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QUESTIONNAIRES AND ACOUSTIC MEASUREMENTS IN LONGYEARBYEN AREA DURING WINTER AND SUMMER SEASONS

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ABSTRACT

The article discusses the results of a survey and acoustic measurements carried out in Spitsbergen near Longyearbyen, the largest town in the area. The surveys focused on the landscape and soundscape existing near Longyearbyen. Questions included: noise sources present in the study area, their perception, important landscape elements, and acoustic impressions. The results made it possible to determine preferences for tourist activities in the Longyearbyen area during the polar pre-winter and summer. Acoustic analyses of the selected sites included: analysis of time courses of sound pressure level A, equivalent sound level A, spectra and spectrograms.

Keywords: *environmental measurements, soundscape studies, sound pressure level, noise*

1. INTRODUCTION

The Svalbard archipelago is a unique place in terms of scientific research. It is the world's northernmost science lab and is a place where climate change is occurring faster than in these mid-latitudes around the globe. On the Svalbard archipelago, the average temperature for the whole year has risen by four degrees Celsius since 1970. The average winter temperature has increased by more than seven degrees. At the measuring station at Longyearbyen Airport on August 10, 2024, the thermometer showed 20.3 degrees Celsius. Previously, the warmest temperature this month was on Svalbard on August 31, 1997, when the temperature was 18.1 degrees C. The absolute temperature record for the archipelago was set on July 25, 2020, at 21.7 degrees, which is also the highest temperature ever recorded in the European part of the Arctic [1].

Most of the acoustic research in the Arctic has focused on underwater sound recordings from animal activities [2], [3] ambient noise [4] and infrasound measurements related to glacier movements [5],[6]. The study presented in paper [7] outlines the findings from spatial impulse response measurements taken in four glacier caves within the Svalbard archipelago near Longyearbyen. These findings underscore the acoustic diversity found within glacier caves, influenced heavily by the caves' structure and size.

The article [8] shows soundscape analysis of the three selected valleys near Longyearbyen. Additionally, paper [9] details the results of acoustic measurements conducted during the 'white winter' at several popular tourist sites near Longyearbyen.

This paper presents survey results related to the identification, perception and evaluation of sounds occurring in the centre of Longyearbyen and Nybyen. Also, in the paper are presented results of acoustic measurements of selected sites in Longyearbyen and further away from Longyearbyen. The sites were selected based on an analysis of a survey to determine preferences for tourist activities in the Longyearbyen area.

2. MATERIALS AND METHODS

Paper questionnaire surveys were conducted in the “white” winter” and summer by participants of five AGH research expeditions. The survey was carried out among randomly selected individuals, including tourists and temporary residents. The survey took place at three distinct sites: the museum entrance, the university's main hall, and the entrance of the largest supermarket. The survey was carried out among a random selection of individuals, including

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tourists and temporary residents, as Longyearbyen has very few long-term permanent residents.
The questionnaire included i.a. the following questions:
1. Is it your first visit in Svalbard? (– Yes, – No, it is my ... visit).
2. How long are you going to stay in this area? (number of days)
3. I can hear well the following types of sounds during my visit of the area like: traffic sources (general, cars, buses, trains, air planes, other), other mechanical sounds (general, construction noise, enterprises, machines, sirens other), human sounds (general, talking, laughing, children playing, footsteps, other), natural sounds (general, wind and leafs, water, birds, other). Responses were given on a 5-point scale: 1 – not at all, 2 – a little, 3- moderate, 4 – very, 5 extremely
4. I perceive the sounds from ”the same sources as above” pleasant/unpleasant during my visit of the area. Responses were given on a 5-point scale: 1 – very unpleasant, 2 – unpleasant, 3 – neither unpleasant nor pleasant, 4 – pleasant, 5 very pleasant
5. List places you have visited during your stay in Svalbard, starting from the one which you like the best.
A total of 142 people participated in the surveys, with 113 respondents in the summer and 29 in the winter.
The acoustics and soundscape analyses adjusted to the specificity of selected based on the survey sites are presented in the 4 chapter. Sound pressure level (SPL) measurements were conducted at the listed sites using the SVAN 971 Class 1 sound level meter. Measurements were taken in the broadband range, incorporating A, C and Z-weighted filters. The meter also determined octave and 1/3-octave spectra within the audio-acoustic bandwidth. For long-term monitoring of sound level changes in Longyearbyen, a SVAN SV 277 PRO monitoring station equipped with a Class 1 sound level meter SV977 was utilized.

3. SOUNDSCAPE EVALUATION SURVEY

Figures 1 to 4 below present an analysis of the survey responses regarding the sounds tourists noticed in the locations they visited in Longyearbyen: the city center – CITY (point 1) and the outskirts – NYBYEN (point 2). Respondents were asked to assess the intensity of different sound categories in each location and rate their perception of those sounds. The sounds in question were categorized as follows:
- Traffic sources: general, cars, buses, trains, airplanes, other;
- Other mechanical sounds: general, construction noise, industrial activity, machines, sirens, other;
- Human sounds: general, talking, laughing, children playing, footsteps, other;
- Natural sounds: general, wind and leaves, water, birds, other.

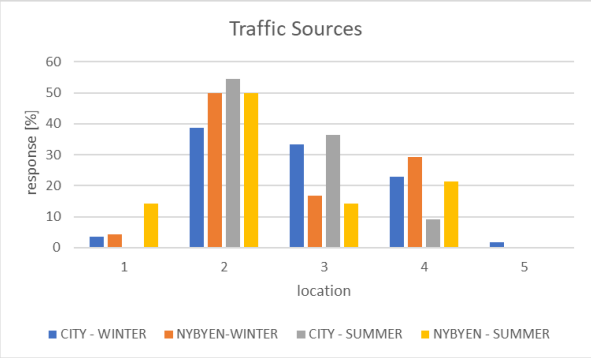

Figure 1. The distribution of answers for question 4: I can hear well the traffic sources.

An analysis of Figure 3 reveals that the majority of respondents gave ratings of 2 and 3. Additionally, four individuals identified "Traffic source" in Nybyen. This finding may be explained by the stark contrast between the prevalent silence in Nybyen and the noticeable rise in sound pressure levels when traffic sounds were present.

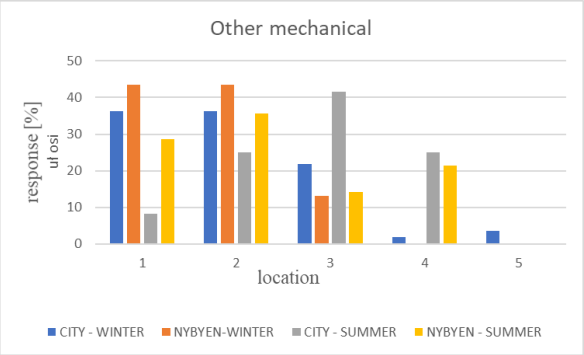

Figure 2. The distribution of answers for question 4: I can hear the other mechanical sources.

An analysis of Figure 2 shows that respondents either did not notice or barely noticed other mechanical sound sources in Nybyen. These sounds were notably more audible in the city center.

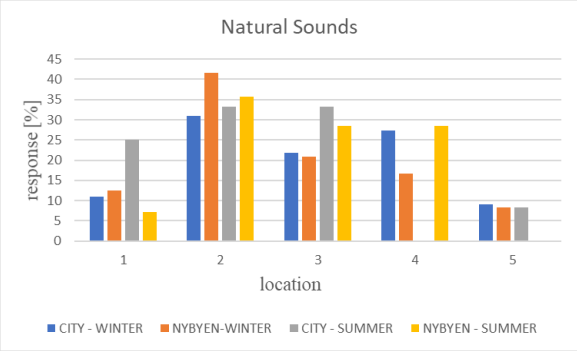

Figure 3. The distribution of answers for question 4: I can hear well the natural sounds.

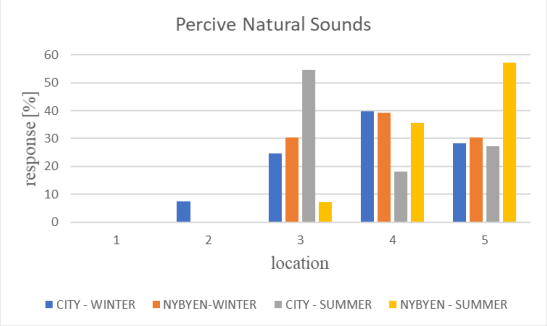

Figure 4. The distribution of answers for question 5: I perceive the natural sounds as pleasant/unpleasant during my visit of the area.

The analysis of Figure 3 reveals significant differences between the two locations. Natural sounds were less prominent in the city center compared to Nybyen. Most respondents described the sounds of nature as pleasant or very pleasant, a trend especially pronounced in Nybyen. In contrast, respondents in the city center generally found natural sounds to be neutral or indifferent (Figure 4).

4. ACOUSTICS MEASUREMENTS

A detailed analysis of the answers to fifth question and an analysis of the preference of tourist activities made it possible to identify three types of most popular activity (see Fig.3). The activities of the respondents can be divided into three main types:
- Nature hikes: trips to the summits of the Sarkofagen, Trollsteinen, Platafjellet, Elveneset peaks, hiking on the Longyear Glacier, fossil hunting, trips to the valleys, long trips to Barentsburg and to Isfjord Radio;
- Trips using mechanical transport: boat or cars: Barentsburg, Pyramiden, Borebukta, Isfjord radio, Barentz camp, walrus safari, Ny-Alesund,
- Longyearbyen activities: a round trip to town, pubs and restaurant

Based on the identified tourism activity preferences in Longyearbyen area, the following sites were selected for further analysis of the acoustic environment (see Fig. 5):
- Longyearbyen – city centre (Fig.6., measurement point 1),
- Longyearbyen – Nybyen (Fig.7., measurement point 2)
- Advent Valley near sled dog kennel area (Fig.8., measurement point 3).

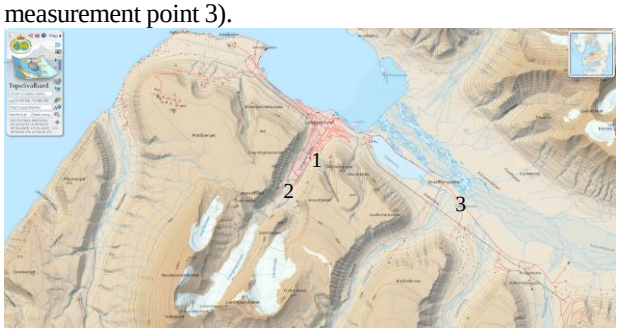

Figure 5. Figure 12. Localization of the acoustic measurement's points: 1 – Longyearbyen – city centre, 2 – Longyearbyen – Nybyen, 3 – Advent Valley near sled dog kennel, (map prepared based on [10]).

Figures 6 to 8 show the results of A-weighted equivalent sound pressure level measurements at selected points.

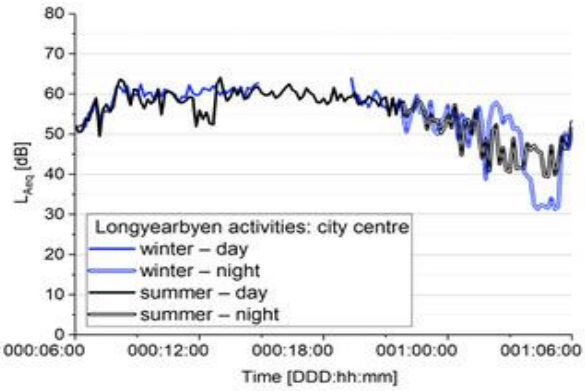

Figure 6. 24-hour 10-minutes step A-weighted equivalent continuous sound pressure level – Longyearbyen – city centre. Comparison of the time course during winter and summer.

For point 1, the 10 minutes step A-weighted equivalent continuous sound level LAeq for the daytime (6:00-22:00 hours) varied from 49.8 dB to 64.6 dB and for the night-time (22:00-6:00 hours) varied from 49.8 dB to 64.6 dB for winter time. It can also be seen that there are no significant differences for the summer season.

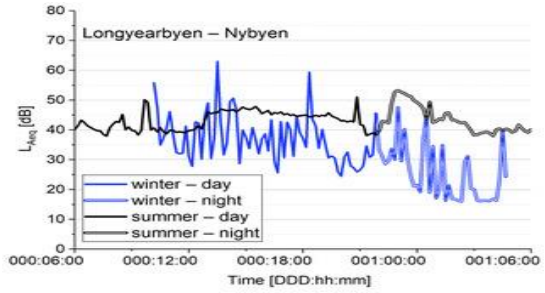

Figure 7. 24-hour 10-minutes step A-weighted equivalent continuous sound pressure level – Longyearbyen – Nybyen. Comparison of the time course during winter and summer.

For point 2, the 10 minutes step A-weighted equivalent continuous sound level LAeq for the daytime (6:00-22:00 hours) varied from 40.1 dB to 50.7 dB and for the night-time (22:00-6:00 hours) varied from 40. dB to 52.2 dB for summer time. For the winter season, on the other hand, the variation is between 28.7 dB and 62.1 dB daytime and 25.1 dB to 48.1dB for the night-time. It can also be seen that there are significant differences for the summer and winter seasons. This is mainly due to less tourist activity in Nybyen in winter.

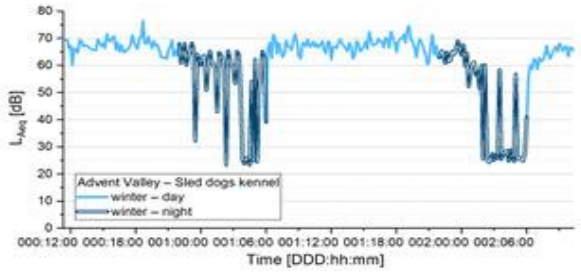

Figure 8. 48-hour 10-minutes step A-weighted equivalent continuous sound pressure level – Advent Valley near sled dog kennel during winter.

Figure 8 shows the huge contrast between the nocturnal tranquillity and the daytime activity of dogs when dog sled tours were organized.

5. CONCLUSIONS

Based on the survey, the most popular summer and winter tourism activities on Spitsbergen and frequently visited sites were identified. These include: nature hikes (a day or multi days hiking on the glaciers, trips to the mountain summits, fossil hunting), trips using mechanical transport (boat or snowmobiles) to Barentsburg, Pyramiden, Borebukta, Isfjord radio, Barentz camp, walrus safari) and Longyearbyen activities (city tours, pubs and restaurants). All sites are acoustically interesting and difficult to measure.

Long-term SPL measurements in the centre of Longyearbyen, Nybyen and Advent Valley were recorded in summer and winter seasons. The recorded data are unique and will provide a baseline for future analysis. During summer, the midnight sun brings continuous daylight, and the town is livelier with increased human activity and tourism and natural sounds are often masked by the higher levels of urban noise. At night, city centre becomes significantly quieter as human activities decrease. At the Nybyen the overall sound environment is more tranquil, contributing to a peaceful atmosphere. The summer and winter are a great opportunity for contact with Arctic nature, natural sounds and tranquillity.

6. ACKNOWLEDGMENTS

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