QUADMAP QUiet Areas Definition & Management in Action Plans

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GUIDELINES
FOR THE IDENTIFICATION, SELECTION, ANALYSIS AND MANAGEMENT OF QUIET URBAN AREAS

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PREFACE

Noise causes annoyance in almost all European cities and it strongly affects the population's perception of quality of life. It is part of European Community policy to achieve a high level of health and environmental protection and one of the objectives pursued is protection against noise. This was initiated in the European Commission's Fifth Environmental Action Plan (1993) and its Green Paper on future noise (1996). Subsequently, the Seventh Environmental Action Plan EC (2013) stated that noise pollution should be significantly decreased by 2020, moving noise levels closer to the World Health Organisation's (WHO) recommended limits.

European Directive 2002/49/EC on the Assessment and Management of Environmental Noise (hereinafter abbreviated as END) was adopted to define a common approach to avoiding, preventing or reducing the harmful effects of exposure to noise. To that end, the EU Commission required the Member States to produce noise maps for the main sources of noise pollution (road, rail and air traffic, as well as industrial activities) and, in a later document, to produce strategic action plans including, as main object of consideration, hotspots and quiet areas.

In addition, a number of studies on psycho-acoustics have demonstrated that noise also influences social relationships, so it is time to make urban spaces pleasant places once again.

The main environmental problem targeted in this regard is the need to improve the definition of QUAs (Quiet Urban Areas).

The END defines a “Quiet Area” as “an area, delimited by the competent authority, which is not exposed, for instance, to a value of Lden or of another appropriate noise indicator greater than a certain threshold (set by the Member State) from any noise source”. In fact, this definition summarizes one of the END's main aims, which is to preserve the acoustic environment where it is good. However, the END is not clear enough to allow the appropriate assessment and management (action planning) of QUAs in urban environments.

A further issue concerns the fact that areas where the public expects to find a quiet environment (such as public parks, gardens, open urban spaces, squares and school courtyards) often exceed noise thresholds defined by national law, where such noise limits or laws exist.

Therefore, as well as the need to recognise and protect areas that actually are quiet, there is also the problem of how to identify and manage areas that have a social role but are not actually quiet, and what action is needed to ensure that they effectively pursue the role for which they were designed.

QUADMAP (QUiet Areas Definition and Management in Action Plans) is a LIFE+ Project on Quiet Urban Areas which started in September 2011 and will end in March 2015. The Project aims to deliver a method and guidelines for the identification, delineation, characterisation, improvement and management of Quiet Areas in urban areas as defined by the END.

The Project will also help clarify the definition of a Quiet Urban Area, its meaning and its added value for the city and the public in terms of health, safety and lowering stress levels.

These guidelines are intended to be applied to Quiet Urban Areas but, as part of the Project, the proposed procedure was also applied to natural areas located outside the city (for example, the case study in Bilbao). Following this experience, it was concluded that some changes should be applied to the proposed method for it to be valid for Quiet Areas in rural environments.

The Project has met the challenge of defining a procedure that is as simple as possible, while optimising the opportunity to give valuable input to the management plan.

These guidelines can be considered one the Project's main final result. They were also drawn up to help policymakers, competent authorities and any other stakeholders to understand the END's requirements pertaining to QUAs and to propose a complete and tested methodology in order to fulfil them. In addition, these guidelines will also help to answer some research questions posed in the *Good practice guide on quiet areas*, published by the EEA in 2014, in particular the need to combine users' acoustic perception of a QUA with their overall opinion of the area.

These guidelines deliver indicators for selecting, analysing and managing QUAs and also propose specific tools for each of the aforementioned phases. Since different local authorities have a wide variety of interests and capabilities and the coordination of QUA management with other policies on the urban public places needs to be promoted, the guidelines offer a high degree of flexibility in their application. The idea is not to present a rigid procedure, but a complete method in which more than one equally valid criterion can be used for designating a quiet urban area.

This document is not an official position paper on behalf of the European Commission. Only the END is applicable and should be transposed into Member States' national laws. If, in any instance, suggestions contained in these guidelines seem to be at odds with those of the Directive, then the text of the directive should be applied instead.

STATE OF THE ART

The END's aforementioned definition of quiet areas in urban areas leaves Member States free to delimit, assess, and designate these areas. Article 8 states that action plans for towns should aim to protect QUAs, but no specific requirements are given. Furthermore, consistency issues have arisen even within the same country (e.g. agglomerations are not defined in the same way) and only a few of Member States have considered plans for the protection of QUAs in open country, although specifically addressed by the END.

With regard to urban areas, a procedure for selecting QUAs simply doesn't exist in most Member States yet. In the others, many different approaches (qualitative and quantitative) have been used until now to analyse and evaluate these areas. Where national and local criteria for identifying and protecting QUAs are considered, significantly different approaches have been taken into account. This “freedom of choice” has resulted in heterogeneous collections of data as well as divergent approaches across the EU. In all EU-funded Projects and initiatives, the need for developing common methodologies for selecting, assessing and managing quiet areas clearly emerges.

The evaluation of how END requirements were first implemented illustrates how little attention is paid to QUAs, at least in terms of implementation and from a practical point of view.

The experience of all QUADMAP partners working at local authority level is that the END implementation gap is mainly due to a lack of knowledge, methods and priorities. As a consequence, all these issues have been addressed in the QUADMAP Project.

In the first phase of the QUADMAP Project, research on the state of the art was carried out. In addition to this, a stakeholder questionnaire was submitted in several European countries, asking the competent authorities involved in the implementation of the END about the methods used to deal with QUAs (see Annex 1). Reports presented by QUADMAP partners demonstrated a wide interest in having a complete methodology concerning QUAs. In fact, over the past few years, papers and general guidelines on the designation of quiet areas as a part of the strategic Action Plan have been developed in Italy, Portugal, Sweden, Romania, Bulgaria, Poland, Slovenia, Hungary, Slovakia, the Netherlands, Estonia, Latvia, and Spain. Other Member States allow the designation of quiet areas based on local criteria. Despite this, a practical and easily-applicable approach shared at European level is lacking. Also according to the analysis of the State of the Art carried out by QUADMAP, many countries have a formal definition of Quiet (Urban) Areas. In many countries in which at least a general approach is followed, a place is designated as a Quiet (Urban) Area because it complies with the national definition or because it meets the established qualitative requirements (safety, cleanliness, pleasantness, green/natural area, etc.) or the quantitative ones (especially Lden limits).

Much importance is also afforded to public consultations and soundscaping (preserving and promoting a positive acoustic environment). Some cities would prefer not to have a standardised national methodology applied in every situation but rather a specific method designed for each pilot-case. Field-tested methods for selecting QUAs, with a description of each phase, have been developed in Florence and Paris.

Concerning the analysis phase of QUAs, many cities have adopted the same criteria that were used during the selection phase: i.e. noise limits established with the Lden indicator, and qualitative requirements.

In Rotterdam and in the Grand Lyon area, field surveys have been carried out in order to check criteria used in the previous selection phase. The results of these experiments have demonstrated the validity of the aforementioned criteria and the necessity of using the selection/analysis methods identified for each potential Quiet Area.

In Paris and Rennes, new indexes have been tested in order to understand if a location is perceived as quiet, taking various qualitative parameters into account.

Concerning QUA management, in general this phase is intended to preserve the calmness of these quiet areas and to avoid increases in noise.

In many countries, no management techniques or methodologies have been introduced yet. In general, there is a common attempt to understand what is the responsibility of each national and local authority in managing quiet areas and to ensure the public has access to them.

Several Member States also chose to include non-acoustic criteria in their definition of quiet areas. Examples of such criteria for quiet areas in agglomerations include: distance from major noise sources, public accessibility, function as a recreational space, population density, presence of sensitive buildings (hospitals, schools) and the public's expectations. Additional examples of non-acoustic criteria for quiet areas in the open country include the status of the area as a nature reserve or protected area, large-scale areas unexposed to anthropogenic noise and landscapes uninterrupted by buildings.

QUA DEFINITION PROPOSED BY THE QUADMAP PROJECT

In order to fulfil the END's requirements, each municipality or agglomeration administration body, must start by clarifying the definition of a QUA.

Consider the END's definition: *'quiet area in an agglomeration' shall mean an area, delimited by the competent authority, for instance which is not exposed to a value of L_{den} or of another appropriate noise indicator greater than a certain value set by the Member State, from any noise source*.

This definition provides a general framework but, considering the results derived from the analysis of the State of the Art, additional criteria should also be taken into account:

• Uses and functions that are important for the designation of an area as QUA;
• Preservation of urban areas that can be considered as already quiet and/or definition of new potential QUAs;
• Other variables included in the concept of quietness (or somehow related to it): safety landscape, accessibility, environmental conditions, etc.

These criteria are mainly affected not only by environmental policies but they are also conditioned by the management strategies of any urban spaces.
Therefore, QUADMAP proposes, the following as a general definition of a QUA, to complement the one provided by the END:

'a QUA is an urban area whose current or future use and function require a specific acoustic environment, which contributes to the well-being of the population'.

Since a positive evaluation of an acoustic and overall environment depends on more than just acoustic variables, several approaches must be included in the methodology for selecting and analysing QUAs.
The ultimate objective of creating QUAs is to provide areas where people can escape from urban environmental stress factors. In conclusion, this might contribute to reduced stress and improved well-being. This issue should be also taken into account when defining the process of QUA management.

QUADMAP METHODOLOGY

INTRODUCTION

The methodology illustrated in these guidelines is essentially organised into three main phases: the pre-selection of potential QUAs, the analysis used to designate them as QUAs and their management.
The set of variables to be considered in these three phases and the procedures to be used are described in the next sections of the guideline.
The proposed methodology is based on crossing information from four main sources:

- Environmental noise maps (which estimate the noise levels generated by road, rail, and air traffic and industrial activities) in the municipality/agglomeration, developed applying the methodology defined by the END. For practical reasons, in order to limit the administrative burden, the indicator chosen for EU noise maps was Lden. All noise maps depict the noise in Lden and not in Lde.
- Expert analysis carried out by the municipality/agglomeration staff, based on their knowledge of the area or on the analysis of official documents, desk studies and "in situ" studies and aimed firstly at the delimitation of Homogeneous Units of Analysis (HUAs) and then at the evaluation of non-acoustic criteria;
- User perception by means of an in situ questionnaire completed by users (the public) about their perception of the selected areas;
- Sound measurements in the selected areas.

To be able to work with each source of information, specific practical tools have been developed. These tools were based on the State of the Art, on stakeholder questionnaires, on networking activity and on the outcomes that emerged during the Project from case studies.

The method was also defined by taking into account the guidance on Quiet Areas recently published by the EEA and according to the suggestions provided by the COST Action on Soundscape. These groups of scholars, academics and experts provide advice and expertise to many relevant stakeholders from European, national and local authorities.

The flowchart in Figure 1 defines the main phases proposed in the methodology developed by QUADMAP.

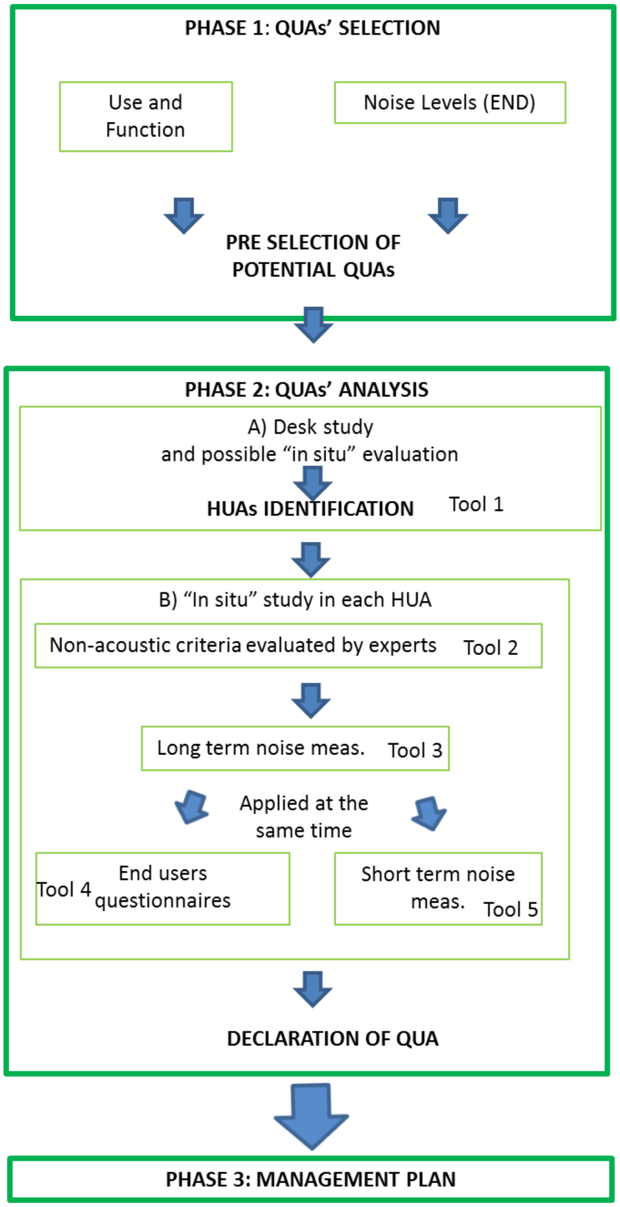

Figure 1: Methodology flowchart.

Table 1 lists all the criteria considered in both the pre-selection and analysis phases and the tools proposed for each one.

Variables and criteria	Tools					
	Noise Map	Expert analysis by the municipality/agglomeration staff: for the characterisation of pre-selected areas	Expert analysis by the municipality/agglomeration staff: for the delimitation of HUAs (Tool 1)	Expert analysis by the municipality/agglomeration staff: to collect non-acoustic data (Tool 2)	In situ questionnaires (Tool 4)	In situ sound measurements (Tools 3, 5)
PRE-SELECTION PHASE						
Use and Function		√				
Environmental Noise Levels	√					
ANALYSIS PHASE						
Acoustic criteria						
Overall Sound Level						√
Density of negative sound events						√
Dominant sound sources and their perception					√	
Perception of calmness					√	
Perception of pleasantness					√	
Perception of congruence					√	
Non-acoustic criteria						
Landscape			√	√	√	
Use and function			√			
Distance and presence of sound sources			√			
Cleanliness and Maintenance				√	√	
Safety				√	√	
General criteria						
Urban environment				√	√	
Proximity to residential areas	√			√		
Accessibility		√		√	√	
Proximity to noise sources				√		
Presence of a multi-source scenario				√		
Noise reduction measures				√		
General perception of the area					√	
Perception of overall satisfaction					√	
Behavioural criteria						
Number of users				√		
Distribution of users in the sub-area				√		
Duration of stay in the area					√	
Activities performed				√	√	

Table 1: Variables and tools considered in the preselection- and analysis phases.

PHASE 1: PRE-SELECTION OF POTENTIAL QUAs

Preselection- is an important, strategic and political stage to enable the subsequent evaluation of areas in the field and take measures if needed. This is the time to involve local elected officials on the issue of quiet areas. Without the support of elected officials, the issue will not emerge.
Pre-selection is based on two questions which should be considered jointly:
- What areas do you consider to be a quiet area in your jurisdiction? Where are they situated? Why to be considered as quiet? How to identify those areas?
- What areas would you consider suitable to become (a) quiet area(s)? Where would they be situated? Why to be considered as potentially quiet? How to identify those areas?
The proposed answer to these questions is to use the quiet area definition coming from the QUADMAP Project.

In particular, the two principal variables (variable 1: use and function; variable 2: noise levels) proposed for the selection of the areas as potential QUAs are defined in this section, as well as the indicators for describing them and the methods for their use. These variables should be analysed in sequence (variable 1 first), since pre-selection could identify areas that do not currently fulfil the noise level requirements (variable 2), but could be improved (by either reducing noise levels or changing their use/function).

Pre-selection of potential QUAs according to their Use and Function (Principal Variable 1)
Some uses and functions of urban areas may require an acoustic environment and/or perceived tranquility that are compatible with the designation of an area as QUA.

Criteria:
- Category of land use in general urban planning: residential, parks, gardens and forests, commercial areas, school areas, historic centre, cultural areas, etc.;
- The area's (current) function: social relationships, conversation, resting, reading, playground, sport activities, leisure activities, etc.

Method of Analysis:
- Category of land use in general urban planning: official urban planning documents;
- Current or future function of the area: interview with and/or observation of key experts and municipality technical staff.

Pre-selection of potential QUAs according to Noise Levels (Principal Variable 2)
This concerns the definition of a noise limit or threshold according to the END definition of environmental noise: “unwanted or harmful outdoor sound created by human activities, including noise emitted by means of road, rail, and air traffic, and from sites of industrial activities such as those defined in Annex I to Council Directive 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control”.

Indicator:
- Yearly averaged Lden values related to noise emitted by road, rail, and air traffic, and industrial sites.

Method of Analysis:
- Comparison of Noise Maps (provided by the END's requirements or national legislation) with the threshold defined below.

Threshold value:
- Lden < 55 dB or another value defined by national legislation, depending on the use and function of the area.

The threshold level of 55 dB, despite not being the most commonly used in the State of the Art (where the threshold level of 50 dB is the most recurrent), has been proposed as indicative in this phase, for three reasons:

1) It is not too restrictive (in order to avoid being too demanding in defining an area as already quiet). After this step it will be possible to assess whether an area, selected because its use and function, can be considered as already quiet or only potentially quiet;
2) It is used in several member states (e.g. Stuttgart, Aachen, and many other towns in France and Scotland);
3) In some Member States this level is used as an intervention threshold; above 55 dB Lden , the local

authorities must intervene to reduce the noise.
In the context of a very dense urban area with usually loud traffic noise and an average daytime background noise of around 50 dB, limiting the definition of quiet areas to the criterion of absolute noise levels and only using the threshold level of 55 dB at day seems (or could be) particularly restrictive.

As well as the principal variables defined above, complementary variables and approaches can also be employed to pre-selection QUAs in a town or agglomeration, and their use is suggested depending on the policies of the competent body (e.g. in case the municipality wants to characterise the QUAs based on additional, specific information). An exemplary complementary approach, developed by the city of Paris, is presented in Annex 2. This approach compares absolute Lden values in the area with the surrounding noise levels to find possible areas with a significant noise (or acoustic) contrast.
Some other complementary approaches are presented below.

Complementary variables for selecting QUAs in a municipality/agglomeration

Fair access
For some competent authorities, the priority is for all citizens to live close to a QUA. In these situations, different criteria can be used to take this parameter into account, with the aim always being to have fair access to quiet areas.

Criteria:
- The QUA’s size in relation to the district’s size;
- The QUA’s size in relation to residential areas or the district's population;
- (Walking) distance from dwelling to a QUA;
- Number of quiet areas in each urban district;
- Others.

Methodology:
- Use of G.I.S. tools for spatial analysis.

Threshold:
- To be decided by each competent authority.

Public opinion
The public's opinion regarding which areas should be quiet or are perceived as quiet is an aspect that could be included in the process for pre-selecting QUAs. The challenge with this method is obtaining enough opinions for a representative sample of public opinion.

Criteria:
- Number/percentage of respondents that consider an area to be quiet or believe that an area should be quiet.

Methodology:
- Opinion survey at district level or in the neighbourhood of the quiet area: by telephone, on the internet; organisation of a public event to inform the district’s inhabitants, etc.;
- Public consultation at district level or in the neighbourhood of the quiet area;
- Website for the general public where it’s possible to select a specific area and to leave comments.

Threshold:
- To be decided by each competent authority.

Public use
The type of properties in the area can be considered when deciding if the area should be designated as quiet.

Criteria:
- Property: public, private, public with private maintenance.

Methodology:
- Knowledge of the municipality or agglomeration's technical staff;
- Analysis of official documents regarding land property.
Data could be collected by means of direct interviews with the agglomeration's technical staff, with the aim of transferring them to the GIS platform.

Threshold:
- To be decided by each competent authority.

Coordinating the pre-selection of potential QUA

There are several possible ways of coordinating the pre-selection of potential QUA. The method chosen depends on the local context, the availability of elected officials and the resources technicians have to perform one of the following activities:

1) Brainstorming-type meeting with elected officials and the town or agglomeration's technicians: a blank page with the tools produced for the pre-selection phase proposed in QUADMAP as resources (noise maps, land-use plans, town planning maps, socio-economic data, etc.). Then, elected officials' opinions are collected and the sites are identified using a prioritisation system defined by the officials.
Comments: According to the workshops carried out during the Project this activity seems best suited where the elected officials know the technicians and they are used to working with each other. It must be possible to implement specific coordination techniques.

2) Identification of areas to be pre-selected by elected officials in two phases (preparatory work and proposal by technicians):
- Definition of the prioritisation system by technicians based on the pre-selection tools proposed in QUADMAP and available in the town or region
- Presentation of the pre-selected areas and prioritisation system to elected officials then approval of the prioritisation system and choice of pre-selected areas by elected officials.

Comments: According to the workshops carried out during the Project this activity seems to be the only appropriate method where the elected officials are not in direct contact with the technicians.

It is also possible to combine approaches by getting the town's technicians and elected officials to pre-select the quiet areas and presenting these first results to local inhabitants to collect their opinions, in relation to the pre-selection complementary criterion of "Public Opinion".

PHASE 2: QUA ANALYSIS (linked to Tools 1-5)

The QUA analysis phase requires two approaches or activities:

A) A preliminary desk study to be developed by the municipality/agglomeration staff, based on their knowledge of the area or on the analysis of official documents. A preliminary "in situ" evaluation can be made and it is recommended. The outcome of this work is the subdivision of potential areas into Homogeneous Units of Analysis (HUAS), which make it easier to apply the analysis procedure and understand the representativeness of its results. Tool 1 was developed to help subdivide potential areas into HUAs.
Frequently, when the candidate QUA is large, several HUAs can be identified. The acoustic environment requirements in each of them may be different, depending on their uses and functions, and the local population's expectations.

B) A further "in situ" study in each HUA is required for subsequent analysis: Non-acoustic criteria evaluation by experts (Tool 2), Long-term measurements (Tool 3), Interviews with end-users (Tool 4) and Short-term measurements (Tool 5).
Tools 4 and 5 are applied simultaneously in each area during the most representative hours (chosen on the base of long term measurement analysis) in which citizens visit the area.

In the following section, Tools 1 to 5 are described and practical examples are given from case studies analysed as part of the QUADMAP Project.

Tool 1: Expert criteria for the delimitation of Homogeneous Units of Analysis (HUAs)

Tool 1 explains how HUAs should be delimited. This decision should be based upon the following main criteria:

Criterion 1 - Landscape: The area must be characterised by uniform visual elements and landmarks.

Criterion 2 – Use or function: The area must only have one main and specific use or function. This is related to the facilities and furniture in the area. For instance, in a park, many different activities can be carried out in different areas depending on the facilities: sports areas, recreational areas, resting and relaxing areas.

Criterion 3 - Presence of and distance from sound sources: The influence of environmental noise sources (road, rail, and air traffic or industrial activities) or other sound elements must be homogeneous in the area.

How to use Tool 1

GENERAL INSTRUCTIONS

1) Two potential HUAs (A and B) were identified using the methodology (Desk study and preliminary “in situ“ evaluation) defined in PHASE 2.
2) Criteria defined in PHASE 2 are evaluated by the municipality/agglomeration staff.
3) From the prior analysis, the presence of two sub-areas (A and B) is confirmed or denied.
4) If more than one HUA is identified, subsequent analysis (evaluation of non-acoustic criteria by experts, long-term measurements, short-term measurements and interviews with end-users) will be carried out in each HUA.

EXAMPLE OF THE TOOL'S USE ON PILOT CASES IN FLORENCE – Montessori-Vamba schoolyard

<table>
<tr><th>Montessori-Vamba schoolyard, plan of the area</th><th>Description of the pilot area</th></tr>
<tr><td rowspan="3">
</td><td>The “Montessori-Vamba” school complex is located in Giardini della Bizzarria Street, Florence (ITALY). The schoolyard designated as a QUA as part of the QUADMAP Project is attended by pupils from the nursery school.
It is mainly affected by road noise from Torre degli Agli Street and Giardini della Bizzarria Street.
Around 460 people use this schoolyard.</td></tr>
<tr><td>Using the tool</td></tr>
<tr><td>• Landscape: The potential HUAs both feature similar visual elements and landmarks;
• Use: The potential HUAs are both in the school grounds but the users are different. Each class is assigned part of garden for recreation time.
• Presence of and distance from sound sources: HUA “A” is affected by road traffic noise from Giardini della Bizzarria Street and Torre degli Agli Street; HUA “B” is only affected by road traffic noise from Torre degli Agli Street.

The presence of two sub-areas is, therefore, confirmed due to their use by different groups and the distance from sound sources.</td></tr>
</table>

Tool 2: Expert analysis for the collection of non-acoustic data

There are some non-acoustic factors that might be required for an area to be considered in the assessment of the quality of QUAs before further analysis (noise measurements and questionnaires) are carried out.
Tool 2 provides instructions for the assessment of general and non-acoustic criteria.
Non-acoustic, general and behavioural criteria are listed in Table 2, while in Tables 3, 4 and 5 they are described in more detail.

CRITERIA
Principal non-acoustic criteria
Landscape
Natural elements
Cleanliness and maintenance
Safety
General criteria
Urban environment
Proximity to residential areas
Accessibility
Proximity to noise sources
Presence of a multi-source scenario
Measures to reduce noise
Behavioural criteria
Number of users
Distribution of users (geographical)
Activities performed

Table 2: Expert evaluation, criteria list.

CRITERIA	DESCRIPTION	PARAMETERS	RATING	POSSIBLE SOLUTIONS
Landscape	A specific view visible from the area (architecture, etc.)	None	🟥	
		Only in 1 direction (N, S, E, W)	🟨	
		3/4 directions (N, S, E, W)	🟩	
Natural elements	Greenery, water, etc. visible from the area	None	🟥	
		Only in 1 direction (N, S, E, W)	🟨	
		3/4 directions (N, S, E, W)	🟩	
Cleanliness and maintenance	Evaluation of cleanliness through observation by experts	Not maintained (uncut grass, broken benches, etc.) and unclean (rubbish on the ground and/or not in the bins, etc.)	🟥	Recommend interventions to improve cleanliness.
		Regular deterioration /badly maintained	🟨	
		Regularly maintained and clean	🟩	
Safety	Evaluation of safety through observation by experts	Dangerous area (robberies, attacks or accidents from official statistics in the area)	🟥	Recommend interventions to improve safety.
		Unguarded spaces or dark zones without proper lighting	🟨	
		Guarded and well-lit spaces	🟩	

Table 3: Expert evaluation, principal non-acoustic variables.

CRITERIA	DESCRIPTION	PARAMETERS	RATING	POSSIBLE SOLUTIONS
Urban environment	Location of the area with respect to key social points in the city (e.g. library, church, etc.)	Far from key points	🟥	No immediate solution
		No key points	🟨	
		Close to key points	🟩	
Proximity to residential areas	Proximity to residential area increases the number of users of the area	More than 3 km	🟥	No immediate solution
		Between 500 m and 3 km	🟨	
		Less than 500 m	🟩	
Accessibility	Accessibility (also considering people with reduced mobility) by public transport or by cycle paths and/or footpaths	No public transport, no cycle path, no footpath	🟥	Create cycle and footpaths; develop public transport; add bus stops or lines; create reduced speed zone.
		Two of the following: public transport, cycle path, footpath	🟨	
		Public transport and cycle path and footpath	🟩	
Proximity to noise sources	Proximity to noise sources means possible high noise levels. If users can also see the source of noise, this psychologically affects their perception of the noise	Main noise source is close to the HUA and it is visible by users, potentially audible	🟥	The choice of solutions should consider measures that hide or mask the sources.
		Main noise source is close to the HUA and it is not visible by users, potentially non-audible	🟨	
		Main noise source is far from the HUA potentially audible	🟩	
Multi-source scenario	Presence of multiple noise sources of one or more kinds (road, rail, air traffic, industrial activities)	3 or more sources	🟥	Assess contribution of every kind of noise source and study solutions also evaluating combined effects for all main sources.
		2 sources	🟨	
		1 source	🟩	
Measures to reduce noise	Noise reduction measures carried out	Measures with good acoustic efficacy are needed but not possible	🟥	Propose possible integration of current measure to improve acoustic efficacy. The choice of solution should be made taking into account the results of end-user questionnaires
		Measures with average acoustic efficacy are needed and possible, but not present	🟨	
		No measures are needed	🟩	

Table 4: Expert analysis, variables for general analysis.

CRITERIA	DESCRIPTION	PARAMETERS	RATING	INPUT TO DEFINE POSSIBLE SOLUTIONS
Number of users (the total number of users during opening hours)	The number of users gives an indication of perceived pleasantness	Less than 1 user / 9 m^2 [1]	🟥	Examine problems related to poor attendance by using the results of end-user questionnaires and suggest actions to resolve them.
		Between 1 and 2 users/ 9m^2	🟨	
		More than 2 users / 9 m^2	🟩	
Distribution of users in the HUA	Users prefer to stay in a specific sub-area	HUAs are not uniformly used (attended) and less than 50 % of HUAs are appreciated	🟥	Provide attractive activities or add elements to encourage users to use all the sub-areas. The choice of solution should also be guided by the results of end-user questionnaires.
		HUAs are not uniformly used (attended), but more than 50% of HUAs are appreciated	🟨	
		HUAs are uniformly used (attended)	🟩	
Activities	Possibility of carrying out various activities (with particular attention to intellectual activities and relaxation)	Only one activity is carried out, and no intellectual activities (i.e. only sport)	🟥	Further evaluations, depending on the size and type of area. In areas where different activities are carried out, consider creating different soundscapes for different activities. The choice of the solution should also be guided by the results of end-user questionnaires.
		A variety of activities, including intellectual activities (e.g. reading), are carried out	🟨	
		A variety of activities, including intellectual activities and relaxation are carried out	🟩	

Table 5: Expert analysis, criteria for behavioural analysis.

[1] *Italian urban parameter, ref. Italian Decree no. 1444/68*

How to use Tool 2

GENERAL INSTRUCTIONS

1) Competent experts (e.g. the municipality's experts responsible for managing the QUA) are appointed in order to evaluate non-acoustic criteria related to the QUAs.
2) Each criterion indicated in Table 2 is rated by experts for each QUA or HUA (where more than one HUA is identified) according to properly identified criteria. For each criterion, the parameters are rated as follows: a yellow or red rating if the criterion is not completely satisfactory or a green rating if it is completely satisfactory.
3) For "PRINCIPAL NON-ACOUSTIC CRITERIA", "GENERAL CRITERIA" and "BEHAVIOURAL CRITERIA", the corresponding tables are completed and measures are suggested where possible.

EXAMPLE OF THE TOOL'S USE ON A PILOT CASE IN FLORENCE – Dionisi schoolyard

Dionisi schoolyard, plan of the area	Description of the pilot area
	“Dionisi” nursery school is located in Aretina Street, Florence (ITALY). It is mainly affected by road noise from Aretina Street. Around 54 people use this schoolyard.

Using the tool

The experts nominated to evaluate non-acoustic criteria were the municipality’s technicians and only one HUA was identified. The tables for “PRINCIPAL NON-ACOUSTIC CRITERIA”, “GENERAL CRITERIA” and “BEHAVIOURAL CRITERIA” were completed.

As an example, some of the “PRINCIPAL NON-ACOUSTIC CRITERIA” are evaluated in Table 6 as follows:

- Landscape is rated as green because greenery can be seen from the area in 3 directions (N, E, & W);
- Cleanliness and maintenance are rated as green because the area is regularly maintained and clean;
- Safety is rated as red because it is a dangerous area (with official statistics from the area showing attacks or accidents). Based on this analysis, one possible solution could be to fence-off the garden.

PRINCIPAL NON-ACOUSTIC CRITERIA

CRITERIA	DESCRIPTION	PARAMETERS	RATING		POSSIBLE SOLUTIONS
Landscape	Greenery, water, or specific view (architecture, etc.) visible from the area	None	red	green	
		Only in 1 direction (N, S, E, W)	yellow		
		3/4 directions (N, S, E, W)	green		
Cleanliness and maintenance	Evaluation of cleanliness through observation by experts	Not maintained (uncut grass, broken benches, etc.) and unclean (rubbish on the ground and/or not in the bin, etc.)	red	green	Recommend measures to improve cleanliness.
		Regular deterioration/badly maintained	yellow		
		Regularly maintained and clean	green		
Safety	Evaluation of safety through observation by experts	Dangerous area (official statistics from the area show robberies, attacks and accidents in the area)	red	red	Recommend interventions to improve safety: fence-off the garden
		Unguarded spaces or dark zones with poor lighting	yellow		
		Guarded and well-lit spaces	green		

Table 6: Results of the application of Tool 2 in the pilot case of the Dionisi schoolyard in Florence.

Tool 3: Long-term measurements

Long-term measurements should be carried out in each QUA to achieve the following three main aims:
1) To validate the noise maps, in the specific studied areas.
2) To collect acoustic information about the variability of sound levels over time in the area and to decide and justify the representativeness of the acoustic environment in the periods when the deeper analysis is made. In this sense, long-term measurements can be used to establish which are the most representative periods for carrying out "in situ" surveys (end-user questionnaires and short-term measurements).
3) To assess the impact of the "local measures". This means, to compare results before and after the interventions.

Tool 3 describes the minimum requirements for the long term measurements to achieve these objectives. In particular, the minimum requirements for a QUA are defined below:
- At least one measurement position is expected per QUA;
- 4.0 ± 0.2 m as the microphone's height above the ground (according to END recommendations, defined in Annex I). Other heights may be chosen, but they must never be less than 1.5 m above the ground and results should be corrected in accordance with an equivalent height of 4 m (the correction could be obtained by carrying out a short measurement (30 minutes), at the same time as the long-term one, at a height of 4 m above ground level);
- 1 week as the recommended minimum duration for long-term measurements;
- The measurement position should be close to the interview location and the place of the interventions;
- Time History, 1 second based, of overall equivalent continuous A-weighted sound pressure level (preferable LAeq,1s) should be considered.

Being able to back up detailed elementary data (e.g. one-second data readings LAeq,1s) is very valuable in order to be able to recalculate new noise indicators if the regulatory indicators have changed or for research and knowledge development purposes.

Based on the Time History of sound pressure levels (LAeq,1s), the following indicators should be used for further analysis: LAeq,T (where T is the QUA's opening hours), Lden, Lday, Time History of LAeq and LA50, related to the QUA's opening hours and Time History of LA10 – LA90 (1 hour based), related to the QUA's opening hours.

A class 1 or 2 measurement device, compliant with the applicable international standards, should be used. Universal time (UT) shall be the common time basis.
Before and after each measurement session, the measurement system should be checked using a class 1 calibrator, according to the applicable international standards. Differences included into the accuracy of 0.5 dB are expected for a validation of the measurement session.
During measurements, the weather conditions should also be noted, since noise data influenced by the weather should be eliminated.
In case of measures to improve the QUA, where long-term measurements take place before and after the interventions, they should be conducted at the same time of year. And when traffic noise is dominant, it is recommended to define the traffic characteristics (volume, speed, distribution) in order to be able to compare data from before and after the interventions accurately.

Analysis of the measurements
The results obtained from the pilot cases in Florence and Rotterdam highlighted that long-term measurements should be carried out as a tool for having further detail of the Lden values, including sound sources that are not considered in noise mapping.
Concerning the analysis of the variability of environmental noise, based on the results carried out in the pilot cases, the recommended parameters for establishing time periods during which the acoustic environment can be considered homogeneous, are:
- LA50 or LAeq, as the main indicators for evaluating the variability of acoustic environment in terms of average noise levels;
- L10-L90, 1, as the main indicator for evaluating the variability of the acoustic environment in terms of noise peaks.
The conditions required in order to define the time period ("T") as representative are as follows:

- The levels of indicators representing the average acoustic environment (like LAeq and LA50) carried out on an hourly basis, are close (±3 dB) to the average levels obtained in the "T" period. It is recommended to carry out this evaluation using the following relation: LA50(T) - 3 < LA50(hour) < LA50(T) + 3 or LAeq(T) - 3 < LAeq(hour) < LAeq(T) + 3;
- The difference between L10 and L90 carried out on an hourly basis, is close (±3 dB) to the average difference obtained in the "T" period. It is recommended to carry out this evaluation using the following relation: LA10-LA90(T)-3< LA10-LA90(hour) < LA10-LA90(T)+3.

How to use Tool 3

GENERAL INSTRUCTIONS

1) Collect long-term measurements following the recommendations given in Tool 3 (respect the minimum recommended number of measurements, the microphone's height, the measurements' minimum duration, the measurement position).
2) From the long-term measurements collected, select a representative time of day for each area and evaluate each of the acoustic indicators listed in tool 3 (LAeq,1h , L50,1h , LA10,1h and LA90,1h) for that period, 1 hour based.
3) Calculate the average of the LAeq,1h , L50,1h , LA10,1h and LA90,1h over the duration (T) of the measurements obtaining the LAeq (T), L50 (T), LA10 and LA90 (T).
4) Apply the relations illustrated in the main text:
LA50(T) - 3< L50,1h< LA50(T) + 3 or LAeq(T) - 3< LAeq,1h < LAeq(T) + 3;
LA10-LA90(T)-3 < LA10-LA90,1h < LA10-LA90(T)+3.
5) Choose the periods in which the LAeq/LA50 and the LA10-LA90 turn out to be within the established range in order to carry out the subsequent analysis (short-term measurements, interviews with end-users).

EXAMPLE OF THE TOOL'S USE ON A PILOT CASE IN FLORENCE – Dionisi schoolyard

<table>
<tr><th>Dionisi schoolyard, plan of the area</th><th>Description of the pilot area</th></tr>
<tr><td rowspan="3">
</td><td>The "Dionisi" nursery school is located in Aretina Street, Florence (ITALY).
It is mainly affected by road noise from Aretina Street.Around 54 people use this schoolyard.</td></tr>
<tr><td>Using the tool</td></tr>
<tr><td>Long-term measurements were collected following the recommendations given in Tool 3 (one measurement position – at 1.5 m above the ground - was chosen and the microphone and results were verified in comparison with an equivalent height of 4 m, the measurement lasted 1 week, the measurement position chosen was close to the interview location). The typical time period of use for this area is from Monday to Friday between 9 a.m. and 6 p.m..</td></tr>
</table>

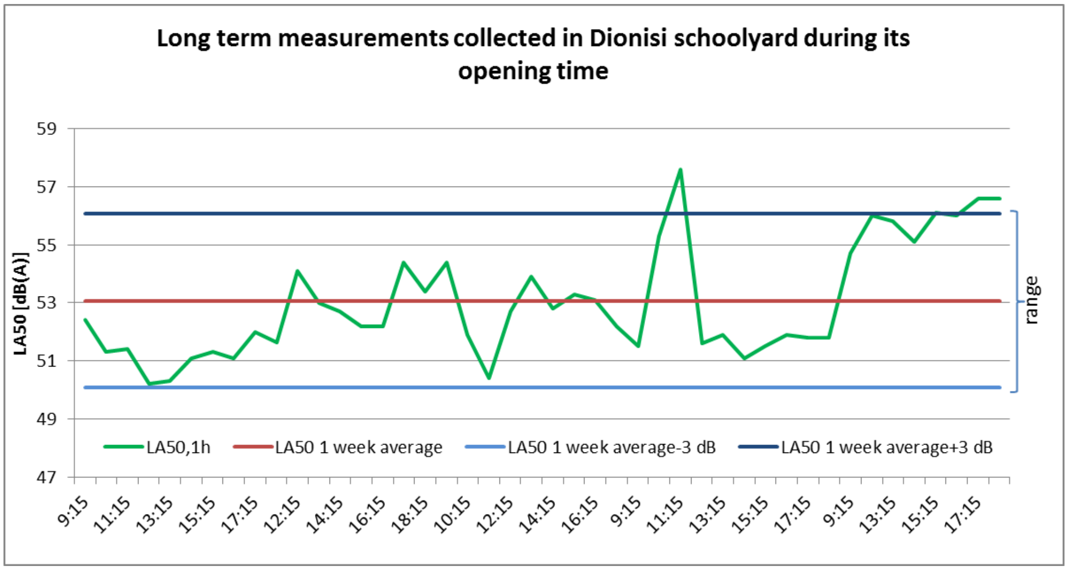

Figure 2: Long term measurements collection (1 week) in the pilot case of the Dionisi schoolyard in Florence.

	L50	L10-L90		L50	L10-L90		L50	L10-L90
average	53,1	6,6	average	53,1	6,6	average	53,1	6,6
MONDAY			TUESDAY			WEDNESDAY		
9:00	<=> range	<=> range	12:00	<=> range	<=> range	9:00	<=> range	<=> range
10:00	<=> range	<=> range	13:00	<=> range	<=> range	10:00	<=> range	> range
11:00	<=> range	<=> range	14:00	<=> range	<=> range	11:00	<=> range	<=> range
12:00	<=> range	<=> range	15:00	<=> range	<=> range	12:00	<=> range	> range
13:00	<=> range	<=> range	16:00	<=> range	<=> range	13:00	<=> range	<=> range
14:00	<=> range	<=> range	17:00	<=> range	<=> range	14:00	<=> range	<=> range
15:00	<=> range	<=> range	18:00	<=> range	<=> range	15:00	<=> range	<=> range
16:00	<=> range	<=> range				16:00	<=> range	<=> range
17:00	<=> range	<=> range				17:00	<=> range	<=> range
18:00	<=> range	<=> range						
THURSDAY			FRIDAY					
9:00	<=> range	<=> range	9:00	<=> range	<=> range			
10:00	<=> range	> range	10:00	<=> range	<=> range			
11:00	> range	> range	11:00	<=> range	<=> range			
12:00	<=> range	<=> range	12:00	<=> range	<=> range			
13:00	<=> range	<=> range	13:00	<=> range	<=> range			
14:00	<=> range	<=> range	14:00	<=> range	<=> range			
15:00	<=> range	<=> range	15:00	> range	< range			
16:00	<=> range	<=> range	16:00	<=> range	< range			
17:00	<=> range	<=> range	17:00	> range	< range			
18:00	<=> range	<=> range	18:00	> range	<=> range			

In this case, surveys were carried out between 2 p.m. and 4 p.m., although other time slots could also be considered equivalent, according to Figure 2 and Table 7. Compared with the noise levels in the noise map produced according to directive 2002/49/EC, the long-term measurements produced very interesting results, because in some pilot cases, such as the Dionisi school, they demonstrated the poor accuracy of noise maps due to overestimated road traffic in the streets close to this school.

Table 7: Results of the application of Tool 3 (3 of 7 days, see the dashed box in Figure 2) in the pilot case of the Dionisi schoolyard.

Tool 4: End-user questionnaire

An "in situ" analysis is carried out during the times of day that are most representative in terms of when people visit the area (chosen based on long-term measurement analysis).
Tool 4 describes the questionnaire's structure and deployment strategy.
The surveys are conducted at the same time as the short-term measurements (Tool 5) and they are grouped within 30 min. periods, in coordination with the noise measurements.
The key data points from the questionnaires to be analysed are as follows:
- Percentage of users that consider the sound atmosphere as CALM
- Percentage of users that consider the sound atmosphere as PLEASANT
- Sound sources (dominant ones) and the way they are perceived (pleasant or unpleasant) by users and the public in the area
- Percentage of users that consider the area to be safe
- Percentage of users that consider the area to be clean and well-maintained
- Percentage of users that consider the area to be accessible
- Percentage of users that consider the area to be beautiful, pleasant or/and natural (from an aesthetic point of view)
- Activity: The user's activity and purpose of the visit to the area
- Other environmental conditions: lighting, temperature, smells, etc.
- Reason for visit
- Frequency of visits
- Duration of stay in the QUA
- Overall satisfaction with the area

An English version of the questionnaire with questions on the above points has been prepared.
To conduct the survey correctly, it is necessary to translate the questionnaire into the interviewer's language and to follow the submission suggestions described in the questionnaire.

TOOL 4: QUESTIONNAIRE

SAMPLE:

- In general: at least 60 interviews are expected for each HUA (Homogeneous Urban Areas) to obtain sufficiently significant statistical data.
- The sample should equally represent the genders (male/female) and possibly include different age ranges. Regarding schools gardens, pupils should be at least 6 years old to be interviewed. If the school is a kindergarten, other forms of survey should be used (e.g. drawings, pictures, etc.).

METHOD:

- Interviewers must be informed of survey techniques
- Interviewers are requested not to introduce interviewees to the main topic of interest (quiet urban areas), to avoid influencing their answers
- Interviewers should keep the questionnaire in his/her hands and read questions to interviewed
- The start and end time of questionnaires should be noted (synchronize interviewers' clocks with those of the sound level meters).

QUESTIONNAIRE'S QUESTIONS : (*in brackets comments to help the interviewer can be found*)

Questionnaire quiet (urban) areas

Interviewer:……………………………………………… Phone:………………………………

Number of questionnaire:……………… (*to be filled in by interviewer*)
Name of area:………………………………… (*to be filled in by interviewer*)
Location:... (*to be filled in by interviewer*)
Date:………………………………………………. (*to be filled in by interviewer*)
Starting Time:………………………………… Ending time………………………….

GENERAL

ASK QUESTION N. 0 ONLY IF THE CONSIDERED AREA IS DIVIDED INTO SUB AREAS.

0. **Among those showed below, what is the sub area you visit most frequently (*Show photo or layout of this QUA and ask what is the sub area visited mostly. If the area is not divided into sub areas, skip to U.1*)?**

Put photo or layout

PLACE USE

IN CASE OF SCHOOLYARDS, ASK ONLY QUESTIONS U.1, U.3, U.4

U.1. How often do you visit this venue (*only one answer*)?

❑ everyday
❑ once per week or more frequent
❑ a few times per month

- ❑ once per month or less frequent

U.2. During what day do you visit this area <u>mostly</u> (*only one answer*)?

- ❑ At week days
- ❑ During the weekend
- ❑ Just like it suits me
- ❑ Other

U.3. At what time of the day do you visit this area <u>mostly</u> (*only one answer*)?

- ❑ During the morning
- ❑ During lunch time
- ❑ During the afternoon
- ❑ In the evening
- ❑ No specific time of the day

U.4. During what period of the year do you visit this area mostly?
(*This question is a multiple-choice*)

- ❑ Spring
- ❑ Summer
- ❑ Fall
- ❑ Winter
- ❑ No specific time

U.5. How long do you mostly stay in this area (*only one answer*)?

- ❑ 0 – 15 minutes
- ❑ 16 – 30 minutes
- ❑ 31 – 60 minutes
- ❑ 61 – 120 minutes
- ❑ More than 120 minutes

U.6. How do you reach this area (*only one answer*)?

- ❑ on foot
- ❑ by bike
- ❑ by public transport
- ❑ by car/ by scooter
- ❑ Other

U.7. This place is close to your(*only one answer*)…

- ❑ home
- ❑ workplace
- ❑ school / university
- ❑ Other

SKIP TO U.9 QUESTION IF INTERVIEWED PEOPLE ARE CHILDREN
U.8. How far is the distance between your <U7 answer>. and this area (*only one answer*)?

- ❑ < 300 m
- ❑ 300 m – 500 m
- ❑ 500m - 1 kilometre
- ❑ 1 kilometre to 3 kilometres
- ❑ further than 3 kilometres

U.9. What is the <u>main</u> reason for you visiting this area (*Don't propose different choices. Let the interviewed express*

his/her preference)?
- ❑ For my children
- ❑ For elderly care
- ❑ To walk my dog
- ❑ To walk or run
- ❑ To meet other people
- ❑ For the nature
- ❑ For relaxation and quietness
- ❑ Listening to radio / music
- ❑ Reading
- ❑ Playing sport or other activities
- ❑ I am just passing this area on my route (for example on my way to work or home)
- ❑ Other reason

SOUNDSCAPE AND NOISE

SKIP TO QUESTION N. S.2 IF INTERVIEWED PEOPLE ARE CHILDREN

1st Ask people to react immediately (quickly) to the following questions without preannouncing them the topic.

2nd Ask about sounds that participant hear (the interviewer asks about the presence of the main sound sources, being traffic sounds, other mechanical sounds, nature sounds and sounds of human beings and if considered necessary he/she illustrates the subclasses of main sound source categories).

3th Ask about the intensity of his or her perception of general categories with the following scale: 1=”not at all” and 2=”yes”.

4th Ask about pleasantness or unpleasantness of the only perceived sounds, with the following scale

Very unpleasant (1)	*Unpleasant (2)*	*Neither unpleasant nor pleasant (3)*	*Pleasant (4)*	*Very pleasant (5)*

	S.1. I can <u>hear well</u> the following types of sounds during my visit of the area			**S.2. I perceive the sounds from“…” <u>pleasant</u> during my visit of the area.**				
	Perception			**(Un)Pleasant**				
Traffic sources (general, cars, buses, trains, air planes, other______)	1	2		1	2	3	4	5
Other mechanical sounds (general, construction noise, enterprises, machines, sirens, other__________)	1	2		1	2	3	4	5
Human sounds (general, talking, laughing, children playing, footsteps, other_______)	1	2		1	2	3	4	5
Natural sounds (general, wind and leafs, water, birds, other_____)	1	2		1	2	3	4	5

IN GENERAL

S.3. How would you <u>describe</u> sound environment in this area during my visit.

(*Please, use for this question the following list of adjectives, when 1 represents the top quality of adjective on the left side* *and 5 the top of the right side adjective. The 3 number represents the intermediate value, neither left nor right adjective*).

SELECT PER ROW ONE | **Fully disagree (1)** | **Disagree (2)** | **Neutral (3)** | **Agree (4)** | **Fully agree (5)** | *ANSWER*

Unpleasant	1	2	3	4	5	Pleasant
Chaotic	1	2	3	4	5	Calm*
Noisy	1	2	3	4	5	Noiseless
Boring	1	2	3	4	5	Lively
Uneventful	1	2	3	4	5	Eventful
Artificial	1	2	3	4	5	Natural

* The adjective "calm" refers not only to the presence of low noise, but also to a general state of low activity (physical, emotional, etc.).

S.4. Do you agree or disagree with the following statement (*Read the question, explaining the meaning of the answer scale*)?

SELECT ONE ANSWER.

I consider in general the current soundscape or acoustic environment as good.	1	2	3	4	5

I'm very sensitive to noise	1	2	3	4	5

I consider the current sounds very congruent with this place	1	2	3	4	5

S.5. What should be done in order to improve the acoustic environment or soundscape, from the acoustical perspective? *(open question)*

ENVIRONMENTAL QUALITY

SKIP TO E.2 QUESTION IF INTERVIEWED PEOPLE ARE CHILDREN

1st Ask about the importance of all items with the following scale: 1="not at all" and 2="yes"

2nd Ask about pleasantness or unpleasantness of the mentioned items, with the following scale

Very unpleasant (1) | *Unpleasant (2)* | *Neither unpleasant nor pleasant (3)* | *Pleasant (4)* | *Very pleasant (5)*

	E.1 I perceive as an IMPORTANT element in a quiet area in general...			**E.2 Referring to this area, I perceive each of the following items as pleasant**				
	Perception			(Un) pleasant				
Air quality	1	2		1	2	3	4	5
Safety	1	2		1	2	3	4	5
Well-maintenance	1	2		1	2	3	4	5
Services and equipment (benches, playing areas..)	1	2		1	2	3	4	5
Accessibility	1	2		1	2	3	4	5
Acoustic environment	1	2		1	2	3	4	5
Natural elements (parks and gardens, water, birds, etc.)	1	2		1	2	3	4	5

Climate (humidity, brightness, wind)	1	2		1	2	3	4	5
Visual aspects	1	2		1	2	3	4	5
Smells	1	2		1	2	3	4	5

E.3 Do you agree or disagree with the following statement (*only one answer*)?

	Fully disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Fully agree (5)
I value this area in general as good.	1	2	3	4	5

E.4. What should be done in order to improve this area (visually)? *(open question)*

E.5. What should be done in order to improve this area (equipment)? *(open question)*

LIVING ENVIRONMENT

L.1. Do you agree or disagree with the following statement (only one answer)**?**

	Fully disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Fully agree (5)
The acoustic environment (outdoor living space) **where I live** is good	1	2	3	4	5

L.2. Are you currently annoyed by the following noise sources when staying at home?

	Not at all (1)	A little (2)	Moderate (3)	Very (4)	Extreemely (5)
Traffic in general	1	2	3	4	5
Heavy vehicles and buses	1	2	3	4	5
cars	1	2	3	4	5
Scooters, motorcycles and mopeds	1	2	3	4	5
Air planes	1	2	3	4	5
Trains	1	2	3	4	5
Trams and metros	1	2	3	4	5
Business and industry	1	2	3	4	5
Windturbines	1	2	3	4	5
Low frequency noise	1	2	3	4	5
Peak noise	1	2	3	4	5
Noise in general	1	2	3	4	5

PERSONAL DATA

P.1. Sex M ❑ F ❑ **P.2. Age**

P.3. Occupation
- ❑ Student
- ❑ Housewife
- ❑ Retired
- ❑ Employee

- ❑ Self-employed
- ❑ Unemployed
- ❑ Other

P.4. Education

- ❑ Primary
- ❑ Degree

- ❑ Bachelor
- ❑ Other

P.5. Residential place____

P.6. Years living in____

How to use Tool 4

EXAMPLE USING TOOL 4 IN THE PILOT CASE IN BILBAO: GENERAL LATORRE SQUARE

General La Torre square was in the middle of a redevelopment during the Project. Consequently, Tool 4 was used twice – before and after interventions – to analyse the improvement in the acoustic environment in an area that underwent changes aimed at reducing noise and increasing tranquillity.

The sample was big enough to be representative: 80 people, 38 (47.75 %) in the morning and 41 (51.25 %) in the evening. There was a good gender split (43.75 % male, 56.25 % female) and the respondents were mainly from Bilbao and from the neighbourhood where the square is located (87.5 % Bilbao residents and 51 % local residents). The main results of the perception analysis are presented in Tables 8 to 13.

-% of users that consider the acoustic environment to be:

	BEFORE INTERVENTIONS	**AFTER INTERVENTIONS**
CALM	32.9 %	**73.4%**
PLEASANT	37.6 %	**78.8%**

Table 8: Results of users' perception about the acoustic environment in the pilot case of General La Torre square.

-% of users that perceived the area to be (free answer):

	BEFORE INTERVENTIONS	**AFTER INTERVENTIONS**
SAFE	18.8 %	**77.2 %**
CLEAN AND WELL MAINTAINED	21.2 %	**81.0 %**
ACCESSIBLE	28.2 %	**87.2 %**
PLEASANT, from a visual point of view	9.4 %	**69.6 %**

Table 9: Results of users' non-acoustic perception of the pilot case of General La Torre.

-Dominant sound sources:

BEFORE INTERVENTIONS		**AFTER INTERVENTIONS**	
traffic	considered unpleasant	**water** (**fountain**), (95% of participants)	perceived as pleasant and remarkable
birds	considered pleasant	**traffic** (71.3% of participants)	considered as unpleasant
		children (31.8% of participants)	considered as pleasant

Table 10: Results of users' perception about sound sources in the pilot case of General La Torre.

-Activity of users:

BEFORE INTERVENTIONS	**AFTER INTERVENTIONS**
Passing by (55%)	Passing by (26.2%)
Enjoying their free time (20.0%)	Enjoying their free time (20%)
Shopping (11%)	Enjoying nature (16.7%)
Waiting for someone (8.0%).	Waiting for someone (22.2%)

Table 11: Activities carried out by users in the pilot case of General La Torre.

-Reason for using the square: passing through or relaxing (free time). In the case of the post-operam scenario, “enjoying nature” was included in the reasons for visiting the area.

-Duration of the stay:

BEFORE INTERVENTIONS	**AFTER INTERVENTIONS**
Less than 15 minutes	30- 60 minutes

Table 12: Activities carried out by users in the pilot case of General La Torre.

-Global pleasantness with the area:

BEFORE INTERVENTIONS	**AFTER INTERVENTIONS**
28.2 %	97.5%

Table 13: Users’ satisfaction of the pilot case of General La Torre.

Tool 5: Short-term noise measurements

The purpose of short-term measurements is to collect acoustic information about the present sound levels during the in situ analysis. They are carried out in each HUA at the time of day that is most representative (chosen on the basis of long-term measurement analysis) in terms of when the public visits the area.
The short term measurements are carried out at the same time as the questionnaires (see Tool 4) and when the HUA is typically used.
The evaluation is made in 30 minutes, since this is the average length of time people remain in the areas in which an interview takes place. This way, the acoustic parameters are strictly linked to the groups of interviews. In this tool, some minimum requirements are given for the short-term measurements.
The minimum requirements for a generic QUA are defined below:

- At least one measurement position per HUA;
- Microphones positioned 1.5-1.8 m above the ground (based on users' theoretical ear height);
- Minimum duration of 30 minutes;
- The measurement position should be close to the interview location, but far enough away (at least 3 m) not to be corrupted by the on-going interview;
- Time History, 1 second based, of overall equivalent continuous A-weighted sound pressure level (LAeq,1s and L50) should be considered;
- If it is possible that pure tones and/or impulse noise could be present, knowing the type of noise sources (industrial noise), other acoustic parameters should be considered, 1/3 octave band spectrum.

Based on the Time History of sound pressure levels (LAeq,1s) the following indicators should be used for further analysis: LAeq; LA50; L10 – L90; number of acoustic events. An event occurs when an unpleasant noise source causes an $L_{Aeq,1s}$ that is 10 dB higher than the average background noise (BGN) of the 30 seconds before and after the event, defined using the L_{90} indicator for BGN. The noise source that caused the event is identified and the analysis of the questionnaire will determine if this noise source, and therefore the event, is classified as unpleasant by the public.
Based on the results of analysis of correlations between acoustic parameters and end-users' perception carried out in the pilot cases, the indicator that best correlates the end-users' perception is the LA50.
The above indicators should be evaluated by 30-minute time periods (a temporal unit which is the average amount of time people remain in the areas) during which an interview takes place. This way, the acoustic indicators will be strictly linked to the interview.
A class 1 or 2 measurement device, compliant with the applicable international standards, should be used.
Before and after each measurement session, the measurement device should be checked using a class 1 calibrator compliant with the applicable international standards. Differences included into the accuracy of 0.5 dB are expected for a validation of the measurement session.
The Time History of LAeq,1s is detailed enough to allow further analysis and choose different indicators, if necessary.
Weather conditions should be taken into account and data influenced by the weather should be disregarded. This can be on-site info or weather data from the nearest station.
In case of interventions to improve the QUA, short-term measurements should be conducted before and after the interventions, at the same time the year. And when traffic noise is the dominant sound, it is recommended to
define the traffic's characteristics (volume, speed, distribution) in order to compare data from before and after the interventions.
In the tools mentioned in this section, the analysis of a set of variables is proposed and minimum requirements for analysis of QUAs are defined. These requirements are expected to be of general validity.

How to use Tool 5

EXAMPLE OF USING TOOL 5 IN THE PILOT CASE IN BILBAO: GENERAL LATORRE SQUARE

Short, 1-second measurements were carried out, collecting information on different noise indicators. In the case of General La Torre square, short measurements were carried out in a point located in the centre of the square.
In Table 14 some of the results of the sound measurements collected during the morning evaluation after the interventions are presented:

Date	Starting time	LAeq	LAFmax	LAFmin	LAF1	LAF10	LAF50	LAF90	LAF99
27/04/2014	11:08:08	63,6	66,5	61,9	66,6	65,8	62,6	62,1	61,9
27/04/2014	11:08:09	75,3	83,9	61,8	83,7	81,0	68,2	62,5	61,9
27/04/2014	11:08:10	61,3	64,2	60,5	64,0	63,0	61,4	60,9	60,6
27/04/2014	11:08:11	61,0	61,7	60,3	61,8	61,5	61,0	60,6	60,3
27/04/2014	11:08:12	60,7	61,8	60,0	61,7	61,5	60,7	60,2	60,0
27/04/2014	11:08:13	61,0	62,0	60,3	62,0	61,5	61,0	60,5	60,2
27/04/2014	11:08:14	61,0	61,9	60,0	61,8	61,6	60,8	60,2	60,0
27/04/2014	11:08:15	61,0	61,6	60,4	61,6	61,3	60,9	60,6	60,4
27/04/2014	11:08:16	61,9	62,4	61,3	62,5	62,3	61,7	61,4	61,2
27/04/2014	11:08:17	62,4	62,9	61,8	63,0	62,8	62,4	61,9	61,8
27/04/2014	11:08:18	62,7	63,2	62,1	63,2	63,0	62,6	62,3	62,1
27/04/2014	11:08:19	63,1	64,0	62,6	64,0	63,6	63,1	62,8	62,6
27/04/2014	11:08:20	63,7	64,7	62,7	64,7	64,4	63,2	62,8	62,6
27/04/2014	11:08:21	63,1	63,9	62,5	63,9	63,6	63,1	62,7	62,4

Table 14: Short term levels measured after the interventions' realization in the pilot case of General La Torre square.

The data from the short measurement is linked to the results of the questionnaires to analyse the possible acoustic causes of certain answers. Table 15 presents an example of measurement data collected after the interventions in General La Torre square.

DATE	NUMBER OF QUESTIONNAIRE	HUA COD.	MEASUREMENT POSITION	STARTING TIME	ENDING TIME	LAeq dB(A)	L10 dB(A)	L50 dB(A)	L90 dB(A)	L10-L90 dB(A)	User
27/04/2014	1	A	Q01		11:40:00	66,0	66,3	66,0	65,7	0,6	Unemployed
27/04/2014	2	A	Q01		11:30:00	65,5	66,3	65,2	64,7	1,6	Employee
27/04/2014	3	A	Q01		11:20:00	60,4	61,9	59,6	58,4	3,5	Employee
27/04/2014	4	A	Q01		11:50:00	61,8	62,8	61,0	60,3	2,5	Employee
27/04/2014	5	A	Q01		12:01:00	65,3	65,8	65,3	64,6	1,2	Student
27/04/2014	6	A	Q01		12:08:00	64,8	65,5	64,8	63,7	1,8	Employee
27/04/2014	7	A	Q01		12:14:00	62,1	62,6	62,1	61,6	1,0	Employee
27/04/2014	8	A	Q01		12:23:00	64,2	65,7	63,8	62,0	3,7	Employee
27/04/2014	9	A	Q01		12:30:00	66,9	69,3	66,1	63,8	5,5	Retired
27/04/2014	10	A	Q01		12:35:00	65,3	65,8	65,3	64,7	1,1	Student
27/04/2014	11	A	Q01		11:15:00	64,5	64,8	64,4	64,0	0,8	employee
27/04/2014	12	A	Q01		11:25:00	63,1	63,5	63,2	62,5	1,0	employee
27/04/2014	13	A	Q01		11:41:00	66,1	66,5	66,1	65,6	0,8	

Table 15: Short term levels associated to concurrently questionnaires in the pilot case of General la Torre.

The information collected was summarised and processed to obtain data from a time of day that was representative of when the area was in use (generally 30 minutes) and during the periods shown in Table 16:
In Table 16, the information in brackets is the difference between the results after and before the interventions.

POST-INTERVENTIONS	Morning		Evening	
	11:00-11:30	11:30-12:00	18:00-18:30	18:30-19:00
LAeq	64 dBA (-3)	66 dBA (+4)	64 dBA (0)	66 dBA (+4)
Negative events	2 (-4)	2 (-4)	2 (-7)	0 (-2)
Positive events	0	0	0	4 (+4)

Table 16: Acoustical environment evaluated in a representative day in the pilot case of General la Torre.

Complementary variables for analysing QUAs in a municipality/agglomeration

As a complementary approach to the analysis phase, an audio recording in WAVE format could be made and analysed. The purpose of this approach is to collect psychoacoustic information (linked to the end users' perception) about the sounds during the in situ analysis.
Annex 3 describes how to perform audio recordings in WAVE format.

Conclusions about the analysis phase

Finally, the following method is suggested for evaluating the results of the analysis phase:
- If the criteria of all analysis (expert analysis, end users questionnaires, noise measurements) do not have a negative rating the area can be defined as quiet;
- If a criterion is present in only one analysis (e.g. in the expert analysis) and has a negative rating (red colour) the area is defined as only potentially quiet;
- If a criterion is present in more than one analysis (e.g. in both the expert analysis and the end-user questionnaire) and has a negative rating (red colour) in the expert analysis, the corresponding score assigned by end-users should be checked; if the evaluation given by end-users is also negative (e.g. average score <=3) the area is defined as only potentially quiet.

PHASE 3: QUA MANAGEMENT

Different management goals can be defined depending on whether the selected areas were defined as actually quiet or only potentially quiet during the analysis phase:

- A plan to preserve the quality of the area if it is defined as already quiet.
- A plan to increase the value of the area and to promote its use. For example, Quiet (Urban) Areas could be identified using signage that shows people how to get there and also makes people aware that these areas are present and accessible. Quiet Urban Areas should be included in walking, hiking and biking routes. The signage could also contain information on the area and instructions for visitors. Moreover, municipalities should promote the use of Quiet (Urban) Areas through promotional campaigns and inform people of their benefits.
- A plan to improve the quality of the area if it can only be defined as potentially quiet, and planning of the type of measures to be implemented.

For the management phase, if the analysis phase has highlighted the need for measures, the following procedure is proposed for defining and designing these measures according to the QUADMAP experience:

- Any intervention should aim to solve all critical situations identified during the analysis phase;
- Intervention should be inspired by the suggestions obtained from the expert analysis and/or end-user questionnaire results (see the following questions: “Suggestions for acoustic improvement”, “Suggestions for visual improvements” and “Suggestions for improvements to equipment”). To help experts, an additional tool (Annex 4) has also been proposed.

Moreover, according to the analysis carried out in the QUADMAP Project, the suggested criteria for

evaluating the effectiveness of noise abatement measures in an quiet urban area are as follows:

- The reduction of noise levels (mainly concerning the LA50/LAeq indicators) compared to a threshold level (e.g. 55 dB);
- The reduction of noise levels (mainly concerning the LA50/LAeq indicators) compared with the noise levels before the interventions; a reduction of unpleasant noise events and/or an increase in pleasant events.
- An improvement in end-users' perception (evaluated through the end-user questionnaire) compared with the users’ perception before the interventions.

Meeting at least one of the above criteria can be considered as an improvement to the area's acoustic environment.

Other aspects that must be highlighted to connect the management of quiet areas with other plans and programs in municipalities are the following:

- The framework of the definition and implementation of the noise action plan should be related to the city's maintenance and renovation strategy. It is crucial to identify opportunities to incorporate the management of potential quiet urban areas in the city and how positively the changes are perceived by the public when the process is constructive.
- The collaboration between the managers of QUAs and urban planners is fundamental and it should start at the beginning of the process of urban redevelopment. The results of the analysis must be easily interpretable by laymen (non-acoustics experts), to allow a participatory decision-making process.
- Four tools defined in the methodology are interesting for defining management requirements: expert analysis, questionnaires, noise measurements and noise maps. Each of them could give ideas of the key aspects to be faced when planning the preservation, improvement or increasing value of QUAs.
- The questionnaire improves the understanding of the interests and expectations of people who use the area. The QUADMAP procedure can be part of a design process that is open to public participation.
- A communication plan regarding existing quietness and awareness-raising activities is mandatory in a management process about quiet areas and can improve the public's perception of quiet areas.

General recommendations referring to the management of Quiet Urban Areas (according to the QUADMAP experience) also include:

Actions for Preservation:

- Measures that exclude mopeds, scooters and other motorized vehicles from Quiet (Urban) Areas. This could be done by means of gates that cannot be used by mopeds and scooters, and signs that prohibit those vehicles from entering the area. Local regulations should be implemented to do inspections and enforcement, and prosecute offenders.
- Municipalities should involve the preservation and management of Quiet (Urban) Areas in their environmental, public green and general policies.
- Municipalities could or should involve local residents in order to participate in the management of the Quiet (Urban) Areas.
- Large Quiet (Urban) Areas could be guarded by park keepers that are also attentive to the misuse of the area.

Actions to increase their value:

- Frequently repeating the interviews among visitors and users of these areas in order to observe trends in user perception and to collect ideas for making these areas more attractive.
- In order to make Quiet (Urban) Areas more attractive, these areas could be made greener using plants, flowers, trees, bushes or green walls. This contributes to climate adaptation, human health, and makes these areas more attractive.
- Municipalities could or should involve residents living in the surrounding districts in order to participate in the management of the Quiet (Urban) Areas.

Actions for their improvement:

- The acoustic environment in Quiet (Urban) Areas should preferably be dominated by natural and human sounds like bird song, rustling leaves, playing children, etc. If these sounds are missing, they could be added by means of fountains, playgrounds or even aviaries.
- In order to make Quiet (Urban) Areas more attractive, these areas could be made greener by means of plants, flowers, trees, bushes or green walls. It contributes to climate adaptation, human health and makes these areas more attractive.
- Municipalities could or should involve residents living in the surrounding districts in order to participate in the management of the Quiet (Urban) Areas.

Referring to the Quiet Areas in the open country, only some indications come out from the experience of rural areas in Bilbao's green ring. In these areas, expectations regarding the quality of the acoustic environment seem to be different to those in urban areas (in this case, users usually prefer to leave the area “as natural as possible”), so expectations of management actions are also different.

CONCLUSIONS AND POSSIBLE FOLLOW-UP

EU Directive 49/2002/EC on Environmental Noise defines a Quiet Urban Area (QUA) as “an area, delimited by the competent authority, for instance which is not exposed to a value of Lden or of another appropriate noise indicator greater than a certain value set by the Member State, from any noise source”. This definition seems extremely vague and does not provide usable procedures to be applied in each country. Proposing a solution to overcome the lack of harmonised methodologies for QUAs is the main aim of the QUADMAP (QUiet Areas Definition and Management in Action Plans) Project. The results of the Project are expected to facilitate urban planning by applying standard procedures for the identification, delimitation and prioritization of QUAs. In fact, QUADMAP has developed a procedure for selecting, analysing and managing QUAs that has been tested in ten pilot areas and that, consequently, has proved to be valid. In addition, thanks to its flexibility, the methodology is also easily replicable in other urban environments. The methodology developed has also proved to be applicable for designing QUAs or for integrating a "quietness" element into local authorities' urban planning and development policies.

One of the methodology's most innovative aspects is the involvement of the public in planning and designing noise abatement intervention. In fact, interviews should always be carried out, in order to ask for users’ opinion about the typical aspects of each QUA and to obtain suggestions for the type of intervention to be implemented.

Using the proposed methodology as a starting point, comprehensive guidelines have been produced. The first aim of the guidelines is to help stakeholders, competent authorities and interested parties to understand the END's requirements with respect to QUAs and to suggest a valid and easily applicable methodology in order to meet them. In addition, these guidelines also suggest possible answers to some research questions posed in the Good practice guide on quiet areas, published by EEA in 2014, in particular the need to combine users' acoustic perception of a QUA with their general opinion of the area.

The QUADMAP Project introduced a general methodology and related tools for the selection, analysis and management of QUAs, which is suited to the specificities of each country involved in the Project.

However, the main environmental problem addressed by the QUADMAP Project was noise, while aspects regarding the possible improvement of air quality in urban spaces and the economic value of QUAs are still open issues.

A follow-up could be the development of a common methodology, starting from the one proposed by the QUADMAP Project, in which new strategies are introduced in order to deal both with acoustic and air quality issues. This approach is expected to considerably improve QUAs' effectiveness with respect both to end users' expectations and urban policies.

ANNEXES

ANNEX 1: OUTCOMES ARISED FROM STAKEHOLDER QUESTIONNAIRE

Here the main results from the stakeholders' questionnaires.
36 stakeholders completed the questionnaire (9 questionnaires from Italy, 11 from Germany, 4 from Spain/Portugal, 5 from the UK, 1 from Norway, 4 from the Netherlands, 1 from Belgium and 1 from France).
Figures 3 and 4 show a summary of the most relevant conclusions.

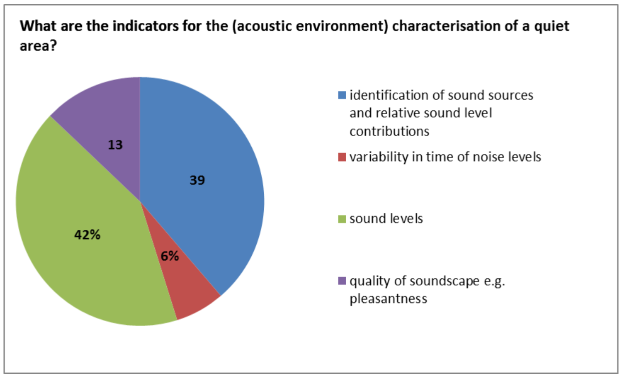

Figure 3: Analysis of answers to question n° 10 - percentage of answers to each choice.

From Figure 3 it can be seen that the most common criteria for the general non-acoustic characterisation of QUAs are their "accessibility", the "reason for frequentation", the "presence of natural elements" and the "frequency of visits". Each of these variables has been introduced in a specific section of the methodology and examined. In particular, "accessibility" is evaluated with the expert analysis and the end-user questionnaires, whereas the "reason for visit", the "presence of natural elements" and the "frequency of visits" are included in the end-user questionnaire.

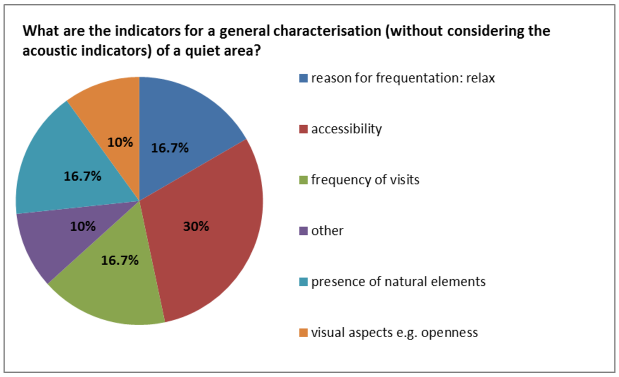

Figure 4: Analysis of answers to question n° 9 - percentage of answers to each choice (note that "other" includes as answers "presence of relevant urban elements).

From Figure 4 it can be seen that the most common criteria for characterising QUAs' acoustic environment are sound levels, the identification of sound sources and relative sound levels. As a consequence, these variables were included in the analysis phase, in relation to the in- situ noise measurements.
As a general conclusion for this section, it can be said that the most important criteria that emerged from the analysis of the stakeholders' questionnaires have been considered in the section of the methodology dedicated to the analysis phase. All things considered, as the number of questionnaires collected is not very significant (36 stakeholders), it has been chosen to maintain a higher number of criteria.

ANNEX 2- COMPLEMENTARY VARIABLE: DESCRIPTION OF THE RQUA (NOISE GRADIENT) METHOD

The rQUA method is inspired by the method for pre-selecting potential QUAs from an experiment developed by city of Paris and Bruitparif (Internoise 2012).

In the context of a dense urban environment, usually close to loud transport noise, it is fundamental to introduce the notion of "relative noise or noise gradient or noise contrast," which consists in also identifying quieter areas within every neighbourhood.
The rQUA method consists in locating sites that can be considered as potential quiet areas, when the area is quieter than the surrounding area. This method relies on data from strategic noise maps, which is usually available. Maps are usually provided in a form that complies with END requirements (i.e. Lden as the acoustic indicator). In order to facilitate the use the GIS software, END noise maps must be collected as a grid of points (e.g. 10m x 10m minimum grid resolution). Noise maps for roads and railways require the same grid points to perform the evaluation. Where noise maps are not available as a grid of points, they must be converted into a grid of points with a resolution of 10m x 10m.
The rQUA requires the use of a GIS that can apply several layers of filters over the existing data.
Processing maps with a GIS avoids any bias on the nature and the location of the results. The basic principle chosen is that any space open to the public is a potential quiet area.
Minimum requirements:
- Data from the noise calculation software: noise levels on grid of receiver points, Lden and Ln indicators according to END requirements;
- GIS platform software with the spatial analyst extension.
At first, it provides to use the overall Lden noise map (this map is usually built up using a GIS software and represents the energetic combination of noise contributions of all main noise sources, such as road and rail, by using Lden indicator). Then, the absolute noise level ($Lden_{absolute}$) is attributed to each point of the map grid.
Secondly, for each point, a circled area with a radius of 250 m (representing the surrounding neighbourhood) is considered, and the average of Lden values of the map grid points in the circle is calculated ($Lden_{aritmetic\_average}(R = 250\,m)$.

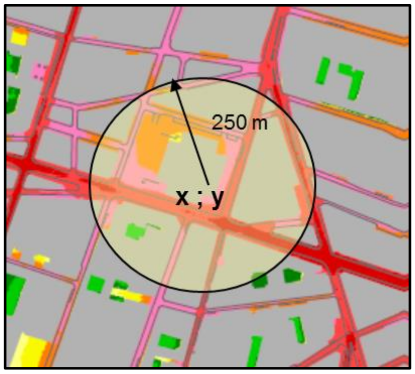

Figure 5: rQUA method, definition of the surrounding neighbourhood

This way, in this step a site's "quietness" is appraised not only with its absolute noise level (above or below 55 dB(A)), but also how it compares to the surrounding area (like a "haven" of calmness).
Finally, the difference between the absolute level and the average level is calculated for each point on the grid:

$$\Delta = Lden_{arithmetic\_average}(R = 250\,m) - Lden_{absolute}$$

With this formula, a positive value of Δ means that the grid point is less noisy than the surrounding neighbourhood. Thanks to this approach, it is possible to define four categories considering both the absolute (Lden_absolute > or < 55 dB(A)) and relative (Δ > or < 10 dB(A)) levels. Each category is identified with a colour (green, yellow, orange and white) as indicated in Table 17:

Colour	$Lden_{absolute}$ dB(A)	Δ dB(A)
Green	≤ 55	> 10
Yellow	≤ 55	≤ 10
Orange	> 55	> 10
White	> 55	≤ 10

Table 17: Possible categories of QUA established using the rQUA method.

From Table 17, it is possible to classify the area in the following categories, to be considered for the subsequent phases of analysis and management:
- Presently quiet, based on the absolute acoustic criteria (Lden<55dBA) (green and yellow areas);
- Presently critical, based on the absolute acoustic criteria (Lden>55dBA), but potentially quiet

(orange). With a significant acoustic contrast, this drop >10 is potentially perceived as at least a halving of the noise level.
The ones coloured in orange, i.e. with a Lde > 55 dB(A) but Δ > 10 dB(A), need particular attention as they would not have stood out with a simple analysis of absolute noise using the map, whereas these spaces have a possible advantage in a noisy neighbourhood.
- Presently critical, based on the absolute acoustic criteria (Lden>55dBA), but potentially quiet (white).
The possible measures to be implemented in white areas could be evaluated (see Annex 4).

ANNEX 3-COMPLEMENTARY VARIABLE: WAVE FILE RECORDING

The purpose of the WAVE file recording is to collect acoustic information about actual sounds during in-situ analysis, strictly related to the end-users' perception.
In this section, some minimum requirements for a general QUA are provided. Nevertheless, some different requirements could come from data collection in the pilot cases.
The minimum requirements for a generic QUA are defined below:
- At least one recording position or a “sound walk” should be carried out in each HUA;
- The recording positions should be close to the interview location, but far enough away (at least 3 m) not to be corrupted by the on-going interview;
- A binaural data acquisition system is required;
- The recording measurements should be carried out during a period when the HUA is typically used, at the same time as end-user interviews (see Tool 4);
- A WAVE file (44.1 kHz sample rate) should be recorded.
Based on the post-elaboration of the WAVE file, psychoacoustic parameters (e.g. loudness, sharpness, roughness, etc.) can be computed.
Before and after each measurement session the recording system should be checked using a class 1 calibrator according to IEC 60942 international standards. The calibration signals should be recorded. The system's recording settings should not be changed during the measurement session.
The calibration device should have been checked by an accredited laboratory according to the applicable international standards within the last 2 years.

Based on the results from the pilot cases of Florence and Rotterdam, the psychoacoustic parameters obtained by processing the audio recording do not seem to add essential information to the end user questionnaires. Consequently, it is confirmed that the WAVE recordings should be maintained as a non-compulsory procedure.

ANNEX 4- COMPLEMENTARY VARIABLE: HOW TO OBTAIN INDICATIONS FOR POSSIBLE ACOUSTIC MEASURES FROM NOISE MAPS, STARTING FROM THE RQUA METHOD DESCRIBED IN THE TOOL 1

The main aim of the first step of the rQUA method (see Annex 2) is to identify public areas that can be considered quiet from an acoustic point of view.
The procedure illustrated in this tool focuses on areas that, according to the same method, cannot be considered as acoustically quiet and recommend possible measures for reducing noise.
For the purposes of this procedure, the concept of “relative noise” and the subsequent steps followed in the GIS environment in order to associate to each vertex of the grid of points obtained from the noise map a value of the Lden and Δ indicators are retrieved.
Originally the rQUA method identifies four possible categories to which each point on the grid can belong (see Table 18).

Colour	*Lden_absolute* dB(A)	Δ dB(A)
Green	≤ 55	> 10
Yellow	≤ 55	≤ 10
Orange	> 55	> 10
White	> 55	≤ 10

Table 17: Possible categories of QUA established by the rQUA method.

Thanks to this classification, referring to the cases where the Lden indicator referred to the points of the grid is lower than 55 dB(A) (“green” and “yellow” classes) no particular problems arise.
On the other hand, a vertex belonging to the “orange” class is decidedly quieter than its surrounding despite being noisy itself. Consequently, no particular interventions are expected in this class to improve the acoustic environment.
Focusing on the last category (the “white” one), the

previous classification does not permit to understand if and which kind of intervention could take place to improve the acoustic environment. For this aim, the “white” class is specified more and split into two further categories to which new identifying colours can be attributed, as illustrated in Table 19.

Colour	*Lden_absolute* dB(A)	Δ dB(A)
Green	≤ 55	> 10
Yellow	≤ 55	≤ 10
Orange	> 55	> 10
Blue	> 55	>-5* and ≤10
Red	> 55	≤ -5*

Table 18: Possible categories of QUA established using the modified rQUA method.

* *The 5 dB threshold associated to the red and blue categories was suggested as a benchmark after the application of this Tool to the pilot cases of schoolyards in Florence.*

According to this classification, the “red” category refers to cases where there is a clear acoustic contrast between the specific vertex and the surrounding areas. On the other hand, the “blue” category refers to situations where there is no apparent acoustic contrast between noisy vertices and surrounding areas.

Regarding the “red” and “blue” categories, it is possible to associate each of them with indications concerning the noise sources and the possible noise reduction measures:

- Blue category: a predominant noise source is not identified and only strategic measures at block level (reduced speed and/or vehicle-free zones, etc.) can be performed.
- Red category: the most relevant noise source is well localised and limited measures performed at the edge of the areas (noise screens, low noise road surfaces, etc.) can be implemented. Moreover, the position of the actual areas used can be optimised.

Suggested measures that come from the application of the new version of the rQUA method should be matched with those proposed by technicians after an on-site survey and by end-users in the questionnaires (see Tool 4) and should integrate the expert analysis (see Tool 2) concerning aspects related to the effectiveness of noise abatement measures.

ABBREVIATION LIST

QUA: Quiet Urban Area.
rQUA: relative Quiet Urban Area.
END: Environmental Noise Directive (European Directive 2002/49/EC, 25 June 2002).
GIS: Geographical Information System.
HUA: Homogeneous Urban Area.

GLOSSARY

Lden: Lden (day-evening-night noise indicator) noise indicator for overall annoyance, as further defined in Annex I of Directive 2002/49/EC of the European Parliament and of the Council of 25 June 2002.
LAeq: Equivalent continuous A-weighted sound pressure level.
L10: Sound pressure level statistically exceeded for 10% of the measurement time.
L90: Sound pressure level statistically exceeded for 90% of the measurement time.
Candidate QUAs: areas that, after the pre-selection phase, could be potentially considered as QUAs.

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