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A COMPARISON OF NOISE SIMULATION MODELS

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The Institute for the Environmental Protection and Research has organized a research activity, on assignment of Ministry of the Environment, in order to compare the results of the main noise simulation models. The comparison has taken in account of all noise sources – roads, railways, airports and industries. This work have allowed to evaluate the gap in the results due to operator choices, different commercial software tools implementing the same models and different infrastructure configurations.

1. Introduction

The Institute for the Environmental Protection and Research has organized a research activity, on assignment of Ministry of the Environment and in collaboration with a task-force composed by several Regional Environmental Protection Agencies, in order to compare the results of the main noise simulation models.

The comparison has taken in account of all noise sources – roads, railways, airports and industries. For each of them a set of test scenarios has been identified, based on the J.R.C. document of the European Commission [1]. The meaningful number of participants has allowed to evaluate the gap in the results due to operator choices and to different commercial software tools implementing the models.

The results of this work have been reported by a statistical analysis from the data obtained using several commercial software tools.

2. Comparison on road noise simulation models

The laboratories taking part to comparison activity on road noise simulation models, indentified for software tools types, are: eight IMMI-laboratories; seven CadnaA-laboratories; five SoundPlan-laboratories and only one Mithra-laboratories. The French Standard NMPB96 [2] has been implemented by twenty laboratories, whereas the German RLS90 [3] by two of those using SoundPlan. The scenarios have been assembled by macroscenarios – Motorway, City and Hill –, ground configurations and types of source, for a total of 14 simulation scenarios. Moreover, scenarios differ depending on the considered meteorological conditions – 100% favorable propagation or 50% favorable and 50% homogeneous propagation – and on traffic conditions.

Motorway scenario represents the typical configuration of a large highway road, passing through free field, spread barrier-protected receptors, urbanized and urbanized with barriers areas, in three ground configurations – flat, depressed and embankment roads.

City scenario characterizes the context of a two-way main city street; the macroscenario is divided in two homogeneous areas – a non-shielded buildings and a barrier-shielded buildings area – in the three described ground configurations.

Hill scenario represents a 4-lane highway road in hilly environment, running at an intermediate height between valley bottom and top of the hill, with receptors on different distances from the source and at various heights from the hill.

The data analysis has been carried out for macroscenarios and in an overall way, considering initially – in the definition of standard deviation and in the range of the results obtained from simulations – all the laboratories and, subsequently, cutting out those presenting a high number of critical data or having differently set up the computing configurations. In Fig. 1 standard deviations obtained from the total pattern and by purging critical data are shown, according both to the z-score criterion [4] and the computing configurations analysis. The values obtained without considering critical data are comprised between 1.3 and 2.8 dB, in compliance with the single scenario, with a total average value of 2 dB.

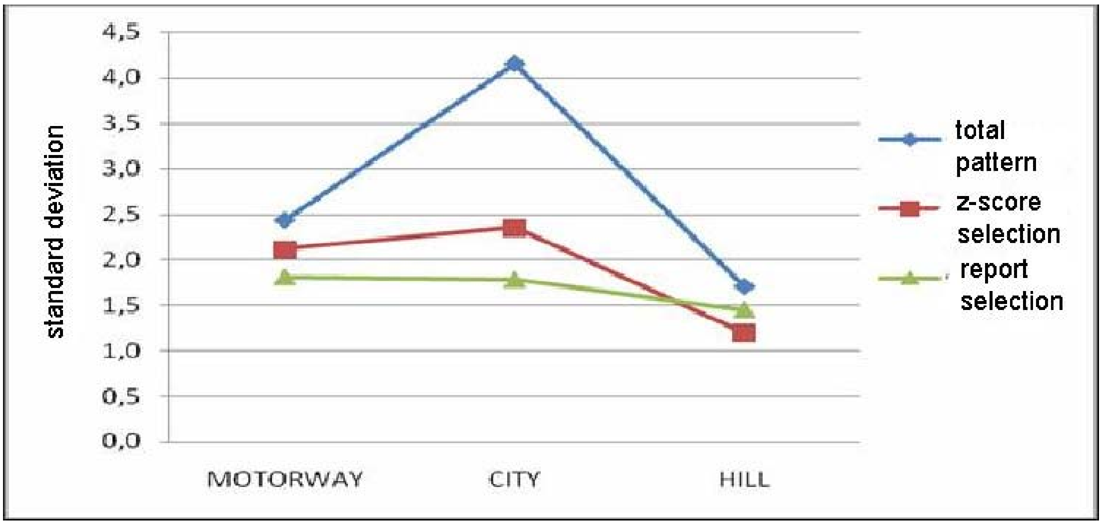

Figure 1. Average standard deviation for macroscenario.

The variations between single macroscenarios and scenarios are therefore limited and essentially due to the complexity of territorial context where the source is inserted; it is clear that dispersions among results of different laboratories increase with the following factors: complexity of propagation environment, distance from source and consequent reduction of the acoustic levels at receptors. Analyzing the three software tools with the highest number of participants – IMMI, CadnaA and SoundPlan – it is not clear if SoundPlan produces significantly different results from CadnaA and IMMI or if participants have committed inaccuracies which have caused an underestimation of all the computed levels with that software tools; worth noting is that IMMI and CadnaA have shown lower dispersions in every scenarios than Soundplan, perhaps due to its simpler set up procedure.

3. Comparison on industrial noise simulation models

Twelve laboratories have taken part to the comparison on industrial noise simulation models. Three different commercial software tools have been compared – CadnaA (4 laboratories), IMMI (6 laboratories) and SoundPlan (2 laboratories), all implementing ISO 9613 [5]. The comparison has been made on three scenarios, with punctiform sources in proximity of completely reflecting buildings. Scenarios 1 and 2 concern a flat environment with presence of receptors in free field and in façade of buildings, areas of different absorption ground, with and without barriers, in two noise propagation conditions –100% favorable or 50% favorable and 50% homogenous. Scenario 3 refers to a hilly environment with receptors at different heights from source and hill. In Fig. 2 standard deviations are reported, obtained from all results, by single software tools with more than two operators and the total pattern purged by critical data through a systematic analysis of the computing set up adopted by every laboratory.

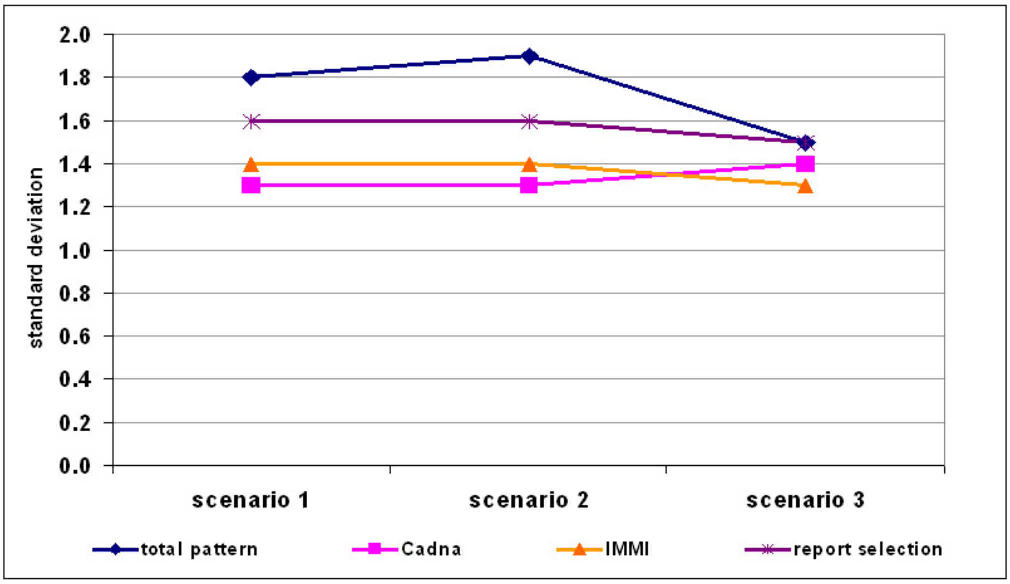

Figure 2. Average standard deviation for scenario.

At different scenarios there are no significant differences in standard deviation, always lower than 2 dB and comparable among software tools. Analyzing the results of simulations, it turns out that IMMI has an understimation of 2 dB compared to CadnaA, because of different set up computing configurations regarding reflected noise in façade of buildings.

4. Comparison on railway noise simulation models

Regarding the railway source, three laboratories with SoundPlan, two laboratories with IMMI and a laboratory with CadnaA have taken part to the comparison. All participants have used RMR model [6]. Nine simulation scenarios overall have been considered, with different train categories and railway line configurations – flat, depressed and embankment – and always favorable meteorological conditions have been assigned. Because of exiguity of the number of laboratories, the data analysis has been carried out assembling the three selected train categories – passenger, freight and high speed trains – and evaluating, for each categories, the average standard deviation obtained from all participant laboratories (Fig. 3).

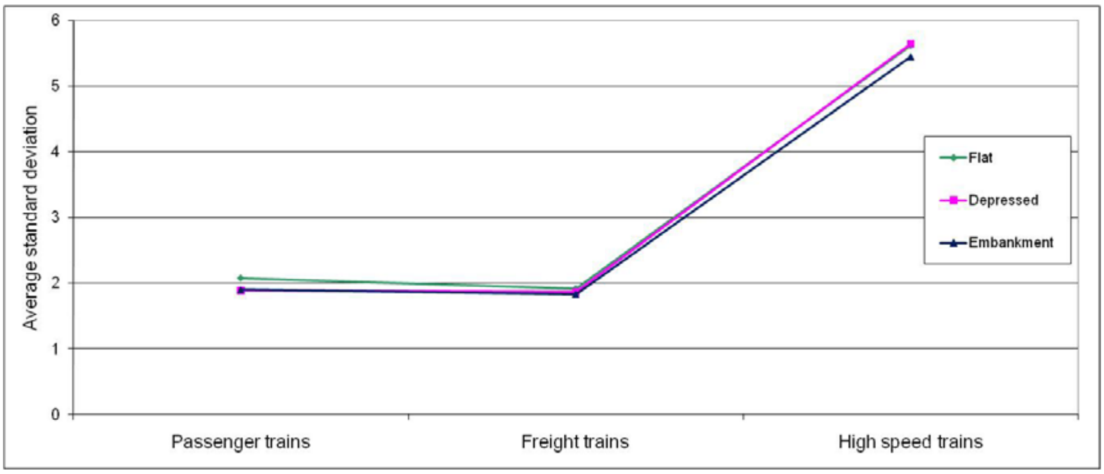

Figure 3. Average standard deviation for train category.

From Fig. 3 it turns out that standard deviations of the freight/passenger trains present content values, while the high speed trains category has higher: this is mainly due to inaccuracies of some operators regarding the choice of high speed trains type and the evaluation of flows.

5. Comparison on airport noise simulation models

The activity on airport noise has been attended by twelve laboratories: nine using INM software – six 7.0a, two 6.2a and one 6.1 version – two CadnaA-laboratories and a SoundPlan-laboratory. The main objectives are the analysis and comparison of simulation results carried out by different operators on the selected scenarios, using different software, and also the comparison of results obtained by the adopted simulation models with those produced by the “ad interim” model prescribed by European Commission – document ECAC.CEAC Doc 29, 2nd version [7]. Nine scenarios have been defined, one of which presents features more responsive to airport sources in the national territory. Taking the same settings for the airport seat and weather conditions, scenarios are characterized by different trajectories of airport take off and landing, aircraft types and number of movements per day. The deliverables are the values of sound pressure levels in LAeq (06-22) for each receptor and – relatively to the chosen configurations – with receiving points located on a rectangular grids. An initial data analysis has identified differences in values due to errors in interpretation of data input, so severe as to suggest subsequent ongoing simulations that, decreasing the influence of choices made by the operators, are able to provide information on different stages and components of noisy event.

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