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The H.U.S.H. project - The geographical data platform for city noise action planning

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ABSTRACT

The H.U.S.H. (Harmonization of Urban noise reduction Strategies for Homogeneous action plans) project moves from the evidence that harmonization of noise action planning methods is needed, not only in Italy but also in all the European countries where a former Legislation about noise planning was existing at the moment of Environmental Noise Directive (END) 49/2002/EC adoption. The general aim is harmonizing national noise management standards with END for obtaining homogeneous noise Action Plans, in order to give contribution to the more general need of transposing, implementing and enforcing a common or harmonized environmental legislation among EU countries. Specific aims of the project are the following ones: a) to point out unsolved conflicts among current standards at Regional, National and European level; b) to define common methods for designing strategic and specific solutions; c) to define a new development system (procedures and database) for action planning by testing it in a pilot case; d) to design guidelines in order to build a system for action plan applications supporting Regional, National and European Law reviews. In this paper the results coming out from a specific action of HUSH project carried on by the University of Florence are described. This specific action focuses to build up the geographical data platform for city action planning. To achieve this aim, a few of city Action Plan data platforms - available in Italy and in European countries - were analyzed and compared referring to address the requirements set out by National, Regional and European regulations.

INTRODUCTION

Because of the lack of methodological guidelines in Italy, each subject involved in noise management and action planning has developed its personal database and procedures. As a consequence, different methodologies are available in order to evaluate criticality and priority of noise scenarios. This paper is aimed to analyse and compare available – both in Italian and EU cities - databases needed to address the requirements set out by National, Regional and European regulations.

At first step, databases and procedures have been acquired for Florence Municipality as a representative case study. Then, other relevant Italian cities - Milan and Turin – have been chosen as possible scenarios for data collection. Ultimately, during the Spring Meeting of Eurocities network a checklist was submitted to participants in order to obtain additional information about similar experiences in selected European cities as described in the data collection section.

The comparison of the above mentioned databases will contribute to define the H.U.S.H. work platform, by analysing and comparing the methods available in Italy with those used in different (European) context.

This action has been pointed out shared and exclusive elements in database development as well as underlining logics involved in analysed procedures. Database incoherences procedural conflicts have been accounted.

DATA COLLECTION

The data collection was carried out by reference to the following steps:

- a literature review has been carried out on the noise management techniques in urban areas;

- the Florence Action Plan database has been analysed;

- a checklist has been defined for the direct collection of data in the cities selected as most significant. The checklist has been defined with the collaboration of VIE EN.RO.SE. (partner responsible for data collection of noise reduction measures into the H.U.S.H. project) based on both the Florence experiences, but also on the results of literature search. The checklist was tested by collecting feedback and comments from a few cities. Then, after revisions and corrections, submitted via mail or by hand through meetings with representatives of all identified cities.

According to data collection results most critical conditions of data structures and currently used methodologies were defined.

State of the art analysis

As a first step, preparatory to the checklist structuring, a study was carried out about the state of the art on realization of noise mapping and action plans. The data collection has been focused in particular on methods of preparation of noise maps and action plans and on methods for defining geographical data platforms.

Concerning the preparation of noise maps, together with Directive [1] the most significant methodological reference used by the operators is certainly the *Good Practice Guide for strategic noise mapping and the production of associated data on noise exposure* (GPG) published by European Commission [2].

Referring to the GPG practical application, numerous publications in recent national and internatonal congresses pointed out the difficulties in noise mapping procedure. For example, some interesting Italian experiences were shown at the last national congress organized by the Italian Association of Acoustics related to noise mapping of some Italian cities (e.g. Bologna, Florence, Genoa, Milan, Pisa, Turin).

Concerning the preparation of Action Plans, the main reference is the END Directive, while there are not guidelines similar to GPG.

Referring to the experiences of implementation of Action Plans in the literature no information is available except for the preparation of the Action Plan of Florence [3].

At the end, on the geographical database definition necessary for the preparation of noise mapping and action plan, the Reporting Mechanism [4] was considered as a useful reference on the definition of the information required by the Directive. In the meantime, useful information was found in reference documents at national level (e.g. the specifications drawn up by the Region of Tuscany [5]) in order to standardize the structure of the information forming the geographical database.

Analysis of Florence Action Plan Database

The main aim of Florence Action Plan was to create a noise management system for urban areas, that would indicate to local government authorities which actions should be implemented in their territory for Hotspots and Quiet Areas, and what the priority order should be related to the single action.

In order to be the properly functioning, the system required a very large interactive database containing a large amount of “acoustic”(sound levels as output of the acoustic calculation, set limits, etc.) and "non-acoustic" (the possible interventions in each critical area, the number of receivers which could benefit from each intervention, etc) information. A GIS environment, thanks to the wide variety of data it can manage, is the ideal platform for developing these procedures [6].

In the Florence geographical database road traffic noise - divided into private vehicles and public transport - was considered as the most important source of urban area. Road traffic noise was divided into private vehicles and public transport contributions.

The railway traffic noise as well as the airport traffic noise, has been acquired directly as noise mapping realized according to Italian legislation, coming from responsible of each single source.

At the end, the Florence database was made up of the following elements [3]:

- the private road sources were represented by arc elements (linear elements placed in correspondence with the median strip of the road); to each arc data traffic flow was associated divided into three reporting periods day-evening-night according to the END requirements;

- the local public transportation sources were represented by arc elements, too (linear elements placed in correspondence with the median strip of the road); to each arc bus traffic flow was associated divided into three reporting periods day-evening-night according to the END requirements;

- the receivers were represented by polygon elements (polygonal element placed in correspondence with the perimeter of the receiving building). Receiver buildings were divided into residential buildings and sensitive ones (eg schools, hospitals, etc). The residential buildings were associated with the information concerning the number of inhabitants. The sensitive building were associated with a representative number of people depending from the building type (e.g. the number of students in the case schools).

- territorial information such as detailed cartography in which altitude points and contours, embankments, bridges, viaducts took place.

- addition of various linear and polygon themes necessary for the allocation of noise limits (riferimento in bibliografia);

- Quiet Areas themes; in the Florence Action Plan Quiet Areas were defined as polygon elements according with the procedure described in the following.

Procedure for calculation of sound pressure levels

The aim of the calculation is to provide acoustic noise levels necessary for subsequent analysis and application of the procedures for both identification of Hotspots and critical sources and noise assessment in Quiet Areas.

Without mentioning details in describing the stages of modeling, the most interesting result concerns the optimization of procedures for transferring data from the GIS platform to acoustic simulation one, minimizing the operation to be conducted within the second one.

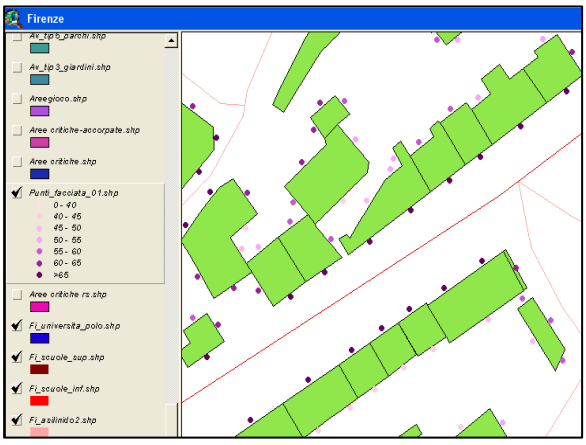

Figure 1 – Output calculation for Hotspots: sound pressure levels on facade points [3].

Semi-automatic import procedures from GIS platform were defined. At the end of calculation the noise output are exported back to GIS for subsequent steps of analysis and assessment.

Referring to the identification of hotspots, based mainly on the verification of excess noise on building facade (Fig. 1), the simulation on the facade points run; on the other hand the Quiet Areas assessment was obtained through the simulation on a grid of equally spaced points (Fig. 2).

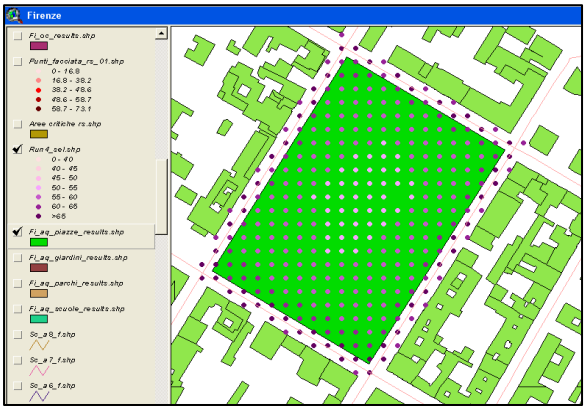

Figure 2 – Output calculation for Quiet Areas: sound pressure levels on a grid of equally spaced points [3].

Through the acoustic model simulations were performed two steps of calculation, evaluating the noise contributions from the private traffic and public transport.

The contributions, that were available for each calculation point, were composed in the GIS platform to get the total sound pressure level that had to be compared with noise limits for defining the Hotspots where limits were exceeded. The separate definition of the noise contributions due to private traffic and public transport service allowed to allocate responsibilities between the infrastructure managers and transportation service.

Procedure for allocating of noise limits

In Italy, limits are defined in accordance with both the noise zoning made by the municipalities and the acoustic band relevance of transport infrastructures.

In the Florence Action Plan database noise zoning and acoustic band relevances were represented by specific polygon themes.

Without mentioning details, the noise limits were assigned to the receiving point simply considering its belonging or not to a band of relevance and noise zoning.

Procedures for identifying critical areas and critical sources

The procedure for the identification of critical areas, should lead to identify the source of criticism and circumscribe a critical area in which the source is believed to have an effect for the overrun.

In the Florence Action Plan database the procedure was based on receiver points close to façade. This choice was made according to the following considerations:

- the noise levels resulting from the calculation are immediately available, divided into the different contributions due to traffic and public transport;

- it is easily possible to assign noise limits with single points;

- it is easily possible to determine if an excess of noise limits takes place and what are the individual responsibility.

However, the Florence Action Plan database was structured so that the façade point theme was linked with building polygonal theme by creating a common key field. In this way, if necessary, it was always possible to link the results obtained at receiver points to the receiver's buildings.

Starting from the hotspot point, the main road source was identified in a search radius set equal to 30 m. This condition is set so to avoid errors in assignment if the hotspot point is close to an intersection.

Then, the distance "*d*" from the road axis to the hotspots point was calculated and a buffer around the point with radius equal to *2.8·d* was created. The buffer corresponded to the critical area as shown in Figure 3.

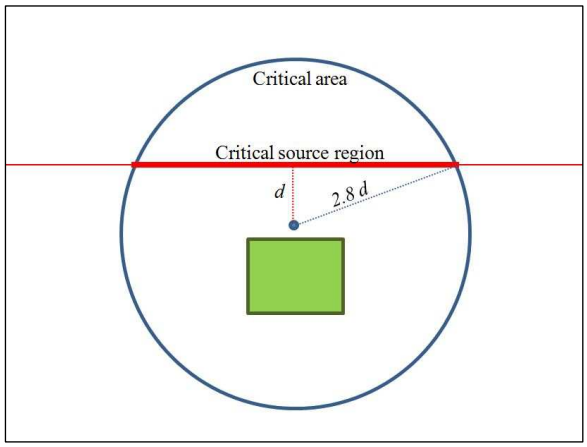

Figure 3 – Critical area defined starting from the hotspot point [3].

This approach is based on the assumption that the far regions of the line source, with distance greater than 2.8 times *d*, contribute less than 1 dB, at receiver position, compared to the close ones [7].

Critical areas associated with the same noise source was subsequently merged. Figure 4 is an example of critical merged area.

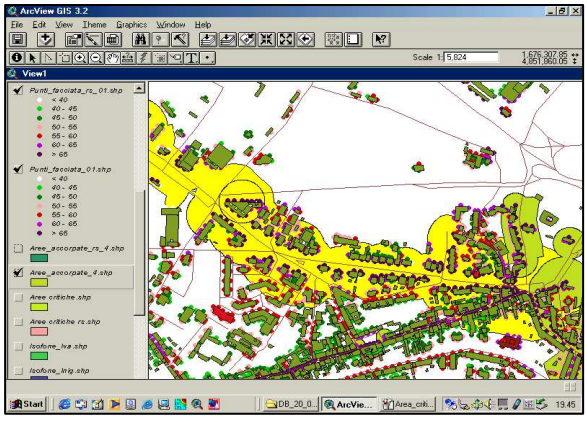

Figure 4 – Critical merged area [3].

At the end, critical sources (regions of road that need noise reduction measures) were identified from the intersection of critical areas merged with the graph of the roads (Fig. 5).

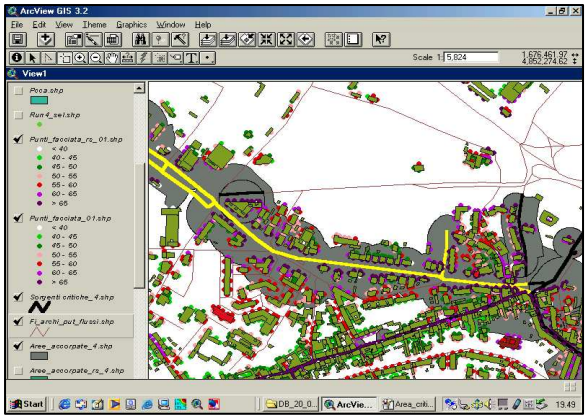

Figure 5 – Critical source region [3].

Procedures for identifying and assessment of Quiet Areas

In Florence Action Plan, the Quiet Areas were identified referring to both the actual availability of data and strategic motivations.

Quiet Areas were classified as follows: Green School (green area close to a school building); Gardens (green area less than 25,000 m^2 with furniture, or between 300 m^2 and 25,000 m^2 although no furniture); Park (green area extending more than 25,000 m^2), Square (area enjoyed by citizens). While the first three items are commonly represented as silent zones, the choice of squares can be considered as a strategic choice because of their high attendance in the immediate vicinity of road infrastructure affected by high traffic flows.

For Quiet Areas assessment two different approaches were considered, a quantitative approach and a qualitative one.

The quantitative analysis was based on the calculation of noise pressure levels on a grid of points 10x10 m spaced in the areas identified as quiet. In particular, the quantitative analysis considers:

- as acoustic parameter, the equivalent sound pressure level evaluated during the day period (period of actual use of Quiet Areas) was considered; the higher value was picked up among those of the grid points that fall within the perimeter of the quiet area;

- as reference limit, the quality values defined by the Italian legislation related to noise zoning was considered.

By using the previous quantitative method, it was possible to determine which areas were actually quiet or were in a critical situation.

Furthermore, in addition to the previous quantitative analysis, qualitative analysis of Quiet Areas took place based on the perception of sound, and on subjective aspects related to the study of the soundscape.

In the soundscape analysis the noise perception was considered together with other components, such as landscape and the expectations of the area users, that contribute to individual assessment of environmental quality.

The experience of Florence shows how procedures for developing, analyzing and managing Quiet Areas can not be reduced solely to quantitative analysis on the equivalent continuous sound pressure level, but must be extended to subjective parameters.

However, even in the Florence Action Plan the question about which approach is more appropriate for definition, evaluation and management of Quiet Areas is not conclusively solved yet.

Check list submitted to EU cities

Checklist on the database needed for the implementation of noise mapping and action plan has been structured to acquire the following information:

- noise parameters, noise limits and their reference time periods;

- data used as input for sound power characterization of sources in noise model (i.e. road traffic data, average speed, noise paving, etc);

- non acoustic data used as input to define the receiver buildings and the number of people for each building;

- non acoustic data used as input to define the outdoor receiver areas and the number of people for each area;

- specific choises in building up the noise model;

- model output for the building receivers and the outdoor receiver areas;

- details about geografichal data, data used for height building assessment;

- details about computational model (i.e. software used in modelling, standard considered for acoustic calculation, number of reflections, ground absorption, model accuracy and calibration method);

- details about methods used to determine criticality and priority index of each kind of interventions.

DATA COLLECTION ANALYSIS

In order to make available, accessible and truly comparable data collection and in order to allow their use for the establishment of an optimal database, the information gathered was analyzed and amalgamated according to the following main themes:

- implementation of Strategic Noise Mapping;

- Hotspots definition and assessment;

- Quiet Areas definition and assessment;

- Action Planning.

Strategic Noise Mapping

As a first result of the analysis of collected data, a substantial uniformity of approach for the realization of strategic noise maps for different cities investigated emerges, generally consistent with the European GPG guideline. Certainly significant differences are in the collection of information (eg data traffic flows, population data to be associated buildings) resulting from the data actually available in each local area, but these differences are still consistent with possible toolkits suggested by the GPG.

The main criticism is related to the difficulty of overlaying and comparing noise maps produced by different operators

for the composition of strategic noise mapping of agglomeration.

It is important that noise maps are stackable to allow local administrators to manage situations of conflict where there is overlap of the contribution of multiple sources.

This difficulty has led the strategic noise map makers to newly calculate noise map for each source, without considering the mapping previously provided by the single infrastructure manager (implemented according to what is required by Italian law). Doing in this way, copies of maps are created with unnecessary waste of resources.

Hotspots

The definition and assessment of hotspots is a specific step af Action Plan according to the END requirements, but it was addressed by only a few cities: of all the cities that responded to the questionnaire only Florence realized the Action Plan, and, within this, has developed a method to define hotspots.

In the case of hotspots, some problems related to lack of definition of a methodology for easy and unambiguous delineation of critical areas can be identified. However, these problems could be easily solved by generalizing the approach of Florence.

Quiet Areas

In the case of Quiet Areas, an actual need consists of a development of a new method for Quiet Areas definition and assessment.

In the case of Florence, an a priori definition of Quiet Areas was made and a quantitative and qualitative assessment approach was proposed. However, it is also evident that such as assessment of quiet areas can be considered as a first somehow hypothetical solution rather than a consolidated one.

Action Planning

Referring to noise reduction measures, they have been analyzed by VIE EN.RO.SE., the early analysis shows a significant criticism of the availability of data. In particular, for direct interventions (eg noise barriers, low noise paving, etc), it proves to be very difficult to find information regarding both the costs for the implementation of intervention and the intervention acoustic effectiveness over time. In practice, no information is available about the intervention maintenance costs. In the meantime, referring to the strategic interventions (eg changes to the traffic plan as noise reduction measure), no data are available about costs or acoustic effectiveness.

Other critical issues in drafting the Action Plan, revealed by the analysis of the checklist, but especially from the meeting of Eurocities, are linked to the absence of a shared method for assigning priorities for action planning.

CONCLUSIONS

In this article have been acquired data regarding the structure of the databases used for the preparation of strategic noise mapping and action plans implemented by some European cities according with END Directive.

In particular, methods used for data acquisition have been described and, finally, a synthesis of data collection has been carried out and the main issues have been listed.

In the prosecution of the HUSH project, a method to solve each critical issue will be developed.

Based on the aim of the END Directive, new guideline will be realized to define the optimal structure of the geographic database and to establish procedures for database management. In addition, referring to the critical issues that need for legislative actions rather than technical ones, the guideline will be submitted to the Italian Ministry and/or to the European Commission for the necessary additions and revisions of the Italian normative and /or European directive.

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