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MANAGING THE 2ND ROUND OF STRATEGIC NOISE MAPPING AND ACTION PLANNING ON NATIONAL MOTORWAY NETWORK

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In order to satisfy the requirements for strategic noise maps and action plans for the second round of strategic noise mapping and action planning under EC Directive 2002/49/EC, the Croatian Motorways Llc conducted for the first time complete round of noise mapping and action planning for nearly 640 km of national motorway network that are treated as major roads as defined in END. This paper describe a consultant's view on the multiple different, independent but connected projects which constitute complete round of noise mapping and action planning. On the basis of experience from previous noise mapping project across EU, some specific tasks has been added in order to enable smooth transition to the development of the conflict (exceedance) maps and public presentation of results. With the usage of the macro functionality within noise mapping software, specific procedure for determination of the candidates of noise management areas has been implemented. Web mapping application has been used during development of the noise action plan, where noise mitigation scenarios has been presented to the public for consultation. As result, nearly 180 noise mitigation scenarios with over 250 mitigation measures for 133 noise management areas has been derived and analysed by using macro functionality of mapping software. Method for an evaluation of scenarios effectiveness not only include noise index, but overall noise exposure, based on individual (façade) building evaluation results. On the basis of overall results, final noise action plan for 2nd round of END has been derived and presented to the public.
Keywords: Noise mapping, action planning, major roads,

1. Introduction

Directive 2002/49/EC relating to the assessment and management of environmental noise, more commonly known as the Environmental Noise Directive (END) [1], places an obligation on European Union (EU) member states to implement noise mapping and action planning for major cities and transport sources in their territories.

END is transposed into Croatian legislation through Noise Protection Act [2] and several ordinances that defines method of preparation and the content of noise maps and action plans with calculation of the allowed noise indicators [3] and highest permitted noise levels (i.e. noise limits) [4] ("Regulations"). Today, with a four-year lag, we are witnessing the correct but un-functional transposition of the environmental noise acquis. Namely, quoted law and ordinances were not specifically designed to be a coherent transposition of the Environmental Noise Directive 2002/49/EC but rather pure "political" transposition of legal framework. Such approach have resulted in a high degree of fragmentation of the environmental noise responsibilities across: ministries, the regional, central and local authorities, and public bodies, which can lead to significant challenges in coordination and decision making. This conclusion is based on the experience of a consultant who delivered majority of strategic noise maps and action plans in Croatia, but also with experience of the similar projects on EU level.

This article shows our experience on separate projects that formed 2nd round of noise mapping and action planning on national motorway network under management of Croatian Motorways Llc with total length 640 km that are considered as "major roads".

2. Noise mapping process

Regulations designate Ministry of Health (MH) as the central government administration responsible for implementing all the requirements that derives from the END. Among all other provisions of the Regulations, it designate responsibilities for the competent bodies for preparing strategic noise maps (Art. 4 of END), preparing strategic noise maps (Art. 7), establishing public consultation procedures on proposed action plans (Art. 8.7), preparing action plans (Art. 8) and establishing procedures for provision of information to the public (Art. 9).

2.1 Tender progress

In October 2011, following the publication of an Official Gazette notice, tender process has been started with the request for service "Development of the strategic noise map for the motorways under management of the Croatian Motorways Llc" (acronym "HAC"). From the content of the tender it was obvious that contracting authority isn't familiar with the future scope of the project, hence complete technical description of work was "copy-paste" content of Annex VI of the END without any additional explanation that could clarify necessary scope of project like coverage area, existing data, traffic data analysis etc. In order to minimise risks for the different understanding of scope of work, public tendering process were extended to 4 months period, with 13 written explanations. In that times, Croatian public tender law specified that the choice of tenderer is based strictly on lowest price. Fortunately, after a wait of 41 weeks, we were informed that DARH 2 had been awarded the contract and in March 2013, we've had first "kick-off meeting".

2.2 Development of strategic noise map

From the start of the project, it was obvious that within HAC there are general misunderstanding about implementation steps of the END instruments. Hence majority of the "high ranked" participants on the kick-off meeting was head of departments, our expectations were really high mainly due to fact that almost same management successfully completed major construction of nearly 400 km of motorways in period between 2000-2010. In contrary, project of development of the strategic noise map were treated as "another project" that must be delivered as a part of EU accession in that time. Therefore during inception phase of the project most of the resources were focused to the number of meetings with responsible persons within departments with explanations about most important issues within noise mapping process like:

- general knowledge about the strategic noise mapping process;
- understanding of the requirements for strategic noise maps;
- knowledge about the definition of the areas to be mapped;
- specifications of the road traffic noise calculation method;
- knowledge of the necessary input data for the noise mapping process;
- readiness for the GIS integration in HAC's GIS infrastructure;
- development dataset specification for the noise mapping process;
- producing datasets for the noise mapping process according to specification;
- influence of the technical aspects in the noise level calculations;
- possible validation of the noise maps;
- post processing and analysis of exposure of inhabitants;
- requirements of the final reports for the strategic noise maps and data reporting;
- possible approaches during public presentation and public involvement.

In this part of the noise mapping project, first preliminary information about action planning process were briefly introduced, primarily within development of the dataset specifications and their production with emphasize to:

- overview of the noise action planning process;
- requirements for action planning;
- development of the noise action planning process;
- implementation of the noise action planning in the future development and environmental strategy.

In order to ease future process of action planning and next round of noise mapping some additional activities were proposed as a vital parts for successful implementation of the noise mapping round, like proper definition of areas the must be mapped (Fig. 1), development of the accurate road traffic data (Fig. 2; Fig. 3), proper modelling of the road centrelines (Fig. 4) etc.

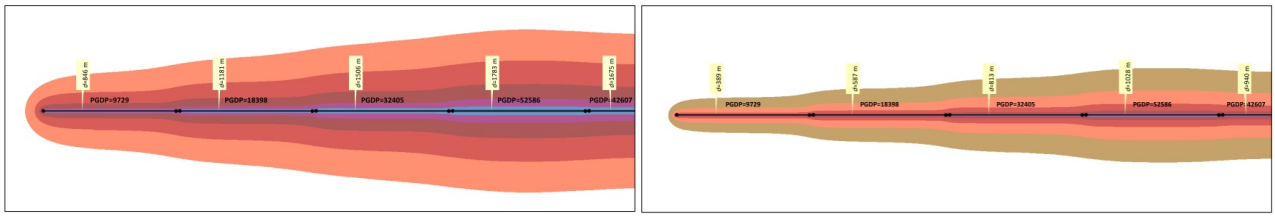

Figure 1: Calculation of L_{den}=55 dB(A) and L_{night}=50 dB(A) with respect to AADT[1]

Special attention has been paid to the development of the accurate road traffic data and geometry, hence complete motorway network has at least one traffic counter within every traffic lane on each motorway section, together with counter for every interchange ramp. All necessary traffic data were defined in specification document which includes description of all necessary data for calculation of road traffic noise emission data in accordance with the interim method together with the naming conventions of motorway sections and interchanges, carriages, ramps, traffic flow directions, placement on bridges or within tunnel etc. Such extensive approach seems to be too detailed, but due to possible applications of such detailed data in later action planning phase (traffic management measures that influences speed and traffic composition) we have decided to analyse nearly 900 datasets. This process has been performed within GIS environment with the usage of the model builder where all necessary data for calculation of noise emission has been analysed and stored within file geodatabase.

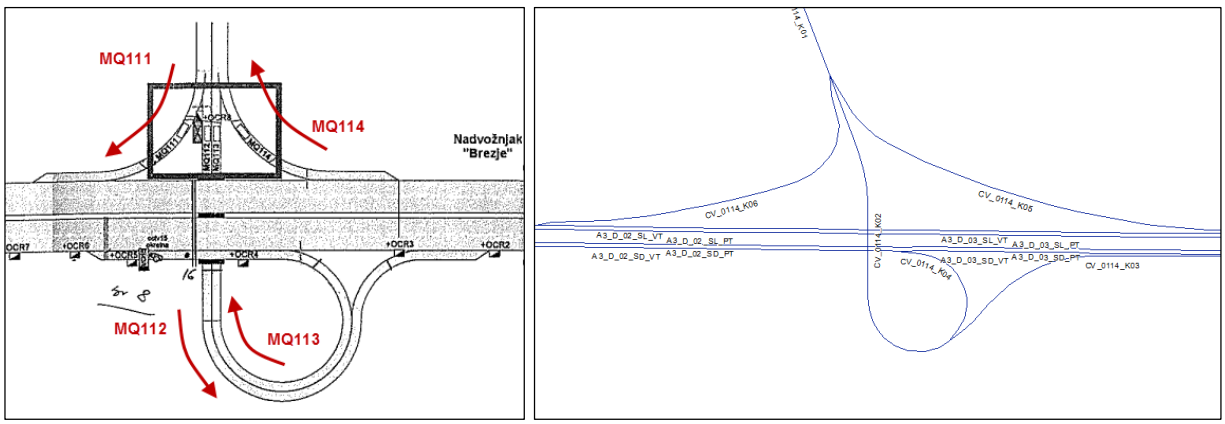

Figure 2: Assignment of traffic counters data to road centrelines on typical trumpet interchange

The FMDI dataset for roads includes special flag for sections within agglomeration roads due to requirement that in this and all future projects, single source dataset must be delivered and calculation must be done in single run for grid and façade calculation.

[1] In Croatian PGDP = AADT

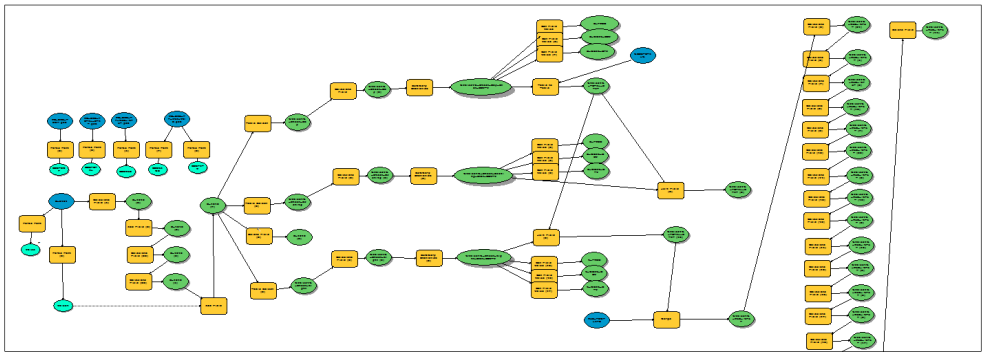

Figure 3: Example of the traffic data analysis within GIS environment

Additional processing of the road centrelines geometry were undertaken in order to get proper gradient correction for 3D noise calculation environment. According to some specific requirements of Croatian regulations, road noise level were calculated for 4 noise level indictors (L_{day}, $L_{evening}$, L_{night}, and L_{den}) for three calculation group of roads[2] and separately for sections of major roads within agglomerations.

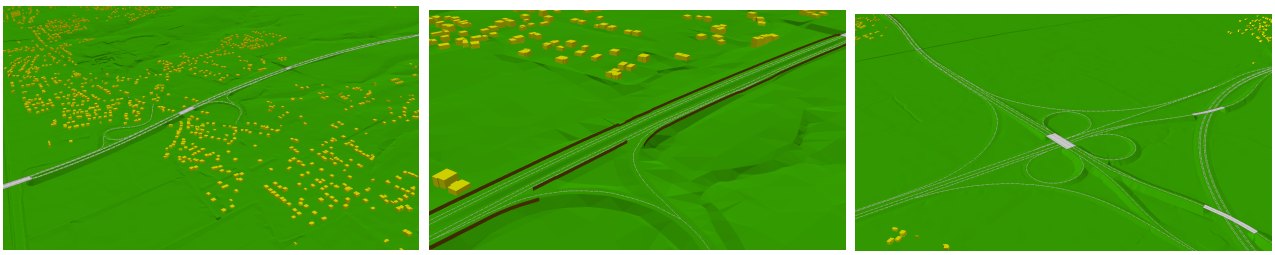

Figure 4: 3D checks and visualization of FMDI datasets

Exposure assessment for the 2nd round of strategic noise mapping together with area coverage analysis were processed and supplied in required form of DataFlow 4_8 ENDRM table. Together with finalisation of the report for END obligatory data, additional conflict noise map has been proposed and derived as an interim step towards action planning process. Results of the conflict noise map were used as a first estimation of the work that must be considered within implementation of noise action plans.

3. Noise action plan

Hence Croatia doesn't have any official national guidance that relates to development of the noise action plan of any source, primary aim of the HAC's 1st action plan was to fulfil END requirements as soon as possible and propose some methodology that could be used as an template for future processes of noise action planning. Therefore, beside experience from consultants from similar projects in England, Malta, Wales, Slovenia and Turkey, extensive literature survey has been made mainly to derive process of development of the "candidates for noise management zones" through various concepts of noise indexes ([5], [6], [7], [8], [9], [10], [12]) and processes of noise action planning. Final proposed process of noise action planning contains five major stages:

- Stage 1 – Development of the conflict noise map that contains identification of areas where noise sensitive locations are exposed to noise values above noise limits sets by the Regulations
- Stage 2 - Review results of strategic noise map and conflict map to identify priorities through application of prioritisation matrix to present list of "candidates for noise management areas" (CNMA).

[2] Groups were defined as motorway sections with ATF> 2 000 000 vehicles per annum (requirement from Croatian ordinance); ATF > 3 000 000 vehicles per annum (END requirement for 2nd round of noise mapping) and ATF > 6 000 000 vehicles per annum (END requirement for 1st round of noise mapping)

- Stage 3 - Confirmation of "noise management areas" (NMA) through field survey that includes on-site visit of every NMA, comparison of acoustical model with on-site situation, possible noise level measurements to confirm that the noise levels indicated by the strategic noise mapping are being realistic within NMA.
- Stage 4 - Review possible mitigation measures through development of scenarios for NMAs. After formal confirmation of NMA, potential noise mitigations measures were proposed and investigated, together with cost benefit analysis undertaken for each NMA.
- Stage 5 - A recommendation for designation priorities and implementation schedule.

3.1 Development of the conflict noise map and CNMA definition

According to Croatian regulations [4], highest permitted noise levels from motorways are L_{day}=65 dB(A); $L_{evening}$=65 dB(A) and L_{night}=50 dB(A) at the boundary of the traffic corridor, so identification process of CNMAs at noise sensitive location must have clear relationship among exceedances during every assessment period, L_{den} value and number of inhabitants and/or dwellings. Therefore, decision about usage of the linear exceedance method has been taken. On the basis of SNM results, for every building, noise score has been calculated in such manner that within GIS environment dissolving into larger areas is possible. From the potential list of nearly 470 CNMAs, 133 areas were promoted into NMAs (example shown on Fig. 5)

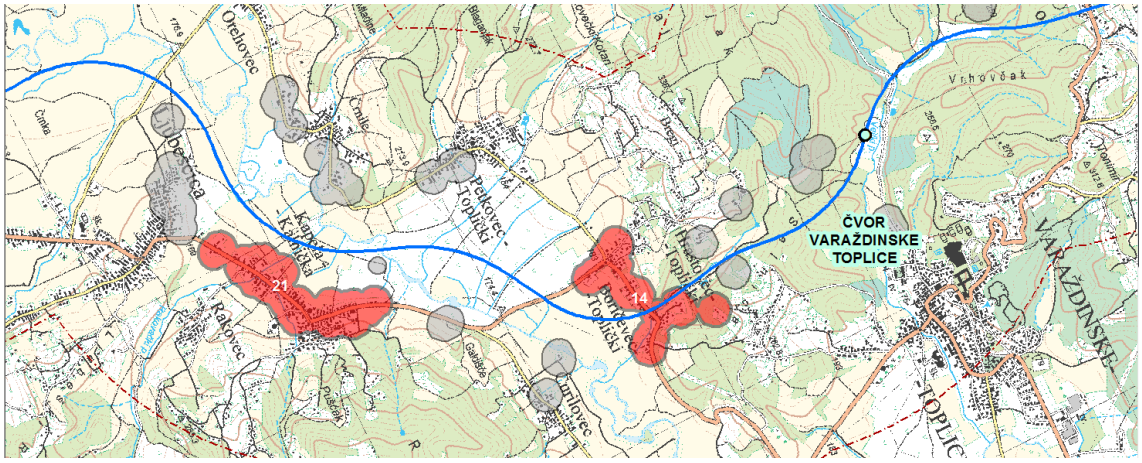

Figure 5: Example of NMAs (red) and CNMAs (grey) on Motorway A4

3.2 Confirmation of "noise management areas"

Prior to the review of potential noise mitigation measures, and any subsequent commitment of budget to undertake any necessary actions, it was proposed to confirm that the noise levels indicated by the strategic noise maps are being experienced by the population within the NMA. This step has been performed by on-site visit of every area, comparison of computer model with situation within NMA, verification of legal status and buildings use in land registry and cadastre and finally filling up a form that describe NMA for later consultation of project team (Fig. 6).

3.3 Development of the noise mitigation scenarios

There are a wide range of potential noise mitigation measures [7, 11], some of which may act at micro or macro (national) level. Due to fact that this was 1st process of action planning, comprehensive list of nearly 40 discrete noise mitigation measures were proposed grouped into three major groups of measures:

- source related mitigation measures,
- propagation related mitigation measures, and
- receptor related mitigation measures.

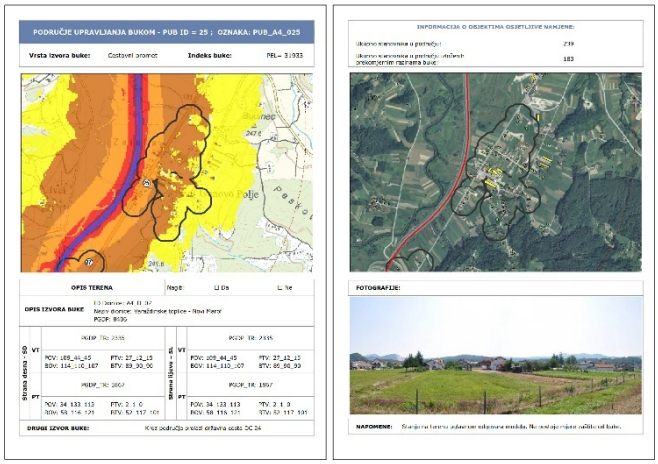

Figure 6: Used form for confirmation of NMAs

On whole road network across Croatia with 133 NMAs, noise mitigation scenario that contains single noise mitigation measure were proposed on 82% of total number of NMAs. Scenarios with two noise mitigation measures were applied on 16 % NMAs, while in remaining 2 % NMAs scenarios were designed in such manner to contain 3 or more noise mitigation measure (Table 1).

Table 1: Noise mitigation measures – frequency of use in NAP

Noise mitigation measures	Percentage of use in NAP
(Re)Construction of noise barriers	59,4%
(Re)Construction of noise barriers with modification on barrier edges	2,3%
Improvement/replacement of road surfaces	6,8%
Traffic management measures	23,3%
Noise mitigation measures rejected	8,3 %

Efficiency of 180 noise mitigation scenarios were calculated with the usage of the macro functionality of the LimA noise mapping software. Macro was designed in such manner to use same calculation settings as the settings used for the SNM, but with 5 meter raster grid and denser façade calculation points. After successful calculations, all the analysis and data processing were done automatically within LimA in such way that for every scenario following results were used in assessment of noise reduction efficiency:

- grid calculation (5 x 5)m within NMA,
- denser façade calculation within NMA,
- calculation of conflict noise map for assessment periods of day, evening and night
- analysis of inhabitants exposure to noise within NMA with export to csv format
- analysis of dwelling exposure to noise within NMA with export to csv format
- area coverage analysis with export to csv format
- calculation of NMA noise score
- export of noise grid results to GIS compatible formats (ASCII grid, polyline isophones and polygon feature classes) for L_{day}, $L_{evening}$ and L_{night}
- export of conflict map grid results to GIS compatible formats (ASCII grid, polyline isophones and polygon feature classes) for L_{day}, $L_{evening}$ and L_{night}
- export of building evaluation points with rating noise values for L_{day}, $L_{evening}$, L_{night} and $L_{den.}$
- export of summary in NMA scenario sheet (csv format).

3.4 Cost benefit analysis

In order to develop a prioritised list of actions to be undertaken, it was relevant to carry out a cost-benefit analysis on the potential actions being considered in order to maximise value for money and deliver benefit from investment in next 10 years. The cost-benefit analysis addressed lifetime construction and maintenance cost against noise reduction benefit without involvement of health related cost/benefit analysis.

3.5 Public consultation

After approval of the drafted NAP from management, formal public consultation has been prepared across country. The Draft NAP and accompanying summary were prepared in electronic format and published on line on the web site of Croatian Motorways Llc, while the paper version of documents were prepared for 6 cities across country where public presentation has been conducted within 30 days of public consultation process. Complete results of SNM and NAP were also accessible online via developed web-viewer application (http://bitly.com/hac_skb)

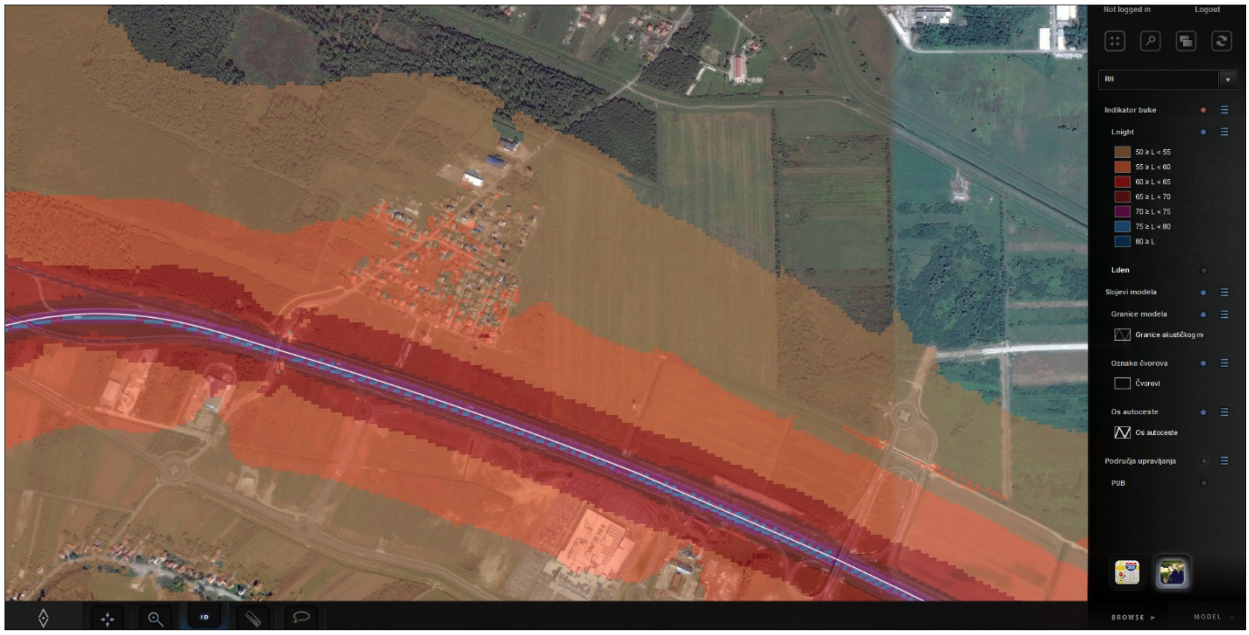

Figure 7: Strategic noise map web viewer application

Figure 8: Noise action plan web viewer application

4. Lessons Learnt

For the first time in period of 2013-2016, Croatian Motorways Llc completed successfully 2nd round of noise mapping and action planning in accordance to END requirements. Experience from the noise mapping process shows that if END deadlines wants to be fulfilled, serious preparation for noise maps must starts at least 12-18 months before commencing noise mapping project with prepared specification documents, known data source provider with organised data structure. Some specific map layers that are usually developed at national level (DMR, ortophoto imagery, cadastre) aren't synchronised in same time schedule as noise mapping rounds. Therefore, scenarios for tracking changes in areas that must be mapped should be prepared in advance. Due to relative short time for development of noise action plan, usage of the macro functionality within software packages are highly recommended hence it dramatically reduces possibility of human error in repetitive tasks and saves considerable amount of time for more important activities. Our experiences shows that public interest for the strategic noise map results increases only when simultaneously scenarios for action plan are proposed. By using described approach, noise map and action plan for 3rd round will be produced within required timescale and less risks.

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