Study of decision to be taken in Noise Maps of urban traffic applying CNOSSOS

Itziar Aspuru
Tecnalia Research & Innovation, Spain.

Igone Garcia, Pilar Fernandez, Alvaro Santander, Manuel Vazquez
Tecnalia Research & Innovation, Spain.

Summary

Application of CNOSSOS method to calculate noise generated by traffic implies some changes, both in input data and in the use of new elements to simulate situations. There are particularities in urban situation that implies a specific approach in the modelling. On one hand, the type of vehicles in the city is different and also the speed is lower. Those particularities imply changes in the sound power of noise sources and, also the acoustic effects of some of the correction factors vary.

The communication presents a study of a real urban situation that allows the analysis of the effect of the presence of intersections. The study compares real data taken in situ and results from acoustic modeling. It is discussed which would be, in this case study, the best way of using the method to represent the reality. In general, it is observed that CNOSSOS method represents better than the Interim method the traffic noise in the case study. On the other hand, it seems that CNOSSOS could represent worse the pedestrian street scenario. Nevertheless, no conclusion can be drawn from this study. As a remarkable result it can be said that the calculations in this case study with different modelling alternatives with CNOSSOS can give noise levels that vary in 4.5 dB. This study should be complemented with other works that represent other situations to look for points in common and to establish possible general criteria for modelling traffic noise in the cities.

PACS no.43.50.Lj, 43.50.Rq

1. Introduction

Noise calculation methods are a key tool in the evaluation of environmental noise, complementary to the performance of measurements.

After years of research, the CNOSSOS - EU method has been developed and the Directive 2015/996 establishes that it should be used as to do Noise Maps of January 2019.

The change of method, with respect to the interim methods, requires new criteria to:

- Define the input data to define scenarios.
- Apply new factors included in the method.
- Quantify the effectiveness of potential improvement of actions to adopt.

Previous partial studies have detected that the new method can imply important changes in noise levels with respect to the interim methods. Therefore, a reflection is required on how the differences between the diagnoses (Noise Maps) and the prioritization of actions (Action Plans) are explained to the public.

Changing the method, as it modifies noise levels, can affect environmental noise management indicators.

Since this method has a definitive character, it is time to invest efforts to analyze in detail the implications of the use of the common method of noise assessment - CNOSSOS - EU for acoustic studies of urban noise and optimize its application.

Studies could be undertaken with the following specific objectives:

- Define criteria to apply specific parameters of CNOSSOS.
- Compare results with CNOSSOS and with the interim method to know, prior to Noise Mapping, possible modification of results with respect to previous Maps (noise levels and people exposure).
- Verify results of CNOSSOS calculations with measurement campaigns.

The final result of these studies would be the drafting of Instructions for the use of the CNOSSOS - EU method, including establishing the quality of the necessary input data, according to its availability and its relevance in the new method, and defining guidelines for the communication to the citizens of the results obtained.
This paper presents a study of a limited scope, so it cannot answer on its own to the objectives raised above. It intends to be a partial contribution: the analysis of one of the elements that incorporates the method for the calculation of urban traffic noise: the correction for acceleration / deceleration of vehicles derived from the presence of traffic lights. A particular case of a street with traffic light in the city of San Sebastian / Donosti, in Spain, has been studied in detail. The selected intersection has been modeled, calculations performed with different conditions in the interim calculation method and in CNOSSOS - EU. In this way, the relevance in this case of the decisions regarding how to model the urban traffic of the city is quantified.
In addition, analyzed the results of a measurement campaign, it is discussed which would be, in this case study, the best way of using the method to represent the reality of the generated noise.

2. Effect of the acceleration and deceleration of vehicles in CNOSSOS

CNOSSOS-EU method defines a correction to be applied at crossings. The crossing modifies the sound power of the streets to which it is associated. The correction to simulate the effect of acceleration and deceleration near crossings depends on the category of vehicles. In general, the effect of these coefficients is the reduction of the contribution of rolling noise and the increase of propulsion noise. In addition, the effect of crossings, according to the method, depends on the distance to the crossings (modifying the acoustic emission of the street in a section from the crossing to 100 m away). The algorithm gives the same values before and after crossings, so the effect does not differentiate if the vehicles are approaching or moving away from the crossing.
When introducing a crossing element, the sound power of the streets associated with it increases. This increase will depend on the percentage of heavy vehicles of each street and on the assigned flow speed.
The method defines two types of crossings: with traffic lights or roundabout. The crossing with traffic light represents how vehicles stop and start according to the traffic light time cycle.
On the other hand, the roundabout represents a more fluid traffic, where the crossing is based on the "give way" rule. This could lead to doubt if it would be of interest to apply the same effect in crossings of the city that, without being a roundabout, are regulated by the same rule.
The acoustic effect of both cases, traffic lights and roundabouts, is similar, although it is higher at traffic lights.

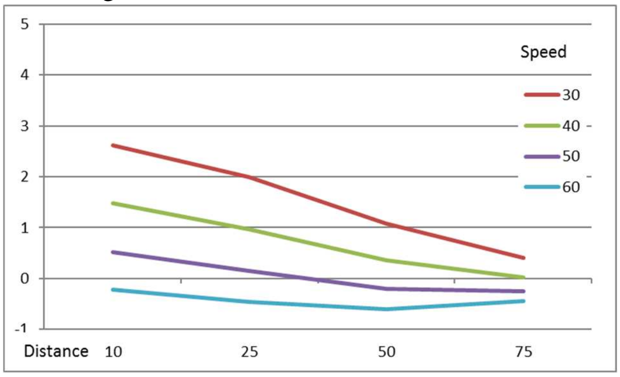

Figure 1. Effect of a roundabout in the acoustic emission of a street with 5% of medium heavy vehicles at different speeds

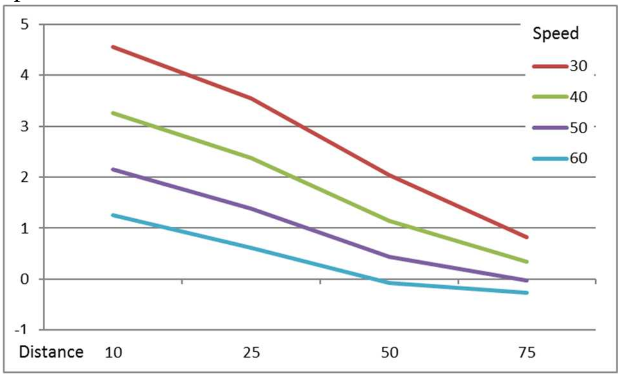

Figure 2. Effect of a traffic light in the acoustic emission of a street with 5% of medium heavy vehicles at different speeds

As seen in the figures increasing the speed, the effect of the crossing is reduced.
The use of this element in a generalized way in the modeling of urban traffic of a city could affect to a large extent the results of its Strategic Noise Map. Decisions to be made in the modeling are the following:
- Use or not the crossing element.
- Assign the average speed to the streets.

Usually in Noise Maps, the speed of urban traffic with interrupted character is defined in a general way, since it is not possible to represent the reality of the behavior of the of vehicles` pass by.

A complete study could propose general criteria to apply throughout the city and / or include specific criteria to better represent different situations: for example, depending on street traffic, or a specific criterion for the day and afternoon situation, compared to that of the night.

3. Case study

The objective is to carry out a initial study of this effect. That is, a detailed analysis of a case study that offers data to define criteria on how to represent noise originated by accelerations and decelerations in the city. The case study sought for this work is a real urban traffic situation in which the most relevant variables can be controlled, although this may imply that the crossing studied is relatively simple.
As a first case, it has been decided to study a traffic light crossing, since it can represent a greater number of crossings in the city, compared to roundabouts. In addition, urban roundabouts usually connect streets with heavy traffic and therefore have several lanes, increasing the complexity of the analysis.

3.1 Description of the crossing selected

The crossing was selected in the city of San Sebastian-Donostia, located in the Basque Country (Spain). City of 186,400 inhabitants and compact urbanization. The city made the Strategic Noise Map in the 2nd phase and is in the phase of approval of the 3rd phase.
An important criterion in the selection of the case of study has been that the streets that form the crossing are of a single lane and that none of the streets has slope. With these criteria the selected crossing is that of Arrasate and Bergara streets, located at the city center.

Figure 3. Location in the city of the streets analyzed

This crossing is regulated by two traffic lights, with a cycle of 90 seconds, distributed as follows: for 40 seconds the Bergara traffic light is green and that of Arrasate red; the next 30 sec, Arrasate is green and Bergara red; and the last 20 seconds, both lights are red.

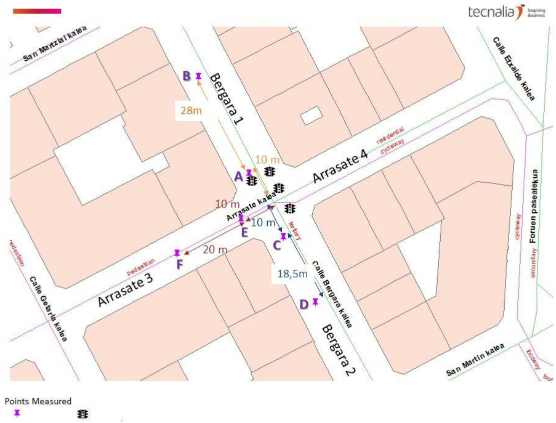

Figure 4. Identification of the 4 streets analysed and the 6 measurement points.

The figure identifies the 4 street noise sources that make up the crossing and its directions of traffic, the location of the traffic lights and the measurement points.

Figure 5. Image of the crossing.

3.2 Measurement campaign

Noise measurements were made at two times of the day, in 6 points around the crossing: 4 measurement points characterize Bergara Street, which has more traffic. Two points located before the traffic light (A and B), and two after (C and D). In addition, it has been considered interesting to measure in one of the sections of Arrasate Street that has a semi-pedestrian character (E and F). Therefore the campaign covers 3 axes of the crossing. In each of them, it has been measured near the crossing (10 m from its centre) and at more distant points, which could represent the effect in the middle of the street, or the more general effect in the city.
All measurement points have direct propagation of traffic noise and are located at 5 m from the noise source and 1.8 m in height. During the measurements, the traffic circulating through each of the 4 sections of the crossing was counted and

recorded. Each measure lasted around 20 minutes (12-14 traffic light cycles), during which an average of 89 vehicles circulated along Bergara street after the traffic light (between 98 and 79, depending on the measurement period).
The following tables show the traffic counted during each measurement period, normalized to represent the corresponding average hourly traffic.

Table I: Traffic counted during each measurements period at morning.

	8:24			8:54			9:20		
Meas time	**19:22 min**			**19:36 min**			**19;43**		
Traffic	IMH	% heavy	% moto	IMH	% heavy	% moto	IMH	% heavy	% moto
Bergara 1	**255**	**6%**	**4%**	265	3%	9%	246	1%	14%
Bergara 2	274	7%	6%	**302**	**4%**	**8%**	270	2%	13%
Arrasate 3	52	18%	6%	83	4%	4%	94	6%	6%
Arrasate 4	58	11%	0	46	7%	7%	**73**	**4%**	**4%**
Points	Bergara A (255 / 6%)			Bergara C (302 / 4%)			Arrasate E (73 / 4%)		
Measured	Bergara B (255 / 6%)			Bergara D (302 / 4%)			Arrasate F (73 / 4%)		

Table II: Traffic counted during each measurements period at midday.

	13:12			13:37			14;03		
Meas time	**18:36**			**19:59**			**19:58**		
Traffic	IMH	% heavy	% moto	IMH	% heavy	% moto	IMH	% heavy	% moto
Bergara 1	**250**	**6%**	**13%**	204	4%	16%	249	1%	18%
Bergara 2	279	6%	12%	**255**	**4%**	**13%**	273	2%	16%
Arrasate 3	39	0%	0%	39	0%	8%	39	8%	0%
Arrasate 4	6	0%	0%	9	0%	0%	**9**	**0%**	**0%**
Points	Bergara A (250 / 6%)			Bergara C (255 / 4%)			Arrasate E (9 / 0%)		
Measured	Bergara B (250 / 6%)			Bergara D (255 / 4%)			Arrasate F (9 / 0%)		

As can be seen in Tables I and II, most vehicles circulate through Bergara street, with greater intensity in section 2, after the crossing. The traffic variation in this section is 11%, which can mean differences of 0.5 dB, while in in Bergara 1 (before the crossing), is higher (23%, theoretical difference of 1 dB). On this street a significant number of motorcycles circulated. Lastly, it is relevant the difference in heavy vehicles among the measurement periods.
On the other hand, the section of Arrasate 2 is apparently pedestrian, although during the morning there were some vehicles circulating.
In each period the measurements in the points near the crossing and in the middle of the street of each section were made simultaneously, so both measurement have the same traffic scenario.
Measurements were made with an integration time of 1 second. Results were processed to eliminate sound events outside the traffic on the streets studied. Nevertheless, in the measurement points, or periods, with lower traffic noise, contribution of the background noise of the whole city cannot be ruled out.
On the other hand, the cycles of the near traffic light have been identified in measurement points Bergara A and Bergara B. The analysis made of the distribution of noise levels during the cycles shows, for example, that in the morning near the crossing, of the 67 dBA of total LAeq measured, the average of the cycles in green light is 69 dBA, while the average of the time in red light it is 65 dBA. As additional information, it has also been distinguished in each measurement period the number of vehicles that circulate fluidly passing the traffic light in green, and those stopping and starting at the traffic light.

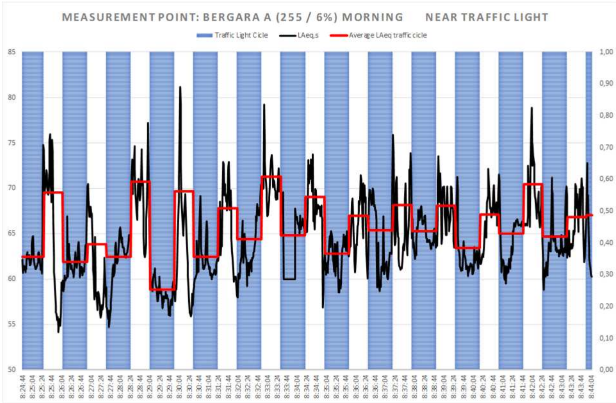

Figure 6. Noise levels measured and analysis of the traffic light cycle (blue corresponds to light in red).

Table III: Noise levels measured at each position.

Points Measured	**Measurment level (dBA)**
Bergara A MO (255 / 6%)	67
Bergara B MO (255 / 6%)	66,3
Bergara C MO (302 / 4%)	67,6
Bergara D MO (302 / 4%)	68,1
Arrasate E MO (73 / 4%)	64,7
Arrasate F MO (73 / 4%)	63,9
Bergara A MI (250 / 6%)	68,2
Bergara B MI (250 / 6%)	66,3
Bergara C MI (255 / 4%)	65
Bergara D MI (255 / 4%)	66,1
Arrasate E MI (9 / 0%)	62,5
Arrasate F MI (9 / 0%)	61,1

On the section before the traffic light, measured noise levels are higher near the crossing than in the middle of the street (Bergara A & B). This does not happen in the section after the crossing (Bergara C & D), but it could be due to potential contribution of traffic noise at point D, coming from other streets in the point furthest from the crossing.

3.3 Acoustic Modeling

The acoustic model of the case study was developed, considering 4 noise sources representing the crossing of the two streets analyzed. It was not possible to use the modeling of the Strategic Noise Maps, nor the traffic data of the city network, so noise sources outside the case study were not included in the modeling.
The gound is considred acoustically reflective, as well as the buildings facades.

Noise levels are calculated in 6 receiving points representing the 6 measurements points. The calculation software used is IMMI, version 2017.
6 modeling scenarios were generated with the same cartographic and acoustic base, varying the traffic conditions to represent the 6 measurement periods, those shown in Tables I and II.
Calculations with each method will be done with different values of traffic speed, between 30 and 50 km/h, since when modeling, decisions should be made on this parameter.

Interim Method for roads:
The noise levels were calculated in the 6 defined scenarios, with 3 flow speeds: 30, 40 and 50 km/h. Since in this method there is no category for two-wheeler vehicles, these vehicles were assigned to light vehicles.
The traffic was modeled as steady fluid, since it is the most common use of this method to calculate urban traffic. It is known that this method overestimates the sound power of traffic at low speeds and with non-fluid traffic, since it supposes a contribution of propulsion noise higher than those of actual vehicles.

Table IV: Results of calculation with interim method at each position

Points Measured	Measurment level	Calculation condictions		
		FR 50Km/h	FR 40 Km/h	FR 30 Km/h
Bergara A MO (255 / 6%)	67	70,8	70,8	71,7
Bergara B MO (255 / 6%)	66,3	70,6	70,6	71,4
Bergara C MO (302 / 4%)	67,6	70,6	70,3	71,0
Bergara D MO (302 / 4%)	68,1	70,6	70,3	71,0
Arrasate E MO (73 / 4%)	64,7	66,1	65,7	66,3
Arrasate F MO (73 / 4%)	63,9	65,1	64,8	65,5
Bergara A MI (250 / 6%)	68,2	70,6	70,7	71,6
Bergara B MI (250 / 6%)	66,3	70,7	70,8	71,7
Bergara C MI (255 / 4%)	65	69,5	69,2	69,8
Bergara D MI (255 / 4%)	66,1	69,6	69,3	70,0
Arrasate E MI (9 / 0%)	62,5	62,7	61,9	62,4
Arrasate F MI (9 / 0%)	61,1	59,4	58,7	59,1

The obtained results indicate that there is no difference between noise levels of traffic qith average speeds of 50 and 40 Km/h, while reducing the speed to 30 Km/h increase the levels.
With regard to the comparison with measurements results, at the Bergara Street receiving points, both near crossing (A and C) and at those located in the middle of the street (B and D), the interim method gives some values between 3 and 5 dB higher than measured.
At the receiving points on Arrasate Street, as there is little traffic on the section itself, the main contribution is the effect of the noise originated by the traffic in Bergara, propagated to those points. At these points the difference is around 1 dB.

CNOSSOS-EU Method:
With this method, noise levels were also calculated in the 6 defined scenarios.
In this case, in addition to performing the calculations varying the speed of circulation (30, 40 and 50 km / h), the calculations were carried out applying or not the crossing element. A single traffic light crossing element was placed at the center of the intersection of the four noise sources and linked to all of them.
Regarding vehicle categories, all heavy vehicles were considered category 2, medium heavy, since passing vehicles adjusted well to the description of this category.
In order to decide how two-wheeler vehicles should be considered, a test was made: calculate noise levels in the scenario with highest presence of motorcycles (13%) and compare results when assigning all those vehicles to one or the other subcategories defined in CNOSSOS (4a and 4b), with respect to considering them as light vehicles. Given that noise levels calculated with the three different options differ less than 1 dB at any of the points, we choose to consider two-wheelers as light vehicles.
As seen in Table V, when the crossing element is considered, the average traffic speed estimated at the noise sources is not very relevant (1 dB differences). In the points of Bergara street the calculated levels are higher than the measured ones, with an average difference of 1.5 dB.

Table V: Results of calculation at each position with CNOSSOS applying the effect of crossings

Points Measured	Measurment level	Calculation condictions		
		INTERSECTION effect		
		50Km/h	40 Km/h	30 Km/h
Bergara A MO (255 / 6%)	67	69,3	69,0	68,9
Bergara B MO (255 / 6%)	66,3	68,6	68,0	67,7
Bergara C MO (302 / 4%)	67,6	69,3	68,9	68,7
Bergara D MO (302 / 4%)	68,1	69,0	68,3	68,1
Arrasate E MO (73 / 4%)	64,7	65,2	64,7	64,5
Arrasate F MO (73 / 4%)	63,9	64,3	63,7	63,5
Bergara A MI (250 / 6%)	68,2	69,1	68,8	68,7
Bergara B MI (250 / 6%)	66,3	68,6	68,1	67,8
Bergara C MI (255 / 4%)	65	68,3	67,7	67,6
Bergara D MI (255 / 4%)	66,1	68,0	67,4	67,1
Arrasate E MI (9 / 0%)	62,5	62,0	61,3	61,0
Arrasate F MI (9 / 0%)	61,1	59,1	58,4	58,1

In the case of Arrasate street, when the traffic is near the receiver point, either because the street itself has traffic, during the morning, or because the point is near Bergara street, calculated levels are similar to the measurements. However, when the street can be considered pedestrian, midday peridod, the levels calculated by CNOSSOS in the middle of the street are lower than those measured by 2.5 dB.

On the other hand, if the crossing element of CNOSSOS is not used, the average circulation speed significantly affects the calculated levels, and there are differences of 3 dB depending on the average flow speed (between 30 and 50 km/h). Noise levels measured are similar to the calculated ones, when the traffic is defined as steady with the speed of 50 km/h or 40 km/h.

Table VI: Results of calculation at each position with CNOSSOS applying steady traffic

Points Measured	Measurment level	Calculation conditions NO intersection effect 50Km/h	40 Km/h	30 Km/h
Bergara A MO (255 / 6%)	67	67,4	65,9	64,6
Bergara B MO (255 / 6%)	66,3	67,8	66,3	64,9
Bergara C MO (302 / 4%)	67,6	68,1	66,5	65,0
Bergara D MO (302 / 4%)	68,1	68,3	66,7	65,2
Arrasate E MO (73 / 4%)	64,7	64,4	62,7	61,1
Arrasate F MO (73 / 4%)	63,9	63,3	61,7	60,2
Bergara A MI (250 / 6%)	68,2	67,1	65,7	64,3
Bergara B MI (250 / 6%)	66,3	67,7	66,2	64,9
Bergara C MI (255 / 4%)	65	67,2	65,6	64,0
Bergara D MI (255 / 4%)	66,1	67,5	65,9	64,3
Arrasate E MI (9 / 0%)	62,5	61,6	59,9	58,2
Arrasate F MI (9 / 0%)	61,1	58,6	56,9	55,2

As has already been seen in previous results, the case of Arrasate street, when can be considered pedestrian, behaves differently and the difference between noise levels calculated and measured is of opposite sign.

4. Analysis of results

The analysis consists of comparing the differences between measurements and calculations for each evaluation point, in the different calculation scenarios and with the two methods.

In the graphs presented below this difference is plotted: positive values indicate that the calculation is greater than the measurement. The area of ± 1 dB is shaded in grey.

The scenarios that are compared are: the calculation with the interim method, represented by the case of speed 50 Km / h; the CNOSSOS calculations with and without the crossing element and applying to the noise sources the three speeds considered.

As can be seen, the comparison of all the alternative ways of modelling the same noise sources offers an important diversity of results. In general, it is observed that CNOSSOS method represents better than the Interim method the traffic noise in the case study. Besides, the modeling conditions when the crossing element is applied and when steady flow is considered with an average speed of 50 km / h, are relatively similar, with some caveats that will be discussed below in more detail.

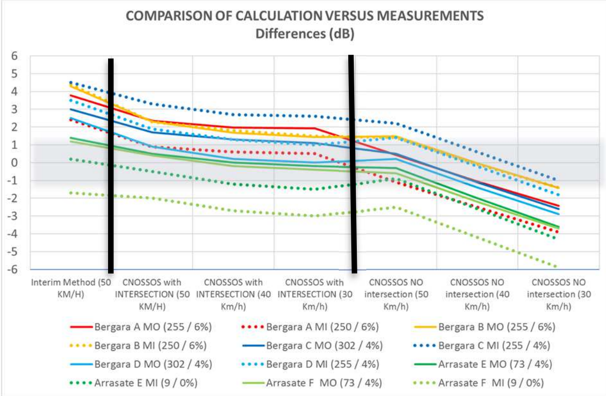

Figure 7. Comparison of calculation and measurements

First, we look at the comparison of the results in the middle of Bergara Street (figure 6), both before and after the crossing. In these points (B and D), the different modeling alternatives with CNOSSOS have the same tendency, improving the results obtained by the Interim method. It should be noted that although the traffic scenarios have differences in the presence of heavy vehicles (6% in the Bergara B point, both in the morning and at midday, compared to 3% in the Bergara D point in both periods), calculated levels at those points do not differ so much.

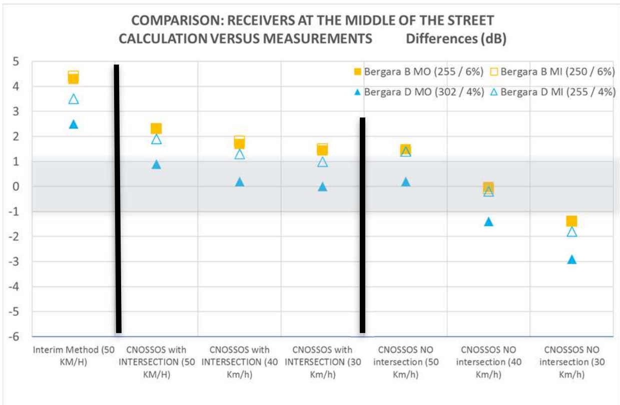

Figure 8. Comparison of calculation and measurements at the middle of the street.

The same analysis is performed in the points near the crossing (A, C and E), in the sections that form the intersection, both before and after the traffic light.

Again, the same tendencies are observed, to those already commented for the points in the middle of Bergara Street. However, at the point of Arrasate Street, with less traffic on the section itself (especially at midday) the difference between results of CNOSSOS and the Interim method is lower. This effect will be accentuated at the point at the middle of Arrasate Street.

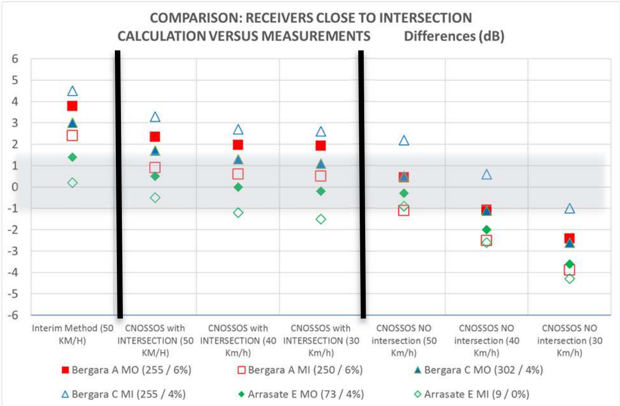

Figure 9. Comparison of calculation and measurements at points close to the crossing.

On the other hand, there is a change in behavior between the points located before and after the crossing (Bergara A, compared to Bergara C and Arrasate E). At the point before the crossing, modeling with steady traffic at 50 km / h gives results clearly lower to the option of modeling the traffic light, which does not happen at the points after crossing. This is not due to the position of the evaluation points, but because the traffic scenario at Bergara A, have a greater presence of heavy vehicles, which makes the effect of the crossing greater, according to the CNOSSOS algorithm, and consequently the difference with respect to steady traffic increases.

However, as we move away from the crossing and its contribution loses importance, according to the CNOSSOS algorithm, the presence of heavy vehicles also ceases to have this influence. This is verified by comparing the Bergara A and Bergara B points on the figures 8 and 9.

Finally, figure 10 shows the comparison of calculated and measured results on Arrasate street, far from the crossing.

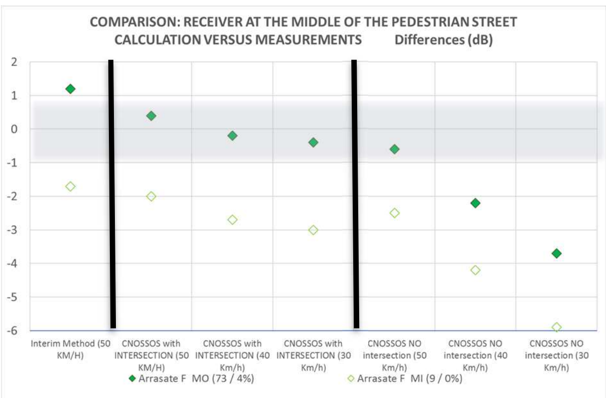

Figure 10. Comparison of calculation and measurements at the pedestrian street

In this figure can be seen that in streets with little traffic or pedestrian (would be the case of the MIdday scenario) the differences between noise level calculated by the Interim method and the CNOSSOS method are lower.

In addition, it seems that CNOSSOS represents worse than the Interim method the pedestrian street scenario. Nevertheless, no conclusion can be drawn from this study, given that it is a single point and that the measure is more critical. Despite the fact that, as in the rest of the points, measurements were processed to eliminate non-traffic sound events, at this point the levels from the source are lower and it would be possible that the background noise of the city contributed to the measure.

However, this result indicates that this typology of situations should be investigated more in detail: urban areas without near traffic. The calculation of noise in these areas is less influenced by the sound power of the traffic sources and more conditioned by the calculation of the sound propagation applied by CNOSSOS.

5. Conclusions

As said in the introduction and foreseen in the planning of this study, it is not considered that results can be extrapolated as conclusions to be drawn either to the whole city or to other situations. Even so, results obtained allow improving the understanding of the effect of different options for modeling with CNOSSOS. From this knowledge decisions can be made about its use to represent the reality of traffic noise in our cities.

In this sense, in the study we have observed some of the factors that influence the effects of how to model the intersections:

- Presence of heavy vehicles on the streets linked to the crossing. In the study can be seen that it could influence the decision to apply or not the crossing.
- Distance to traffic noise sources. Results obtained in the study show that CNOSSOS represents worse the situations with less contribution of traffic.
- Another factor that can influence is the traffic light cycle. However, it is not analyzed in this study. This factor would require very detailed input data and a lot of modeling effort. Therefore, studies with different configurations should be compared to determine if in practice it is a factor relevant enough to be taken into account.

As a remarkable result of this analysis can be said that the calculations in this case study with different modelling alternatives with CNOSSOS can give noise levels that vary in 4.5 dB in the zones near the crossings (Bergara A and C), and in 3.7 dB in the rest of the areas with traffic (Bergara B and D). In areas not directly exposed to traffic noise, the variation in noise levels would be around 4 dB (Arrasate F).

Therefore, it is confirmed that the decisions made regarding the modeling of the city's traffic junctions can influence significantly on the result of the noise levels and consequently on the indicators of the diagnosis of the Strategic Noise Maps and on the evaluations of the effects of the Action Plans.

Therefore, it is a decision in which, despite being technical, the managers of the environmental noise of the city should be involved. This would also ensure that coherence between studies carried out in different periods is maintained and that real monitoring of the evolution of the sound situation and the effectiveness of the adopted strategies can be carried out.

The criterion adopted for the calculation with CNOSSOS should seek the best representation of the reality of the noise levels generated by traffic in the city. In this sense, table VII summarizes, for the case study, those CNOSSOS modeling configurations that offer a difference of less than 1 dB with respect to the results of the measurements.

Table VII: Evaluation of the modelling configurations

Situations	With Intersection	NO Intersection	
		50 Km/h	40 Km/h
Close to intersection (6%)		-0,4	
Close to intersection (6%)	-0,5		
Close to intersection (4%)		-0,5	
Close to intersection (4%)			-0,6
Close to intersection (less traffic)	0,2	0,3	
Close to intersection (less traffic)	0,5	0,9	
Middle of street (6%)			0
Middle of street (6%)			0,1
Middle of street (4%)	0	0,2	
Middle of street (4%)			0,2
Middle of street (less traffic)	0,4	0,6	
Pedestrian	2		

A clear conclusion about the best configuration cannot be drawn, since more similar studies should be made and their integrated analysis could support this decision.

However, as a conclusion of this study, some general reflections can be made: It seems necessary to study in detail the calculation in the areas not affected directly by traffic (named as pedestrian in this study), since according to the results obtained calculations differ more from reality. These areas are especially important since the result of the calculation can help identify them as candidates to be declared as Quiet Areas.

Another reflection is linked to the importance of correctly representing the situation in the night period, as it is usually more critical in terms of population exposure. Given that circulation in this period may have different characteristics, it could be analyzed in more detail how to use the method to better represent these situations.

On the other hand, the need to optimize the effort invested in acoustic modeling must always be taken into account. It must be adjusted to the relevance of each input data in the indicators of Noise Maps and the monitoring of the benefits of Action Plans. Therefore, in these analyzes, the complexity of applying the proposed criterion to the scale of a complete city should be taken into account.

In this sense, in terms of optimization of input data, the study carried out endorses that in urban noise calculation heavy vehicles can be assigned to category 2 and that the motorbikes can be considered as light vehicles.

There is no doubt that the crossing is an element that we should know well, since it can help to better represent the greatest noise source of our cities. It is worth mentioning that similar studies should be addressed regarding the modeling of roundabouts. The diversity of ways to tackle this task seems even greater than the case studied of traffic lights

As indicated, the conclusions of this study should be complemented with other works that represent other situations to look for points in common and to establish possible general criteria for modelling traffic noise in the cities.

The effect of different decisions taken in different cities can make it even more difficult to compare results obtained by Strategic Maps of European agglomerations.

Acknowledgement

This project has no external funding and was funded with internal resources from Tecnalia.