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Implementation test for the Common Noise Assessment Method Directive (EU) 996/2015 in the Alpine Region

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ABSTRACT

Commission directive (EU) 996/2015 will become mandatory for noise mapping in Austria this year. During the implementation phase, calculations and sensitivity analyses were carried out both on the emission side and in the propagation path. After implementation as national calculation rules, first experiments were carried out describing the impact of changing from the national methods to the common assessment method in the alpine region of Tyrol. A region with a topography characteristic of alpine situations with a highway located in a valley and annoyance reactions of people living nearby, were analysed. The implementation methods for the calculations are described, noise index results are compared, and the specifics of the two individual prediction methods are discussed.

Keywords: Noise, Environment, Annoyance
I-INCE Classification of Subject Number: 13, 76

1. INTRODUCTION

With the European Commission Directive (EU) 996/2015 a common noise assessment method according to the Environmental Noise Directive 2002/49/EC was introduced. Austria, as member state, has to use this method for strategic noise mapping. In addition, it should be used as basis for general national methods to predict environmental noise. An implementing process was performed, taking into account the emission data from existing national guidelines. The initially measured sound emission levels, defined as sound pressure level at 1 m distance to the centre of the road lane for each type of vehicle and pavement type were translated in the road surface related α and β-values to get over the entire speed range the same A-weighted pass by level (1).

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The implementation of the sound transmission model of directive 996/2015 into a national prediction model was done by an expert working group and published as ÖAL-Guideline no 28 (2). This project should demonstrate potential changes for noise indices when changing from the existing to the new prediction models for the example of a typical alpine topography.

2. MATERIALS AND METHODS

2.1 Emission

The emission of vehicles driving on Austrian roads has been regulated by RVS 04.02.11 from 2006 with the latest amendment of 2009 (3,4). It contains emission sound level $L_{A,eq}$[1] at one meter distance to the axis of the vehicle pass-by. These emission data were used to generate the appropriate α and β values to achieve sound power level per meter length for each vehicle and pavement type. Emission data was available for light, medium (noise reduced and not noise reduced light trucks combined together) and heavy vehicles (noise reduced and not noise reduced heavy trucks combined together). The initial RVS standard included motorbikes in the light truck, now called medium vehicle category. The new RVS standard proposes a default value of 0.5 % motorcycles on highways (5). This number has been used for the new category 4b motorcycles and was subtracted from the category medium vehicles to achieve the same total number of vehicles per hour for both prediction methods input data.

2.2 Propagation

Sound propagation for road noise was regulated also in RVS 04.02.11. However, for details it referred to a version of ÖAL 28 from 1987. This standard includes attenuation due to geometrical spreading, air absorption, ground absorption, diffraction, reflection as well as optionally for vegetation. The ground model was based on the Nordic prediction model (6).

By implementing directive 2015/996 the ÖAL 28 standard was completely renewed and based on the propagation method described in the European Directive (2). The main regulations for Austria include an average temperature of 10°C and a default definition of favourable sound propagation conditions in case of strategic noise mapping.

2.3 Analysed region

The analysed region is representative for an alpine situation. A highway is situated in the valley, while living houses are located in parallel in elevated positions (see figure 1). The highway is partially located in an inclination, while in the southern part it is equipped with a noise barrier to its west. This barrier is up to 5.5 m and its diffraction edge is moved closer to the first lane by a curved construction. In addition, a smaller barrier is located between the two directions, to achieve better attenuation of the lanes going to the north (located on the east, more distant to the analysed objects).

The pavement type on this highway was heterogenous with parts made of split mastic asphalt as well as noise reducing split mastic asphalt.

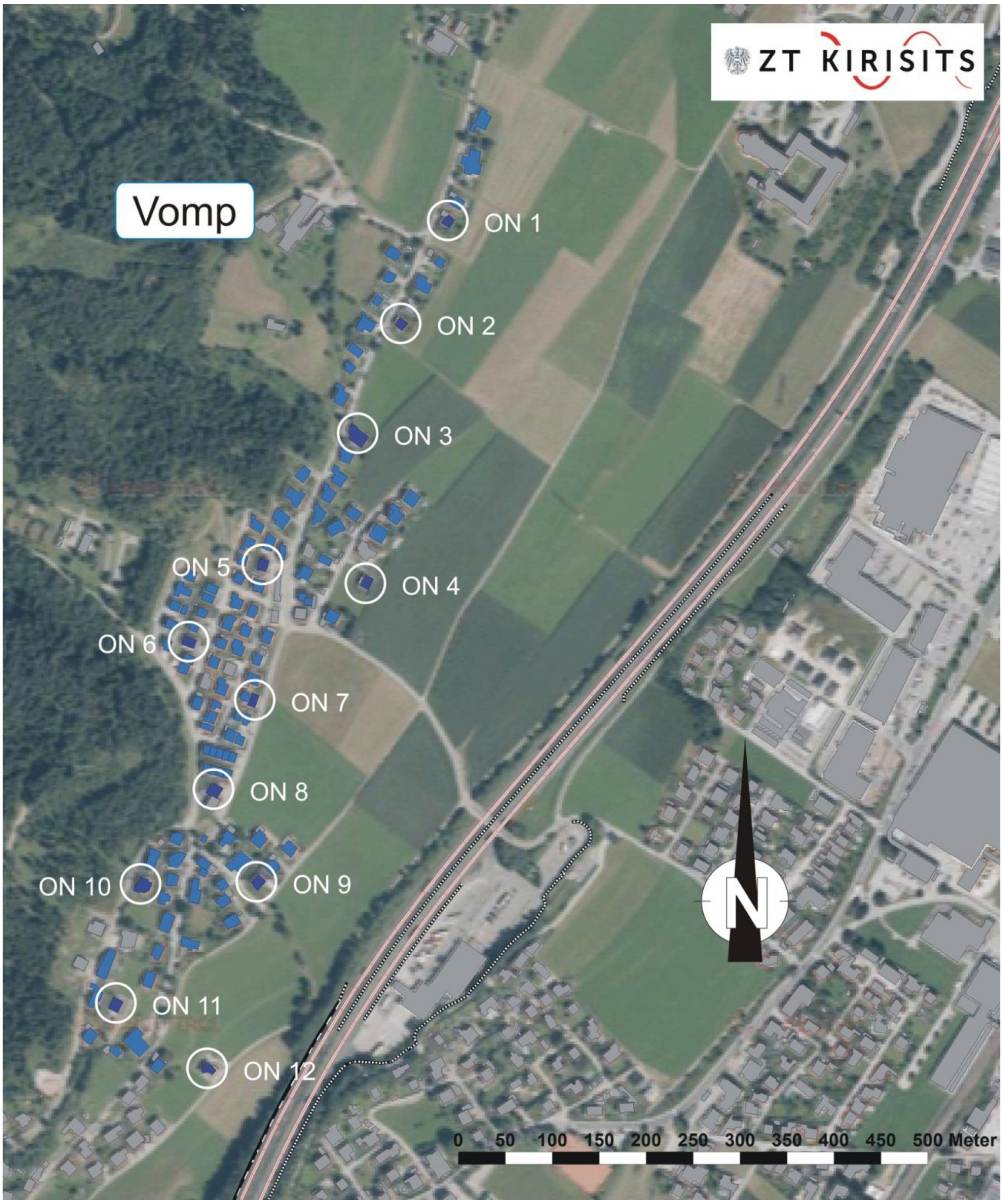

Figure 1: Analysed region with the highway running diagonal from south-west to north-east. Object numbers (ON) 1-12 indicated houses where façade levels have been analysed in detail. Close to ON12 the highway is equipped with a noise barrier.

2.4 Calculations

The calculations have been performed using the sound propagation software IMMI 2018 (Wölfel Engineering GmbH + Co. KH, Höchberg, Germany). The α and β values for the two pavement types have been entered into the software manually as well as vehicle numbers and maximum speed for the different types. The calculation software was used to calculate the noise indices on the façade of the objects. In addition to strategic noise mapping, the receiver points were also positioned at each individual level of houses to include results for ground and different upper levels. Such a detailed analysis would be standard for environment impact analysis and national noise mitigation programs for existing highways in Austria.

The calculations were performed twice, using the existing standard RVS 04.02.11 and the new version for 2019 including the 2015/996 regulations. For both regulations L_{night} and L_{den} values were compared to each other, as well as exposed persons in different noise level bins.

3. RESULTS

3.1 Façade points

Differences between calculated values using the existing standard RVS 04.02.11 and its new version based on directive 2015/996/EU could be evaluated using different approaches. A crude overview was performed at 100 facade points located on 10 representative houses distributed within the analysed region. These were 6 to 12 facade points per house depending on the number of floors. Several houses at this hillside topography had only parts of the ground level above ground, so that not always all 4 directions had facade points.

Of 100 facade points 8 points showed an increase of > 1 dB, 23 points remained within ± 1 dB difference and 69 points had differences lower -1 dB. The maximum positive difference was 2.4 dB, which occurred on a façade with view on the highway. However, this was not the most exposed façade, which was at the 3rd floor of this house, but located at the ground level. Probably different ground attenuation effects at large distance to the source between the two prediction methods might play a major role. The point with the highest negative difference of -7.6 dB was located at another house on the lowest exposed façade with no direct view on any part of the highway. For this point attenuation by diffraction has the highest impact. The general pattern showed major difference at those façade points which had not any direct view on to the highway.

3.2 Most exposed façade

A second analysis was restricted to the most exposed façade of these 10 houses. As indicated in table 1 the houses with object number (ON) 1, 2 and 3 showed a positive difference. All of these objects had free line of sight to parts of the highway and were located at ~ 400 m distance. The houses ON 10, 11 and 12 on the contrary showed most negative differences. All of them were substantially influenced by diffraction from either noise barriers or other houses, mainly from both. ON 12 was located at just 80 m distance behind a noise barrier.

While the actual RVS 04.02.11 showed the most exposed facade always at the highest floor of each house, for the new 2015/996 based standard this point was very often at the ground floor.

Table 1: Comparison of noise index value for the most exposed façade of 12 representative objects

Object number (ON)	L_{night} existing [dB]	L_{night} 2015/996 [dB]	Difference [dB]
1	47,6	49,0	1,3
2	49,1	49,7	0,6
3	49,4	50,5	1,1
4	51,7	51,1	-0,6
5	48,0	46,5	-1,5
6	45,6	45,3	-0,3
7	51,1	49,3	-1,8
8	49,5	49,4	-0,1
9	52,7	51,2	-1,5
10	51,1	49,1	-1,9
11	50,8	48,4	-2,4
12	54,1	52,0	-2,0

3.3 Strategic noise mapping and exposed persons

The following analysis was made for all 116 houses located in the analysed region, however restricted to the most exposed façade at a constant height of 4 m above ground, as used for strategic noise mapping. Only 4 points showed an increase of up to 0.3 dB, whereas 75 houses had more than 1 dB less for L_{night}. Again differences were higher for houses with obvious diffraction attenuation at the 2^{nd} or 3^{rd} row of the houses. In total the deviations were on average -1.4 dB with 0.9 dB one standard deviation.

Another analysis was based on exposed persons living in the analysed region. The summary is shown in table 2. Due to the small decrease in calculated noise levels several persons were shifted from the highest level classes to lower ones.

Table 2: Exposed persons living in the analysed region classified according to the most exposed façade for L_{den} and L_{night}

Level [dB]	L_{den} existing	L_{den} 2015/996	L_{night} existing	L_{night} 2015/996
40-44	0	0	34	70
45-49	0	0	246	281
50-54	60	122	108	36
55-59	243	248	0	0
60-64	84	17	0	0

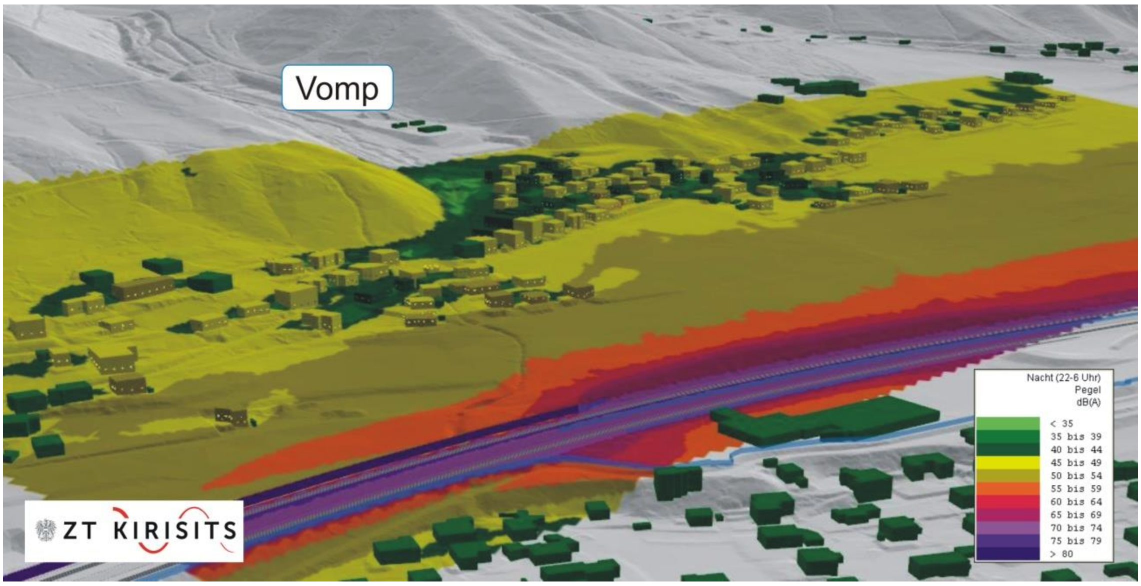

Figure 2: Noise map for the entire analysed region indicating the L_{night}

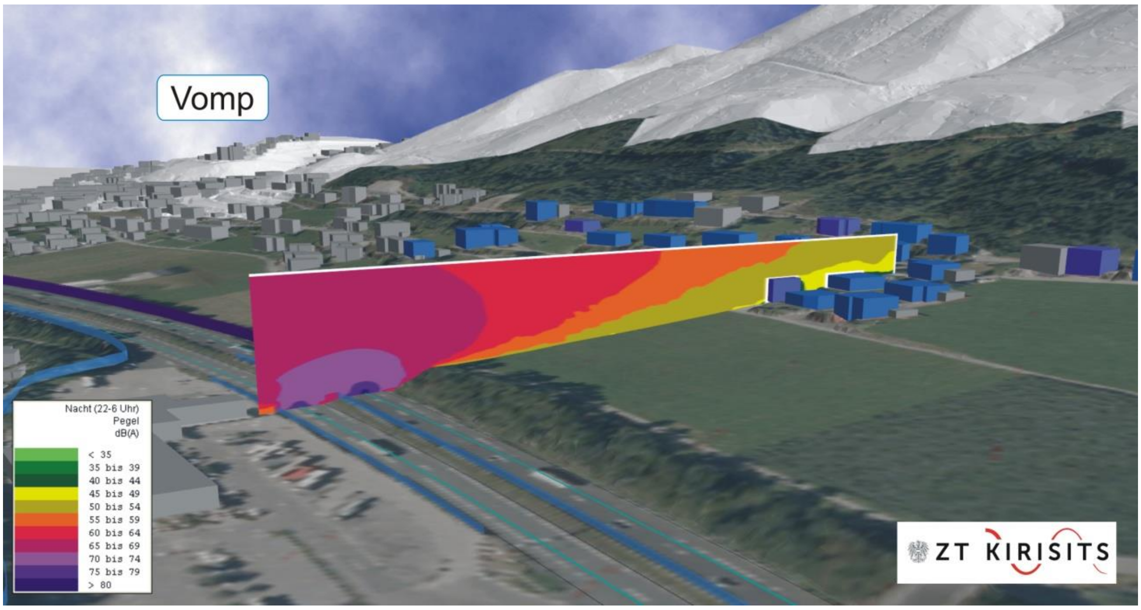

Figure 3: Vertical noise map showing diffraction effects for the highway located below the adjacent ground profile

4. DISCUSSION AND CONCLUSIONS

The results show good agreement of noise indices calculated by the existing national methods and the new methods based on European directive 2015/996. The national specifications for the emission of the pavement type and propagation conditions were selected appropriately to allow for a direct transition. However, the present example shows on average lower noise index values. These effects, which are on average about 1 dB, cause already visible changes in the number of exposed persons per sound level bin. A 1 dB change at 100 m is related to ~20 m shift of the isophone. This can cause an entire row of houses to be shifted from one to next lower sound level bin.

Although the analysed living houses with their receiver points on the façades are located much higher compared to the highway in the valley there are several obstacles present which cause diffraction. These are noise barriers parallel to the road either directly next to the outer lane and within the two driving directions. Another diffraction edge results from the ground profile, where the highway is located at an inclination. The model for diffraction of the initial Austrian was mainly based on path length difference and the formula of Maekawa (7), which are not directly comparable to the new directives method. Second, although the A-weighted sound level at 1 meter distance was converted into the appropriate sound power level the frequency spectrum changed. The initial Austrian RVS 04.02.11 had only one spectrum for all vehicle types, whereas the new model is based on individual spectra.

Especially for situations with several diffracting obstacles (barriers and houses) large deviations between the existing and the new model could be observed. These deviations are most probably related to the implementation of the diffraction in case of multiple diffraction and favourable sound propagation condition. The calculation of the path length difference is not clearly described in directive 2015/996. The current version of the used sound propagation software is based on a strict interpretation of the directive, while current ISO working groups (ISO 17534-4 working draft of ISO/TC 43/SC 1/WG 56) proposed the calculation of the path length difference using curved segments in the vertical plane (8). This underlines the need for appropriate quality assurance, test cases and clear definitions for uniform noise mapping results within Europe.

5. ACKNOWLEDGEMENTS

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