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Technical Note

Noise map validation by continuous noise monitoring

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ABSTRACT

This paper presents a comparison of two noise assessments in the Gdansk agglomeration in Poland. One is based on the noise map produced by computational method for the city in 2007, the second one is based on real data from continuous measurements acquired by a noise monitoring network operating in the city since 2008. Differences are shown and analyzed. Additionally, seasonal and weekday influence on noise indicators (L_{DEN}, L_D, L_E and L_N) is analyzed and discussed in this paper.

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1. Introduction

According to the Environmental Noise Directive [1], noise maps must be produced for all large agglomerations, major airports, roads and railways. The first stage of noise mapping was finished in 2007 when all EU Member States had to deliver noise maps for agglomerations and infrastructures specified in the Directive. The second noise mapping campaign is going to finish in 2012 and will cover an even bigger area than the one in 2007. At least every five years the strategic noise maps should be reviewed and revised if necessary.

The Noise Directive also indicates that it is necessary to establish common assessment methods for environmental noise and a definition for limit values in terms of harmonized indicators for the determination of noise levels. To perform the first task, that is to establish common methods of prediction and measurements, two European Framework Programs have been established. The first one was called HARMONOISE, the consecutive one IMAGINE. Although the projects successfully ended a few years ago, the developed methodology called HARMONOISE/IMAGINE is still not officially recommended for noise assessments in European Union [2–5].

At present, noise maps are made mostly by calculations based on known and estimated parameters such as: 3D digital terrain characterization, traffic flow and composition, average speed, and meteorological conditions. Usually not all relevant data are readily available for all locations. As a result certain assumptions and speculations must be made to fill the model with necessary input data. Because of this, whenever possible, the maps are "calibrated" by measurements performed in certain points, usually using only "short time measurements".

During the last decade the concept of "dynamic noise maps" was developed and in some cases also practically accomplished [6]. The dynamic maps, being regularly updated and based on measured and accurate data, present comprehensive information on the acoustic climate in a given area. Measured data come from the noise monitoring system and are used for calculations when producing the dynamic noise maps. This provide the noise maps to be very representative and adopt to situations not foreseen in standard noise mapping process, such as diverted traffic or changes in preferences of drivers. The data are acquired through a system of monitoring stations equipped with noise measuring devices as well as other sensors (weather and traffic) deployed in significant locations in the city. Dynamic noise mapping is possible only in places, where a noise monitoring network is in use (that is at most of airports and some big cities).

Dynamic noise mapping may be useful not only as a tool for analyzing current noise situation in given region, but also as a verification method for standard (static) noise maps. Continuous noise monitoring provides data that can be averaged over a desired period of time, including the period of one year which is used for static maps.

Acoustic map of Gdansk was elaborated by computational method according to the Environmental Noise Directive 2002/49/EC [1]. The Cadna/A software of DataKustik GmbH company was used to create the map [7].

This article presents the comparison of noise assessments based on classical, static noise mapping on one hand and dynamic noise mapping, which relies on continuous monitoring in the city of Gdansk in Poland, on the other.

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2. Description of the monitoring system

The monitoring system developed and used by the Gdansk authorities [8] is based on the measurement requirements specified by the IMAGINE project [4,5]. The so-called "Backing Board" technique developed by Fégeant [9] is used. The microphone is positioned flush to a hard and totally reflecting surface. This method allows to make measurements at any site with reflecting conditions similar to those produced by urban building facades. Fig. 1 shows the typical monitoring station. The only important restriction in the placement of the monitoring station (board with the microphone) is that the board must face the dominating noise source (cannot be tangential to the wave propagation patch).

Monitoring stations used in the project carried out in Gdansk are equipped with a single microphone (for noise measurements) and with a simple weather station (for estimation of environmental variables:temperature and humidity).

The stations are powered via commercial telephone lines, which also provide data transmission for the system. This simplifies the system and considerably reduces both initial and running costs. Data from all 40 stations are stored in Oracle 10 g database and are analyzed by the server. Averaging time of acquired data is 1 min. The implemented software provides easy access to real time data as well as to the time histories of each parameter and noise indicator (L_{DEN} and L_N). The data are presented both in tabular and graphic form (maps and graphs). The access to all data is available via the Internet.

3. Monitoring and mapping comparison

For the purpose of this paper 14 monitoring stations were selected for analysis. The selection was based on station's installation date. The monitoring stations were installed in batches of a few during almost one year time starting in the summer of 2008. The oldest ones, operating for over or almost one year, were selected.

The noise data from all selected stations were analyzed and compared to noise mapping values obtained through calculations. The noise sources and road traffic data (estimated on the basis of short term measurements) of those monitoring stations are given in Table 1. The installation dates of stations are also shown in this table. The monitoring periods start at that dates and end on January 31, 2010. Some drops in acquired data were noted during monitoring period due to temporary malfunctions of the system but they are negligible.

The selection consists of nine monitoring stations that monitor mostly road traffic noise, three stations monitoring road and tramway noise, one monitoring road and railway noise and one recording pure railway noise. Seven of the selected stations are located close to dual carriage roads. Tramway lanes are located in the middle of three of those roads (ID 10, 12 and 15). Eight of the selected stations are located close to roads of a rather high traffic flow (over 1000 vehicles per hour in daytime), two of medium and three of low traffic density. The monitoring station ID 28 is located at a small street in close neighborhood (about 80 m) of a major road and railway tracks.

The calculated values of noise indicators (L_{DEN}, L_D, L_E and L_N) for locations where the selected monitoring stations operate are presented in Table 2. They were obtained directly from the digital version of the noise maps produced for the city of Gdansk. Separate values for road traffic noise and railway/tramway noise, as well as calculated values for total noise, are also shown in that table.

The detailed noise data acquired by monitoring stations with averaging time of 1 min allow to calculate required noise indicators (L_{DEN}, L_D, L_E and L_N) for any selected time period (e.g. year, month, day). Noise indicators obtained on the basis of monitoring were compared with indicators obtained for the same locations from noise maps (indicators for total noise that are presented in Table 2). Differences ($L_{X\ monitoring} - L_{X\ map}$) are presented in Fig. 2.

The biggest differences (up to 8 dB) can be observed for the L_N noise indicator. This is true for all selected monitoring stations and means that during the night period the measured noise level was always higher than the one calculated and presented at the noise maps. One of the possible reasons can be the underestimation of assumed traffic density. Another, very likely reason may be related to the activities going on near the microphones (see Fig. 1 where parking maneuvers close to the microphone definitely lead to the overestimation of noise levels in comparison to the noise maps). Much lower differences were noted for other noise indicators – the lowest for L_D. For five monitoring stations, in case of L_D, and for three in case of L_E, the differences are negative which means that the real noise levels were lower than predicted.

The biggest positive differences (except differences for L_N) were recorded for the monitoring station ID 07 located 15 m from railway tracks (L_{DEN} – 6.2 dB, L_D – 4.9 dB, L_E – 6.7 dB and L_N – 6.4 dB). Even though dedicated measurements of train noise were performed and implemented when producing the noise maps (to distinguish rather noisy trains utilized in Poland in comparison to those in western Europe), the measured noise levels were much higher than predicted. This situation is contrary to the monitoring

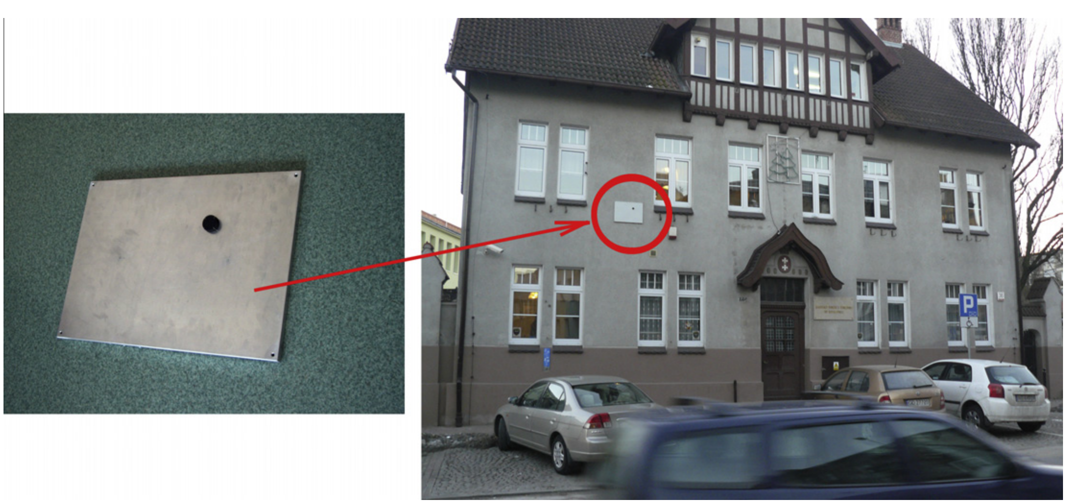

Fig. 1. Typical monitoring station.

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