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NOISE HAZARD TO THE POPULATION OF AREAS CONNECTED WITH FUNCTIONING OF ROADWAY FRONTIER CROSSINGS

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In spite of Polish observing the *Schengen Convention* connected with the freedom of internal moving in European Union, the problem of operating the external frontiers is still valid. Such border crossings can be crossed only at the special border crossing points and in defined time. The controls over them are executed according to uniform criteria. As long as the political situation in Europe is not change, Poland will stay as the border's state of E.U. and people will be put at risk of the border crossing action.

The noise connected with border crossing functioning is emitted at whole border crossing – at all developed area and routes lead to it. It is not only the border crossing point itself but also all grounds which come under it.

The conducted researches have shown that noise connected with border crossing functioning could be troublesome for the inhabitants of border areas. The problems of exceeding the maximum permissible level of noise on protected areas are mainly connected with many sources of noise producing, for instance lorry type vehicles. On the basis of filled questionnaires it has been found that noise is an important problem for the border areas inhabitants. The scale of the disaster requires taking preventive steps.

The problem of many noise sources seems to be quite serious because the Polish border is 3500 km in length and there are 200 Polish border crossings.

Keywords: ecology, acoustic, environment, noise, method.

1. Introduction

Noise is an important environmental problem not only in Poland, but in all industrialised countries. The consequences of its effects on the human organism and the environment are very complex and are of various character. These can be either temporal or long-term changes, physical, psychical and behavioural [3, 6, 19]. In this connection, the existing situation needs taking corrective actions, either at the stage of creating or

verifying land development plans of individual communes or within the framework of the so-called ecological development plans of the voivodeships. The corrective actions on the existing hazard must lead to elimination or minimisation of these types of hazards. Before taking such tasks, it is necessary to perform investigations on the condition of hazard to the environment due to noise impact. Only such a document can provide a basis for taking actions aimed at eliminating or minimising the existing hazards, taking into account the effectiveness, technical possibilities and costs of realisation of such an assumed work programme [5, 6, 12, 14].

The studies relating to traffic noise are very often limited to measurements of its objective level, neglecting entirely its subjective reception and evaluation of annoyance by the population exposed to its impact. On the other hand, it seems that the social evaluation of the annoyance produced by traffic noise is not a direct function of its objective level and may depend on a number of factors, such as: socio- demographic characteristics, number of years during which a defined noise intensity is maintained, perception of the relationship between the noise and health, etc.

Hence, the problem of noise cannot be considered solely in an objective aspect (intensity measured in dB), it is also necessary to take into consideration the subjective aspect, that is the evaluation of the degree of annoyance made by the person exposed to its effects. Among those "exposed persons" belong the people inhabiting the areas along the main roadways leading to the state frontier. The length of frontiers of the Republic of Poland is as large as 3 503.82 km, and Poland is connected to its neighbours through more than 200 frontier crossings.

In this connection, a task has been taken relating to assessment of the hazard to the inhabitants produced by noise due to "functioning of roadway frontier crossings", considered as an effect of sources in the vicinity of the frontier crossing (terminal) itself, considered as an area which, in accordance with land development plan, is provided for such type of activity, and of sources of road-type noise generated by vehicles moving along a "general-access noise" to the crossing.

On the basis of the site tests and questionnaire inquiry performed, the rules have been developed for creation of a protection program against noise for inhabitants of the frontier-adjacent areas.

2. Investigation of noise related to functioning of frontier crossings

The subject of the investigations was to study noise related to functioning of specified roadway frontier crossings. They were aimed and creating a suitable database of results obtained "*in situ*" that can be used when developing methods for preparation of acoustic maps of the areas endangered with noise generated at frontier crossings. Such maps provide a basis for developing the environment protection programme against noise [8, 12, 13, 18].

The general scope of work performed at the frontier crossing included:

- conducting the measurements of noise in the locations specified in accordance with a given methodology, at the access roads leading to the crossing, in the acoustically-protected areas, and in close vicinity of the crossings themselves (direct roads of access, places of expedition, car parks);
- determining the intensity and structure of traffic of vehicles moving along the access roads, and within the checkpoints at the crossings;
- analysing the obtained results of tests and evaluating the emitted noise;
- selecting the data with the aim to chose the representative points of measurement acquisition;
- developing a method of collecting acoustic data in the outer environment, consistent with the requirements contained in the standardisation documents, and specifying the measuring locations and their number on the basis of the results of a site view (GPS);
- developing a method of transmitting them to the prepared acoustic database on the annoyance in the outer environment;
- making final selection of locations to carry out acoustic measurements.

In general, the number and layout of measuring places in the area for which the noise measurements are to be conducted depend on the conditions characteristic to the investigated area [11, 12, 17, 18, 21]. For this reason, it is not possible to formulate uniform procedures for all the cases considered. In this case, the experience of the research team is of vital importance.

3. Validation of the method for creating acoustic maps for the areas related to functioning of roadway frontier crossings

The results obtained in the course of measurements conducted on individual, specified roadway frontier crossings have enabled to elaborate and calibrate the assumed computation model, with particular consideration of the effect of input data that relate to the acoustic parameters of the sources [4, 7–10, 12, 13].

The model computation methodology of noise emitted from the area of the considered frontier crossings into the outer environment was consistent with the PN ISO 9613-2 standard. This document specifies engineering methods for computation of noise existing at defined distances from single sources or their groups. The standard provide a basis for computation standards used in many European countries, and is recommended in creating computational models in national statutory instruments.

The principal quantity that characterises the source of noise is the level of its acoustic power. The noise resulting from the sources having a character of either surface or linear sources is represented by the collection of equivalent point sources with defined level of acoustic power and direction of action [7, 8, 12, 16–18, 20, 21].

For the needs of creating the model, the following sources were taken into consideration [7, 8, 12]:

- those related to the traffic of vehicles along a "general access" road towards and outwards the frontier crossing;
- an access road along which only the vehicles crossing the frontier move; here the noise dominates which, depending on the vehicle flow capacity of the frontier, can be connected with constant braking and starting the vehicles;
- source of noise originating in the limits of a given crossing: driving up to the checkpoint, starting and breaking at this point, manoeuvring of vehicles within the limits of existing car parks.

The computations were performed using the CADNAA computer programme. The acoustic parameters of individual sources were verified in the course of testing the model. The results of calibration were the criterion of their adequate selection. The correctness of the computation model assumed was then verified through comparing the values of A noise level, obtained using the method of direct measurements with the computed values obtained for the same working conditions of the sources [4, 7, 8, 17, 18, 20, 21].

Using these assumptions for the present model, the acoustic maps were elaborated of the areas localised in the surroundings of the frontier crossings (Cieszyn, Korbielów, Dorohusk and Świecko). An example of the prepared acoustic map is shown in Fig. 1.

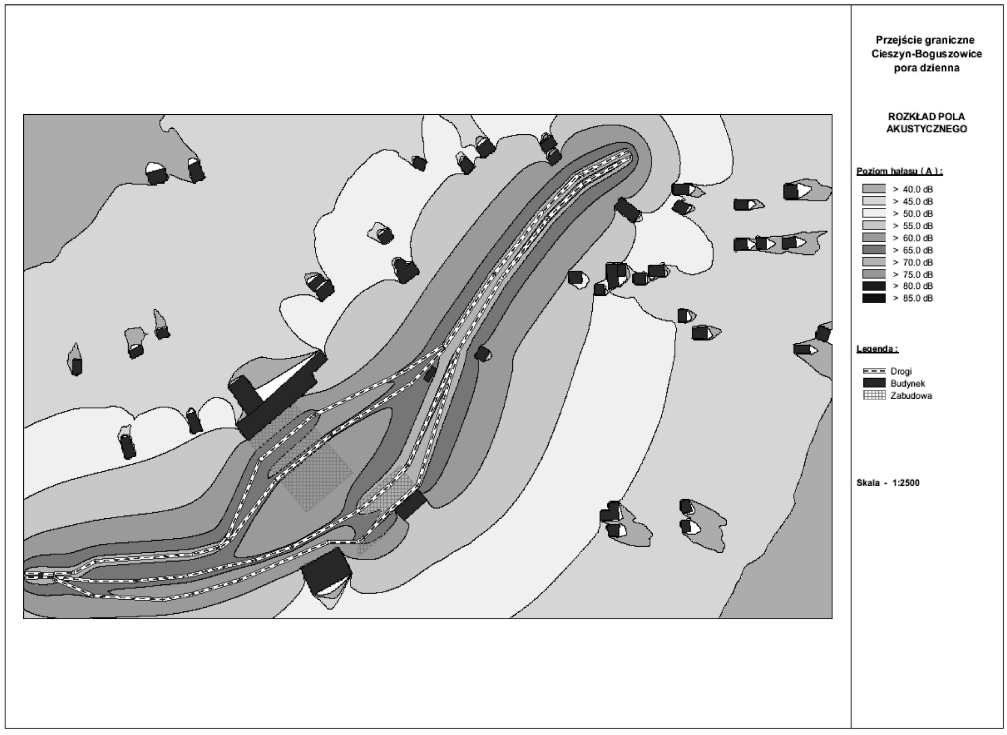

Fig. 1. An example of the prepared acoustic map for the Cieszyn–Boguszowice frontier crossing.

4. Reception of annoyance of roadway noise

Results of questionnaire survey

The main objective of the survey was to find the subjective reception of noise annoyance among the inhabitants of the frontier-adjacent areas.

Besides, in the research executed, the following issues related to roadway noise were considered, as:

- social conditions of assessment of noise annoyance,
- socially acceptable methods of limiting noise level,
- perception of noise causes,
- perception of the relation between noise, physical/mental state and health,
- evaluation of profits resulting from functioning of the roadway frontier crossing.

In Poland there are over 200 frontier crossings – 89 of them are river, pedestrian, cycling, skiing, while the rest of them contribute to increasing the car traffic or railway traffic noise, and in consequence, to generation of noise.

The phenomenon of noise itself, apart from its objective dimension (intensity measured in decibels), has also a subjective dimension, and in this sense one can discuss the question of noise. Therefore, the investigations were aimed at finding out whether and to what extent the noise is annoying to inhabitants of frontier crossing-adjacent areas, that is those who live close to the frontier and to access roads to the crossing.

The investigations were carried out in two phases. In the first phase, the frontier crossings were characterised, and two of them were selected for questionnaire inquiry. In the second phase, the inquiry was executed among the population living close to the roads leading to the frontier crossing. For this reason, the conclusions resulting from the scope of work in two phases are presented separately. These are as follows:

- the problem of noise relates to inhabitants of more than 43% frontier crossing-adjacent areas (neglecting pedestrian, cycling, skiing and river crossings). In the case of over 26% of crossings, the generated noise was considered fairly annoying, in nearly 12% – very annoying, and in 5% – extremely annoying;

16 frontier crossings were recorded, the operation of which entails exposure of the neighbouring population to very or extremely annoying noise. These were exclusively roadway crossings. Nearly on fourth, i.e. 23.6% of them were counted into the group with very and extremely annoying noise;

- the main source of noise is, following the opinions of respondents, the road traffic toward the crossing;
- other sources of noise, i.e. railway traffic, industry, neighbours and that connected with recreation places, make no problem for the respondents;
- a comparative analysis of the assessment of annoyance of road traffic noise with demographic-social data and those characterising selected parameters of the place of dwelling has shown that subjective evaluation of noise annoyance can be related to: education level, age and, sometimes to staying at home, and the character of land management (the lower the level of education, time of staying at home, lesser distance between the house and the crossing – in case of urban but not rural development – the more frequently road traffic noise is considered as very annoying);

• the results of investigations point at a strict relationship between the assessment of noise annoyance and evaluation of its effect on the frame of mind. In each of consecutive categories of noise annoyance, i.e. little, fairly, very and extremely intensive, the percentage of respondents convinced about negative effects of road traffic noise on the frame of mind increases, while those respondents who declared the road traffic noise to be entirely not annoying, did not also found its effect on their frame of mind;

• the respondents who defined road traffic noise to be entirely not annoying or of little annoyance, declared, at the same time, that it has no effect on their health. In turn, in each of consecutive categories of noise annoyance: fairly, very, extremely intensive, the percentage of respondents convinced about negative effects of road traffic on the frame of mind increases.

5. Evaluation of health hazard to the inhabitants

The assessment of the health hazard to the inhabitants due to functioning of frontier crossings was carried out on the basis of measurements and questionnaire inquiry conducted in parallel [7, 9, 10, 15, 19].

When specifying the permissible sound levels for the noise related to operation of frontier crossings, apart from the character of protected land management, the type of noise source was taken into account, in accordance with the division presented below:

Remaining objects and groups of sources, connected with noise originating within the crossing itself (traffic to checkpoints, starting and breaking vehicles for checking, parking in specified places), and with noise emitted during movement of vehicles along the access road, depending on the number of vehicles, this traffic can be relatively smooth or traffic jams may occasionally appear, in particular on Friday, Saturday and Sunday.

Roads, connected with noise originating during movement of vehicles towards the frontier crossing, along the "general access roads", when they contribute to the general stream of vehicles.

Hence, the assessment of the hazard due to noise impact needs determining a common area limited by isolines of permissible levels, and the areas subject to acoustic protection with their density of population.

An important source of noise emitted from the crossing area is the group of operations related to manoeuvring, stopping and starting the vehicles within the checkpoint. Of importance is also noise emitted by vehicles waiting in a queue on an access road.

On the basis of performed computations and measurements, it can be found out that the range of impact of noise emitted from the frontier crossing area depends, in particular on:

- acoustic parameters of individual sources, in particular acoustic power connected with starting, breaking individual vehicles; in case of need of manoeuvring of importance is the area of the surface prepared for such operation within the premise of crossing;
- total number of dispatched vehicles;
- proportion of heavy vehicles and their technical condition;

- method of managing the area of the crossing and its close proximity; screening effect of existing cubature objects.

The investigations carried out lead to the conclusion that the rate of over standard noise emitted during night time from the crossing area can reach up to 500 m depending on its value. The health of the inhabitants of buildings localised in this area is endangered with illnesses related to excessive emission of noise.

6. Principles of creating the programme for protection of inhabitants of frontier-adjacent areas against noise

The guidelines presented below relate to creating the program for environmental protection against noise designed for the areas connected with functioning of the "roadway frontier crossing" [2, 6, 8, 12].

The noise connected with "functioning of the frontier crossing" is an action of sources within the area of the crossing itself, considered as the area which, according to land management plan, is designed for such activities, and sources of road-type noise related to the traffic of vehicles on a "general access road".

The programme of environmental protection against noise resulting from operation of frontier crossings should be prepared in a written form and contain the following parts:

- descriptive,
- specifying limitations and duties resulting from programme realisation,
- justifying the scope of issues.

The scope of issues included in the environmental protection programme should take into account the data and conclusions contained in the *prepared acoustic map for the areas in which the impact of noise sources in consequence of functioning of a frontier crossing may produce the exceeding of the permissible levels of noise in the environment.* In particular, one can use other studies, for instance those with the assessment of impact on the environment of installations and objects located in the area covered by the programme, but not connected directly with functioning of the crossings, e.g. various service and repair shops, filling stations that would not exist if there was not a crossing.

7. Conclusions

The investigations performed in individual phases of the project have revealed that the noise connected with functioning of a frontier crossing can be annoying to the inhabitants of the frontier- adjacent areas. Close proximity of noise sources connected mainly with approach of heavy trucks, and areas subject to acoustic protection can be a cause of exceeding the permissible levels in the outer environment. On the basis of performed questionnaire enquiries it has been found that the noise is an important problem to the population living close to frontier crossings, and its scale needs taking preventive actions. Taking into account a subjective evaluation, one can say that it is annoying for most inhabitants of the adjacent areas.

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