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COMPARATIVE ANALYSIS BETWEEN CNOSSOS-EU AND INTERIM METHODS

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ABSTRACT

According to Order PCI/1319/2018, Spain has replaced the interim calculation methods with a common calculation methodology developed by the European Commission through the project "Common noise assessment methods in Europe (CNOSSOS-EU)".

The establishment of the common European calculation method CNOSSOS-EU in noise mapping projects implies the replacement of the previously used calculation methodologies (interim methods) for this new methodology.

It is therefore necessary to compare these calculation methods, in order to evaluate the traceability of the Strategic Noise Maps of different rounds, assess the real effectiveness of the Noise Action Plans and compare simulations carried out using different methodologies.

This paper presents a comparative analysis of the interim calculation methods and the CNOSSOS-EU calculation method. For this purpose, 45 different scenarios were analysed in pairs using both calculation methods, with more than 12 variables studied, for road, railway and industrial noise.

Pairs of sound power level data (when comparable) and mainly pairs of LAeq levels were compared, resulting in more than 1,800 pairs of data analysed.

Keywords: *environmental noise, noise mapping, CNOSSOS-EU, interim methods, comparative study.*

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1. INTRODUCTION

According to Directive 2002/49/EC of the European Parliament and of the Council of 25 June 2002, the use of common assessment methods was recommended across all Member States of the European Union. This Directive was transposed into national legislation through Royal Decree 1513/2005 of 16 December, which implements Law 37/2003 of 17 November on Noise, specifically regarding acoustic zoning, quality objectives, and noise emissions.

The common assessment methods outlined in the aforementioned legislation—known as interim calculation methods—include the following, depending on the noise source:

- The French national calculation method, NMPB – Routes – 96 (SETRA-CERTU-LCPC-CSTB), designated as the reference method for road traffic noise.
- The Dutch national calculation method SRM II (Reken- en Meetvoorschrift Railverkeerslawaai'96), designated as the reference method for railway traffic noise.
- The ISO 9613-2 method, designated as the reference method for industrial noise.
- The ECAC.CEAC Doc. 29 method, designated as the reference method for aircraft noise.

In 2008, the European Commission initiated the development of a unified methodological framework for noise assessment through the project Common Noise Assessment Methods in Europe (CNOSSOS-EU), led by the Joint Research Centre (JRC), the scientific service of the European Commission.

As a result of this initiative, Commission Directive (EU) 2015/996 was adopted, establishing common noise assessment methods pursuant to Directive 2002/49/EC.

This Directive replaced Annex II of Directive 2002/49/EC with the updated methodology and was required to be transposed into the legal frameworks of Member States by no later than 31 December 2018.

Spain transposed Directive (EU) 2015/996 through Order PCI/1319/2018 of 7 December, amending Annex II of Royal Decree 1513/2005 of 16 December, which implements Law 37/2003 of 17 November on Noise, in relation to the assessment of environmental noise.

Under this regulation, the previous calculation methods for noise indices were replaced by a unified calculation methodology developed by the European Commission through the CNOSSOS-EU project. The use of this methodology has been mandatory for all Member States since 31 December 2018.

Subsequently, the European Commission conducted a revision of this common calculation methodology, addressing several aspects including new formulations for diffraction in sound propagation and approaches for evaluating population exposure to noise on building façades. These updates were incorporated into Annex II of the Environmental Noise Directive via Commission Delegated Directive (EU) 2021/1226 of 21 December 2020, which amended Directive 2002/49/EC to align with scientific and technical progress. This Directive was transposed into national law through Order PCM/80/2022 of 7 February, which amends Annex II of Royal Decree 1513/2005 of 16 December, concerning the assessment and management of environmental noise.

The establishment of the European CNOSSOS-EU common calculation method for noise mapping tasks marks the replacement of previously used interim methods for this new standardized methodology. Consequently, a comparative analysis between the interim calculation methods and the CNOSSOS-EU method is presented in this study through a comprehensive examination of 45 noise scenarios.

By identifying systematic variations in noise predictions, we seek to provide insights into how the methodological shift affects environmental noise assessments and regulatory compliance.

2. METHODOLOGY

To conduct a robust comparative analysis, a set of 45 noise scenarios was designed, divided into road traffic (17 scenarios), railway (12 scenarios), and industrial noise sources (16 scenarios). Each scenario was modeled using both CNOSSOS-EU and interim models, keeping environmental, topographical, and source parameters consistent with receptor grids placed at varying distances and heights to capture sound propagation effects under different environmental conditions.

2.1 Road Traffic Noise

Several hypotheses have been proposed to assess how sound power and sound pressure levels vary based on the Average Daily Intensity, the percentage of heavy vehicles, and speed.

Different values of Average Daily Intensity were considered: high (which constitute major roadways), medium, and low (which do not constitute major roadways). For each scenario in which the traffic value was set, other variables (percentage of heavy vehicles, speeds, etc.) were varied to assess the variation in both methods.

The percentage distribution of heavy vehicles, as well as the speed, has been varied for probable scenarios and to determine actual ranges of comparable cases.

Free field, urban settings and noise barriers have been included to assess the effects of diffraction and obstacles.

The study considers different road types, traffic compositions, and surface materials. Key parameters analyzed include:

- Traffic volume (light and heavy vehicles).
- Vehicle speeds (urban vs. highway conditions).
- Pavement type (reflective vs. absorbent materials).

2.2 Railway Noise

As in the case of road noise, for railway noise, a series of variables have been established and others varied for each case study to assess their effect on both methods.

The most critical aspect was determining similar rolling stock, as both methods differ significantly in the definition of noise sources and the track parameters considered in each.

Different types of trains have been considered, analyzing not only the sound pressure levels of the receivers, but also evaluating the vertical meshes to compare the different radiation of the source and the propagation between methods.

Noise emissions from railway operations depend on train characteristics and track conditions. The study accounts for:

- Train types (high-speed, freight, regional).
- Track configurations (ballast, slab track).
- Speed variations and train frequency.
- Barrier effects and terrain interactions.

2.3 Industrial Noise

In order to compare methods for industrial noise sources, point, linear, and surface sources were analyzed. Setting the same sound power level (Lw) for each method enabled comparability between methods.

Particular attention was paid to analyzing vertical and horizontal diffraction, for which urban environments with more complex obstacles were modeled to analyze differences in propagation.

Key factors evaluated are:

- Source height and spatial distribution of noise emissions.
- Influence of obstacles (buildings).
- Ground absorption and terrain effects.

2.4 Ground absorption

Finally, different noise sources were analyzed comparing ground absorption (absorbent ground and reflective ground) as a variable.

Results were statistically analyzed to quantify differences in power level estimations and equivalent continuous sound levels (LAeq), as shown in **Table 1.**

Table 1. Summary table of all the cases considered and the pairs of data analyzed.

		Power Data Pairs	Pressure Data Pairs	# Cases
Road Traffic	Free field	18	288	6
	Agglomerations	6	96	4
	Noise barriers	0	96	2
Railway Traffic	Free field	21	336	7
	Agglomerations	12	96	4
	Noise barriers	0	96	2
Industrial Noise	Free field	0	192	4
	Agglomerations	0	144	6
	Noise barriers	0	192	4
Ground Absorption	Various	0	288	6
		57	**1824**	**45**

3. RESULTS AND DISCUSSION

3.1 Road Traffic Noise

3.1.1 Percentage of Heavy Vehicles:

Variation of the percentage of heavy vehicles has a more pronounced effect on the sound power level in the interim method (NMPB – Routes – 96) compared to CNOSSOS-EU.

3.1.2 Vehicle Speed:

Speed variations impact the sound power level more significantly in the CNOSSOS-EU method.

3.1.3 Receiver Height and Distance:

The greatest differences in sound pressure levels are observed at lower heights and distances beyond 25 m from the source, with the interim method producing levels typically over 5 dB(A) higher.

3.1.4 Obstacles (Buildings and Barriers):

Obstacles reduce discrepancies at low heights and shielded positions, though the interim method still results in higher levels.

Summary: Overall, the interim method produces higher road traffic noise levels under the studied variables and conditions.

3.2 Railway Traffic Noise

3.2.1 High-Speed Trains:

The interim method (SRM II) delivers higher sound pressure levels than CNOSSOS-EU, with differences ranging from 4 to over 6 dB(A).

3.2.2 Other Train Types:

For medium-distance, suburban, and freight trains, CNOSSOS-EU estimates levels between 0.1 and 3.5 dB(A) higher than the interim method.

3.2.3 Vertical Propagation:

CNOSSOS-EU shows notable differences in vertical propagation due to its inclusion of directivity effects.

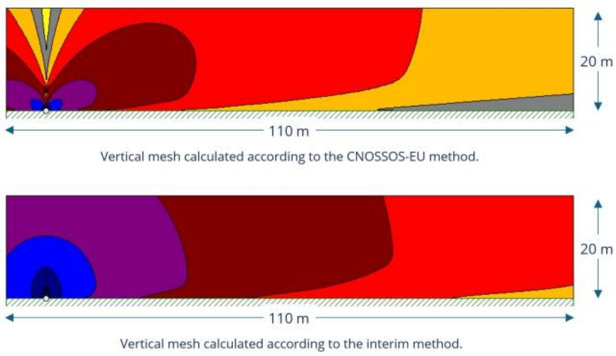


Figure 1. Comparison of vertical propagation for different methods for railway traffic noise.

3.2.4 Obstacles:

The presence of buildings or barriers reduces differences at shielded receivers, although variations persist.

Summary: Generally, the interim method produces higher values. However, direct comparisons are complex due to differing input data and modeling formulations.

3.3 Industrial Noise

3.3.1 Point, Line, and Vertical Surface Sources:

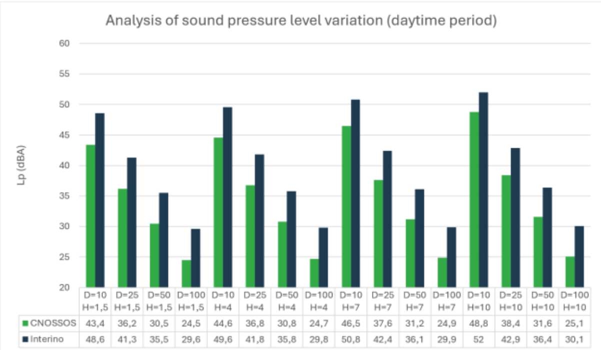
Sound pressure levels estimated using the interim method (ISO 9613-2) are consistently about 1 dB(A) higher across different distances and heights.

3.3.2 Surface Sources:

The interim method again produces higher levels, particularly at low heights and long distances, with differences exceeding 3.5 dB(A).

3.3.3 Noise Barriers:

In shielded scenarios, the interim method estimates sound pressure levels 4–5 dB(A) higher than CNOSSOS-EU.



	D=10 H=1,5	D=25 H=1,5	D=50 H=1,5	D=100 H=1,5	D=10 H=4	D=25 H=4	D=50 H=4	D=100 H=4	D=10 H=7	D=25 H=7	D=50 H=7	D=100 H=7	D=10 H=10	D=25 H=10	D=50 H=10	D=100 H=10
CNOSSOS	43,4	36,2	30,5	24,5	44,6	36,8	30,8	24,7	46,5	37,6	31,2	24,9	48,8	38,4	31,6	25,1
Interino	48,6	41,3	35,5	29,6	49,6	41,8	35,8	29,8	50,8	42,4	36,1	29,9	52	42,9	36,4	30,1

Figure 2. Comparative analysis of sound pressure levels for a point source of industrial noise with an acoustic barrier (*CNOSSOS-EU in green and interim in blue*).

3.3.4 Obstacles and Diffraction:

Without Lateral Diffraction: CNOSSOS-EU predicts higher levels (~6 dB(A)) at shielded positions.

With Lateral Diffraction: The interim method shows higher levels (~5 dB(A)).

With Combined Vertical and Horizontal Diffraction: The interim method estimates levels ~7.5 dB(A) higher.

3.3.5 Vertical Propagation Differences:

CNOSSOS-EU introduces a vertical propagation component for point sources, absent in the interim method.

Summary: Variability in results for industrial noise prevents broad generalization. Nevertheless, significant discrepancies exist, especially in complex propagation scenarios involving multiple obstacles.

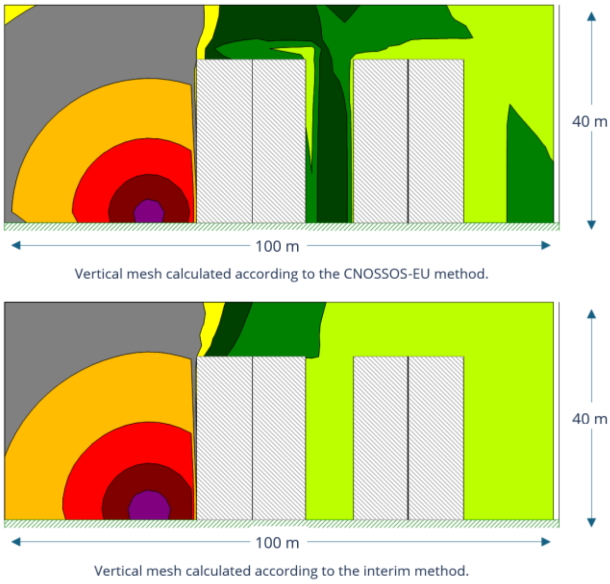


Figure 3. Comparison of the diffraction effect for both methods with industrial noise sources**.**

3.4 Ground Absorption

CNOSSOS-EU is more sensitive to ground absorption variations, leading to greater differences in sound pressure levels. With reflective ground, propagation differences between methods are reduced.

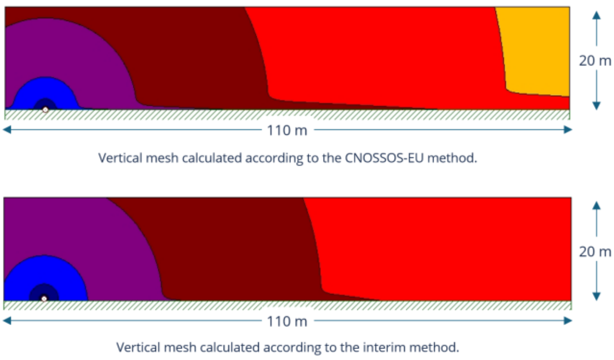


Figure 4. Comparison of methods for road traffic noise in reflective terrain.

4. CONCLUSIONS

This study highlights systematic differences between the CNOSSOS-EU and Interim methods for environmental noise assessment. The main findings are:

- Comparison between methods is not immediate and can be complex since, in addition to differences in the input parameters, the output variables of the parametric equations can also yield different indicators.
- Road traffic noise and industrial noise are more easily comparable, as the power level indices are comparable.
- The comparison is especially sensitive when it is made between railway noise indicators, as there are significant methodological differences between the two methods.
- The Interim method generally predicts higher LAeq values, particularly in road traffic and railway noise scenarios. These differences can be up to 5 dBA.
- The sound pressure level using the interim method may, in general terms, be higher than that used by CNOSSOS for railway noise from high-speed trains. However, for medium-distance trains and freight trains, the opposite may be true.
- Vertical propagation for rail traffic noise is very different between methods.
- Regarding industrial noise, there is large variability when comparing methods. Significant differences are found when comparing scenarios with many obstacles and vertical and horizontal diffraction.
- The transition to CNOSSOS-EU may affect regulatory compliance and noise action plans, requiring careful evaluation of historical and future noise maps.
- The change in ground absorption has a greater impact on the sound pressure levels predicted using the CNOSSOS-EU method. With reflective ground, there is less difference in propagation between the two methods.
- Further research is needed to assess the impact of these differences on long-term noise exposure assessments and public health policies.

This analysis was focused on direct comparisons of comparable pressure levels and power levels across methods; it did not analyze population allocation methodologies or noise-exposed population calculations, which could be the subject of future research.

5. ACKNOWLEDGMENTS

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