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Life+2010 Quadmap Project (Quiet Areas Definition and Management in Action Plans): The methodology tested and optimized in pilot cases in Florence, Rotterdam and Bilbao

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Summary

Current practices about selection, assessment and management of Quiet Areas in EU Countries, though regulated by the EU Directive 49/2002/EC on Environmental Noise, appear to be extremely fragmented and inhomogeneous. In fact, each country during past years adopted a set of strategies strictly related to specific contexts. Proposing a solution to overcome the lack of harmonized methodologies for Quiet Areas is the main aim of QUADMAP (QUiet Areas Definition and Management in Action Plans) project. The project has a high level of demonstrativeness guaranteed by the fact that the methodology proposed for identification, delimitation and prioritization of QUAs will be tested on a number of case study areas. In particular, it will be applied in a set of pilot cases in Italy, Spain, and in The Netherlands. The project started on 1st September 2011 and lasts three years. At the beginning of 2013 the harmonized methodology has been defined. The proposed procedure has been tested since February 2013 in all pilot cases and optimized according to data collected in the pilot cases. In this paper the optimization procedures are described, with particular attention to those developed in the period April-June 2014.

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Introduction

Current practices about selection, assessment and management of Quiet Areas in EU Countries, though regulated by the EU Directive 49/2002/EC on Environmental Noise, appear to be extremely fragmented and inhomogeneous. Moving from these considerations and from previous studies in the field of urban noise analysis and management carried out by some of the authors [1-4], the necessity of dealing with the definition and management of QUAs clearly emerged.

At the beginning of 2013 a draft procedure in order to select, analyse and manage QUAs has been developed and it is briefly summarized in the paragraph 1. The detailed description of each section of the method, data to be acquired and related tools are exposed in previous works [5-6]. The proposed methodology has been tested in different typologies of pilot areas, selected in three European cities: six school yards in Florence, two public parks in Rotterdam, a square and a sub-urban area in a green ring in Bilbao. The decision of testing the method in a variety of pilot areas permit not only to optimize the general procedure, but also to understand which adaptations are needed in each case.

Data requested have been collected (see paragraph 2) and analysed using mathematical and statistical approaches agreed by project partners in order to check the feasibility of each tool. The applied procedure of analysis and most significant recent results are described in the paragraph 3 and changes made in the optimized procedure starting from the original one are illustrated in the paragraph 4.

1. Brief description of the original version of the methodology

In the following the original proposal of the methodology developed by the Quadmap project is shortly reported as a sequence of schematic flowcharts (Figure 1 and Figure 2).

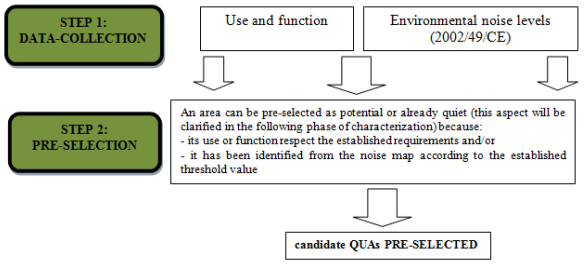

Figure 1. Phase of QUAs selection.

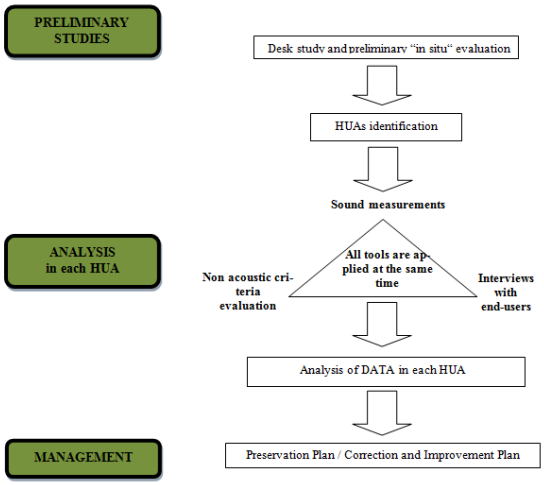

Figure 2. Phase of QUAs analysis and management.

2. Application of the methodology and collected data

Pilot areas chosen in order to test the draft procedure are identified in Table I.

City	Name of the area	Geographical Coordinates	Typology
Florence	P. Uccello	43°47'39.13" N, 11°10'46.56" E	School yard
Florence	E. De Filippo	43°46'51.34" N, 11°12'09.05" E	School yard
Florence	A. Manzoni	43°47'39.13" N, 11°10'46.56" E	School yard
Florence	F. Dionisi	43°46'00.24" N, 11°18'23.74" E	School yard
Florence	M. Vamba	43°47'46.33" N, 11°13'14.74" E	School yard
Florence	P. Fedi	43°46'51.55" N, 11°12'15.01" E	School yard
Rotterdam	Southern	51°52'50.70" N, 4°29'11.83" E	Park
Rotterdam	Spinoza	51°52'34.72" N, 4°31'16.14" E	Park
Bilbao	General La Torre	43°15'23.70" N, 2°56'48.38" O	Square
Bilbao	S. Marina	43°17'00.50" N, 2°56'40.02" O	Peri-urban area in Green ring

Table I. Pilot areas identification

According to in-depth information provided in the methodology, data collected in each pilot case are indicated in Table II.

Name of the area	Lden Noise Map	End-users Questionnaire	Expert Analysis	Short term Measurements	Long term Measurements	Wave Recordings
P. Uccello	x	x	x	x	x	x
E. De Filippo	x	x	x	x	x	x
A. Manzoni	x	x	x	x	x	x
F. Dionisi	x	x	x	x	x	x
M. Vamba	x	x	x	x	x	x
P. Fedi	x	x	x	x	x	x
Southern	x	x	x	x	x	x
Spinoza	x	x	x	x	x	x
General La Torre	x	x	x	x	x	Not provided
S. Marina	x	x	x	x	Not provided	Not provided

Table II. Data collected in each pilot case

3. Analysis performed on collected data

In the following the procedures of analysis carried on basing on different typologies of data are described and obtained results are shown.

3.1 Verification of procedures aimed at data collected during the selection phase

The rQUA criterion developed by the city of Paris and Bruitparif [7] has been tested on nine pilot areas (all excluded the S.Marina peri-urban area) in order to understand if it effectively could give useful information during the selection phase, according to an exclusively acoustical criterion. The applied method has been deeply described in a previous work [8].

3.2 Verification of procedures aimed at data collected during the analysis phase

Evaluation the subdivision in HUAs

Once an area is pre-selected, the proposed methodology requires to assess the necessity of a subdivision in HUAs (Homogeneous Urban Areas) according to the landscape, the use and the distance and presence of sound sources. Among the pilot areas the subdivision in two HUAs has been carried on only in four school yards and, as a consequence, in these cases tools have been applied not in the whole area but in each sub-area.

In order to verify the utility of this tool and the effectiveness of its application, end-users questionnaires have been used to check if answers to specific questions could be considered not equally distributed in each HUA, according to a non-parametric analysis deeply described in a previous work [8].

From the obtained results it has been concluded that non parametric tests confirm the utility and necessity of a subdivision in HUAs.

Expert Analysis

In general, moving from results obtained in pilot areas, the expert analysis has been confirmed as a main preliminary activity for the analysis of QUA.

Based on the practical experience carried out by partners with case studies during the data collection phase, some variables of the "expert analysis" have been slightly modified. In particular, the aspect related to "natural elements" has been separated from the more general "landscape", parameters associated to the "accessibility" have been redefined and the variable "noise reduction interventions" has been better specified. Furthermore, some variables have been considered not applicable referring to the specific typology of area identified as "school yard".

End-users Questionnaire and Sound Measurements

In general, based on the practical experience carried out by partners during the data collection phase into case studies, a new improved version of the end-users questionnaire has been developed by partners during May 2014. Several questions have been simplified, made more comprehensible for respondents and easier to be analysed. In addition, it was decided to skip a few questions in case the respondents are children (e.g. distance between the studied area and their home) as they had proved to be too complicated for them.

Referring to the analysis activity carried out up to now on data obtained in case studies, the effectiveness of the sound measurements (long and short term measurements and wave recordings) and some other questions of the questionnaire is evaluated, starting from specific questions in the end-users questionnaire.

In particular, since the answers to the end-users questionnaire are collected as a score from 1 to 5, an ordinal regression model has been proposed for the analysis, since it is considered as the most appropriate in case among the chosen variables some are ordinary [9-10].

The main aim is to understand if the acoustic and more general perception of a QUA by the users can be explained by objective acoustical information.

The models return the probability of obtaining a score minor than a certain value for the dependent variable as a function of the independent one according to the following formulation:

$$\ln\left[\frac{P(y \le k)}{1 - P(y \le k)}\right] = \alpha_k - \beta_i \cdot x_i \qquad (1)$$

where k goes from 1 to the number of categories minus 1, i goes from 1 to the total number of independent variables taken into account and with y each dependent variable is indicated.

The considered 'dependent variables' (questions from end-users questionnaire) are the following:

- 'Do you agree or disagree with the following statement: "*I value this area in general as good?*" '

- 'How would you describe sound environment in this area during my visit: "*noisy or noiseless?*" '

- 'Referring to this area, I perceive the acoustic environment as pleasant '

The considered 'independent variables' (acoustical data and other questions from end-users questionnaire) are the following:

- Parameters from short term measurements such as LAeq, LA50, LA10-LA90;
- Parameters from long term measurements such as LAeq, peak analysis (using indicators such as "NA70", "NNEL55" and CNI);
- Psychoacoustic parameters from wave recordings such as Loudness, Sharpness, Roughness;
- Questions from end-users questionnaire regarding the evaluation of the following items as being (unpleasant): natural elements, air quality, safety, well-maintenance, services and equipment, accessibility, climate, visual aspects, smells, acoustic environment.

Results achieved in the pilot cases permit to consider that from short term measurements the most appropriate parameter to describe the perception of users is the LA50 whereas the LAeq, the LA10-LA90 and the psychoacoustic parameters are not considered as very representative ones.

Referring to long term measurements, the use of $L_{den,week}$ is confirmed as a good practice to validate noise maps realized according to the END, but with poor accuracy. On the other hand, a deeper work has been done to understand the time-variability of noise in a QUA and, consequently, which are the homogeneous periods, in terms of acoustical climate, to carry out the deeper analysis (made using end-users questionnaires and short-term measurements). This further analysis is based on long term measurements collected in the pilot cases of Firenze and Rotterdam on which parameters such as LAeq, LA50, LA10-LA90, NA70, etc., 1 hour based, have been evaluated. In order to establish time periods in which the acoustic environment can be considered homogeneous, two variables are considered: the first one based on average noise climate (well represented by L_{Aeq} and/or L_{A50} parameters); the second one based on presence of noise peaks (well represented by NA70 and/or L_{A10}-L_{A90} indicators). Proposed conditions for the definition of "acoustic climate homogeneity" for the time period T are the following:

- referring the variable "average noise climate", it is requested that the noise levels of parameters L_{Aeq} and L_{A50} carried out hourly based, are closed (±3 dB) to the average levels obtained in the T period. It is proposed to carry out this evaluation using one of the following relations:

$$L_{A50}(T)-3 < L_{A50}(hour) < L_{A50}(T)+3 \quad (2)$$

or

$$L_{Aeq}(T)-3 < L_{Aeq}(hour) < L_{Aeq}(T)+3 \quad (3)$$

- referring the variable "presence of peaks", considering the LA10-LA90 indicator, it is requested that the difference between LA10 and LA90 carried out hourly based, LA10-LA90(hour), is closed (±3 dB) to the average difference obtained in the T period, LA10-LA90(T). It is proposed to carry out this evaluation using the following relation:

$$L_{A10}-L_{A90}(T)-3<L_{A10}-L_{A90}(hour)<L_{A10}-L_{A90}(T)+3 \quad (4)$$

Otherwise, considering the NA70 indicator, it is requested that the number of peaks one hour based, NA70(hour), is closed to the average number of peaks obtained in the T period, NA70(T). In particular, it is proposed to carry out this evaluation using the following relation:

$$N_{A70}(T)/2 < N_{A70}(hour) < N_{A70}(T)\bullet 2 \quad (5)$$

In conclusion, according to the results obtained in the pilot cases, referring to average noise climate LAeq and LA50 seem both robust and stable parameters to perform this kind of analysis.

Otherwise, referring to "presence of peaks", only LA10-LA90 indicator appears to be stable specifically in the case studies where the average LA50 is below 55 dB(A). The NA70 indicator does not seem stable, with values very different hourly based.

4. Optimized procedure

Moving from results obtained in pilot areas, the most part of proposed tools have been confirmed and optimized. A few of tools have changed the position in the flow chart of methodology. In particular, expert analysis and long term

measurements have been moved as preliminary activities for the analysis phase.

In Table III and Figure 3 a comparison between the draft and the optimized procedure is made, according to analysis illustrated in the previous paragraph and to observations made by partners and technicians who have taken part to the in situ analysis.

Table III. Comparison between the draft and the optimized methodology.

		Draft proposal	Optimized proposal	Changes in the otimized proposal
Selection	use and function	x	x	/
	noise levels	x	x	/
	rQUA-complementary approach	x	x	/
Analysis	HUAs subdivision	x	x	/
	expert analysis	x	x	Addition of the aspect "natural elements" separated from the more general "landscape" to be evaluated, new definition for parameters associated to the variable "accessibility", variable "noise reduction intervention" better specified. In addition variables considered not appropriate for the typology of area identified as "school yard" have been indicated.
	in situ questionnaire	x	x	Some modifications to the end-user questionnaire, especially regarding its simplification, have been agreed by the Project partners.
	short term measurements	x	x	Based on the results of analysis carried out in the pilot cases, the acoustical parameter that best correlates the end-users perception seems to be the LA50 on the time span when each interview is submitted.
	long term measurements	x	x	The results obtained into pilot cases of Firenze and Rotterdam put in evidence that the long term measurements should be carried on as a tool for noise maps validation, when considered not enough accurate. An additional use of long term measurements regards the possibility of establishing from them some homogeneous periods, in which further evaluations should be carried on during the analysis phase.
	wave recordings-complementary approach	x	x	/
	indications for possible acoustic interventions from noise maps using the rQUA method-complementary approach		x	The suggested procedure is retrieved from the rQUA method but, differently from it, focuses on those area that cannot be considered as acoustically quiet and give suggestions for possible typologies of interventions to be realized.
Management			x	Interventions should be aimed to solve all the criticalities defined during the analysis phase. They are also inspired to the suggestions obtained from expert analysis and end users questionnaire results. To help experts also the new version of the rQUA method can be used.

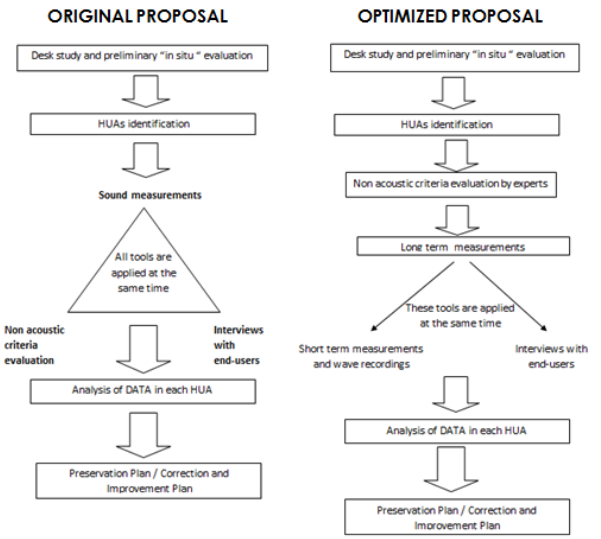

Figure 3. Comparison between draft and optimized flow chart methodology concerning of analysis and management phases.

5. Conclusions and further work

The main aim of the QUADMAP project is to provide with a shared methodology concerning the definition, selection, analysis and managing of QUAs. In the first part of the project a draft proposal has been made by QUADMAP partners and tools for the main phases of the methodology have been developed. In the second part this method has been tested in ten pilot areas selected in Florence, Rotterdam and Bilbao. Collected data have been analysed in order to confirm or modify previously suggested methodologies for data acquisition, to be used for post-operam data collection, and to verify which of the tested variables can be considered as the most significant for the analysis phase. From shared results about the analysis it has been possible to:

- confirm the validity of the principals variables indicated for the selection phase and also the rQUA method as a complementary approach;
- introduce a new method (retrieved from the rQUA criterion) able to give indications about possible interventions to be realized;
- optimize the tools to be used respectively for the expert analysis and for the end-users questionnaire;
- propose the "LA50" as a significant parameter to be evaluated from the short term measurements in order to explain the users perception;
- introduce an additional use of long term measurements;
- give first indications for the management phase.

Within the next months it is expected that the post-operam analysis will be completed in all pilot areas adopting the optimized methodology.

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