INTER-NOISE 2007
ISTANBUL, TURKEY

"FIRST CONCLUSION ABOUT THE END IMPLEMENTATION: EGRA SPANISH ROAD STRATEGIC NOISE MAPPING EXPERIENCE"

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Fecha: 28- 31 agosto de 2007

INTER-NOISE 2007

28-31 AUGUST 2007
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First conclusions about the END implementation: EGRA Spanish Road Strategic Noise Mapping Experience

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ABSTRACT

The Direccion General de Carreteras of the Spanish Ministry of Transport started one year ago the process of Strategic Noise Mapping of Spanish Major Roads (EGRA). The methodology applied for Noise Mapping and the quality control procedure defined to monitor the work done by different contractors were already presented in EURONOISE 2006 by the same authors. The whole National road network to be noise mapped for the first END round was divided into 20 contracts. At this moment 5 of those studies are finished and the other 15 studies are under development during spring 2007. So, the whole network is already on the process. The present paper contains -First conclusions about the robustness and coherence of the methodology adopted; – Some comments to the second version of the Good Practice Guide; - Suggestion about used indicators and its validity to set priorities for Action Planning; and – View to the first results obtained in terms of people, land and buildings exposure to noise.

1 INTRODUCTION

The Direccion General de Carreteras of the Spanish Ministry of Transport is clearly driving the process of Strategic Noise Mapping of Major Roads by the EGRA project. Spanish Major Roads managed by the Ministry to be noise mapped in the first round defined in the END have a length of 6.400 km. The process is already on and nowadays 5 studies are finished, covering 26 different roads, total of 580 Km. length. These studies describe the noise exposure of 226.600 inhabitants, 798 dwellings and 600 Km^2 of land. There are another 15 studies running each of them in different stages of development.

The present paper presents some conclusions about the 5 finalized studies and about the acquired experience about Major Road Strategic Noise Mapping.

Some papers were published, see references, containing the methodological approach and the Quality Control Procedure defined to assure the coherence of the whole process. Some of the most relevant issues are explained here to introduce the paper content.

The elements contained in Strategic Noise Maps are the followings:

- Noise Level Maps: Isoline noise level maps created from the noise levels obtained over the whole area studied.
- Exposure to Noise Maps: Population exposure to noise in 5 dB ranges.

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- Noise Affection Maps: Surface, dwellings, schools, hospitals and population exposure to noise in 10 dB ranges estimated from the analysis of land uses and type of buildings in the area.

The Strategic Noise Maps of the Major Roads in Spain are being done in two phases: Phase A, Basic Strategic Noise Maps; and Phase B, Detailed Strategic Noise Maps. First of all the Basic Strategic Noise Map is done using the cartography 1/25.000. Analyzing the results of these maps some affected areas could be identified for a Detailed Strategic Noise Map to be done with a 1/5.000 cartography and a more precise methodology. The criteria to select the areas where a Detailed Map is required concern the expected exposed population.

A quality control procedure was defined and its goal is to check the acoustic quality of each Strategic Noise Map and to assure the coherence of the whole process of Strategic Noise Mapping of the Spanish Major Roads in 2007. The quality control team is composed by the Direccion General de Carreteras, CEDEX and LABEIN.

2 INPUT DATA

2.1 Some conclusions about Strategic Noise Mapping methodology

One of the first steps in the Strategic Noise Mapping process is to visit the site of the study with the contractors. During the visit some doubts about traffic conditions (mainly intensity and speeds) are solved and the decisions about how to consider the road platform and the number of lanes are approved before the modelization process starts. There are also some initial comments about the possible conflictive areas in the studied area. The Quality Control Team considers this visit important to understand how the contractor will simulate the reality.

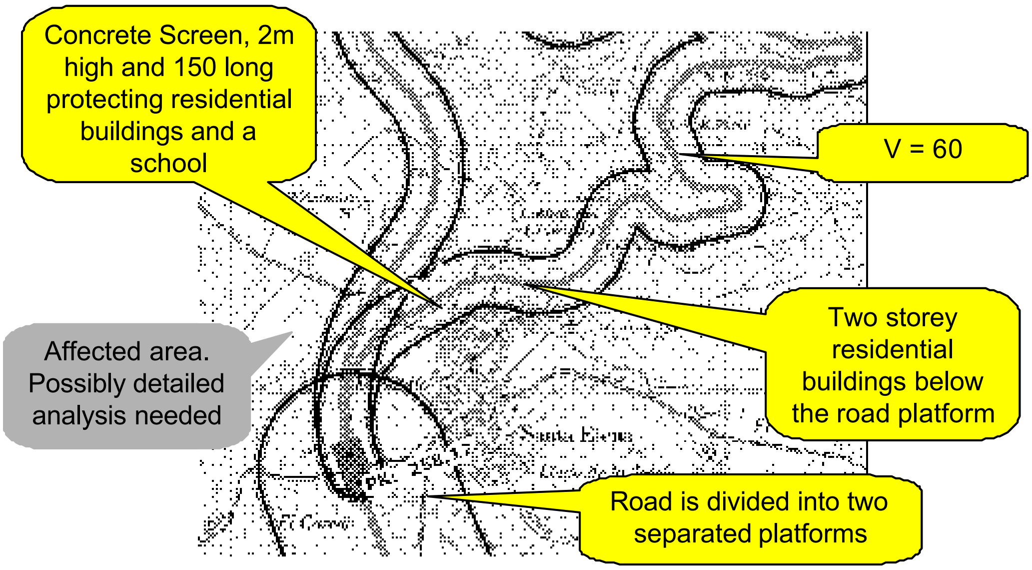

Figure 1: Sketch of the information obtained during the site visit.

One of the most important input data is the cartography and its quality in terms of topography and buildings definition. On that sense, as it was explained above the methodology defines two levels of detail in the study: the Basic level in 1:25.000 cartography and 30 m. grid, and the Detailed level, only applied in conflictive areas, in 1:5000 cartography and with a more dense grid. There are big differences in the results obtained, so the two phase methodology is considered positively.

An example of Strategic Noise Mapping in one area applying the two approaches is shown in Figure 2.

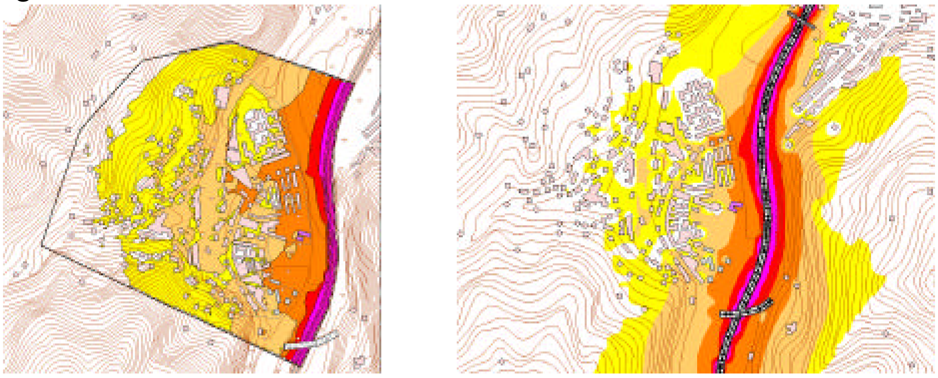

Figure 2: Strategic Noise Mapping applying Detailed methodology on the left and Basic methodology on the left.

Some examples of errors found by the Quality Control Team before the noise calculation process starts are shown in Figure 3 and Figure 4.

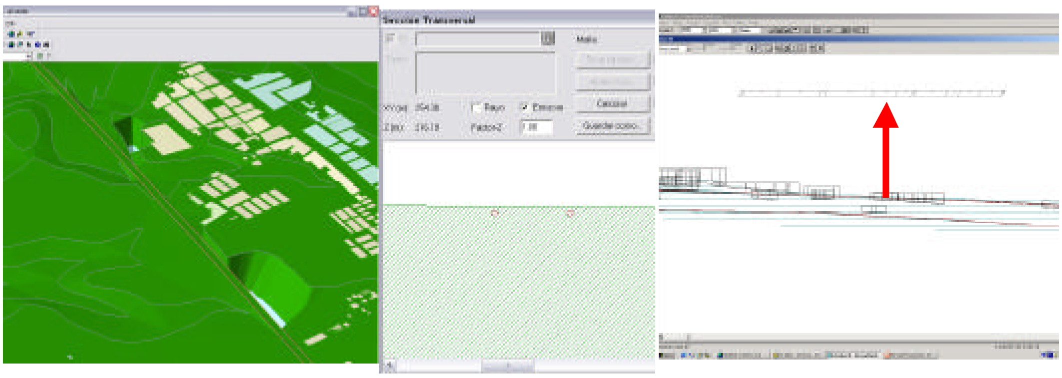

Figure 3: Left and middle figures show examples of detected errors in the description of the position of the road platform on the ground. The figure on the right shows a "flying" screen found in one of the studies.

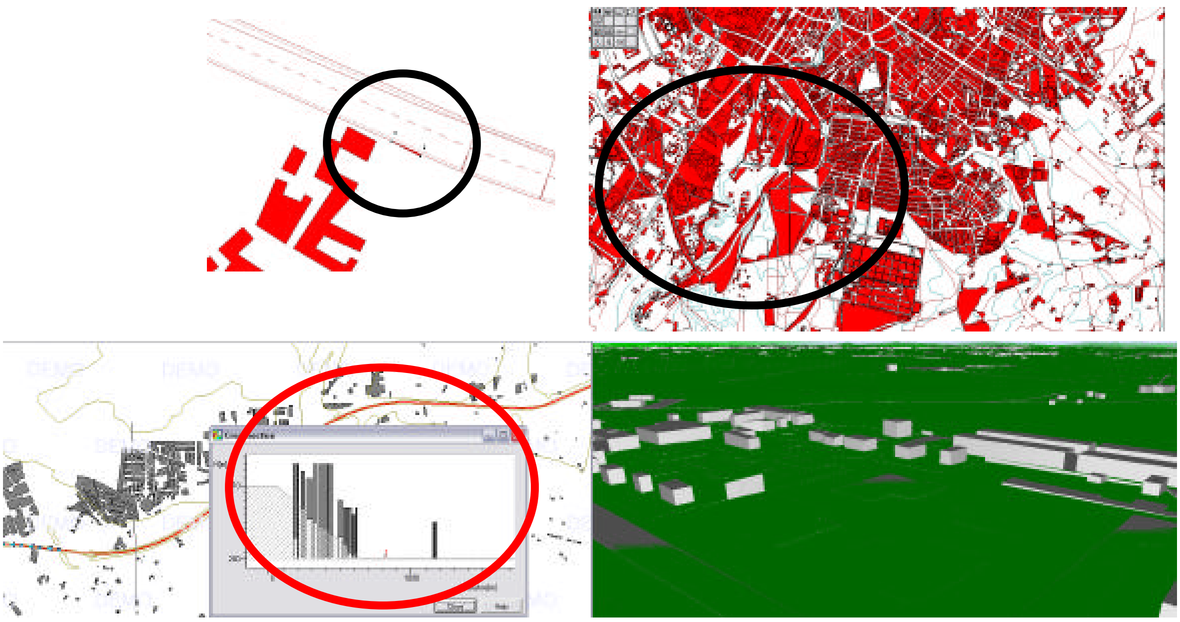

Figure 4: Set of errors in building definition: road passing though a building, wrong recognition of building polygons and ground "flooding" buildings.

The amount of geographical information to handle during Strategic Noise Mapping is huge and some automatic processes of GIS tools could help in the modelization. However, there should be a tight quality control of the decisions made by these tools in order to avoid errors that could be crucial, specially near the road and in the buildings definition.

In the EGRA process, the Quality Control Team checks the model before the noise calculation starts, at this step of the process some errors were found in the description of the position of the road platform, buildings and screens on the terrain. The checking of the ground model is done using the noise calculation software to avoid non detected errors when importing geographical information into it and to check how special situations are solved such as viaducts over the ground.

2.2 Comments to the Good Practice Guide

The Good Practice Guide is the reference to solve doubts when answering END requirements. At this moment of the Spanish Major Roads Strategic Noise Mapping process, we would like to do some comments to the GPG about issues related to input data.

- Average year as regards meteorological circumstances: "Toolkit 17 provides suggested default values for meteorological conditions. However, WG-AEN strongly recommends that every effort should be made to obtain locally representative meteorological data". Toolkit 17 does not quantify the accuracy for the default values.

Major Infrastructures Strategic Noise Mapping should simulate the situation in very large areas where the meteorological conditions are not homogenous. At the same time, obtaining locally representative meteorological data implies a huge effort and the best option is to use default values; therefore, the default values proposed by the GPG are being used. However, there are some doubts about the accuracy obtained when using the proposed values and the toolkit does not give any hint about it. We suggest to do a revision of the default values and to give advise about the associated accuracy.

- Some toolkit provides accuracy values to specific approaches to obtain required input data. Some of them seem to be not well adjusted or analysing all of them as a whole some unbalanced values were found. Table 1 shows the most relevant cases.

Table 1.

Toolkit	Parameter	Method	Accuracy
3.5	Road traffic speed	Use speed limit (e.g from traffic signs)	2 dB
7.3	Road gradient	Use 0% as default value	3 dB
12.3	Cutting and embankments	Estimate the position and height from the site visit	1 dB
13.3	Ground surface type	Use reflective ground everywhere as a worst-case default	3 dB
14.2	Barrier heights near roads	Divide barriers into classes and take a default barrier height	2 dB

There could be some deviations in real circulation speed from the value defined in traffic signs, however it is difficult to find a year average deviation of 15% (100 Km/h in a road limited to 120 Km/h), that corresponds to this 2 dB error. In general, Spanish Major Roads Strategic Noise Mapping uses speed limit as input value.

Regarding road gradient, the European Interim Method for road traffic noise concerning noise emission, "Guide du bruit des transports terrestres", provide formulae and abacus to define the dependence of noise emission from speed at different circumstances. The application of this method concludes that traffic noise is not influenced by road gradient at a speed of above 60 Km/h. This is due to the fact that rolling noise is predominant at this speed.

The average speed in major roads is larger than this, so the conclusion is that in those cases the error of not taking into account the road gradient is negligible.

The option of considering ground reflective as an approach to Strategic Noise Mapping is interesting. An advice concening the use of this method could be given. This method implies that road platforms will be in reflective ground. At least some of the most known acoustic software add, in general, 3 dB to the road noise emission due to the first reflection on the road platform. When the road platform is included in a reflective area, the software will add another 3 dB, so the whole calculation will have a systematic error of + 3 dB.

Finally, the accuracy values associated to toolkit 12.3 and 14.2 look low, at least compared to the previously commented ones.

3 CALCULATION AND INTERPOLATION PARAMETERS

During the Major Roads Noise Mapping Process, different acoustic software are being used. This paper is not intended to comment about the software development quality.

The selection of calculation and interpolation parameters will modify the obtained results. There are different options to speed up calculation time that could be a big problem. However, the final results should be carefully checked to assure their coherence and quality.

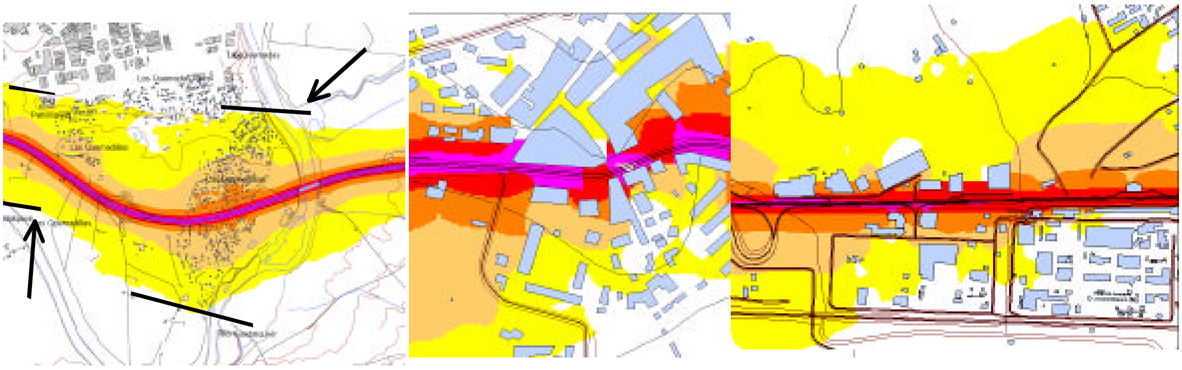

Figure 5: Some examples of incoherence in Noise Maps results.

4 STRATEGIC NOISE MAPS RESULTS

4.1 Some general results

The results obtained are being produced following a similar format. Some of these formats were already presented in previous communications so here, only two examples are shown. Figure 6 is an example of how exposed to noise population is represented in reports.

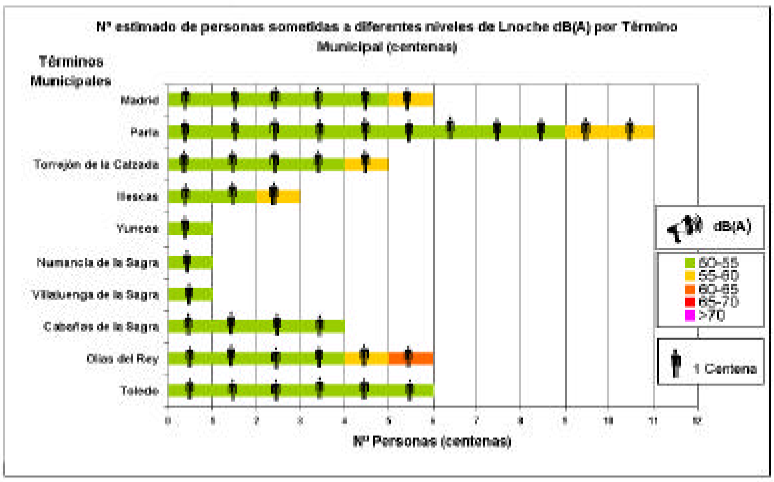

Figure 6: Estimated number of inhabitants exposed to L_{nigh}t levels over 55 dB in each studied municipality, obtained for one road analyzed in one of the finalized studies.

And Figure 7 is an Exposure to Noise Map of part of one road and it includes 4 areas where Detailed Maps were done with data about the exposed population in each of them.

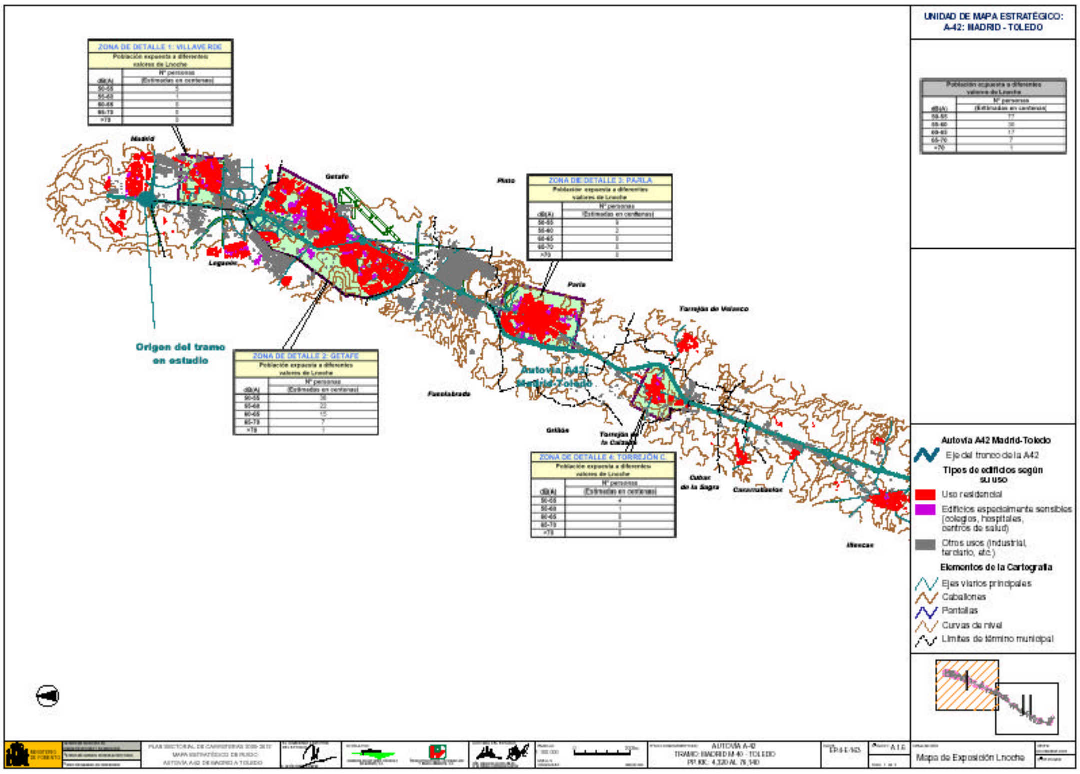

Figure 7: Exposure to Noise Map containing three areas studied applying the Detailed methodology.

Results about exposure to noise obtained in the 5 finalized studies have been analyzed. First of all, Table 2 contains an analysis of the average distribution of the exposure to noise parameters among the different set of ranges established in the END.

Table 2.

SURFACE AFFECTED BY L_{den} % values in each dB range			
Total Surface exposed to >55 dB (Km^2)	55-65	65-70	>75
594,3	74%	20%	6%

DWELLINGS AFECTED BY L_{den} % values in each dB range			
Total units exposed to >55dB (hundreds)	55-65	65-70	>75
798	75%	15%	10%

POPULATION AFECTED BY L_{den} % values in each dB range			
Total inhabitants exposed to >55dB (hundreds)	55-65	65-70	>75
2.282	75%	21%	4%

EXPOSED POPULATION TO L_{den} % values in each dB range					
Total inhabitants exposed to >55dB (hundreds)	55-60	60-65	65-70	70-75	>75
2.282	53%	24%	14%	6%	3%

EXPOSED POPULATION TO L_{night} % values in each dB range					
Total inhabitants exposed to >50dB (hundreds)	50-55	55-60	60-65	65-70	>70
1.273	55%	28%	12%	4%	1%

It should be clarified that in the table above, total values always refer to the sum of the surface, unit of dwellings or inhabitants exposed to the lowest value of the set of ranges. And the percentage in each range is calculated in relation to this total value. So, it does not mean a general % of exposition.

The obtained distributions in ranges of the different values of exposition to noise show that the results are coherent and the pattern was expected.

Most of the results (75%) concerning noise affection in 10 dB ranges are in the 55-65 dB range. This range does not give too much information to identify conflictive areas or situations. On the other hand 25 % of the information is focused to the most interesting areas.

Comparing the figures of exposed population to L_{den} and to L_{night}, it is clear that applying L_{den} parameter someone could conclude that more population will be affected by noise (2.282 versus 1.273). This is due to the fact that the ranges for L_{den} and L_{night} are shifted only 5 dB, meanwhile the difference in traffic noise level used to be closer to 10 dB, although the figure normally is an intermediate value. In fact, excluding the lower range in the number of inhabitants exposed to L_{den} the total exposed population becomes 1.072 inhabitants, which is closer to the L_{night} value.

Another conclusion is that in every range there is a general tendency of being the L_{den} value higher than the L_{night}. The following chapter analyses the relation between those parameter.

4.2 How relevant is L_{den} parameter?

As the L_{den} is a new parameter and it is not easy to understand and feel what represents, its importance is analyzed in one of the studies.

As L_{den} value is calculated by weighting by 5 dB, $L_{evening}$ values; and by 10 dB, L_{night} values, and sum both results to L_{day} values, to analyze the real meaning of L_{den} values a set of references for each of the three components of the L_{den} is defined, following the same relation (5 dB larger to $L_{evening}$, and 10 dB larger to L_{night}). Population exposed to noise is analyzed applying these references, in one of the studies that contains 6 roads (50 Km. total length). Table 3 shows the results obtained in this analysis.

Table 3: Inhabitants in hundreds exposed to noise levels higher than the defined references in each parameter.

	$L_{day} > 65$	$L_{evening} > 60$	$L_{night} > 55$
Road 1	6	10	7
Road 2	0	1	1
Road 3	5	21	19
Road 4	1	1	2
Road 5	6	21	20
Road 6	11	22	10

The conclusion of the analysis is that when considering the L_{den}, in most of the cases the crucial day period is the evening. In general in Spain the traffic peak caused by leaving work is in the evening period defined by END. This situation means that to reduce the exposure to L_{den} values, the focus should be in the evening situation. However, we understand that the annoyance caused by noise is much higher at night, especially taking into account that the exposure is considered at home. Therefore, the conclusion is that the diagnosis to set priorities for action plans will be focused to L_{night} values. The L_{day} parameter will be the main focus for considering the exposure of schools to noise.

4.3 Area to be mapped and validity reference of methods

Toolkit 1 of Good Practice Guide suggest to map a distance 1,5 times the distance of the referred to L_{den} = 55 dB and L_{night} = 50 dB. There is a caution note advising that the road traffic interim method defines a limited validity range to a maximum distance of 800 m.

In order to know the relevance of this limitation, a statistical analysis of the results of the 5 studies was done. In each of the 26 roads it was calculated the relation between surface above 55 dB in L_{den} and the length of the road (S/L). There were two roads, 88 km. total length, were the relation was bigger than the validity limit of the method. Applying statistical analysis, could be concluded that 5.000 among the total 27.000 inhabitants counted in the 50-60 dB range in those two roads were calculated outside the validity of the method, increasing the uncertainty of the results. Considering the total 5 finalized studies, the amount of "uncertain" values represents only 3 % of the total number of inhabitants counted in the 50-60 dB range. Therefore, it seems that globally the validity limit of the road traffic calculation method does not derive in a big problem. However, it could be locally relevant as it is shown in the following figure, where a line shows the validity limit and it can be shown that the calculation is being done farther than that.

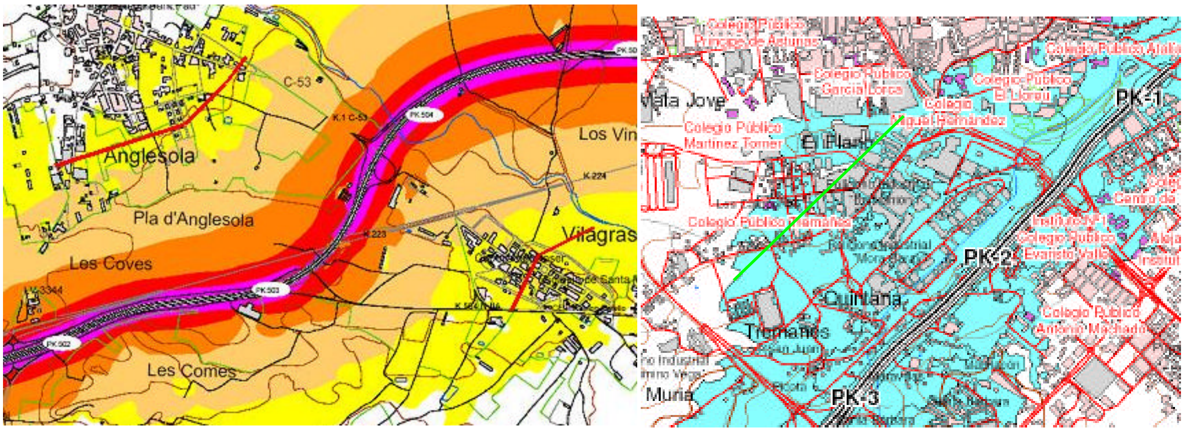

Figure 8: Noise Level Map and Noise Affection Map with a red and green line showing the validity limit distance of the calculation method.

4.4 Calculation of exposed population

The methodology adopted for Spanish Major Road Strategic Noise Mapping defines a two phase approach: Basic Maps and Detailed Maps, as was explained above. The cartography has different quality in each phase and, in order to be coherent, also the method to assign population to noise levels is different: Phase 1 imply only one set of calculation (grid points) and Basic Maps refer population to the whole building; and Phase 2 implies two sets of calculation (grid points and points at building façade) and Detailed Maps refer population to the dwellings in each building.

The areas where Phase 2 has to be applied are defined analyzing the Basic Map results and the criteria for their definition are related to expected exposed population.

It can be said that in the 5 finalized studies, 94% of inhabitants exposed to L_{night} above 50 dB have been studied in Detailed Maps. That means that the criteria was applied correctly and the two phase approach allows to simplify the work where nobody is affected and to focus the effort to quantify the population exposure.

To check the worth of Detailed Maps, the following figures show the results obtained. In general, Detailed Maps reduce the population exposed to noise due to the more detailed method to consider the exposition to noise (two calculations and inhabitants distributed in the building). Figure 9 shows this effect, but it also includes some cases where the exposition to noise increases due perhaps to better definition of the propagation path.

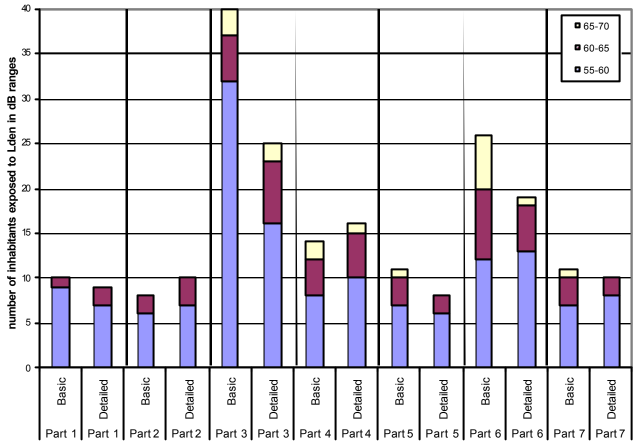

Figure 9: Comparison of results obtained by applying basic or detailed methodology. Results refers only to selected areas.

The exposure to noise of the whole road is calculated modifying the data of the Basic Maps to include the results obtained from the Detailed Maps. Figure 10 shows the effect of Phase 2: the change in dB between the results of the two phases is presented as a percentage of the value obtained in Phase 1.

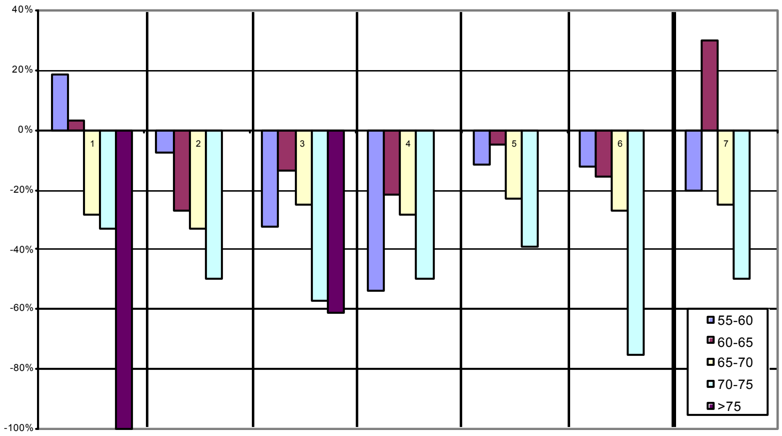

Figure 10: Comparison of results obtained by applying basic or detailed methodology. Results refers to the whole road.

5 CONCLUSIONS

After analyzing the results provided in the first 5 studies carried out in Spain, it can be said that the methodology and procedures to produce Major Road Strategic Noise Maps is robust and coherent. The acquired experience in this process will allow an interesting review of the Guides for Strategic Noise Mapping.

6 ACKNOWLEDGEMENTS

The Spanish Major Road Strategic Noise Mapping will contribute to the Environment Noise Management thanks to the work carried out by the Quality Control Team, formed by 10 people from the three institutions presenting this paper, and also to the different companies that are developing Noise Maps.

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