



The soundscape of the Kościeliska Valley in the Tatra National Park – case study

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Abstract

The development of our civilization and increasing noise pollution are strongly connected. This connection is particularly noticeable in national parks. The aim of the paper is analysis of noise pollution of the most popular national park in Poland – Tatra National Park. The Kościeliska Valley was selected for the study, because it is the second area in the park in terms of the number of tickets sold according to the statistics kept by the Tatra National Park show. Three measurement points were selected in the valley: entrance to the valley, a glade by the Ornak shelter and the Smreczyński pond. The paper presents the results of the analysis of acoustic measurements and ambisonic recordings made in four seasons using classical method and the soundscape method. In addition, an electronic composition was made using ambisonic recordings of unique sounds recorded in the Kościeliska Valley, thus giving an example of the creative use of natural sounds and the possibility of recording a unique soundscape for posterity.

Keywords: natural soundscape, national parks, tourist noise.

1 Introduction

In most countries of the world, National Parks are created to preserve biological diversity, resources, creations and components of inanimate nature and landscape values, restore the proper condition of resources and nature components and restore distorted natural habitats, plant habitats, animal habitats or fungal habitats [16]. There are 23 national parks in Poland, they are distinguished by a relatively small area - from over 2,000 ha (Ojcowski National Park) to about 60 thousand ha (Biebrza National Park). National Parks cover a mere 1% of Poland's territory [9]. Protected areas are characterized by particular natural, scientific, social, cultural and educational, which is subject to the protection of all nature and landscape values. The area of national parks is divided into areas that differ in the use of separate methods of nature protection. There are areas of strict, active and landscape protection.

Giving the area the status of a national park makes willingness to visit this place and contact nature in search of aesthetic impressions. Therefore, national parks attract a large number of visitors, which causes a systematic increase in tourist traffic in their area. In national parks or in the natural environment in general, we look for places of peace and quiet, sometimes for scientific inspiration [2, 8]. Currently, the attendance in Polish National Parks varies in individual parks - from less than 12 thousand people to about 3 million visitors a year. The highest turnout (about 3 million visitors) was noted down in Tatra National Park.

Tatra National Park (Polish: Tatrzański Park Narodowy; abbr. TPN) is a National Park located in the Tatra Mountains in the Lesser Poland - Małopolska region, in central-southern Poland. Tatra National Park is the only national park in Poland located within Alpine Mountain range. The Tatra Mountains form a natural border between Poland to the north and Slovakia (Tatranský Národný Park, TANAP) to the south, and the two countries have cooperated since the early 20th century on efforts to protect the area. The Polish Tatra

range, which is a part of the Western Carpathian Mountains, is divided into two sections: the High Tatras (Tatry Wysokie) and the Western Tatras (Tatry Zachodnie). The landscape of the Tatras is characterized by sharp-jagged peaks and stunning rock formations. Rysy is the highest summit in Poland reaching a height of 2,499 m. Since 1993 the mountain range Tatras, together with the Polish part of the National Park, has been identified as natural, biospheric, reserve of UNESCO [22]. Tourism in the TPN is organized and supervised by the authorities of the national park - all tourist entrances to the park are monitored through the sale of admission tickets.

The red coloured trail to Morskie Oko is the most frequently visited trail in the Tatra National Park. On average, one million people go to the Tatra Mountains from Palenica Białczańska per year, which constitutes about 30% of the total entry traffic to the Tatra National Park [17].

The second trail in the TPN, which is characterized by intense tourist traffic, is the green coloured trail on the section Koscielisko Kiry - shelter in the Ornak glade. In Koscielisko Kiry, 21.7% of total inbound traffic to the TPN was observed. [17]

One of the elements of environmental protection is the protection of the acoustic environment, including the analysis and protection of the soundscape [11]. They can be various types of soundscapes: natural, sensitive, endangered, unique, recreational, representative, cultural, and everyday soundscapes [13.14.15]. Within each soundscape's values, threats, management objectives and monitoring directions are identified as the basis for planning protection [3,4,5].

Standards enabling the analysis of soundscapes have been published in recent years. [7,10, 19,20,21] Sound events can be analysed from the perspective of their source, function, and social context (warning, internal, landmark, relaxing, stress-inducing, status-indicating sounds) as well as associations and symbolism. Also the spatial and temporal dynamics of occurring sounds can be analysed, and human impact on natural soundscapes is evaluated [5,6,12].

The conducted research and analyses allow to conclude that in most Polish National Parks, the noise hazard was most often rated as medium. However, in the case of four parks it was rated as high (Drawa, Ojcowski and Karkonosze NP) or very high (Tatra NP). [1]. In 2006, a single measurement of the sound pressure level were carried out at various points of the Tatra NP. Based on the measurements carried out, it was found that: the acoustic background for the Tatra National Park is 30-35 dB, the equivalent sound level on hiking trails is 34.7-62.5 dB, tourists grouping: 48.6-57.5 dB, car traffic: 64.2-70 dB, Ornak glade shelter 48.6-53.6 dB [18].

The aim of the paper is analysis of soundscape and noise pollution of the most popular national park in Poland – Tatra National Park. The Kościeliska Valley was selected for the study, because it is the second area in the park in terms of the number of tickets sold according to the statistics kept by the Tatra National Park show. Three measurement points were selected in the valley: Koscielisko Kiry entrance to the valley, a glade by the Ornak shelter and the Smreczyński pond. The paper presents the results of the analysis of acoustic measurements and ambisonic recordings made in four seasons using classical method and the soundscape method. In addition, an electronic composition was made using ambisonic recordings of unique sounds recorded in the Kościeliska Valley.

2 Methods and measurement

Currently, the attendance in Polish National Parks varies in individual parks - from less than 12 thousand people to about 3 million visitors a year. The highest turnout (about 3 million visitors) is noted down in Tatra National Park. The second trail in the TPN, which is characterized by intense tourist traffic, is the green coloured trail on the section Koscielisko Kiry - shelter in the Ornak glade (Tab.1.). In Koscielisko Kiry, 21.7% of total inbound traffic to the TPN was observed. For comparative measurements of acoustics environment three points at Koscieliska Valley have been selected (Tab.2). The measurements of sounds and their recording were made using the following measuring equipment: Sound level meter Svan 971 and Svan 979, Class 1, Noise monitoring station Svan 307, Class 1, Soundfield SPS200 1st order ambisonic microphone, ZOOM H6 and F8n recorders. During four recording sections following events were recorded:

rustle of trees, noise of a stream, wind, sheep grazing, horses passing, footsteps (squeaking snow, crampons), noise of people, screams of children, passing vehicles.

Tab. 1. Tourist traffic statistics in Polish National Park and Tatra National Park (TPN)

Tourist traffic statistics	
2019 year TNP - 2 645 834 tickets KV - 519,929 tickets	2019 year Koscielisko Valley Spring 86 500 Summer 270 500 thousand Autumn 93 000 Winter 68 000
2018 year TNP - 2 619 857 tickets KV - 478,507 tickets	

Tab. 2. Dates and map of selected measurement points

Chosen measuring points	Map of the TNP witch selected points
Kiry - at the entrance to the valley	
PTTK shelter on Hala Ornak - a clearing to the left of the entrance to the shelter	
Smreczyński Pond - at the observation deck	
Selected weekends days	
<ul style="list-style-type: none"> ○ November 23, 2019 ○ February 15, 2020 ○ May 23, 2020 ○ September 12, 2020 	

3 Results

The conducted measurements and analyzes allowed for the calculation of SPL, sound spectrograms, and the determination of psychoacoustic parameters. Selected characteristics of SP changes over time, spectrograms and acoustic parameters are presented in Figures 1 and 2 and Table 3.

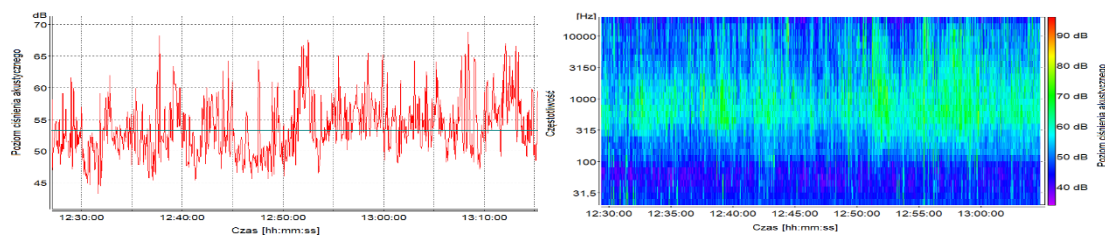


Figure 1 - Sound spectrogram at PTTK shelter on Hala Ornak – P2

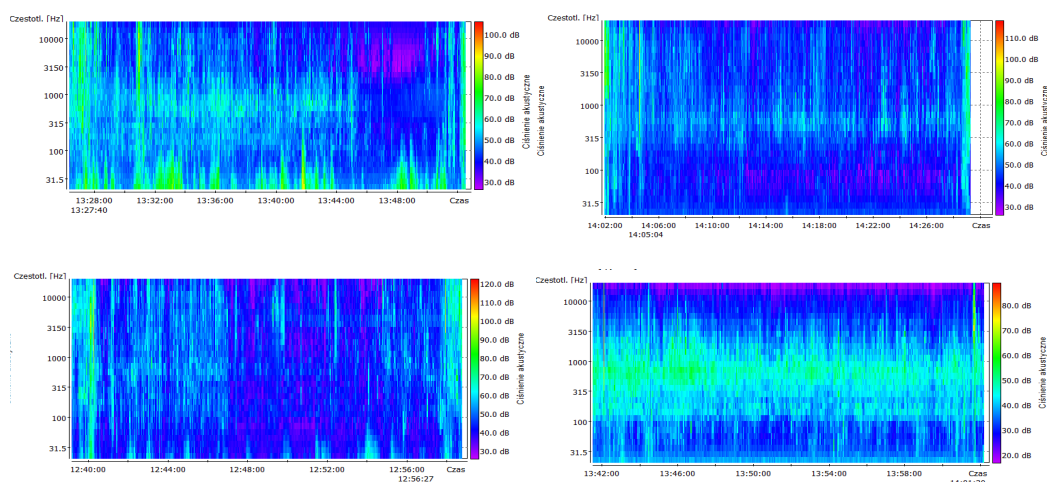


Figure 2 - Sound spectrogram at Smreczyński Pond - at the observation deck – P3

Table 3 Sound pressure level and psychoacoustic parameters. Ornak Glade

Parameter - symbol [unit]		Spring	Summer	Winter
sound pressure level (A)	– L_{Aeq} [dB]	46,7	59,3 *2001 year 53,6	50,0
5th percentile sound pressure level	– L_{AF5} [dB]	50,7	65,2	57,1
95th percentile sound pressure level	– L_{AF95} [dB]	39,1	52,4	42,9
N5 percentile loudness	– N_5 [son]	3,7	9,8	4,5
N95 percentile loudness	– N_{95} [son]	7,1	15,4	8,4

4 Conclusions

Measurements of the acoustic pressure level will allow the examination of the daily and annual variability of the noise level. There are very high values of the sound pressure level in very popular places of the national park, especially at the entrance to the Koscieliska valley. There was a noticeable increase in the sound pressure level at PTTK shelter on Hala Ornak in summer by about 6 dB.

The increase in the number of tourists visiting the national park and the very high SPL values indicate a necessity:

- performance of long-term measurements and tests,

- implementation of a noise protection strategy in vulnerable areas.

Moreover, it was proved that ambisonic recording could be used not only for research purposes. As an example, an electronic composition was made using ambisonic recordings of unique sounds recorded in the Kościeliska Valley. Natural sounds were used in an artistic way. It is an example of how to save a unique soundscape for posterity.

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