared to the second spot.

Table 1. Sample values of eco-acoustic indicators (calculation window – 5 minutes).

Indicator	Firs spot	Second spot
NDSI	0.690243	0.1074219
Bio	3.389821	1.52644

Figure 1 shows a sample result from psychoacoustic research – visualization of the graphical classification of the soundscapes [7]. We could notice that all three soundscapes were categorized as rather pleasant and peaceful. Third soundscape was categorized as more annoying and eventful than first and second.

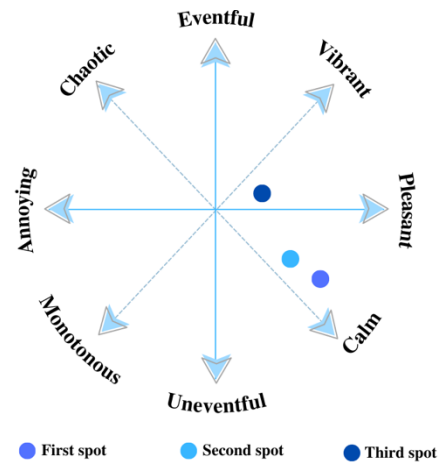


Figure 1. Sample results from psychoacoustic research: visualization of the graphical classification of the soundscapes [8].

Table 2. shows Spearman's correlation between how soundscape was categorized and respondents' well-being. Results for the first spot are shown. The highest correlation of well-being is evident for the annoying assessment of soundscape. The correlation coefficient for this case was -0.86, indicating a very strong negative correlation. Quite noticeable is also the correlation between the evaluation of the soundscape as calm and well-being. As the perceived wellbeing improved, the soundscape was described as more peaceful. A positive correlation for the relationship between wellbeing and the degree to which the soundscape is assessed as chaotic could be also seen.

Table 2. Spearman's correlation between respondents' well-being and the perception of the surveyed spot.

Soundscape categorization	First spot
Pleasant	0,33
Chaotic	0,48
Vibrant	0,3
Calm	0,6
Annoying	-0,84
Eventful	0,06
Monotonous	0,15
Uneventful	0,22

4. CONCLUSIONS

In summary, this paper presents an analysis of the restorative properties exhibited by various natural soundscapes. The research encompassed the determination of acoustic, acoacoustic, and psychoacoustic parameters, as well as the implementation of psychoacoustic tests utilizing virtual reality tools, followed by statistical analyses. Drawing from the research outcomes, a comprehensive guide was developed, outlining the soundscape parameters that play a pivotal role in perceiving them as relaxing or stress-relieving. This guide provides valuable insights into the specific soundscape parameters and their optimal values that contribute to a positive restorative evaluation.

5. ACKNOWLEDGMENTS

Authors would like to express deepest gratitude to Sandra Lichoń for her invaluable input throughout the research process. Moreover, Authors are deeply grateful to all auditory tests' volunteer participants. This work was funded by the Department of Mechanics and Vibroacoustics of AGH University of Science and Technology in Cracow, Poland, grant number 16.16.130.942.

6. REFERENCES

- [1] Alvarsson, J. J., Wiens, S., & Nilsson, M. E. (2010). Stress recovery during exposure to nature sound and environmental noise. *International journal of environmental research and public health*, 7(3), 1036-1046.
- [2] Gutierrez, R., & Schultheis, H. Effects of biofeedback-informed soundscapes on well-being and cognition. *Proc. of the 24th International Congress on Acoustics*, 2022.
- [3] Lee, S., Eom, Ch. Ryu, J. Effects of noticeability of birdsong sound on annoyance due to residential noise in apartment. *Proc. of the 24th International Congress on Acoustics*, 2022.
- [4] Czopek, D., Lichoń, S., Małeck, P., Wiciak, J. The Soundscape of the Sarek National Park – Case Study. *Proc. of the 24th International Congress on Acoustics*, 2022.
- [5] ISO (2014). ISO 12913-1:2014, “Acoustics—Soundscape—Part 1: Definition and conceptual framework” (International Organization for Standardization, Geneva, Switzerland).
- [6] 16. ISO (2018). ISO/TS 12913-2:2018, “Acoustics—Soundscape—Part 2: Data collection and reporting requirements” (International Organization for Standardization, Geneva, Switzerland).
- [7] 17. ISO (2019). ISO/TS 12913-3:2019, “Acoustics—Soundscape—Part 3: Data analysis” (International Organization for Standardization, Geneva, Switzerland).
- [8] Lichoń S., Czopek D. Study of the preferred properties of the natural soundscape, Krakow 2022.