THE INCLUSION OF RECREATIONAL ACTIVITIES IN STRATEGIC NOISE MAPS

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ABSTRACT

Strategic Noise Maps in Europe are supported mainly by Directive 2002/49/EC and by Good Practice Guide for the preparation of Strategic Noise Maps. These documents address mainly four types of noise sources: Roads, Railways, Airports and Industries and was therefore not included the Recreational Activities. This article seeks to justify the need for inclusion of Recreational Activities in the Strategic Noise Maps, present some examples, the main difficulties associated with, and the methods that can be used for characterization and modelling of this special type of noise source.

1 INTRODUCTION

The definition of Environmental Noise in the Directive 2002/49/EC [1], often referred by END (Environmental Noise Directive), is as follows, in accordance with paragraph a) of Article 3 of the END: "…*shall mean unwanted or harmful outdoor sound created by human activities, including noise emitted by means of transport, road traffic, rail traffic, air traffic, and from sites of industrial activity* ...".

Although an explicit reference does not exist, it is clear that the noise of Recreational Activities can match the definition of "*unwanted or harmful outdoor sound created by human activities*" so should appear in Strategic Noise Maps.

Also note, in this regard, the provisions of paragraph m) of Article 3 of the END [1]: "*«quiet area in open country» shall mean an area, delimited by the competent authority, that is undisturbed by noise from traffic, industry or recreational activities*".

Notwithstanding the above, the European Good Practice Guide for Strategic Noise Mapping [2], often known by GPG (Good Practice Guide) states the following on page 50 of 129: " *It should also be noted that the END does not require the acquisition of data on recreational noise ...*".

Put in another way, the END [1] does not require that Strategic Noise Maps include noise of Recreational Activities.

Of course, despite not being required by the END [1], it is possible, and in some cases it is necessary, to include noise of Recreational Activities in Strategic Noise Maps, as already indicated, for example, in references [3,4].

However, given the absence in GPG [2], or even in reference [5], about a standard methodology for the characterization and inclusion of Recreational Activity in Strategic Noise Maps, the methodologies could be different and without any framework of suitability.

So, the aim of this paper is alerting to the explained above, present examples of some Strategic Noise Maps that include noise of Recreational Activities and of some Strategic Noise Maps that do not include noise of Recreational Activities, and explain the main difficulties and methodologies for characterization and modelling of this type of noise source.

2 NOISE MAPS EXAMPLES

This paper is directed to the Strategic Noise Maps laid down in the END [1], but may be extend, *mutatis mutandis*, to any other type of Noise Map. Thus, in view of clarification that there are already several Noise Maps that include Recreational Activities, spite the difficulties and facts described, the examples presented here are not confined to Strategic Noise Maps, but for better understanding are divide in: 1) Strategic Noise Maps and 2) Other Noise Maps.

2.1 Strategic Noise Maps

There are 4 types of Strategic Noise Maps, laid down in the END [1]: 1) Agglomerations, 2) Major Roads, 3) Major Railways and 4) Major Airports. In these circumstances, the possible inclusion of Recreational Activities in Strategic Noise Maps can only occur for Agglomerations.

An example of an Agglomeration Strategic Noise Map which includes some Recreational Activities is the Strategic Noise Map of Lisbon City, as described on page 2 of it Non-Technical Summary, available on the website identified as reference [6] (to note that the information available, for this case, not allows to verify the methodology used for characterization and modelling of the Recreational Activities concerned): "*with regard to stationary sources were considered those whose activity is a sound source with influence on the environmental noise in the area, namely 'Parque da Nações' (riverside), 'Santo Amaro' docks (Alcântara) and 'Bairro Alto'*" (free translation).

An example of an Agglomeration Strategic Noise Map which does not include Recreational Activities is the Strategic Noise Map of Berlin City. As described immediately before Table 3, and in Table 3 itself, in the website identified as reference [7], the Strategic Noise Map of Berlin City only includes the IPPC industrial units [8].

2.2 Other Noise Maps

In Portugal, for example, apart from the obligation to prepare Strategic Noise Maps within the scope of the END [1], there is also the obligation to prepare Noise Maps within the scope of Municipality Land Use Plans, in accordance with Portuguese Decree Law No. 9/2007 [9] and reference [5]. In this context there are several Plans with Noise Maps that include Recreational Activities, namely:

- Albufeira Noise Map, 2013, with Non-Technical Summary available in the website identified as reference [10]. To note that in this case the information available indicates that the methodology of characterization and modelling used was based on the realization of a special program of noise measurements.

We list below examples of others Noise Maps that include Recreational Activities, in Brazil, Australia, Italy and Spain:

- Noise Map of Belém (Brazil) Trade Zone, which contains noise of the community and existing loudspeakers on the streets [11].
- Noise Map of an Entertainment area in Brisbane, Australia [12].
- Noise Map of Ships, including Cruises, anchored in the port of the Italian city of Venice [13].
- Noise Map of ZARE zone (Special Regime Acoustic Zone) in Barcelona, Spain, mainly consisting of pubs [14].

3 TYPES OF RECREATIONAL ACTIVITIES

There are several Recreational Activities capable of producing noise with potential affectation of people who live or stay in its vicinity, but they can be divided into the following three broad categories that influence the type of characterization and modelling, as discussed in the next chapter:

- Open Air Recreational Activities: People socializing and strolling the streets, outdoor concerts, water sports, etc.
- Recreational Activities in Semi-open Buildings: Pubs that work with open door, concerts and games in stadiums, etc.
- Recreational Activities in Closed Buildings: Closed Discos and Pubs, etc.

4 DIFFICULTIES AND METHODOLOGIES

4.1 Noise classes

One of the major difficulties of characterization of Recreational Activities, as mentioned in reference [4], relates to the possibility of different noise emission over time, for example, in areas of pubs, in the early evening may exist fewer people and less noise, but with the night "advance" the number of people and the pubs themselves can emit more noise. With specific regard to the Strategic Noise Maps, as they must correspond to an annual average, and since many Recreational Activities are seasonal, it is relevant to know the months and/or days of the week on which the Activity takes place to determine the necessary annual logarithm average of the noise emission.

To note that the chapter 3.1.6.3 of reference [15], discusses typical seasonal cases (daily, weekly, and monthly) and the overall results usually associated, warning that each case is unique and that sometimes certain assumptions based on preconceptions considered adequate reveal themselves wrong, after proper quantitative analysis.

According to references [4,14] the best way to determine the variations of noise will be the realization of 24 hours measurements on weekdays and on weekend, preferably near to receivers affected. However, these references do not specify the form of division of noise variations in different classes.

Having regard to the provisions of Chapter 6.5.1 of ISO 1996-2 [16], we have: "*The source operating conditions shall be divided into classes. For each class, the time variation of the sound emission from the plant shall be reasonably stationary in a stochastical sense. The variation shall be less than the variation in transmission-path attenuation due to varying weather conditions ... The time variation of the sound emission from the plant shall be determined from 5 min to 10 min L_{eq} values …*".

It is believed that, in the absence of other standard information, we should consider that a particular type of noise belongs to the same class if the associated variations are smaller than the variations due to weather conditions. Since according to Figure A.1 of ISO 1996-2 [16] the best value of Standard Uncertainty, due to weather conditions, is 1.5 dB, it can be considered that we have a single Noise Class if the standard uncertainty associated with different measurements (5 to 10 minutes for each measurement duration) is less than 1.5 dB. This means, in terms of standard deviation s_d of measurements and of the number n of measurements (assuming the relations of the chapter 4.2.4 of reference [17]):

$$\frac{s_d}{\sqrt{n}} < 1{,}5 \text{ [dB]} \quad (1)$$

4.2 Measurements around noise sources

Measurements of Sound Pressure Levels around noise sources, for characterization of Sound Power Levels associated with each Noise Class (determined in accordance with the previous subchapter), may follow, in adapted form, the provisions of ISO 8297 [18]. To note that, as stated in reference [19], at least under Strategic Noise Maps scope, is expected the necessity of using a simplified adaptation of ISO 8297 [18], namely the reference [20]. To note also that, despite the fact that ISO 8297 methodology is more adequate for Open Air Recreational Activities, it can be adapted to any type of Recreational Activity (Open-Air, Semi-open Building, Closed Building).

In other cases, a more detailed characterization may be required, as noted in references [21,22].

The greater or lesser simplicity of characterization and modelling, and the method chosen, will depend primarily on the greater or lesser proximity of the receivers to the sources of noise. Typically a greater proximity of receivers implies the need for characterization and modelling less streamlined and less proximity allows simplified characterization and modelling.

Can also be used the called Relational Method, according to references [15,23], or the called Inverse Noise Modelling Method, according to reference [24]. In general, these methods make use of the emission, propagation and reception relations established in ISO 9613-2 [25], to construct a system of equations and determine, by solving the system of equations, the unknown values involved (usually the Sound Power Levels).

Given the particular importance and use of the ISO 8297 [18], are analyzed in the next chapter its main limitations.

4.3 Main Limitations of ISO 8297

The following are the main limitations of ISO 8297 [18]:

- Area: The Step 4 of ISO 8297 (section 10.4) defines a parallelepiped volume above ground witch surface area must be logarithmic "add" to the Sound Pressure Level in order to calculate the Sound Power Level. This approach means, in on one hand, the assumption of an acoustic reflector ground (not considering the imaginary volume below the ground), which may not be the case in many practical situations (possibility of a typical error of 3 dB in the calculation of the Sound Power Level), and secondly the parallelepiped surface area may deviate more or less from the hemisphere surface area that should be used to determine Sound Power Level of Point Source, depending on the horizontal and vertical dimensions in question (especially for horizontal dimensions higher than the 320 m limit established in the standard, and for not very lofty heights of measurement that do not comply with section 9.3 of the standard (which sometimes may be required), may occur a significant difference in areas that may lead to significantly erroneous determination of the Sound Power Level concerned).
- Proximity Correction: The Step 5 of ISO 8297 (section 10.5) defines an expression to correct the Sound Pressure Level measured at a distance less than twice the largest dimension of the source that may no longer be valid for higher dimensions that may be necessary to characterize (largest dimension of source higher than 320 m).
- Atmospheric attenuation: The values of Atmospheric Absorption Factors shown in Step 7 of the ISO 8297 (section 10.7) are based on ISO 3891 [26], which is a relatively old standard (1978), where the Factors considered are similar to those considered in ISO 9613-1 [27] (base standard of the European Interim method for Industries [25]), with the exception of 8000 Hz octave band, where the attenuation factors may be significantly different, and may subsequently lead to outcomes of Sound Power Level proportionally different.

For the reasons given is advised that the determination of the Sound Power Level through ISO 8297 [18] be accompanied by an auxiliary calculation of Correction Terms of passage of Sound Pressure Levels for Sound Power Levels, by using a software of outside acoustic modelling, using a prediction method appropriate (typically the European Interim method ISO 9613-2 [25]) instead of using the formulas of Steps 4, 5 and 7 of ISO 8297 [18]. So, such auxiliary calculation permit exceed the limit of 320 m for the largest horizontal dimension of a the sound source and to enable the characterization of non-horizontal sound sources, such as the typical case of vertical sources in the buildings façades.

4.4 Measurements inside buildings

For Recreational Activities in Semiopen Buildings or Closed Buildings, may be appropriate the characterization of the sound pressure levels inside, not only to meet these values and compare them with good practice limits, for the protection of workers and audience [28], but also with the purpose of characterizing the Façade Sound Emission of these buildings, according to EN 12354-4 [29].

A practical example of the use of this methodology is located in reference [14], considering that the sound radiation occurs primarily through open doors and windows. The general equation applicable for determination of Sound Power Level corresponds to the combination of equations (2) and (3) of EN 12354-4 [29], i.e.:

$$L_w = L_{p,in} + C_d - R' + 10\log\left(\frac{S}{S_0}\right) \quad (2)$$

$$R' = -10\log\left[\sum_{i=1}^{m}\left(\frac{S_i}{S_0}10^{\frac{-R_i}{10}}\right) + \sum_{i=m+1}^{m+n}\left(\frac{A_0}{S}10^{\frac{-D_{n,e,i}}{10}}\right)\right] \quad (3)$$

Where prevail propagation openings (Recreational Activities in Semi-open Buildings) *R'* tends to zero [14]. Where not prevail propagation openings (Recreational Activities in Closed Buildings) will be necessary, using this methodology, meet the applicable values of *R*', or perform measurements of sound pressure levels outside, for infer the values of *R*', or even the values of L_w, for example through a methodology that use ISO 8297 [18] with the aid of software, as described in the previous sub-section.

4.5 Typical Database

In line with the provisions of the GPG [2], may be used, for Strategic Noise Maps, a less precise method, which makes use of default values for typical situations. In this case it is considered of particular interest the values provided in VDI Guide 3770 [30]. Are presented in Table 1 examples of default values given in VDI 3770.

In the particular case of water sports, it is also considered of particular interest the limit values of the reference [31], presented also in Table 1.

Table 1: Default values for Recreational Parks [30] and Crafts [31]

Source in Recreational Parks	Sound Power Level L_{WA}	Single engine power in kW	Maximum Sound Pressure Level L_{pASmax}
Music express	98	$P \leq 10$	67
Chairoplane	100	$10 < P \leq 40$	72
Roller coaster	102 a 107	$P > 40$	75
Stage (presenter)	105		
White water ride	89		
Saurian (loudspeaker)	91		
Swing boat	102		
Circus (children)	99		

It's also highly relevant the given sound power data of human communication noises, useful for pedestrian streets and touristic areas, and some references of emission level of discos, open-air concerts and other facilities with music, applicable to noise mapping of this type of activities.

5 CONCLUSIONS

It is easy to understand, that in certain cases, assume particular relevance the inclusion of Recreational Activities on Strategic Noise Maps, although this kind of noise source is not mandatory to include in Strategic Noise Maps. The authors wish that this paper could help those looking to include Recreational Activities on Noise Maps and could contribute also, in its proper measure, for the path that must be drawn in the direction of future harmonization – one of the objectives of Directive 2002/49/EC [1] – to use the most effective and appropriate methods for characterization and modelling of Recreational Activities.

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