Industrial noise in the Arctic settlement

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Summary

Longyearbyen is the largest settlement and the administrative center of the Svalbard Islands, situated between mainland Norway and the North Pole. The town has a population of just over 2,100 people. This article presents the issues of the impact of industrial noise sources in the Longyearbyen, Arctic settlement. The small city is characterized by typical sources of industrial noise such as the coal-fired CHP plant, heat exchangers stations, transformer stations, fans, pumps, etc. The results of noise measurements are presented in the form of acoustic maps for the summer season and the winter season. A discussion of the results of industrial noise research on the creation of the Longyearbyen sound environment is presented.

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1. Introduction

The progressive nature of civilization causes noise to be generated by man throughout the world. It also begins to dominate in environments whose climate is unfriendly to people, such as the Arctic area. Research was carried out on the soundscape of Spitsbergen and its natural sounds [1,2], while an assessment of the impact of road and industrial noise in the areas of its main city, Longyearbyen, was made. The city and region are administered by Norway. Noise is considered to be pollution under the Norwegian Pollution Control Act [4]. The authority in Svalbard is exercised by the governor (Sysselmannen) who is the representative of the Norwegian government. The governor upholds Norwegian sovereignty, exercising administrative and judicial authority, protecting the environment and public order. Statistics on the continental part of Norway show that about 27,400 people were exposed to noise production in 2014, other business activities affected about 25,300 people [3].

Longyearbyen has a small population (around 2,100 inhabitants), and despite this there is a lot of road traffic (a network of about 50 km of roads). There are also many industrial sources of noise. Additional acoustic effects during sound propagation arise as a result of the landform as the city is located in a valley with high slopes on both sides. Flowing from the glaciers, the Longyear River fills the entire city area with noise, masking the noise impact of other sound sources. Also, the large number of tourists (usually larger than the city's population) increases the noise levels associated with tourist traffic and activity. Accordingly, Longyearbyen rules no person may use ship sirens, fire guns or produce other loud noises less than one nautical mile from a seabird colony during the period 1 April to 31 August [5].

2. Noise emitters in Longyearbyen

The acoustic map allows you to visualize the spread of noise in the studied area, e.g. the city, roads, plant surroundings, etc. To plot the distribution of sound levels A, it is required to identify individual sound sources present in the area and to determine their acoustic parameters. There are many sources of noise in Longyearbyen. The dominant sources are traffic noise such as light and heavy vehicles, motorcycles and scooters, and the noise of flying and landing planes and helicopters at a nearby airport. In the winter, snowmobiles become a major source of traffic noise. Industrial noise is the noise generated in general by stationary sources, located inside and outside of various types of industrial, construction and service facilities. In Longyearbyen, noise is mainly associated with technical facilities operating to meet the needs of residents, business and tourism (Fig.1).

a) Coal-Fired Power Plant

b) Transformer Station

c) Heat exchanger station

d) Exhaust of wall fan - Industrial fans

e) Business buildings

f)) Shop ventilation fans

g) Housing estate

h) Heat exchanger and transformer station

Figure 1. Noise emitters in Longyearbyen.

The noisiest object of the industrial type is the only coal-fired CHP plant in Norway. It is a very economically important facility providing electricity and heat to the residents of Longyearbyen, processing plants, businesses, UNIS University, cultural facilities and the hotel and restaurant chains of the city. Noise generated by machinery and equipment inside the power plant building is radiated through the walls and roof of the building, as well as through the chimney to the environment (Fig. 1a).

The power plant is located in the eastern part of the city. Noise emission for housing estates (Fig.1g) occurs only in the western and north-west directions. The energy facilities such as transformer stations (Fig.1b) and heat exchangers (Fig.1c) are located within the city. Numerous ventilation devices for shops and restaurants (Fig.1f) in the central part of the city, as well as industrial halls (Fig.1d, e) and port facilities in the coastal part of the city create many noise sources. All noise emitting objects were identified and their sound power levels were estimated based on measurements [6].

The characteristics of acoustic conditions in the Longyearbyen environment were evaluated on the basis of round-the-clock sound measurements using the SVAN 979 noise monitoring station located at several points of the city.

Noise levels were measured at two measuring points located in the city center, in areas of traffic noise dominance and tourist traffic noise. The third measurement point was located on the northern edge of the city. To identify noise sources, determine their acoustic parameters and assess the acoustic impact, measurements were taken directly at the noise sources.

These were technical sources such as fans, air conditioners, transformer stations and heat exchangers. The determined sound power of these devices was the input data for the acoustic model, which allowed the plotting of maps of the sound level distribution in the city areas.
SoundPlan 7.4 software package was used to prepare sound level distributions. An acoustic model of the city of Longyearbyen was created, which was then calibrated on the basis of measurement results at many points of the city and on the basis of 24-hour noise measurements at

Figure 2. Noise map in the vicinity of the heat and power station

several points of the city. In this way, maps of distribution of sound levels A in Longyearbyen for the daytime and night time were plotted. Such maps have been prepared for two seasons of year: winter and summer.

3. Results - noise map

In the summer season the noise of industrial origin is masked by the hum of the Longyear River and traffic noise. In winter, the snowmobile trail runs along the river bed, which also means that the noise of the power plant, especially during the daytime, is less audible. As road noise is more noticeable in the central part of the city, the noise of industrial origin is not a dominant noise. Figure 2 presents the distribution of sound levels A in the vicinity of the combined heat and power plant.

Locally, shop fans and restaurants are noisy, but they do not have a major impact on noise levels in residential areas.

The impact of industrial noise is not significant in the environment of Longyearbyen. In the summer, the sounds of nature, such as the sound of the flowing river, as well as the noise coming from the main streets are clearly audible. The lines of the same level of sound are arranged parallel to the direction of the river current. The acoustic activity of the cascade on the river in the northern part of the city is clearly visible. Practically, all the residential buildings are located in the zone where the noise level is not high during the day or night.

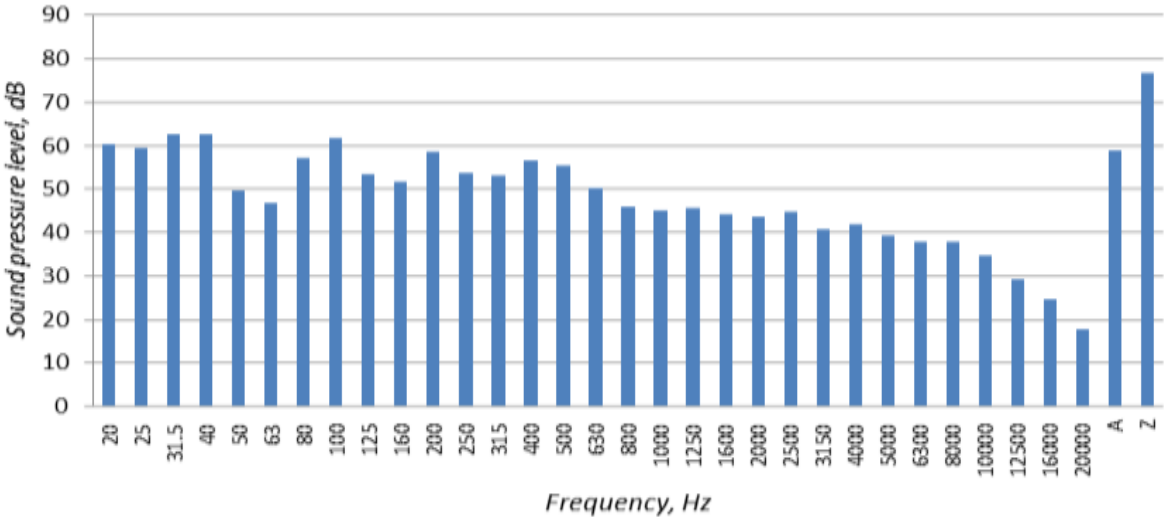

Figure 3 The noise spectrum of the transformer station

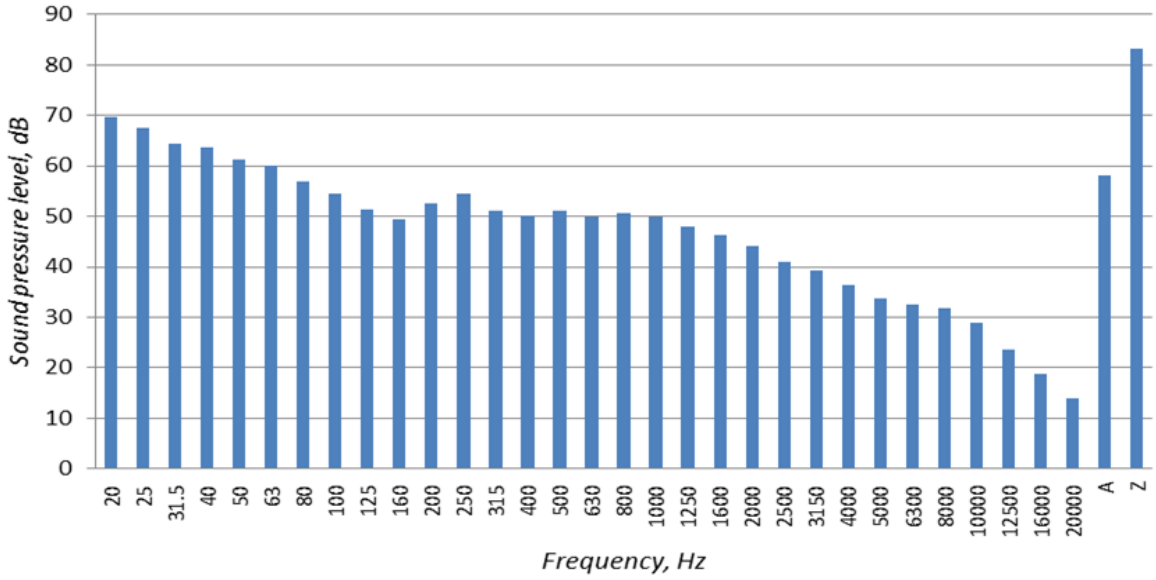

Figure 4 The noise spectrum of heat exchanger station

Using the capabilities of the software, we can turn on and off layers of individual sources, learning about their impact on the acoustic climate of the city.

The spectra of the noise of the transformer station and heat exchanger are shown in Figures 3 and 4. These objects are not bothersome noise.

4. Conclusions

This Longyearbyen is constantly expanding. New activities, such as tourism, fish-processing and other businesses require more electricity. The development of Longyearbyen will cause a progressive increase in noise sources, which after some time will make the city environment acoustically similar to other European cities. However, at present, the city is an interesting sound experiment that allows you to show how man changes his acoustic environment and how some of the noise problems are unknown to him. Perhaps this is the moment when some noise reducing solutions should be implemented, such as: planning of transportation routes in the city and its vicinity, planning of land development, regular noise measurements, selection of noise sources, and introduction of noise abatement, etc.

The preparation of the noise map is the basis for noise management in the environment, to create an action plan for its reduction.

Using acoustic maps and applying additional tools in the software package, it is possible to carry out a "what-if" analysis and to analyze activities aimed at recognizing how man can consciously create the acoustic environment in a territory new to himself.

Acknowledgement

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References

[1]. Wiciak J., Czopek D., Malecki P., Piechowicz J., Soundscape of Spitsbergen – realized and future research, Proc. of The Svalbard Science Conference 2017, 234

[2]. Piechowicz J., Czopek D., Malecki P., Wiciak J., Identification of soundscape components in the Arctic settlements: Longyearbyen and Pyramiden, Proc. of The Svalbard Science Conference 2017183-184.

[3]. Holz K.E., Engelien E., Noise exposure in Norway. 1999-2014 Growing number of Norwegians are exposed to noise, https://www.ssb.no/en/natur-og-miljo/artikler-og-publikasjoner/growing-number-of-norwegians-are-exposed-to-noise

[4]. Bugge H.Ch., Environmental Law in Norway, Kluwer Law International, 2011

[5]. Svalbard Environmental Protection Act, Act of 15 June 2001 No.79 Relating to the Protection of the Environment in Svalbard

[6]. Engel Z., Piechowicz J., Stryczniewicz L., Foundaments of Industrial Vibroacoustics, WIMiR AF+GH, Kraków, 2003