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Noise Mapping: the Evolution of Italian and European Legislation

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Maps are the most suitable method to represent environmental noise. Noise mapping allows to clearly indicate several aspects of environmental noise: the state of acoustic pollution, noise limits, breaches of limit values, acoustic zones, number of people affected by noise in a particular area. The recent Italian and European legislation in the field of acoustic pollution prescribes the redaction of maps. Data about environmental noise levels should be collected, collated or reported in compliance with comparable criteria among the EU member states. This fact implies the use of harmonised indicators and evaluation methods. The recent European Directive 2002/49/EC (June 25, 2002) [1] establishes that each EU member states must apply L_{den} and L_{night} noise indicators when creating strategic noise mapping. In the paper, Italian and European legislation, with particular reference to noise mapping, are compared. The most important Italian noise indicators are described such as L_{VA} indicator, peculiar to noise in the surrounding airport areas [2]. Lastly, the effects of the new European indicators on noise mapping in Italy have been evaluated.

1. INTRODUCTION

Environmental noise may be represented through maps. Noise maps may be created in a graphical or tabular way; three kinds of maps are generally taken into account: maps informing citizens about noise pollution in their territory; maps for noise zoning or noise reduction planning; maps for noise reduction interventions design. Recently, a European Directive [1] has been issued in order to define common rules on which noise maps may be realized by EU member states. The aforesaid Directive (2002/49/EC of June 25, 2002) [1] has introduced two noise indicators, L_{den} (day-evening-night level) and L_{night}. Thus, noise levels have to be measured or estimated in three reference periods: day (07.00 a.m.-07.00 p.m.), evening (07.00 p.m.-11.00 p.m.) and night (11.00 p.m.-07.00 a.m.). The European Directive is here summarized. The new noise indicators are compared with the ones used in Italy till now. In particular, the Italian Legislation does not include the evening reference period. Some examples are reported regarding Italian Municipalities acoustic zoning, a comparison between noise levels calculated by means of Italian and European Legislation, the problematics about noise mapping in the surrounding airport areas and the necessity to include noise evaluation procedures into the guidelines the Commission will publish no later than July 1, 2003.

2. EUROPEAN DIRECTIVE 2002/49/EC

The Directive 2002/49/EC of the European Parliament and of the Council (June 25, 2002) "relating to the assessment and management of environmental noise" [1] establishes a common approach, in every EU member state, to avoid, prevent and reduce the effects due to human exposition to noise sources. The main Directive aims are: the evaluation of exposure to environmental noise, through noise mapping, by using noise indicators common to the Member States; ensuring that information on environmental noise and its effects is available to the public;

the adoption of action plans by the Member States, based upon noise mapping results. Such a directive proposes to unify noise indicators and environmental noise evaluation methods depending on the noise pollution source. Such criteria and methods may be established by the Community. The Directive defines noise mapping as “the presentation of data on an existing or predicted noise situation in terms of a noise indicator, indicating breaches of any relevant limit value in force, the number of people affected in a certain area, or the number of dwellings exposed to certain values of a noise indicator in a certain area”. A "strategic noise map" is a map designed for the global assessment of noise exposure in a given area due to different noise sources or for overall predictions for such an area. There are different kinds of noise maps: maps with data to be sent to the Commission, maps which provide a source of information for the citizen and maps which provide a basis for action plans. The Directive 2002/49/EC provides to develop and complete the existing set of Community measures concerning noise emitted by the major sources (road and rail vehicles and infrastructure, aircraft, outdoor and industrial equipment and mobile machinery). This Directive does not cover noise generated by the exposed person, from domestic activities, generated by neighbours, at work places, on board of means of transport or due to military activities in military areas. The selected common noise indicators are L_{den} (day-evening-night noise indicator) and L_{night} (night-time noise indicator). The determination of the two proposed indicators values may be obtained through phonometric measurements or by means of mathematical evaluation methods. L_{den} indicator allows to assess the degree of community noise annoyance. L_{night} is highly correlated with sleep disturbances inflicted on the community. The day-evening-night level L_{den} is evaluated in decibels (dB) as follows:

$$L_{den} = 10 \cdot \log \frac{1}{24} \left(12 * 10^{\frac{L_{day}}{10}} + 4 * 10^{\frac{L_{evening}+5}{10}} + 8 * 10^{\frac{L_{night}+10}{10}} \right) \quad (1)$$

where L_{day}, $L_{evening}$ and L_{night} are the A-weighted long-term average sound levels defined in ISO 1996-2: 1987, determined respectively throughout the day, evening and night periods of a year. The default reference time periods used to evaluate such indicators are 07.00 a.m.-07.00 p.m. (day), 07.00 p.m.-11.00 p.m. (evening), 11.00 p.m.-07.00 a.m. (night). Each member state may apply the national evaluation method until common methods to evaluate L_{den} and L_{night} are adopted, but adapting it to L_{den} and L_{night} definitions. For example, in Italy, it is necessary to introduce the evening period, not prescribed by the national legislation. For Member States that have no national computation method or wish to change their existing ones, Directive recommends the following methods: ISO 9613-2 for industrial noise; ECAC.CEAC Doc. 29 for aircraft noise; the French national method NMPB-Routes-96 for road traffic noise; the Netherlands national method Reken en Meetvoorschrift Railverkeerslawaai ’96 for railway noise. Those methods must be adapted to L_{den} and L_{night} definitions. The Commission will publish guidelines on the revised methods no later than July 1, 2003. No later than EU Member States must designate the competent authorities and entities responsible for making and approving noise maps. Member States may use other noise indicators different from L_{den} and L_{night} for acoustical planning and noise zoning. Noise indicators limit values must be communicated by the Member State to the Commission no later than July 18, 2005. Besides, the

Directive prescribes that no later than 06.30.2007 strategic noise maps have to be elaborated and, where relevant, adopted relative to 250000 inhabitants agglomerations, major roads with more than six millions passages per year, major railways with more than 60000 train passages per year and major airports (more than 50000 movements per year, except for training and light aircraft). The relative noise plans have to be drawn up no later than July 18, 2008. Strategic noise maps relative to the other agglomerations, major roads and major railways have to be ready no later than June 30, 2012. The relative noise plans have to be drawn up no later than July 18, 2013. Strategic noise maps shall be reviewed and, if necessary, revised at least every five years. Data have to be sent to the Commission within six months of the aforesaid dates. Member States must ensure that strategic noise maps and the drawn up noise plans are made available to the citizens. Thus, the Commission shall set up a database about noise maps data. Maps with the purpose of informing the citizens or developing action plans require detailed information. In particular: a graphical presentation is necessary; maps representing the exceedance of a limit value must be given; difference maps (a comparison between the existing situation and various possible future ones) must be given; maps showing the value of a noise indicator at a height other than 4 m where appropriate must be given.

3. ITALIAN LEGISLATION

In Italy, the year 1995 represents a new awareness in national policies on the battle against noise pollution; in fact, Law n. 447/95 [3] was issued. Afterwards, the concept of noise mapping has become very important with the publication (June 12, 2000) on the Italian Official Gazette of the Environmental Minister Decree of November 29, 2000 [4]. Such a Decree establishes the criteria that the firms and the agencies which manage public services of transport or relative infrastructures must follow in order to plan and to execute noise plans. It is the first decree in which noise mapping is pointed out and made obligatory explicitly. According to the Decree, the firms and the agencies which manage public transport services or relative infrastructures are obliged to present their noise plans as follows: 1) within eighteen months from the Decree enforcement (therefore within August 6, 2002), the manager firm or agency should have transmitted to Municipalities, competent Regions or other indicated Authorities, noise data relative to the areas where a noise limit exceedance has been estimated or measured (it is obvious that the maps may represent such data in a synthetic form); 2) within eighteen months from the 1) deadline, the manager firm or agency will have to submit its noise plans in compliance with Law 447/95. Noise plans have to be submitted also if noise limits exceedance has been verified after 1) data transmission to the competent Authority; 3) noise plans purposes must be realized within 15 years (for local, regional or national linear infrastructures) or 5 years (for airports and the remaining infrastructures) from the date when the competent Authority issues a provision or from the plan submitting date if after 3 years a provision has not been still issued. Mathematical models may be used to estimate noise levels and report them on cartographic support. Single points values and iso-level curves have to be reported relatively to the situations prior or following the noise reduction interventions. Each acoustic plan has to be designed by considering the infrastructure characteristics. It must be constituted at least by: noise equivalent levels emitted in the more exposed receivers before the interventions; noise equivalent levels emitted in the more exposed receivers after the interventions; interventions dimensioning in order to comply with Law noise limits; the zone chorography (scale not less

than 1:5000); the interventions zone planimetry (scale not less than 1:1000); any potentially important sections (scale not less than 1:200); photographic documentation; the evaluation of interventions results by means of mathematical models and measurements.

4. AIRPORT NOISE MAPPING

The Directive 2002/30/EC of the European Parliament and of the Council (March 26, 2002) [5] defines common rules to evaluate noise exposure in the surrounding airport zones. In particular, this Directive suggests that the assessment of noise exposure shall be carried out by using at least the common noise indicators L_{den} and L_{night} proposed by the Directive 2002/49/EC [1]. Instead, Italian Law defines peculiar noise indicators relatively to transport infrastructures. For example, airport noise must be evaluated following the Minister Decree of October 31, 1997 [2]. Such a Decree defines an airport noise level (L_{VA}) as follows:

$$L_{VA} = 10 \cdot \log \frac{1}{N} \cdot \sum_{j=1}^{N} 10^{L_j/10} \quad \text{dB(A)} \tag{2}$$

where N is the observation time in number of days, L_j is the airport noise level referred to a one day observation time. N must be equal to 21 days (three weeks). The observation weeks must be chosen in the following three periods of the year: October 1-January 31; February 1-May 31; June 1-September 30. The one-day airport noise level (L_j) is obtained as follows:

$$L_j = 10 \cdot \log \left[\left(\frac{17}{24} \right) \cdot 10^{\frac{L_d}{10}} + \left(\frac{7}{24} \right) \cdot 10^{\frac{L_n}{10}} \right] \quad \text{dB(A)} \tag{3}$$

where L_d e L_n are the airport noise levels referred respectively to a day time period (06.00 a.m.-11.00 p.m.) and a night time period (11.00 p.m.-06.00 a.m.) [2]. Previsional computational models may be used in order to evaluate L_{VA} values in the surrounding-airport zone. Specific Commissions chosen by the Italian Institute for Civil Aviation are instituted to define three airport limit zones surrounding each airport area: A zone (no activities limitations); B zone (agricultural, livestock breeding, industrial, trading, tertiary and assimilated are allowed only if suitable noise reduction procedures are adopted); C zone (only activities due to the airport infrastructure are allowed). L_{VA} values have not to exceed the following limits. A zone: 65 dB(A); B zone: 75 dB(A); C zone: 75 dB(A); out side A, B and C zone: 60 dB(A). Flight paths are provided in order to determine the L_{VA} level curves relative to each airport zone.

5. THE IMPACT OF THE EUROPEAN DIRECTIVES IN ITALY

Italian Municipalities noise mapping has been realized in order to acoustically zone the entire territory. 593 Italian Municipalities have approved the acoustic zoning until 2000. Now 10.6% Italian Municipalities have approved acoustic zoning (812 Municipalities) [6]. Figure 1 represents the percentages of zoned Municipalities for each Italian Region/Autonomous Province. The new European noise indicators have to be taken into account. CIRIAF (Centro Interuniversitario di Ricerca sull'Inquinamento da Agenti Fisici) has evaluated the impact of the

new European indicator L_{den} on Italian noise legislation. Traffic noise produced by the Italian highway junction Perugia-Bettolle (the area between Prepo and Pallotta tunnels) has been considered [7]. A measurement campaign has been carried out to evaluate both L_{den} and italian noise indicator L_{dn}. Measurement results have shown the following condition:

$$L_{den} - L_{dn} < 1\text{dBA} \tag{4}$$

The previous condition may be explained because European Legislation reference period (07.00 p.m.-10.00 p.m.) is considered 5dB more disturbing than the Italian one.

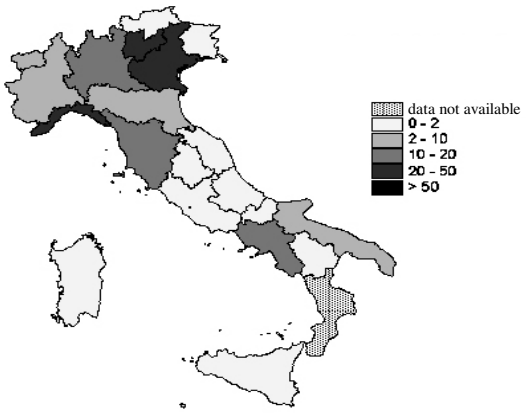

Figure 1: *percentages of acoustically zoned Municipalities in Italy [6]*

Also airport noise mapping should take into account the new European indicators. Some Italian airports are built near crowded areas; thus, ground activities (such as container charge/discharge) noise levels in the surrounding airport zone have to be mapped. Italian surrounding international airport areas are usually mapped for short (relative for example to year 2005) and long term conditions (relative to 2015). Ground activities noise maps are usually realized by using peculiar modelling code. L_{Aeq} noise indicator has to be evaluated, relatively to the day and night Italian reference periods. Air activities noise levels are usually evaluated by INM code and the airport future development plan. L_{VA} noise maps are referred only to air activities. Thus, noise maps relative to ground and air airport activities do not use the same indicators in agreement with the Italian legislation. European legislation suggests instead only one noise indicator (L_{den} or L_{night}) both for ground and air activities. European directive proposes methods for noise evaluation. It would be worthwhile to introduce also noise evaluation procedures in order to control and verify estimation errors. Procedures might be included into the guidelines the Commission will publish no later than July 1, 2003. As an example, CIRIAF has introduced the procedure ACIR-V-3VL/1 for industrial noise evaluation [8]. The procedure ACIR-V-3VL/1 is based on three kinds of noise measurements: A) measurements to individuate the characteristics of the noise source (power level, spectrum, directivity, emitting surface area); B) measurements to calibrate the evaluation model; C) measurements to establish whether estimated levels are sustainable. Estimated levels may be accepted if they differ less than 2 dBA with respect to the measured ones; on the contrary, the evaluation method must be repeated. The procedure introduces an

external revisor whose task is to: individuate C) measurement points; measure noise levels in those points; compare C) points measured levels with the estimated ones. The proposed procedure may be used jointly with ISO 9613-2 to achieve more accurate estimated noise levels. Thus, it is strongly recommended to introduce procedures into the Commission guidelines.

6. CONCLUSIONS

Italian and European Legislations on noise mapping have been analyzed and compared. The most important noise indicators have been described: L_{den} and L_{night}, introduced by European Directives 2002/49/EC and 2002/30/EC; L_{Aeq} and L_{dn}, derived by Italian Legislation; L_{VA}, introduced by Italian DM of October 31, 1997. European Directives introduce an evening (07.00 p.m.-11.00 p.m.) and a night (11.00 p.m.-07.00 a.m.) period respectively 5dB and 10dB more disturbing than the day (07.00 a.m.-07.00 p.m.) one. Italian Legislation introduces only the day period (06.00 a.m.-10.00 p.m.) and a night (10.00 p.m.-06.00 a.m.) period 10dB more disturbing than the day one. Thus, the period between 07.00 p.m. and 10.00 p.m. is considered more disturbing by European Legislation compared to the Italian one. Noise mapping rules introduced by the new European Directive have been described and compared to the ones adopted in Italy. The situation of Italian Municipalities noise mapping has been described. In particular, only 10.6% Italian Municipalities have approved acoustic zoning at this time. The impact of the new European indicators on airport noise mapping has been verified; lastly, in order to control estimation errors, it is proposed to include noise evaluation procedures into the guidelines the Commission will publish no later than July 1, 2003.

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