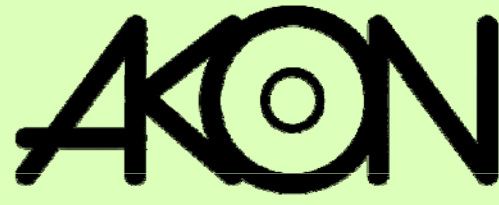
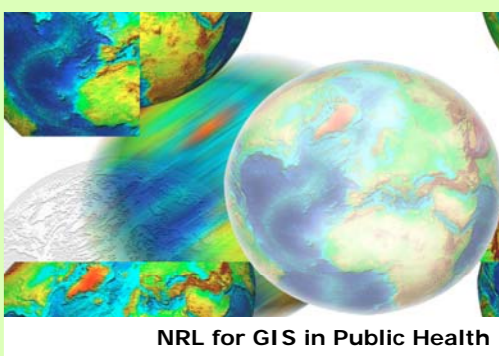


Annoyance analysis of population affected by railway noise – EU Strategic Noise Mapping

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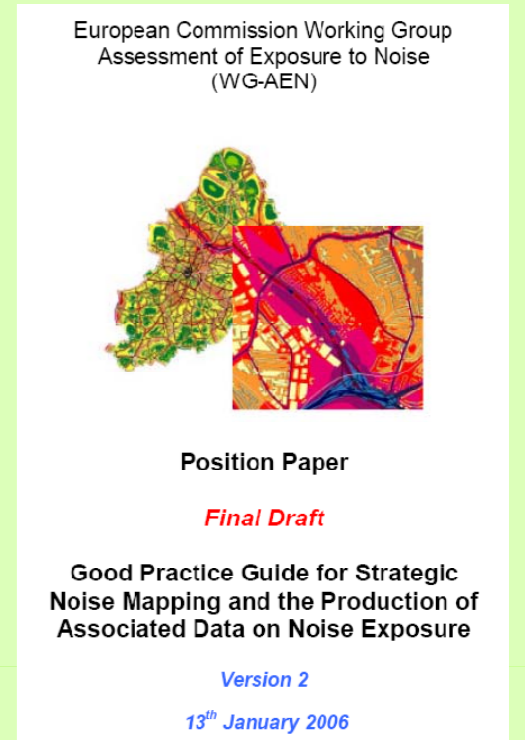


Introduction

The EU member states were obliged to elaborate Strategic noise maps till June 2007. This duty was given them by the Directive 2002/49/EC of the European Parliament and of the Council of 25 June 2002 relating to the assessment and management of environmental noise. Member States had to apply the noise indicators L_{den} (L_{den} - day-evening-night noise indicator - mean the noise indicator for overall annoyance) and L_{night} (10p.m.–6a.m.) for the preparation and revision of strategic noise mapping. Until the use of common assessment methods for the determination of L_{den} and L_{night} is made obligatory, existing national noise indicators and related data should have been converted into the indicators mentioned above. The National Reference Laboratory for using GIS in Public Health was delegated by the Czech Ministry of Health with the task to elaborate strategic mapping of rail transport noise.

Data and Methods

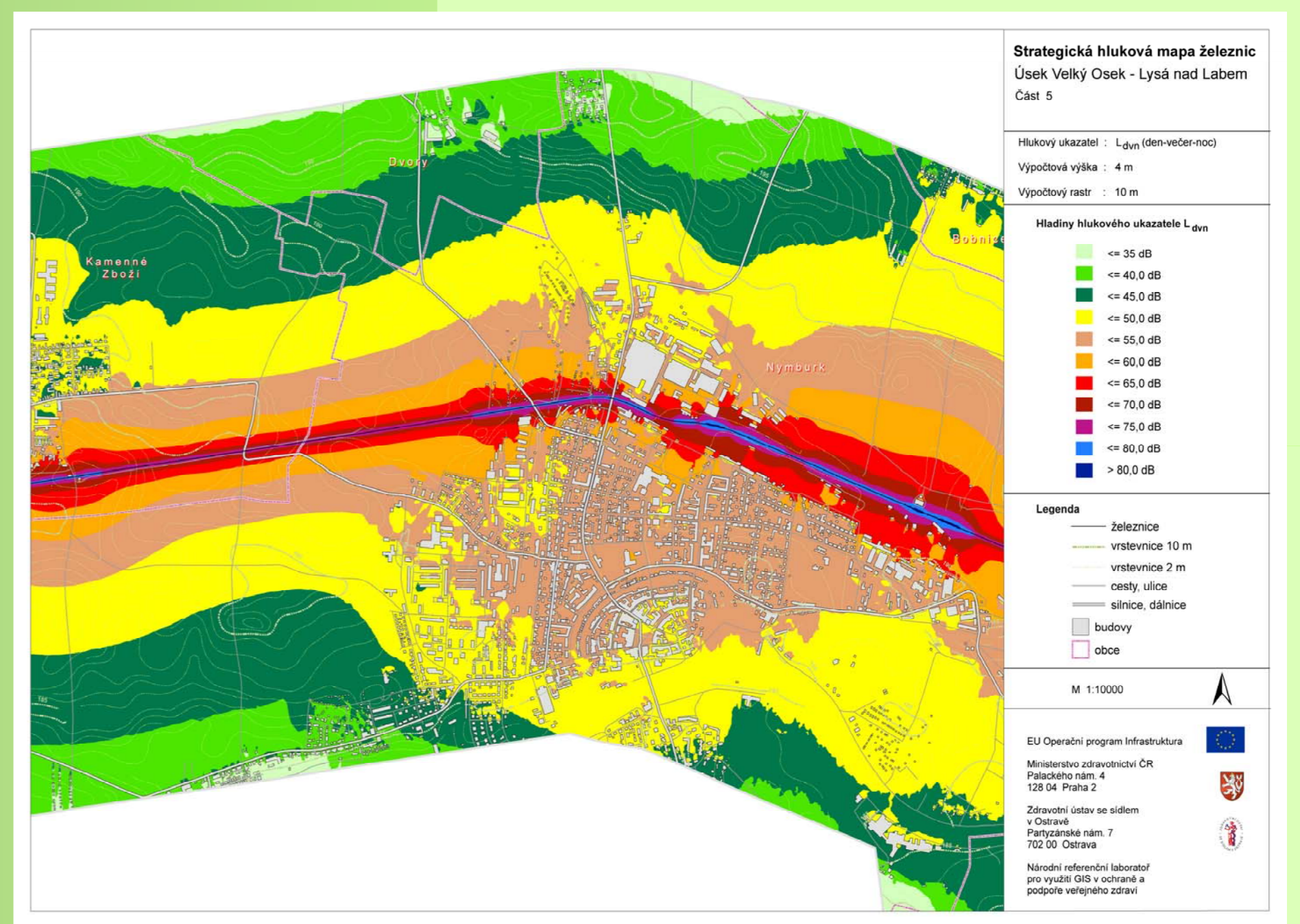
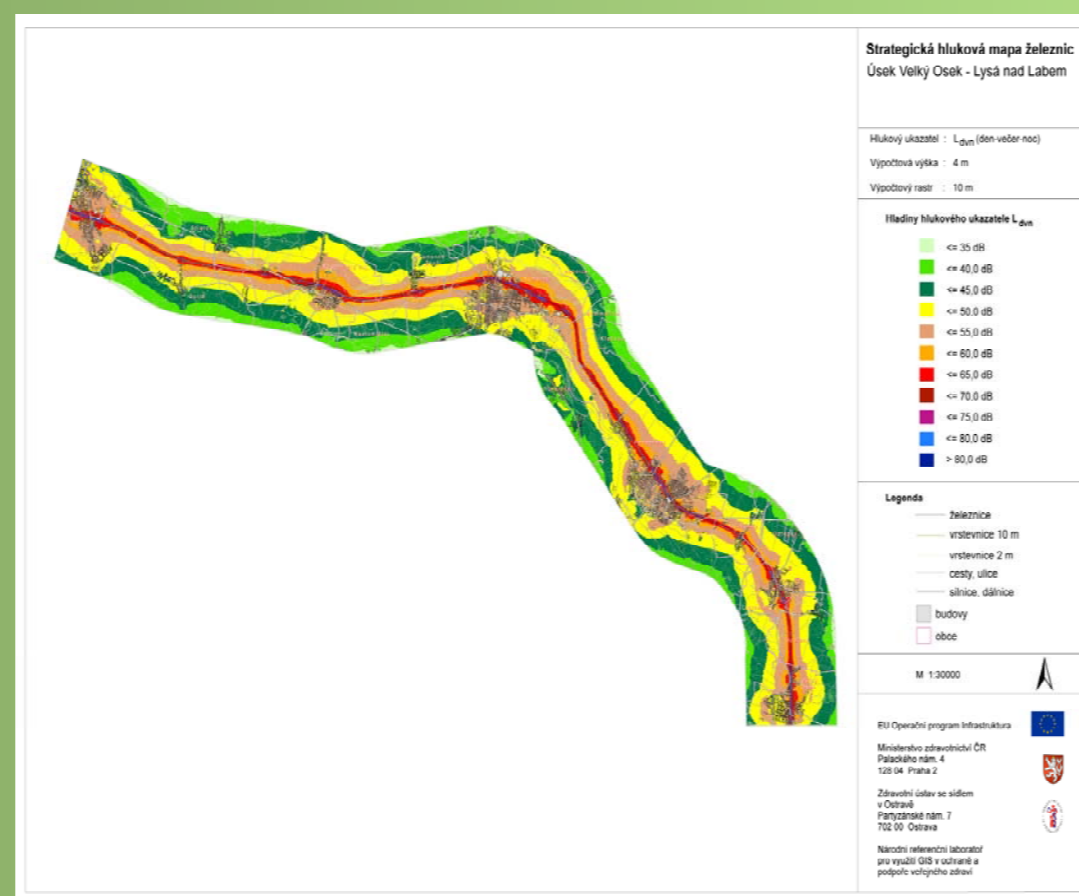
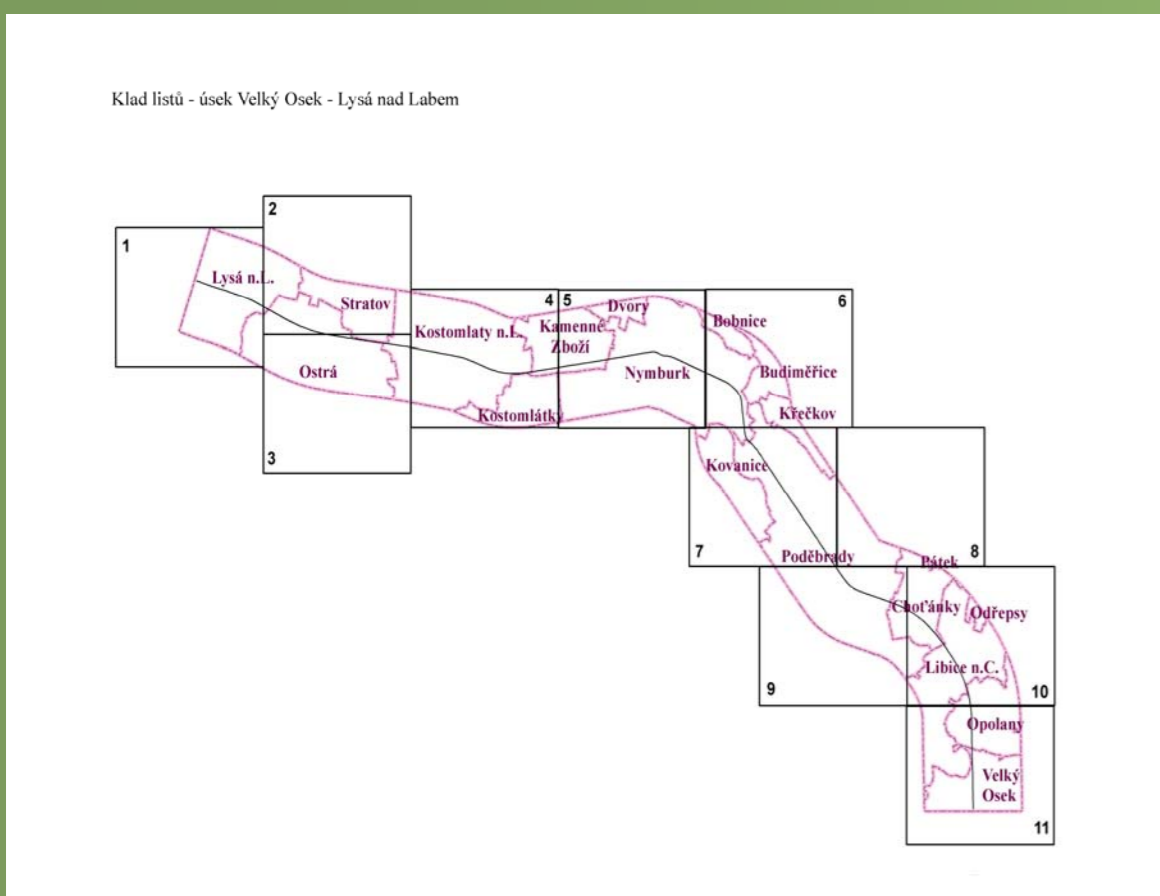
According to criteria of the Directive 2002/49/EC in the Czech Republic the maps of 300 km of tracks were elaborated. Whereas the Czech Republic did not use the national methodology for calculation of railway noise annoyance, the Dutch methodology was used. Geographical data (geographic, topographic and geodetic data) was obtained from the Czech Office for Surveying, Mapping and Cadastre (ZABAGED®). It creates a digital topographic model of the Czech Republic territory in measuring scale 1:10000. Data on categories of railway vehicles, graphic timetable and track construction was obtained from the Railway Research Institute prepared according Dutch computing method standards (“Reken- en Meetvoorschrift Railverkeerslawaaï 2004 Ministerie Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer Versie: 7 december 2004”). Input data were prepared using GIS (desktop ArcView GIS ESRI, GIS Christine) according the recommendation of the EC Good Practice Guide (GPG) for Strategic Noise Mapping and the Production of Associated Data on Noise Exposure (WG-AEN). The calculation of the noise models followed the European Noise Directive (END) using software LimA Advanced Type 7812 C.



Results

Geographical results of noise level modelling

According the GPG area of 1.5 km along both sides of the railway tracks was mapped. The outputs were visualized in scales 1:30000 and 1:10000 by 5 dB noise levels. In total 22 layouts in format A0 and 208 layouts in format A2 were produced as final outputs separately for L_{den} and L_{night} . The total mapped area was divided into 5 segments. For a quick orientation in maps 1:10000 map layouts were prepared and numbered (Fig. 1). An example of outputs in A0 and A2 formats is demonstrated on the 30 km long segment Nr. 5 and its detail for L_{den} (Fig. 2 and Fig. 3).



Results of population annoyance analysis

The results of annoyance analysis are performed as a sum of population (houses, school and hospitals) living/being situated in the noise level below 55 dB L_{den} and 45 dB for L_{night} (lower cut-off), over 70 dB L_{den} and 65 dB for L_{night} (limit value) and the categories between by 5 dB. In the area of interest live about 542 thousands inhabitants. For indicator L_{den} 524 thousands people live below lower cut-off and 300 over limit value. For indicator L_{night} live 485 thousands people below lower cut-off and 200 over limit value (Fig. 4). Out of 38,700 houses 37,000 is placed in lower cut-off and 50 over limit value for for L_{den} and 35,000 houses in lower cut-off and 27 houses over limit value for L_{night} . Within the strategic railways noise mapping also population living in houses with a quiet facade was assessed (not mandatory END requirements). In total 4,605 for L_{den} and 5,051 people for L_{night} live in houses with a quiet facade (Fig. 5). Most of the 495 schools is situated below lower cut-off for L_{den} (484 schools) – Fig. 6. Out of 26 hospitals the majority (24) is situated in lower cut-off for L_{den} and 15 hospitals for L_{night} – Fig. 7. Neither school or hospital is being situated in area with over limit value both for L_{den} and L_{night} .

Segment of the rail	dB	Population										Total people
		<35	35-39.9	40-44.9	45-49.9	50-54.9	55-59.9	60-64.9	65-69.9	70-74.9	>=75	
Praha - Pardubice	L_{den}	97566	28885	40595	30666	4734	1154	510	254	69	2	204435
	L_{night}	140851	38648	20688	2719	897	416	186	29	1	0	204435
Pardubice - C. Trebova	L_{den}	2577	9560	20106	39984	32234	2686	759	319	59	8	108292
	L_{night}	18615	22805	48830	15702	1564	538	202	34	2	0	108292
Olomouc - Prerov	L_{den}	5760	8591	17952	18602	11810	3285	300	108	48	3	66459
	L_{night}	19890	18961	15946	10125	1215	194	112	16	0	0	66459
Prerov - Ostrava	L_{den}	19467	21609	23940	34592	17560	4841	495	206	115	2	122827
	L_{night}	47565	27373	31092	14134	2046	360	212	45	0	0	122827
Velky Osek - Lysa n/L	L_{den}	1110	1945	6942	20045	7826	1285	554	219	57	2	39985
	L_{night}	4291	10486	20598	3040	940	468	130	31	1	0	39985
Total	L_{den}	126480	70890	109535	143889	74164	13251	2618	1106	348	17	541998
	L_{night}	231212	118273	137154	45720	6662	1976	842	155	4	0	541998

Fig. 4 – Population in all mapped areas according annoyance by 5 dB noise level

Segment of the railway	Population	
	L_{den}	L_{night}
Velky Osek - Lysa nad Labem	393	393
Ceska Trebova - Pardubice	963	968
Praha - Pardubice	1973	2477
Prerov - Olomouc	919	856
Prerov - Ostrava	357	357
Total	4605	5051

Fig. 5 – Population living in houses with a quiet facade*

* According to Annex VI (1.5), (1.6) of the END, a facade is 'quiet' if its value of L_{den} is more than 20 dB lower than at the facade having the highest L_{den} level, for the same dwelling unit.

dB	Schools			
	L_{den}	L_{night}	Sum L_{den}	Sum L_{night}
<35	80	172	80	172
35 - 39.9	53	124	133	296
40 - 44.9	115	157	248	453
45 - 49.9	169	33	417	486
50 - 54.9	67	6	484	492
55 - 59.9	8	3	492	495
60 - 64.9	3	0	495	0
65 - 69.9	0	0	0	0
70 - 74.9	0	0	0	0
>=75	0	0	0	0

Fig. 6 – Schools in all mapped areas according noise level

dB	Hospitals			
	L_{den}	L_{night}	Sum L_{den}	Sum L_{night}
<35	4	7	4	7
35 - 39.9	1	2	5	9
40 - 44.9	3	6	8	15
45 - 49.9	2	10	10	25
50 - 54.9	14	1	24	26
55 - 59.9	1	0	25	0
60 - 64.9	1	0	26	0
65 - 69.9	0	0	0	0
70 - 74.9	0	0	0	0
>=75	0	0	0	0

Fig. 7 – Hospitals in all mapped areas according noise level

Conclusions

The noise maps enable to assess environmental noise and provide information on noise exposures to enable developing further actions to tackle environmental noise. The results of annoyance analysis indicated population living and houses being situated in areas along railway tracks where the limit noise level was exceeded. In future the strategic noise maps (and its noise levels by 5 dB) may be used in public health for decision on noise reduction. The next step will be the elaboration of the Actions Plans for reduction of the noise annoyance of population.