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ENVIS 4 – Environmental Information System in Prague

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1. INTRODUCTION

The main purpose of ENVIS 4 project (assigned by the Prague City Hall) was to increase the relevancy, availability and quality of detailed informations about the environment in area. The project was focused on the four environment components very sensitively perceived by people in Prague, namely: 1. **Air**, 2. **Noise**, 3. **Landscape**, and 4. **Greenery**.

The project was divided into two phases - implementation and operational. The implementation phase, given the quantity of processed data and the extent of calculation area, was processed in a record-breaking time of 4.5 months and finished in June 2008 thanks to the well-coordinated implementation team.

The aim of the operational phase is subsequent updating and keeping the system for a period of 5 years.

The authors made use within the project of the maximum possible extent the state-of-the-art and the best available technologies and standard methodologies in the analyses and modelling of individual environment components, which had been used for European cities. The authors had the advantage in the possibility to use the intensively developing data bank of the Capital City of Prague.

24 municipal districts of the Capital City of Prague have been involved in the project. These districts have cooperated in preparation of this system since the very beginning of the project. Participating districts cover approximately 40 % of the area of the Capital City of Prague.

The aim of the ENVIS 4 project was to create a suitable tool for effective management of environmental care and control within the city. The information is made available in a simple and intuitive manner both to the wide public and the authorities, state administration and self-administration bodies on the website of the Capital City of Prague.

The company EKOLA group was the main researcher in the whole project responsible for one of the project parts, which was topic noise. The project endeavoured in this part to approximate the noise burden from motor traffic both in day and night time to the actual situation as possible, not only within the areas of individual city districts but also on building facades along the monitored road network. This is why ENVIS 4 project was focused just on the noise from car traffic, which burdened the biggest part of the area of the Capital City of Prague.

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2. PROJECT PREPARATION

Within the project preparation phase there was made an inventory of the database and were collected needs of the project users.

The database inventory resulted from the database of the Capital City of Prague. From this database was extracted data concerning the area of the involved city districts (e.g. traffic intensities in a selected road network, data on buildings, roads, etc.)

The monitored road network in the Capital City of Prague is only a skeleton simplification (main roads) of the entire road network in Prague. For changeover from calculations based on the basic road model to more precise calculations for the area of the surveyed city districts must have been the basic transport-engineering data extended about values collected in direct surveys.

The database was extended about data on traffic intensities in other 100 census points, i.e. traffic intensities and composition were established for additional 377 of traffic profiles.

This procedure ensured that the model assessment of noise and pollutions from traffic within the ENVIS 4 project was based on the same database. (This also satisfied the requirement for integral approach to the issues of noise and pollutions from road traffic.)

Questionnaire survey was chosen as a form of finding the needs of users in the topic NOISE. The questionnaire was set up so as to provide the possibility to define the most relevant current and future needs of the districts concerning noise to individual users (municipal districts).

The results obtained confirmed the generally known fact that especially road traffic was the main source of noise in the area. This was corroborated both for noise sources located in the territories of the municipal districts and for noise coming from the neighbouring municipal districts. Other ranks of relevancy of noise sources are already closely related to their occurence in the area.

We can deduce that the successful solution of noise protection need not be only the matter of noise solution just in the addressed or assessed area but also the matter of occurrence the sources of noise in the neighbourhood. The solution of the issue from noise in an area must therefore always be approached from the position of the *occurrence of noise sources relevant for the addressed area*.

The relatively surprising result of the survey was that the answers for questions concerning “other noise sources” included noise from construction. It seems that, although the occurrence of such noise sources is mostly locally and temporally limited, the acoustic qualities of the area are affected from these sources considerably. Noise from construction activities is perceived to be very negative and disturbing. This means that there should be higher emphasis put on protection of population against noise from construction than until today when assessing investment plans and during the area management and building-permit proceedings.

3. MEASUREMENT OF ACOUSTIC SITUATION IN STRATEGIC CALIBRATION POINTS

Verification measurements made in 24 strategic points author-defined were used for acoustic situation calculations in a municipal districts.The aim of these measurements was to “tune up” the calculation model, i.e. to verify the relation between the results of measurements and those of acoustic situation calculations in the area for a particular situation in measurement. This is the method commonly used by our company to check the quality of its calculation models for already more than 10 years.

47 verification (calibration) measurements in total were made during March 2008.

Fig. 1: Location of strategic calibration points in the area under survey

4. CALCULATIONS OF ACOUSTIC SITUATION

The CADNA A software by Datakustik GmbH. (Germany) was used to calculate road traffic noise, especially due to possibility use the specific noise parameters of the Czech car fleet.

Preparation of the data and the calculation procedure were based on the EKOLA group’s many-years’ experience in noise mapping in the Czech Republic and abroad. We also used the experience gained in the creating the noise maps of car traffic in Prague 2000 and Prague 2005 made by EKOLA group for the Capital City of Prague and also experience from the strategic noise maps.

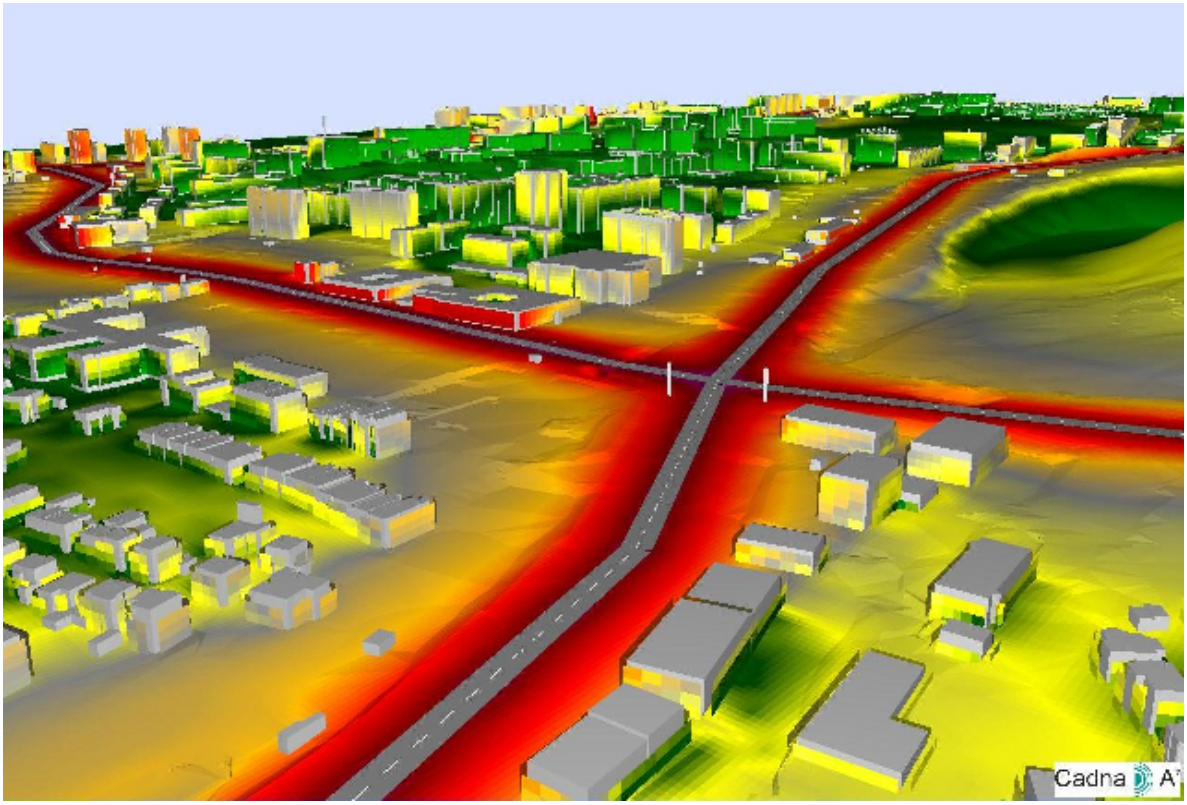
Given the great volume of data (2,551,767 calculation points in total on building facades and 2,020,000 grid points of the 10x10 m calculation grid), the calculation was carried out

using the unique, 28-cluster CADNA calculation system developed by the firm in its noise mapping centre.

Brief calculation solution procedure:

- Preparation and generation of input source data for the calculation
- Development of a 3D model
- Generation of emission calculation points in front of all building facades and of an area calculation grid (10x10 m)
- Measurement in check points and check of calculation model results (calculation model adjustment), check of results
- Output display of the acoustic situation, output data and its interpretation, digital outputs

Fig. 2: Cut-out sample of the calculated noise map of area noise distribution and of noise on building facades in the CADNA A software



As follows from the evaluation of the differences between the measured and calculated values LAeq for measured situation in day and night time, the average difference between the measurement and calculation results for standard measurement conditions was 1.3 dB for daytime and 1.8 dB for night time.

5. VERIFICATION MEASUREMENT OF CALCULATION RESULTS IN USER-DEFINED POINTS

Within the project, it was made possible for the users to choose 24 user-defined points for verification of calculation results. This measurement series was carried out according to the assignment solution schedule both in day and night time during April 2008.

In the event that users did not choose any place for measurement, the researcher picked a point of measuring at its own discretion.

To check the results of calculations and measurements in these user-defined points, however, it was possible to take into account a limited number of measuring points only, i.e. those that just were dominantly affected by the noise sources - roads which had monitored and entered in the calculation model. 15 user-defined points out of 24 met these assumptions.

Other points were mostly assigned in development areas outside the monitored road network or in potentially quiet areas. These points are necessarily burdened by different noise sources located in the localities but have not been entered in the calculation model and, therefore, cannot be compared with the calculated values.

As follows for the satisfactory points from the evaluation of differences between the measured and calculated L_{Aeq} values for particular measured situations, the average difference between the measurement and calculation results for standard measurement conditions is 1.2 dB.

Fig. 3: A sample of distribution of user-defined measuring points or quiet areas

The user-defined points of measurement differed from the points of calibration measurements chosen by the researcher. By this way the quantity of check points for calculation could increase.

6. RISKS ANALYSIS OF NOISE

The subject of evaluation of health risks from noise within the ENVIS 4 project was *noise from road traffic in 24 municipal districts of the Capital City of Prague.* The aim was to prepare supporting documents for the project users making it possible for them to assess the acoustic situation in the area not only from the technical and economic point of view but also in terms of impacts on population health. This should generate specific data advisable to determining the solution priorities in the current or future policy concerning noise.

In general, knowledge of noise burden related to the concrete number of exposed persons is the basis for exposure evaluation and for quantitative estimate of noise level risk to health.

Calculation results that evaluated the acoustic situation in the 24 municipal districts of the Capital City of Prague from road traffic and the numbers of people exposed to individual noise values in five-decibel bands for day and night times were available in the given case. Any detailed informations about exposure conditions (such as orientation of windows, population age, representation of the sensitive part of population, exposure duration, etc.) weren´t available for this evaluation.

The outputs from the calculation model, especially the equivalent levels of acoustic pressure L_d (6-22 h) for day time and L_n (22-6 h) for night time, were inputs for this evaluation. Relations for the evaluation of population burdening by traffic noise (recommended in the EU countries) are derived for the exposure expressed in descriptors L_{dn} or L_{dvn}. These descriptors can be obtained by recalculation from determined values L_d and L_n.

The noise emission values **in day time** in 8 municipal districts reached the band above 75 dB, and in 20 municipal districts they reached the band 70-75 dB.

Approximately 11,568 people live in the bands above 70 dB, which represents 3.1 % of the total number of population in the monitored municipal districts.

1,216 protected buildings are located in the areas in the band of equivalent level of acoustic pressure A above 70 dB.

248,555 and 152,389 people of the monitored municipal districts live in the bands above 50 dB and above 55 dB respectively.

These values represent moderate burden by noise in daytime in conservative assessment in approximately 65 % of the exposed population and strong noise burden in approximately 40 % of the exposed population.

Much relevant is this fact for the sensitive groups of population (small children, old and sick people), but no data on the proportion of this part of population was available for the study. Noise impact should also be assessed in terms of eventual disturbance of communication through speech and, especially, in terms of irritation, dissatisfaction, sullenness and discomfort.

The noise emission values **in night time** in 18 municipal districts reached the band above 65 dB, and values within the band of 60-65 dB were found in all 24 districts.

In the conservative point of view, the night-time levels of acoustic pressure A within the band of 60-65 dB represent light sleep disturbance in approximately 21-26 % and high sleep disturbance in approximately 11-15 % of the exposed people. Night noise levels are deemed to be a chronically acting factor representing a constant, basal burden for the organism. Probability level of the health disablement can be assessed already from 40 dB.

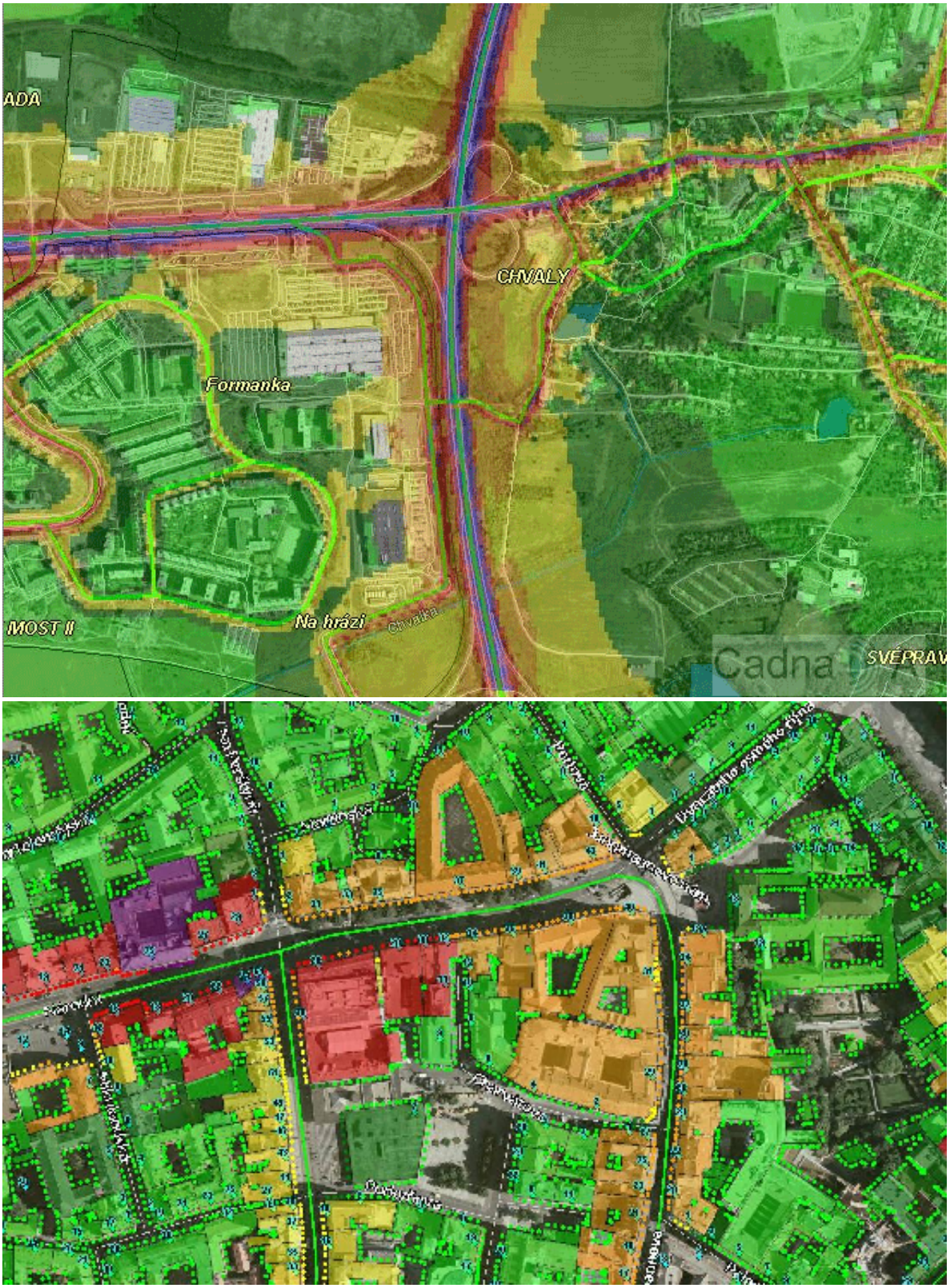
303,385 people, i.e. approximately 80% of the total population in the monitored municipal districts, were exposed within the values of noise indicator for night time L_n in the band above 40 dB. 24,051 people, i.e. 6.4 % of the total population in the monitored municipal districts, lived above the limit value of L_n = 60 dB.

34,195 of monitored protected buildings are located within the values of noise indicator for night time Ln above 40 dB. 2,615 of monitored buildings, i.e. 7.6 % of the total number of the monitored 34,195 protected buildings, are located in areas above Ln 60 dB. No data on the number of educational establishments and hospitals in the monitored areas was available for assessment.

7. PROJECT PRESENTATION

The outputs from the project for NOISE were transferred to the required web interface and to GIS. The outputs, available on the Internet, include especially the basic information on sources of noise in individual municipal districts; location of individual measuring points and information about these points; information about the values of acoustic pressure levels from the calculation area grid of 10x10 m; information about the calculation points evenly distributed on the facade surface in a vertical calculation area. This level then makes it possible for the users to obtain relatively detailed data on noise situation in scale of individual buildings and facades, as well as to make any further analyses, for instance in relation to air pollution, etc. It means that everyone can find quite easily the level of acoustic pressure A in front of own window. Moreover, the users can make simple analyses in an area they choose themselves and find out, for instance, where and how much the limiting values are exceeded, including statistical reports and concrete identification of the place or building where such levels occur, etc.

Fig. 4, 5: Samples of the graphic possibilities of the project in the resulting web presentation



8. OPERATION OF INFORMATION SYSTEM

The graphic outputs of the project with numerous statistical reports, measurement records, etc. are presented on CD/DVD, but especially on the website of the Prague City hall, e.g. http://www.premis.cz/envis4.

As follows from the analyses of the use the application ENVIS 4 in the topic NOISE, the system is used relatively frequently by the state administration bodies and the Prague City hall, as well as by the municipal districts, professional and lay public, by NGOs and other subjects and companies which are interested in environmental protection.

9. CONCLUSION

ENVIS 4 - NOISE project is at present the most detailed and first thus presented informational material about the noise situation in an area processed to the detail of individual building facades and each building floor. The set-up 3D model endeavours to show as close as possible the actual situation in an area burdened by car traffic.

Owing to the developed area noise map (horizontal), the project makes it possible for users to obtain information not only about the area noise situation at the base height of 4 m above the ground, but especially in a vertical plane. With the help of the vertical noise map, users can obtain information about noise burden distribution on all building facades, i.e. about noise burden on individual floors of these buildings.

However, users should constantly be trained and informed that when using and interpreting values that they have been obtained through model calculations, any local situation cannot be described in detail through this model if it could also be affected by other local noise sources which are not and even cannot be included in the mathematic model. The model values follow from the input data that were available, and the accuracy of these calculations depends on the input data. The input data cannot contain all local anomalies or deviations. It means that these values should be understood as first approximation to the acoustic situation in a locality, and values measured according to approved procedures or standards must always serve to objective assessment of the acoustic situation.

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