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Good practice guide on quiet areas

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Preface

Noise pollution is a growing concern in Europe. Of particular importance is noise from transport and industrial sources, which are addressed by Directive 2002/49/EC relating to the assessment and management of environmental noise, otherwise known as the Environmental Noise Directive (END).

As well as actions to reduce human exposure to this noise, the END highlights the need to preserve environmental noise quality where it is good. It is these quiet areas that are the subject of this report by the EEA Expert Panel on Noise.

The EPoN is a working group that supports the European Environment Agency (EEA) and the European Commission to develop and implement effective noise policy for Europe.

The Panel aims to build upon results delivered by previous working groups, particularly those concerning the END. This good practice guide has been drawn up to help policymakers, competent authorities and any other interested parties understand and fulfil the requirements of the END. The guide makes recommendations based on examples of good practice in assessing and managing quiet areas in Europe.

This document is not an official position statement on behalf of the EEA or the European Commission. Only the text of the END is applicable in law at Community level. If, in any instance, suggestions contained in this good practice guide seem to be at variance with those of the Directive, then the text of the directive should be applied instead.

Members of the EPoN who helped prepare the document are Gaetano Licitra (Italy), Paul de Vos (the Netherlands) and Martin van den Berg (the Netherlands) as joint lead editors. Other contributing members of the EPoN are Wolfgang Babisch (Germany), Guillaume Dutilleux (France), Anna Backman (Sweden), Brian McManus (Ireland), Alan Bloomfield (United Kingdom), Núria Blanes (Spain), Luis Bento Coelho (Portugal), Stephen Turner (United Kingdom) and Søren Rasmussen (Denmark).

The Panel is chaired by Colin Nugent (EEA), and observer members from the European Commission include Marco Paviotti (Directorate-General for the Environment) and Stelios Kephalopoulos (Joint Research Centre).

1 Introduction

Directive 2002/49/EC of the European Parliament and of the Council relating to the assessment and management of environment noise, more commonly known as the Environmental Noise Directive (END), has a clearly stated aim: to 'define a common approach intended to avoid, prevent or reduce on a prioritised basis the harmful effects, including annoyance, due to exposure to environmental noise'. Thus, the END acknowledges the need for preventing or reducing environmental noise levels that may negatively affect human health, including annoyance and sleep disturbance. In addition, it highlights the need to preserve 'environmental noise quality where it is good', as well as to preserve quiet areas. The foundation for preserving these quiet areas was laid through the Green Paper on Future Noise Policy (EC, 1996): 'They (the noise maps) make it easy to recognise the noise exposure and thereby identify areas where action is required and other quiet areas where exposure should not increase'.

The END's regulation of quiet areas is somewhat limited. Article 8 states that action plans for agglomerations with more than 250 000 inhabitants 'shall also aim to protect quiet areas against an increase in noise'. This is followed up by the requirement in Annex V to report on actions or measures that the competent authorities intend to take to preserve quiet areas. Actions may include land use planning, systems engineering for traffic, traffic planning, and noise control of sources. The END does not specify any requirements regarding the protection of quiet areas in open country.

In the review report from the first round of END implementation (Milieu, 2010), many Member States spotlighted the absence of any guidance on quiet areas. This led to the issue being listed in the Commission's implementation report as one possibly requiring technical improvement (EC, 2011).

Furthermore, a report published by the European Parliament in 2012 made recommendations for the development of a more comprehensive noise strategy, wherein, the vague definition of quiet areas by the END was highlighted as leaving ample discretion for interpretation to Member States, which led to confusion and divergence in approach to the protection of quiet areas (EP, 2012).

The weak focus of the END on quiet areas has led to heightened activity in this field, especially in areas like soundscapes, the study of how people perceive the acoustic environment. Several Member States initiated or intensified their policies with respect to quiet areas. This means there is currently more knowledge and experience on the subject than there was at the time of publishing the Green Paper. The EEA EPoN has been able to collect, order and redistribute this experience for wider use.

2 Sound, noise and quiet

A common misunderstanding is the belief that absence of noise automatically implies total silence; this is the equivalent of believing that creating a vacuum is the solution for air pollution. Sounds are, however, an essential ingredient of human life. They are meaningful, and provide information about our surroundings — on the volume of a space, for instance, and on which activities occur in that space. The atmosphere is in constant movement, generating all kinds of sound itself and in its streaming around objects. Countless (natural) activities and objects have their characteristic sounds. Putting humans in a relatively soundless environment like a remote desert typically makes them feel very uncomfortable.

Following the definitions provided in Article 3 of the END, a quiet area is not one that is silent, but rather one that is undisturbed by unwanted or harmful outdoor sound created by human activities (i.e. environmental noise). Harmful sounds are those that negatively affect human health; they include annoyance and sleep disturbance. In other words, quiet areas can be understood in terms of absence of sound that interferes with activities. Communication in all its subtle (orientation, signals of impending danger) or direct (speech, warning signals) forms will of course be disturbed by noise; processes like thinking, reading, writing, sleeping and learning are also known to be disturbed by noise (e.g. Stansfeld et al., 2005; and WHO, 2000, 2011).

Box 2.1 Calm or quiet — a view by EPoN

Context
The designation 'quiet' may accidently lead to the assumption that a quiet area is an area with a very low noise level. In urban situations noise levels below 45 dB L_{day} or 40 dB L_{night} are hardly ever found.

Quiet would not be the right designation for the general public. Absolute silence tends to frighten most people. Therefore, we are not searching for silence, we are searching for relaxation. Most people feel the need to compensate their busy, noisy city life with an occasional or more regular calm and relaxing day. So, instead of searching for quiet, we should be searching for calm. Defining a quiet area only by the noise level is therefore not adequate. Below is a list of alternative criteria that can be used to identify and qualify quiet urban areas. As a start, the designation 'calm area' or 'tranquil area' would fit more closely to what the public experiences.

Definitions
The best definition for a calm area is an area where noise is absent or at least not dominant. Note that there are no noise level figures whatsoever in this definition. Nevertheless, the residents would understand this definition and would be able to indicate areas in their neighborhood or in their town which would candidate for calm areas.

Such areas could be found in towns in parks, within building blocks, in courtyards, in gardens, in leisure areas etc. In rural areas they could coincide with natural parks or protected areas, but they may also be part of an agricultural area or unused land outside the city.

Effects
There is only marginal evidence that calm really compensates the negative effects from too much noise. We do not really know for certain, that staying in a calm environment is good for our health. What we do know is that most people value a calm environment from time to time, for relaxation, for rest, for peace of mind. Then maybe we should not bother too much about the quantitative health effects to be achieved, but instead we should offer people the opportunity to find calm, possibly in the vicinity of their homes, or else inside their homes, in the suburbs, on extensively used leisure areas, or out in the country.

Box 2.1 Calm or quiet — a view by EPoN (cont.)

Practical guidelines
Calm areas need to be identified, designated and protected. But this is not necessarily a legislative action nor necessarily a task for the authorities. Once people are made aware of the significance of calm, they should be able to point at calm areas or calm spots near their homes. They will probably be more than happy to engage in an 'official' designation of these spots as calm areas, areas intended for relaxation, possibly with some restrictions. In a calm area there is room to play an occasional game of football, there is room to talk and listen to music, as long as it is not too loud or as long as it is restricted to certain previously designated periods for loud activities. A task for the authorities would be to keep the noise from the major sources away from the calm areas. This would apply to busy roads, railway lines, industrial activities, etc. All the rest could be regulated by the residents themselves, who would be motivated to take the responsibility for the calm area.

3 Definitions and selection criteria

The END defines quiet areas both inside and outside agglomerations, and also defines quiet façades.

3.1 Definitions of quiet in the END

- **A quiet area in an agglomeration** shall mean an area, delimited by a competent authority, for instance, which is not exposed to a value of L_{den} ([1]) or another appropriate noise indicator greater than a certain value set by the Member State, from any noise source.
- **A quiet area in open country** shall mean an area, delimited by a competent authority, that is undisturbed by noise from traffic, industry or recreational activities.
- **A quiet façade** is the façade of a dwelling at which the value of L_{den} 4 metres (m) above the ground and 2 m in front of the façade, for the noise emitted from a specific source, is more than 20 decibels (dB) lower than at the façade having the highest value of L_{den}.

The first two definitions are operational. The first aims to define a 'quiet area' based on its physical qualities, whereas the second is more directed towards its effect or disturbance. The definition of a quiet façade borders quite literally on the definition of a quiet area in agglomerations: connect a number of quiet façades and a quiet area is the natural result (and vice versa).

3.2 Relation to current practice

An examination of current practices shows that approaches, methods and indicators used for the identification of quiet areas vary widely, as do the physical and effect-oriented definitions or selection criteria (see Table 3.1).

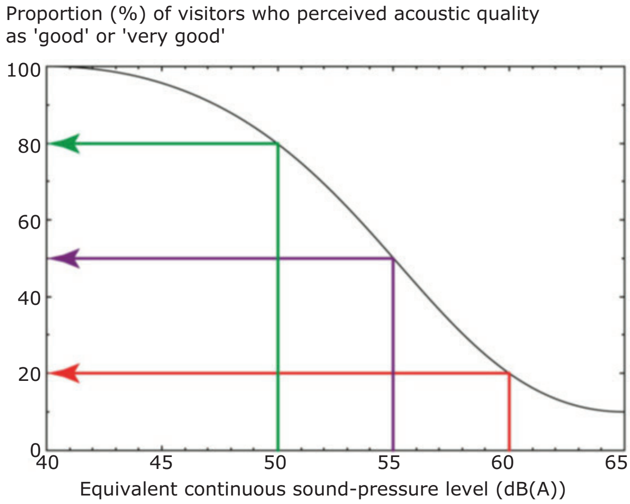
Many of these criteria can be and are used in combination, often at separate steps of a particular process. For example, one may first apply a course selection on the basis of functional and acoustic criteria, and then apply the other criteria on the resulting areas.

Figure 3.1 illustrates a model of relationship between sound-pressure levels and perceived acoustic quality. Furthermore Annexes 2 and 3 present evidence that supports selection criteria based on sound-pressure levels. This is summed up in Table 3.2, which highlights a number of studies on the effects of sound-pressure levels upon visitors to quiet areas. Annex 2 offers more information on possible dose–response relations.

3.3 Reporting of data relating to quiet

The Electronic Noise Data Reporting Mechanism (ENDRM) was developed by EEA in order to assist with data reporting obligations introduced by

Figure 3.1 Model of relationship between sound-pressure levels and perceived acoustic quality of green areas



Source: Adapted from Nilsson, 2007b.

([1]) L_{den}: day, evening, night sound level.

the END. It is fully compatible with the electronic reporting system, Reportnet and has been formatted to permit delivery of data that is also required by the INSPIRE Directive for the establishment of an infrastructure for spatial information in the European Community. Such data can include noise maps, agglomeration boundaries and action planning areas, including zones delimited as quiet areas. To this end, the ENDRM accommodates the reporting of spatial data for designated quiet areas and also data for population exposure in buildings with quiet façades on a non-mandatory basis (EEA, 2012).

Table 3.1 Selection criteria for quiet areas (not-limitative set)

Type	Indicator	Range criteria Urban (dB)	Range criteria Open country (dB)
Acoustic indicators	$L_{eq,24h}$	40	25–45
	L_{den}	50–55	-
	L_{50}	-	35–45
	L_{90}	-	30
	L_{95}	30	-
	L_{day}	45–55	30–40
Functional	Recreation	Moderate intensive activity	Passive activity
	Nature protection	Moderate	Priority
	Health protection/restoration	Health protection	Restoration priority
Distance	From motorway	-	4–15 km
	From agglomeration	-	1–4 km
Soundscape	Perceived acoustic quality/appreciation	-	-
Size	-	100–100 000 m^2	0.1–100 km^2
Visual	Areas with established values in official documents, e.g. land use plans or nature conservation plans	-	-

Table 3.2 Sound-pressure levels related to perceived acoustic quality/appreciation

Sound-pressure levels (L_{Aeq}, L_{day})	Perceived acoustic quality/appreciation ([a])
< 45 dB	~ 100 % of visitors perceive acoustic quality as good
45–55 dB	~ 50 % of visitors perceive acoustic quality as good
> 55 dB	% of visitors perceiving acoustic quality as good falling rapidly with rising sound-pressure levels

Note: ([a]) Besides sound-pressure levels, the score depends on other area qualities (e.g. visual quality, air quality and perceived types of sounds: human, nature and technology) as well as on the correlation of theses with the users' activities and expectations. See Annex 2 for more detail.

Box 3.1 Quiet façades — a view by EPoN

Context
The façade of a dwelling represents a significant reduction of the exterior noise level. The insulation of the façade depends strongly on the mass of the building elements used. Often, the windows represent the weakest link, their insulation depending on the window frame sealing type and the glazing (single or double glazing; glass panel thickness; air filled or gas filled). When the window is open (for ventilation purposes) the insulation is highly affected. Permanent sound proof ventilation devices may serve to create good ventilation without affecting the insulation of the window.

Exposure to noise inside dwellings can cause annoyance and complaints. Good practice floor plan design includes situating the sensitive rooms (sleeping rooms, living rooms) with large windows on the quiet side of the dwelling, and less sensitive rooms (facilities, kitchen) on the side facing the noise source.

It is plausible to expect that the annoyance is less likely to occur in dwellings where the resident can experience relative quiet from one side, and is well protected against high noise levels from the other side of his home. Compared to a dwelling with noise on both side, the resident in a dwelling with one quiet side is better off. Windows on the quiet side can be opened to experience a calm environment and let fresh air in without being disturbed by noise, whereas the windows on the noisy side are (permanently) closed and hence the noise does not cause disturbance.

Definitions
Various definitions of a quiet façade can be found in literature. Some examples: quiet façade, meaning the façade of a dwelling at which the value of L_{den} for the noise emitted from a specific source, is more than 20 dB lower than at the façade having the highest value of L_{den} (END, Annex VI) quiet façade, meaning a façade of a dwelling at which the value of L_{den} is not higher than 55 dB.

The City of Amsterdam in the Netherlands applies the following definition: Façade in urban residential area can be considered quiet if:

- noise level on façade is not higher than at other façades; and
- noise level < 55 dB L_{den} (L_{night} ≤ 45 dB); and
- outdoor space has sufficient quality (e.g. garden or park vs.parking lot).

Effects
Various studies show a difference in noise impact from the noisy side of at least 2.5 dB in situations with one noisy and one quiet façade. This occurs at level differences of 10 dB and higher between the façade with the highest value of L_{den} and the façade with the lowest level of L_{den}.

Practical guidelines
Quiet façades are best created when a new building block is introduced into an existing urban environment. In existing situations, quiet façades can be created by: reducing or banning the traffic in the back street; closing gaps between building blocks so that enclosed court yards are created; glass roofing court yard spaces (creating atria).

4 Health benefits of quiet areas

People living in quiet areas do not suffer the negative health effects which befall those exposed to the average sound-pressure levels in an agglomeration; quiet areas also benefit the health and well-being of regular visitors.

For example, there is some evidence for annoyance and restoration, as indicated below.

- Access to the quiet side of a residence (i.e. $L_{Aeq,24h}$ < 45 dB) reduces annoyance. Also, nearby quiet zones in noisy areas seem to reduce annoyance. In fact, mere access to nearby green areas seems to improve well-being (Öhrström, et al., 2006; Gidlöf-Gunnarsson and Öhrström, 2007).

- People recover faster in natural surroundings, an effect that seems applicable to quietness and natural sounds as well (Kaplan, 1995; Ulrich, 1984; Alvarsson et al., 2010).

- Among residents in Amsterdam, 75 % indicate that quiet around the house is important, and 50 % state that quiet in the neighbourhood is important (van den Berg, 2008).

- In the Netherlands, 46 % of the population consider their neighbourhood to be 'not quiet'. Half of the population visit quiet places in the neighbourhood daily or weekly (van den Berg, 2008).

- In the United Kingdom, 91 % of the population believe that existing areas of quiet must be protected. In London, the corresponding figure is 62 % (NSCA, 2007).

With respect to the general health impacts of environmental noise and the application of the latest scientific evidence to action plans, reference should be made to the *Good practice guide on noise exposure and potential health effects*. This was prepared by EPoN in 2010 and is available via the EEA website (see http://www.eea.europa.eu/publications/good-practice-guide-on-noise).

5 Biodiversity effects

It is worth considering biodiversity issues when identifying and implementing quiet areas. Indeed, a symbiotic interaction is expected between the two subjects. Biodiversity benefits quiet areas, as nature sounds are generally valued positively by visitors to a place, and they may serve as indicators of a low level of traffic disturbances.

Quiet areas also benefit biodiversity for several reasons, from the general perspective of limiting biodiversity loss. One of the major causes of biodiversity loss is habitat destruction and fragmentation. Quiet areas should be selected bearing in mind the contribution to green infrastructure, whenever possible.

Another significant cause of wildlife mortality is collision with vehicles. Large-surface quiet areas may offer a safer place to live in this respect.

Finally, and this point refers back to the original focus on noise control, many species rely on acoustic communication, and there is evidence that anthropogenic noise adversely affects wildlife (their species richness, reproductive success and population size), and also widely affects their behaviour. Here again, a quiet area could offer a refuge to some species, provided it is life-supporting, e.g. that it adequately provides local food,water resources and places to shelter.

Botanic Gardens in Belfast © Colin Nugent, 2014

6 The economic value of quiet areas

Benefits of quiet areas in agglomerations can be estimated via the increase of property values. The direct effect of lower sound-pressure levels is estimated to be ~ 0.5 %/dB (RIVM, 2007). The indirect consequences of having a quiet area in a neighbourhood are harder to estimate.

According to the WHO report on Burden of Disease from Environmental Noise (2011):

- at least one million healthy life years are lost every year in western Europe due to noise from road traffic alone;
- it is the second-worst environmental cause of ill health, next to ultra-fine particulate matter ($PM_{2.5}$).

In the report from the Commission to the European Parliament and the Council: on the implementation of the Environmental Noise Directive in accordance with Article 11 of Directive 2002/49/EC, the social costs of rail and road traffic,noise across the EU was estimated as amounting to EUR 40 billion per year, of which 90 % is related to passenger cars and goods vehicles. EC, 2011, available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52011DC0321:EN:NOT.

The Swedish Transport Administration estimates that the social cost for noise in Sweden is SEK 20 billion (~ EUR 2 billion). Of this, approximately 80 % corresponds to reduced value of properties located in noisy areas. The remaining 20 % corresponds to the cost to society owing to health effects of noise.

In the United Kingdom, the Intergovernmental Group on Costs and Benefits noise subject group and Department for Environment, Food and Rural Affairs (Defra, 2008) reported that the health impact of noise could be costing the economy as much as GBP 2 billion to 3 billion per year. Subsequently, Defra published a report in 2011 which indicated that protection of quiet areas in the major cities of England could be valued at as much as GBP 1.4 billion per year to the economy (Defra, 2011).

7 Review of current practice among Member States and competent authorities

A significant number of competent authorities have made a conscious effort to promote or protect quiet areas. However, as previously stated, approaches vary owing to cultural differences including language and the difficulty of translating 'quiet area' into other languages. Despite the currently limited experience on quiet areas, much can be learned from these efforts.

7.1 Overview of actions on quiet areas in Europe

The following section offers an overview of various ongoing actions to address quiet areas across Europe. This is both within the context of agglomerations, and also across more rural areas of open country. Specific END-derived action plan work is included, as are research papers commissioned to identify possible solutions to the definition, delineation and protection of quiet areas. The list of projects is by way of example only, and is not exhaustive.

When analysing the fascinating array of approaches to identifying quiet areas, one must applaud the ingenuity of the policymakers and experts concerned. Every possible definition of 'quiet area' seems to have been explored.

Sound-pressure levels play an important role in almost all schemes, but there are exceptions, indicating that sound-pressure level is not the only important factor in identifying quiet areas. Member States with the most developed soundscape approaches (Belgium, the Netherlands, Sweden and the United Kingdom) acknowledge that acoustic quality also relates to how an area is perceived by people, including the balance between wanted and unwanted sound and the area's recreational value, or how appropriate the sounds present are to the area and its use. This calls for new kinds of indicators, as well as new methods for identification or measurement of perceived acoustic quality/appreciation of quiet areas. This is because there are few evaluation studies, and it is not possible to determine which of the current approaches works best — something that underlines the need for further research into this area.

The more complex methods (in Belgium and Sweden, for instance) require more data and may be problematic when trying to control the sound-pressure levels once the quiet area is operational. Nevertheless, it must be stressed that the definition of quiet areas in an agglomeration presupposes that sound-pressure levels of noise sources may be measured in isolation from other kinds of sounds, like wanted sounds of humans and nature. In urban agglomerations, however, wanted sound may be as loud as unwanted sound. An example is how people in an urban park sit by a fountain, because it masks the background sound of road traffic.

Most of the currently used sound-level meters do not have the capacity to separate the sound-pressure levels of noise sources from the sound-pressure levels of wanted sounds. Consequently, detailed measurement of sound-pressure levels of noise sources in a quiet area of an agglomeration may be practically impossible. The solution is to rely entirely on calculated sound-pressure levels based on noise mapping, which is not at all the same as actual in situ measurement. This supports the observation that there is a need for new approaches towards measuring the acoustic quality of quiet areas, which move beyond sound-pressure levels. Soundscape is one such new approach.

The simpler approaches, for instance applying only L_{den}, can be effective for quiet areas in open country, because there, loud sounds are more likely to originate from sources like traffic, industry or recreational activities. Thus, if sound-pressure levels are below a certain level, e.g. < 40 dB on a calm day, the area is probably free of such sources. The Dutch regions laid down special regulations whereby regional inspectors have the power to restrict noisy activities before they occur or once they are perceived. This may be applied to a motor-sport event, for instance, but such a mechanism seems to be missing, or is not made explicit, in terms of END-related action plans.

Table 7.1 Overview of actions with a focus on quiet areas

Name of principal location	Scale ([a])	Type ([b])	Indicator	dB	Selection method	Observations
Oslo (Norway)	AG	AP	% area > L_{den} value	< 55	• Discussion with key persons in the City of Oslo who have good knowledge of potential areas • Review of registered green areas and meeting places in Oslo • Use of the results of noise mapping • Site visits, use of the registration schedule • Discussions with representatives from city districts and special interest organisations	Of 77 potential areas, 14 were selected. Additional criteria of the number of inhabitants living within 500 m of quiet area was also applied.
Berlin (Germany)	RE	PP	–	–	• Urban park remodelled using soundscaping approach: • 8 measurement locations • Noise modelling • Soundwalks • Workshops with residents • Desirable artificial sounds introduced	Soundscape of a busy urban area re-designed to offer escape from road traffic noise. Highlighted by European Soundscape Award 2012 http://www.eea.europa.eu/highlights/berlin-park-wins-award-for
Leipzig (Germany)	AG	AP	L_{den}	< 55	Acoustic criteria for natural and recreational areas: • 100 ha outside agglomerations • 20 ha inside agglomerations • 5 dB difference between centre and margin inside agglomerations	5 areas outside agglomeration. Total 3 000 ha designated. 10 areas inside agglomeration, approximately 800 ha. General standstill policy for these areas, and improvement whenever possible
Munich (Germany)	AG	AP	L_{den}	< 50	Quiet areas: • L_{den} < 50 dB • Appropriate land use • Minimum size of 20 ha Inner-city recreation areas: • 6 dB difference between centre and margin • Appropriate land use • Minimum size of 10 ha • At least 60 000 inhabitants within walking distance (≤ 1 000 m) Recreational areas with rural characteristics: • 6 dB difference between centre and margin • Appropriate land use • Minimum size 100 ha • Quality requirements for recreational function	http://www.stmuv.bayern.de/umwelt/laermschutz/ruhige_gebiete/doc/ruhige_gebiete.pdf

Table 7.1 Overview of actions with a focus on quiet areas (cont.)

Name of principal location	Scale (a)	Type (b)	Indicator	dB	Selection method	Observations
Germany	MS	PP	L_{den}		Quiet areas in agglomeration: • appropriate land use • L_{den} < 50 dB • minimum size 400 ha Quiet areas in open country: • selection by local knowledge • appropriate land use • L_{den} < 40 dB	http://www.lai-immissionsschutz.de/servlet/is/20170/LAI-Hinweise.pdf?command=downloadContent&filename=LAI-Hinweise.pdf
England (United Kingdom)	RE	AP	-	-	• Accessibility • Generate community benefits because of quietness	
Bradford (United Kingdom)	RI	PP	L_{day} TR = + 5		• Acoustic • Natural features • Aesthetic appeal • Public perception survey • In situ measurement verification • Photo survey	Tranquillity RAting Prediction Tool (TRAPT) used to determine a Tranquillity Rating (TR) according to TR = 9.68 + 0.041 NCF – 0.145 L_{day}, where NCF is natural and contextual features. TR = + 5 is acceptable for urban quiet
Warsaw (Poland)	AG	AP	L_{den}	< 55	• Demographical — population density • Land use plans with maps for transportation network development • Consideration of spatial management • Guides for future land use planning and spatial management • Nature preservation areas, especially Nature 2000 areas	15 potential quiet areas identified
Netherlands	MS	PP	-	-	• Ecological infrastructure (EHS) • Sound quality fitting for function of area	Monitoring actions (for the treasury) show that 70 % of the EHS areas are over 39 dB L_{den} (equivalent to 40 dB $L_{Aeq,24hrs}$). Standstill (2000–2010) reached
Limburg (Netherlands)	RE	AP	$L_{Aeq,24hr}$	40	• Sites of natural and cultural interest • Acoustic	31 areas covering 20 000 ha. Elaborate regulation against noisy activities. Regular evaluation shows that policy is highly appreciated by communities and visitors
Flevoland (Netherlands)	RE	AP	$L_{Aeq, 1hr}$	35	• Acoustic • Recreational value • Nature area	Monitoring of % quiet area exceeding the indicator

Table 7.1 Overview of actions with a focus on quiet areas (cont.)

Name of principal location	Scale (a)	Type (b)	Indicator	dB	Selection method	Observations
Gelderland (the Netherlands)	RE	AP			Sites of natural and cultural interest: • Acoustic	There are 15 true quiet areas and about 5 quiet policy areas. The largest (20 x 50 km) seems to form a buffer around the quiet areas. Elaborate regulation against noisy activities. Provincial policy is to use quiet asphalt where the road is close to a quiet area
Bilbao (Spain)	AG/RI	AP	L_{day} $L_{evening}$	60	• Acoustic • Surface > 2 ha • Open access • Recreational/cultural value • Approved by city council	The use of L_{95}-L_5 is considered as an indicator
Lyon (France)	AG	AP	L_{den}	50	• Accessibility • Noise mapping	
Paris (France)	AG	AP	L_{de}	55	• END noise maps • Land use • Open consultation with residents and local authorities via web tool • Maps of relative noise created • Verified with in situ measurement and perception surveys	Only road and rail noise maps considered, but aircraft noise to be integrated later. Relative noise maps show contrast with differences of + – 10 dB against L_{de} 55 dB. 184 citizen responses to online web tool. 380 potential quiet areas identified
Scotland (United Kingdom)	RE	PP	L_{den}	55	• Acoustic • Minimum area of 9 ha	Quiet areas included in action plans
Wales (United Kingdom)	RE	PP/AP	L_{day} L_{de}	65 55	• Natural rather than mechanical sounds are favoured • Visual quality can enhance 'quietness' or tranquillity • Size as such is immaterial — small spaces in inner cities can have high value in terms of providing respite and opportunity for relaxation and exercise • Attitudes to what constitutes quiet are to some extent determined by culture and location • The WHO guideline of 55 dB(A) has been taken as a starting point for looking at the designation of quiet areas • A substantial part of a space being at least 6 dB below the typical daytime level of its surroundings might be a practical early guideline	PP contains checklist to assess 'tranquillity'. Items are soundscape, presence of nature, visual or aesthetic quality, sense of personal safety, culture and freedom. In agglomerations, at least 75 % of the quiet area must be < 65 dB L_{day} global noise map for road and rail. Total of 29 urban agglomeration quiet areas declared in 2012, each with protected status
Northern Ireland (United Kingdom)	RE	AP	L_{den} L_{night}	< 55 < 50	• END noise maps • END global noise maps, i.e. all agglomeration sources • Area not affected by L_{den} or L_{night} threshold	Applied to agglomeration only, and areas declared only as candidate quiet areas (CQAs)

Table 7.1 Overview of actions with a focus on quiet areas (cont.)

Name of principal location	Scale (a)	Type (b)	Indicator	dB	Selection method	Observations
London (United Kingdom)	AG	AP	$L_{Aeq, 1 min}$ $L_{Aeq, 15 min}$		• Understanding noise environment • Understanding the view of visitors • Coordinating approach to Quiet Areas with other initiatives	Special projects which may feed into quiet areas: • iconic sounds of the city • city sound walk • area based initiatives
Bristol (United Kingdom)	AG	AP	L_{den}	< 55	• Acoustic • Recreational value • Nature area • Public participation via Citizenscape web tool	Combined noise map for L_{den} road and rail utilised in an online map viewer, where public can upload their opinions concerning which spaces are quiet, along with marker pin to identify the area. Webcasts and blogs were also used to glean public opinion. This permits a combined assessment of CQAs; they are then divided into three categories: proposed, possible and deferred. 203 CQAs identified
Florence (Italy)	AG	AP	$L_{Aeq,day}$ $L_{Aeq, night}$		Quality level of function is leading; relevant classes: • class I: special protected areas such as hospitals, schools, recreational areas; special urbanistic areas: 45 L_{day}, 35 L_{night} • class II: low density residential: 50 L_{day}, 40 L_{night}	Measures for quiet areas will be integrated in hotspot measures of action plan
Tuscany (Italy)	RE	AP	L_{day} L_{Aeq}		• Extra-urban • Lday < 50 dB(A) • N70 < 12 • > 300 m from roads • > 150 m from parking and recreational area • Natural, historical or cultural landuse • Urban • L_{day} < 55 dB(A) • N70 < 12 • Minimum size 0.1ha • > 50 % of candidate quiet area • Protected, residential or semi-commercial landuse	$L_{day} = L_{Aeq}$ for transport and industrial noise N70 = number of events from railway and aircraft noise with LAeq > 70 dB(A) during day (06.00–20.00 hours)
Czech Republic	MS, RI	PP	L_{day} L_{night}	40 40	Land use plan: natural parks and protected landscapes: • luxury: L_{day} & L_{night} < 40 • comfortable: L_{day} < 50, L_{night} < 40 • good: L_{day} < 55, L_{night} < 45 • acceptable: L_{day} < 60, L_{night} < 50 • unfavourable: L_{day} > 60, L_{night} > 50	Quiet areas in agglomerations may include luxury and comfortable areas

Table 7.1 Overview of actions with a focus on quiet areas (cont.)

Name of principal location	Scale ([a])	Type ([b])	Indicator	dB	Selection method	Observations
Denmark	MS	AP			• Nominations by local authorities • Recreational value • Nature benefits • Noise limits **not** applied	One quiet area declared at Frederikshåb near Billund. It is a rural area of about 16 km^2 in size, and is located within 4 km of an international airport and 3 km from a major road. It is protected by local planning law
Sweden	MS	PP	L_{Aeq}	25	Determine acoustic landscape Determine positive experienced sounds Determine negative experienced sounds Assess overall acoustic quality on a scale • Class A: freedom of noise < 25 dB. 1–2 events < 5 minutes/week • Class B: < 35 dB. 3–4 events < 5 minutes/day • Class C: < 5 dB. 60–120 events < 1 hour/day • Class D: < 45 dB. 120–240 events < 2 hours/day • Class E: < 50 dB, L_{day} or 10–20 dB below surroundings	
Flanders (Belgium)	RE	PP				Leaflet with instructions to derive quiet areas. See Dender-Mark area below for content
Dender-Mark area (Belgium)	RE	AP	$L_{50,\ 15min}$ L_{night}	45 30	• L_{50} value of non-area–specific sounds • L_{night} value of non-area–specific sounds • Visitors' score of quietness • % of time that non-area sounds are perceived • Perception of non-area–specific sounds • Number of non-area–specific events per 15 minutes. • Perceived appropriateness of area sounds • Geographic cohesion • Natural or cultural value of landscape	The acoustic quality of an area must be guaranteed 80 % of the year (anywhere) and any day in at least 80 % of the area
Ireland	MS	PP	$L_{A90,\ 1hr}$	30 day 27 night	• Measurement and observation • GIS analysis of land use and anthropogenic sources • 300 reference sites • 21 000 digital recordings • 170 000 measurements	L_{A90} recommended for identifying quiet areas in open country by measurement, but L_{den} is identified as the best indicator for agglomerations

Table 7.1 Overview of actions with a focus on quiet areas (cont.)

Name of principal location	Scale (a)	Type (b)	Indicator	dB	Selection method	Observations
Dublin (Ireland)	AG	AP	L_{den} L_{night}	< 55 < 45	• Modelled consolidated noise levels • 15 long-term measurement sites to verify model • Land use analysis	Eight areas of green space approved as quiet areas with full designation received in July 2013
Estonia	MS	AP	L_{den}	< 45	Three criteria applied: • area with less than 45 dB L_{den} • at least 3 ha in size • must have recreational land use only	Only applied to the action plan for the agglomeration of Tallinn
Greece	RI	PP	-	-	Distance-based criteria, using: • transport • recreation • agglomerations • industry and construction sites	Assessing quiet areas based on distance criteria for whole country (Aristotle University of Thessaloniki)

Note: (a) AG = agglomeration, MS = Member State, RE = Region, LA = Local authority, RI = Research institute.

(b) AP = Action plan, PP = Position paper.

8 Methods for identifying quiet areas

Member States mainly use four complementary methods for identifying quiet areas: (1) noise mapping by modelling and calculations, (2) actual measurements of sound-pressure levels in situ, (3) evaluation of user/visitor experiences (i.e. the soundscape approach), and (4) expert assessments. The benefits and limitations of these methods are examined below.

8.1 Noise mapping

As stated in the introduction, the idea of preserving quiet areas originates in the development of noise maps. Such maps can be used to identify areas that are not exposed to calculated sound-pressure levels from environmental noise above a given magnitude. A common European method for assessing noise is under development (Kephalopoulos et al., 2012).

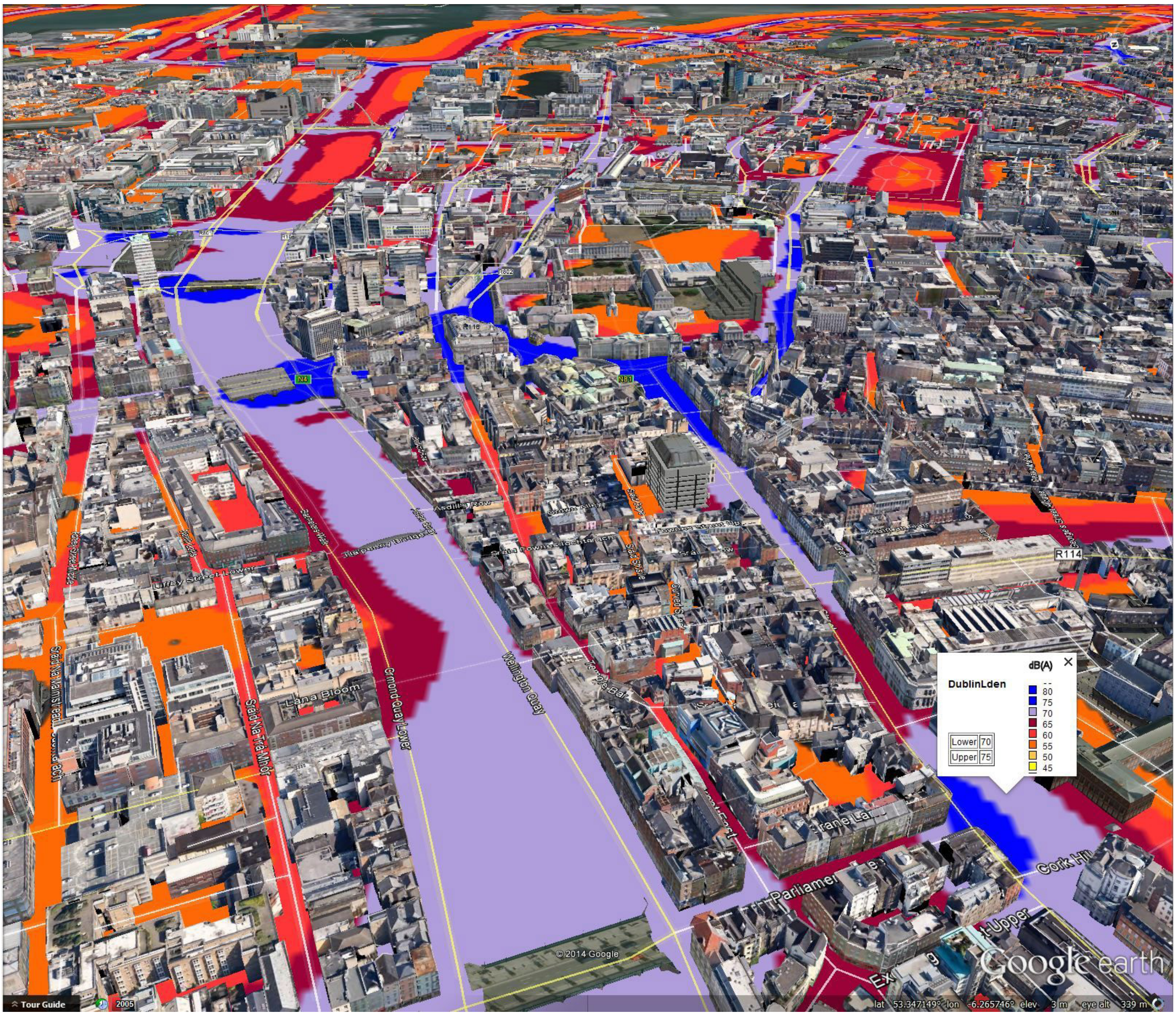
Benefits

- Noise maps provide an easily interpreted visual presentation of the distribution of calculated sound-pressure levels from given noise sources, such as traffic or industry, in a given region, and for a defined period.
- Calculations of sound-pressure levels are more cost-efficient than actual measurements, particularly if a large area is to be mapped. This is due to the necessity of having many measurement or receiver points and lengthy measurement periods in order to obtain representative long term average noise levels.
- Noise maps present calculated sound-pressure levels from environmental noise, separated from other sources. Note that the definitions of 'quiet area' in the END presuppose that this distinction is possible in practice.
- Noise maps are particularly useful when planning a new area. At the planning stage, actual measurements are not possible, because noise sources like roads and vehicles do not yet exist in the area.

Limitations

- Noise maps are based on mathematical models of environmental noise emission and propagation outdoors, under given and restricted conditions. Deviations from the given criteria result in calculated sound-pressure levels that may not correspond to reality. Examples of factors that may influence the results are topography, weather, buildings or other physical barriers, as well as façade and surface material. With this in mind, modelled noise maps should be validated by actual measurements.
- Noise maps are typically based on one noise source at a time (road traffic, railway traffic, aircraft or industry). It is important to calculate the net effect of sound-pressure levels from multiple and simultaneous noise sources, to prevent the sound-pressure levels from being underestimated, e.g Article 3 (r) of the END regarding global assessment.
- Noise maps do not include pleasant or preferred sounds, like wind in trees, purling water or birdsong.
- Noise maps identify quiet areas based on calculated sound-pressure levels. One must keep in mind that an area which is undisturbed by environmental noise, for example a marshland, may not necessarily be valuable to human health when considering aspects other than environmental noise.
- Noise maps typically present calculated A-weighted sound-pressure levels. These values do not provide an accurate representation of how people perceive the acoustic environment, not even with regard to loudness (e.g. Nilsson, 2007a, 2007b). Sound provides a great deal more information to human beings than simply the magnitude of a pressure wave.

Map 8.1 Sample noise map for road traffic L_{den}, Dublin



Source: Dublin City Council, 2012.

The European Cooperation in Science and Technology (COST) group on soundscapes has recently developed techniques and concepts for producing alternative maps (see http://www.soundscape-cost.org/ online), as well as for relevant publications by the group members.

These include:

- sound maps, which include both noise (e.g. traffic noise) and pleasant sounds;
- psychoacoustic maps, where psychoacoustic parameters like sharpness can be mapped;
- soundscape maps based on the previously surveyed soundscape evaluation, using artificial neural network techniques (Yu and Kang, 2009).

8.2 Measurement of sound-pressure levels

Besides calculating the sound-pressure levels, many authorities measure the actual levels in situ. These measurements are typically used to complement or to validate modelled noise maps.

Benefits

- Measurements provide the actual sound-pressure levels at a given place and at a given time. As such, they may well be a better reflection of reality than models and calculations. Moreover, under conditions prohibiting application of calculation models, e.g. a lack of reliable model input data, this is the only method by which to obtain accurate sound-pressure-level data. In many instances, the calculation models could not accurately predict the sound-pressure levels in courtyards enclosed by buildings. As noise mapping evolves, further limitations may be discovered.

Limitations

- Measuring sound-pressure levels is a potentially labour-intensive and costly process, particularly if a large area is being mapped, using many measurement points. In addition, applying standards, such as ISO 1996, require long term averages so that representative values are obtained, making the measurement procedure very time consuming.

- Presently, most of the measurements cannot distinguish sound-pressure levels from different sources, nor measure environmental noise separately. This is particularly important for quiet areas. The actual measurement is a mixture of sound-pressure levels from various sources, including the sounds of the place: sounds of people, wind in vegetation and flowing water — and environmental noise. This means that there is a risk of a mismatch between calculated and actual sound-pressure levels, and that measurements cannot be used to validate the calculated levels of environmental noise in a quiet area. It should be noted that the definitions of 'quiet areas' in the END presuppose that it is possible to distinguish environmental noise from other sources.

- Measurements are typically based on A-weighted sound-pressure levels. These values do not provide an accurate representation of how people perceive the acoustic environment, not even with regard to loudness (e.g. Nilsson, 2007a, 2007b). Sound provides a lot more information to human beings than magnitude.

COST members have also developed techniques and basic concepts for the automatic identification of sound types, using data of real-time measurements in situ, or recording. This could be linked to city sensor projects, with a grid of microphones across an area. Quiet areas can be better evaluated by identifying the types of sounds, with measured sound levels (see http://www.soundscape-cost.org).

8.3 Evaluation of user/visitor experiences

The purpose of preserving quiet areas is to protect human health. This includes protecting people from noise annoyance and sleep disturbance, psychological factors that cannot be measured with physical measuring instruments. Thus, it is essential to understand how people perceive quiet areas. This insight, in combination with the limitations of calculated and measured sound-pressure levels, particularly with regard to quiet areas, has fuelled interest in soundscape studies. The launch of the European Soundscape Award, sponsored by the EEA, underlines the progress and importance of the soundscape approach in Europe.

Benefits

- Only an evaluation of user/visitor experiences can provide insight into how people perceive a quiet area. Such studies may include, but are not limited to, the perception of how dominant different sound sources are, the perceived acoustic quality or appreciation, tranquillity, annoyance, what sounds are appropriate to the place, and the recreational value and actual use of the area.

- In contrast to present sound-level meters, human beings can distinguish the intensity of sounds from different sources like technology, humans and nature. Such measurements have repeatedly been proved to be a stronger predictor of perceived acoustic quality in an area than A-weighted sound-pressure levels (e.g. Nilsson, 2007a and 2007b).

- Perceived acoustic quality is not limited to the acoustic environment per se, but is also influenced by the visual quality of an area. A lush and green environment may increase perceived acoustic quality and reduce annoyance, even though greenery has a limited influence on sound-pressure levels. Physical measuring instruments cannot capture such psychological effects.

Limitations

- Evaluation of user/visitor experiences is typically conducted by questionnaire surveys in situ. This is a weather-dependent method, in the sense that it is hard to conduct surveys when the weather is bad (rainy, windy or cold). Moreover, people are reluctant to visit quiet areas in bad weather conditions, and there is no point in conducting user/visitor surveys when there are no visitors.

- Like measurements of sound-pressure levels, evaluating user/visitor experiences is a time-consuming, labour-intensive and costly process. They need time for preparation and for development of appropriate questionnaires. Typically they require a relatively large number of staff, and time to collect the questionnaires. They also depend on visitors' willingness to participate in the survey. After data collection, the data must be processed, something demanding both time and skill.

- Evaluating user/visitor experiences calls for expertise in behavioural science in order to develop appropriate questionnaires. The quality of the data depends on the developers' skills and experience in the field, particularly of soundscape and environmental psychology.

- There are no standardised methods for evaluation of user/visitor experiences of quiet areas to date. Such standards, in the form of a standardised questionnaire, for instance, would make this method more accessible to non-experts.

ISO Working Group 54 is currently working on the minimum criteria for soundscape research and reporting. Working Group 2 of the COST Action has compared various survey methods, and has also identified a number of issues to be evaluated.

8.4 Expert assessments

As stated above, identification of quiet areas by sound-pressure levels is limited — an area which is undisturbed by environmental noise may not necessarily be valuable to human health, when considering aspects other than that of environmental noise. For this reason, it is important to include additional criteria to that of sound-pressure levels. Such criteria may include land use plans, cultural heritage, ecological values, social and recreational values, and accessibility. Assessment of such criteria typically requires expertise.

Benefits

- Expert assessments of a potential quiet area contribute with valuable insights on aspects of the area other than sound-pressure levels. Experts may include urban planners, landscape architects, sociologists, biologists, psychologists and antiquarians as well as acousticians.

- Involving experts who contribute with different points of views early in the process helps to achieve an appropriate outcome faster than exclusively applying a limited set of criteria like sound-pressure–level data from noise mapping.

Limitations

- Skilled experts are in short supply.

- Like sound-pressure–level data, expert assessments do not provide information on how users/visitors experience a quiet area.

9 Research questions

Research on quiet areas is notably difficult to carry out. Essentially, this is because searching for the effect of the absence of stimuli may be considered as a direct contradiction in itself.

This review of the state of the art concerning approaches to quiet areas in different EEA member countries highlights the need for in-depth research in this field. Specifically, further research will also call for the following:

1. Systematic and accumulated data on the relationship between quiet areas, and health and well-being, including annoyance, sleep disturbance, restoration and quality of life.

2. Data on perceived acoustic quality/appreciation of quiet areas, including data on dose–response relationships of perceived acoustic quality/ appreciation and sound-pressure levels (levels in the quiet area, as well as in the surroundings).

3. Consideration of whether global noise assessments for multiple sources, rather than single source models, are more appropriate for identifying quiet areas in high density urban agglomerations.

4. Further development of indicators and measurements of human appreciation of quiet areas and perceived acoustic quality.

5. Knowledge of factors other than sound that may affect perceived acoustic quality/appreciation of quiet areas.

6. Knowledge of the influence on health and well-being, including annoyance, sleep disturbance, restoration and quality of life, of the number and nature of events, including further exploration of the Swedish approach highlighted in Chapter 7.

7. Awareness of the differences in use of quiet areas in agglomerations and in rural areas, e.g. consideration of whether it is short or long term, degree of accessibility and who the different users are. In particular, are residential areas appropriate, if acoustic quality is high and beneficial to health?

8. Knowledge of the relationship between activities in quiet areas and the appropriateness of different kinds of sounds: what sounds enable and what sounds interfere with the activities? What activities and sounds are appropriate to a quiet area?

9. Practical methods to establish tranquillity as well as enhance the visual and social attractiveness of quiet areas.

10. Economic value (reduced social costs) related to quiet areas.

11. Benefits of quiet areas for biodiversity, including ecosystem services.

10 Recommendations and conclusions

The issue of quiet areas remains under development. Many different selection criteria are being explored, and it is perhaps too early to determine which are preferable in terms of good practice. There is a need for further in-depth research into the field, and it is questionable whether any single set of criteria will be considered best practice, because there are different types of quiet areas, with diverse functions, situations, sound-pressure levels, access, as well as visual and other qualities. Evidently, quiet areas in agglomerations require different selection criteria than those in open country.

In terms of the preservation of quiet areas, it is perhaps too early yet to determine if the action plans required by the END offer examples of good practice. However, it is recommended that areas of good acoustic quality, both inside and outside agglomerations are given due consideration for protection.

Competent authorities are advised to seek inspiration for potential selection criteria in Table 3.1. With regard to methods for identifying quiet areas, a combination of the four methods examined in Section 8 is recommended. In addition, it is proposed that research collaboration with universities and other academic institutions be sought, to support further development in this emerging field.

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Glossary

dB	Decibel
dB(A)	Decibel (A-weighted to account for human hearing parameters)
DG Env	Directorate General — Environment, European Commission
EC	European Commission
EEA	European Environment Agency
END	Environmental Noise Directive
ENDRM	Electronic Noise Data Reporting Mechanism
EP	European Parliament
EPoN	Expert Panel on Noise
ETC SIA	European Topic Centre on Spatial Information and Analysis
EU	European Union
JRC	Joint Research Centre, European Commission
L_A	A-weighted sound level indicator (often denoted as level exceeded for a % of the measurement time, e.g. L_{A90})
L_{Aeq}	Equivalent continuous A-weighted sound level (reference time may also be shown, e.g. L_{Aeq}, 24hr)
L_{day}	Level for day period
L_{de}	Level for day and evening period
L_{den}	Noise indicator for day, evening and night as defined by END
$L_{evening}$	Level for evening period
L_{night}	Noise indicator for night time as defined by END
MS	Member State
QA	Quiet Area
QSI	Quietness Suitability Index
SPL	Sound-pressure level
WHO	World Health Organization

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Annex 1 Current research into quiet areas

QSIDE (http://www.qside.eu)

Current methods for assessing urban traffic noise and its effects on people are focused on the most exposed façades, and are less suitable for quiet façades and quiet urban areas. The QSIDE project (LIFE09 ENV/NL/000423) will provide a calculation model suitable for quiet façades and quiet urban areas.

The QSIDE model consists of two submodels:

- an acoustic model for calculating noise levels at quiet façades and in quiet urban areas;
- a human-response model for calculating the beneficial effects of quiet façades and areas.

The QSIDE project will make it possible to quantify the positive effects of quiet façades and quiet urban areas. To facilitate and promote their implementation, it will produce a practical document with guidelines for EU cities, based on both QSIDE results and practical experiences in Amsterdam, Gothenburg, and other European cities.

CityHush (http://www.cityhush.org)

'Acoustically green road vehicles and cityareas' (CityHush) is a three-year research project co-funded by the European Commission under the Seventh Framework Programme (FP7). The CityHush project will support city administrations in the production and implementation of noise action plans according to Directive EC 2002/49.

Q-zones are a major concept in the CityHush project. A Q-zone is an area where a low level of traffic noise is maintained by allowing only low-noise vehicles to enter. Work Package 1 aims to identify the boundary conditions required to obtain Q-zones, and to do so in a real setting. Identification of the boundary conditions requires simulations of traffic management with respect to the introduction of new vehicle technology (like electrically propelled vehicles) and policies to encourage the usage of this technology (like noise charges).

As traffic and other conditions may differ between European cities, five test sites reflecting different traffic conditions in Europe will be subject to simulations.

HUSH (http://www.hush-project.eu/en/index.html)

'Harmonization of urban noise reduction strategies for homogeneous action plans' (HUSH) is co-funded by the European Commission, under the LIFE+ 2008 programme (LIFE08 ENV/IT/000386).

Project goals include identifying strategies for interventions in Florence, including quiet areas, to realise case studies in the urban environment (EUR 400 000 is available for two pilot interventions to be realised in the second year of the project). Particular attention will be paid to the perception and definition of noise disturbance by citizens, especially in more sensitive contexts such as schools and hospitals. The specific strategic intervention for noise reduction in the city will be designed, and then will be subject both to acoustic testing effectiveness and to checks on citizen satisfaction.

Hosannah (http://www.greener-cities.eu)

'Holistic and sustainable abatement of noise by optimized combinations of natural and artificial means' (Hosanna) is a collaborative three-year project under Theme 7 of FP7, Sustainable Surface Transport. Initiated in November 2009, it will produce a toolbox for the reduction of road and rail traffic noise in the outdoor environment.

The project focuses on noise abatement along the propagation path, dealing with greening of buildings and use of vegetation on other urban and rural surfaces, innovative barriers including recycled materials, and treatments of the ground and the road surface. The research will permit a better description of quite façades of buildings through the development of specific algorithms and the analysis of perception.

Listen (http://tii.se/projects/Listen)

'Auralization of urban soundscapes' (Listen) is financed by the Visualisation programme run by the Knowledge Foundation, the Foundation for Strategic Research, Vinnova, Vårdalstiftelsen and the Invest in Sweden Agency.

The goal of the project is to build a demonstrator of a software system for simulation and auralisation of the sound environment of a restricted urban area. The purpose of the demonstrator is to show that it is possible to listen to an urban soundscape, even from the planning stage. The main objective for Listen is to develop a user-motivated 3D-software demonstrator of urban soundscapes, by which architectural and noise-control solutions for improving urban soundscapes can be auralised at the planning stage. Various solutions for soundscape improvement may thus be evaluated by simply listening to their effect on the perceived soundscape.

The demonstrator will illustrate the potential and feasibility of soundscape auralisation, by demonstrating the application for three scenarios in a typical urban environment:

1. outdoor soundscapes at traffic noise exposed side of apartment building;

2. indoor soundscapes in apartment room exposed to traffic noise;

3. outdoor soundscapes at the shielded side ('quiet side') of apartment building.

All scenarios will include the perceptual effects of noise barriers of various materials and geometries.

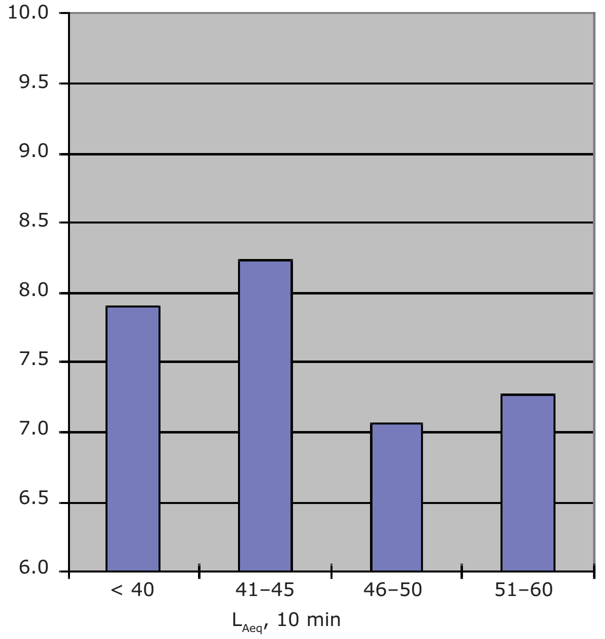
Quadmap (http://www.quadmap.eu)

'Quiet areas definition and management in action plans' (Quadmap) is a LIFE+ project focused on quiet urban areas. The project aims to deliver a method and guidelines for the identification, delineation, characterisation, improvement and management of quiet areas in urban areas, as described in the END.

The project will also explore the definition of a quiet urban area, and its meaning and added value for the city and its citizens in terms of health, social safety and lowering stress levels.

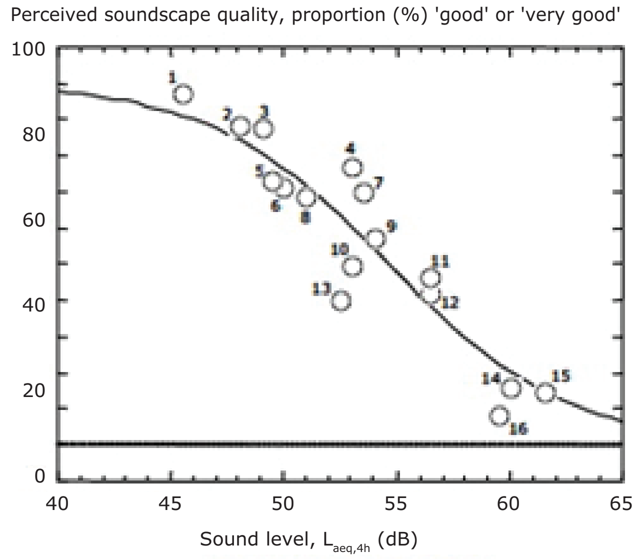
Annex 2 Information relating to appreciation and disturbance in quiet areas

Figure A2.1 Survey results in open country areas (rated index of appreciation of sound quality)



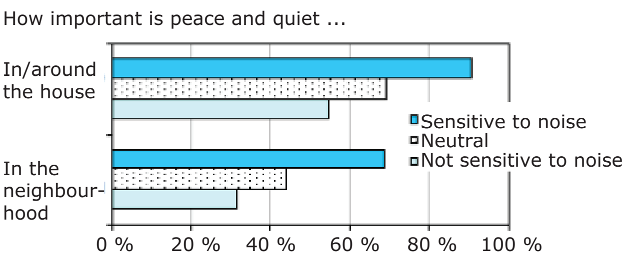
Source: Belevingsonderzoek stiltegebieden, TNO, 1998.

Figure A2.3 Proportion of visitors perceiving the soundscape quality as 'good' or 'very good', as a function of measures sound level ($L_{Aeq,4h}$)



Source: Belevingsonderzoek stiltegebieden, TNO, 1998.

Figure A2.2 Influence of noise sensitivity on importance of peace and quiet at home and in neighbourhood



Source: Belevingsonderzoek stiltegebieden, TNO, 1998.

Figure A2.4 Importance for quiet area with respect to fulfilment of personal needs

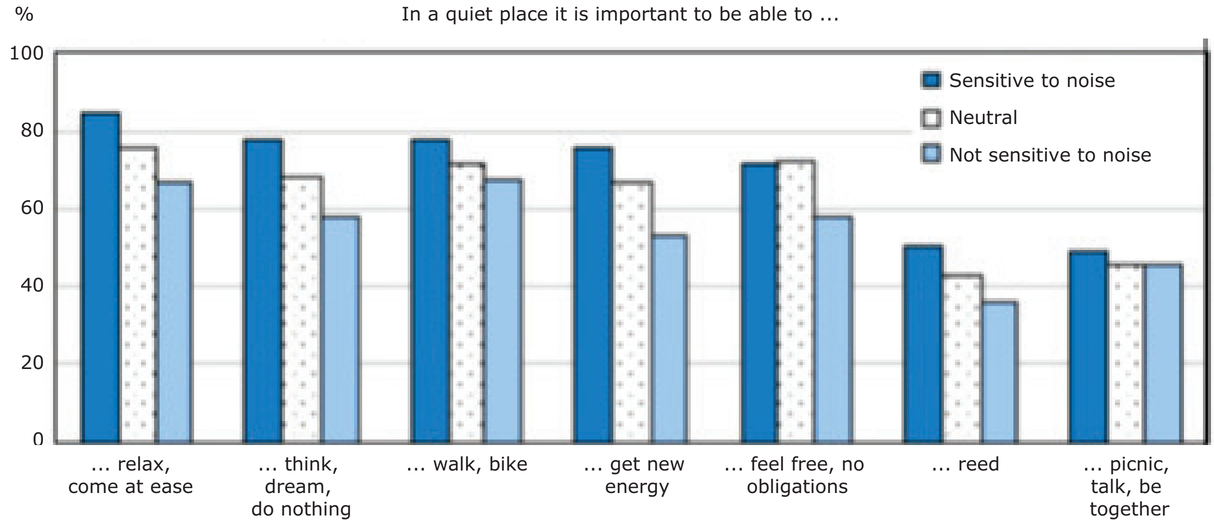


Figure A2.5 Number of areas named (black) and numbers of times areas were mentioned (rest) in relation to noise level from road/rail traffic (green/black) or maximum of all industry + transportation (white)

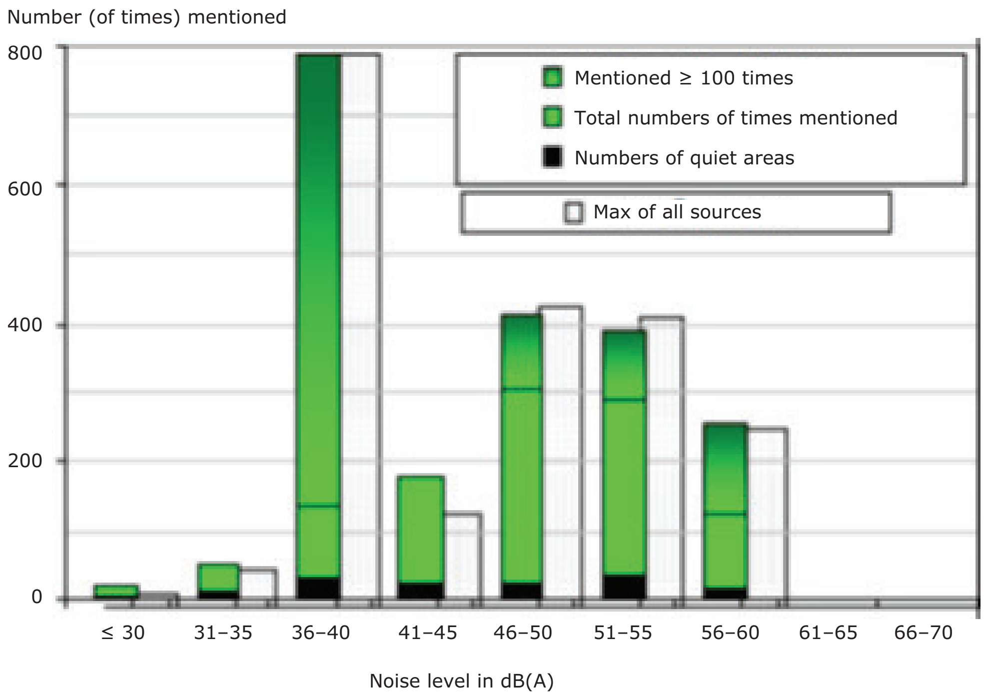


Table A2.1 Sounds (not) disturbing the quiet in four areas in percentage of persons that heard sound

	Not disturbing			Disturbing		
Area	'Weembben + Wieden'	'Utrechtse Heuvelrug'	'Zuid Beveland'	'Weembben + Wieden'	'Utrechtse Heuvelrug'	'Zuid Beveland'
Number of persons	450	127	57	450	127	57
Recreating People	69	61	47	8	12	20
Dog	71	53	56	11	19	24
Agriculture	71	53	44	8	13	17
Music	32		41	38		0
Motorboat	49			23		
Industry	84		4	9		79
Motor/moped	46	18	22	30	56	59
Train		22	12		25	47
Aircraft	62	18	24	17	40	52
Road traffic	53	27	25	21	38	41

Note: White = $P_{non}/P_{dis} > 2$;
Blue = $P_{non}/P_{dis} < 1/2$;
Green = in between.

Source: Stichting Natuur en Milieu (SNM), 2003.

Table A2.2 Summary of criteria for quiet areas noise limits criterion

	Description	Level	Resultant L_{den}
WHO	Clarity of speech at 1 m	45 dB L_{Aeq},T	47 dB
WHO	Moderate annoyance limit	50 dB L_{Aeq},T	52 dB
Speech interference level	Quiet female voice at 1 m	44 dB SIL	53 dB
Natural sounds dominate	Natural sound 5 dB above man-made immissions	37 dB L_{Aeq},T	40 dB
Other factors	Landscape, water, natural sounds, vegetation, access, etc.	No quantified index available	N/A

Annex 3 A recommendation by EPoN to make reference to a report published by Defra in 2006

The study was carried out by Symonds and made the following recommendations:

1. for the initial stages of the END, the general noise indicator for urban quiet areas should be L_{den}; however, for some areas, the use of the ancillary noise indicators L_d, L_e, and L_n may be more appropriate;

2. L_{den} 50 dB should be the upper limit for relatively quiet areas in urban locations. If a higher 'gold standard' level is to be defined for urban areas, then it would be sensible to strive for 40 dB L_{den};

3. consideration of quiet areas should be integral to the formulation of action plans, and must not be treated as an add-on to be addressed once other issues have been resolved;

4. despite the acknowledged problems of accuracy in mapping to low levels, Member States are strongly advised that the L_{den} limit for the first round of strategic noise mapping should be lowered from 55 dB to 45 dB L_{den}; for the night-time index, the value should be lowered to 40 dB from 50 dB;

5. the noise index for rural quiet areas should be an annual $L_{Aeq,24}$ hour or its equivalence in L_{den};

6. the upper noise limit criterion for rural quiet areas should be 40 dB $L_{Aeq,24}$ hour or its equivalence in L_{den}; and

7. competent local authorities should explore means of visitor-friendly labelling of quiet zones at local level for rural quiet areas.

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Annex 5 Extract from Good Practice Guide for Strategic Noise Mapping and the Production of Associated Data on Noise Exposure (2)

2.48 Quiet areas in an agglomeration

Formal END definitions

Article 3(l)

A '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.

Discussion

In agglomerations, it is suggested that 'quiet' could be described by a value of L_{den} (or by another appropriate noise indicator), which must be defined by the Member State. This would be more or less a quantitative acoustical definition.

It is generally accepted that in agglomerations, quiet areas can only be relatively quiet because of the presence of major noise sources and noise that are caused by normal human activity in such densely populated areas. Once these 'relatively quiet' areas have been identified, the END requires that, in agglomerations with populations of more than 250 000, action plans to protect these areas be drawn up (this was to be completed by no later than 18 July 2008).

It is also generally accepted that noise mapping can be used to identify these areas. However, the END gives no advice on how to do this, other than that offered in Article 3(l), which merely identifies L_{den} as a possible indicator, without suggesting limits. There appears to be no strong evidence for the use of a different indicator to L_{den} and no evidence concerning appropriate levels for relatively quiet areas in any indicator.

In addition, in agglomerations, the L_{den} in relatively quiet areas will often be dominated by the weighted night-time noise and may thus be a misleading indicator. Consequently, the L_{den} may not be an appropriate indicator for setting targets for protecting or enhancing the quietness of such areas through action plans. For action plans, it may be appropriate to set standards in terms of L_d (3) and L_e (4). In some areas, the use of a short-term indicator to deal with transient noises may also be appropriate in the development of effective action plans. For further information, see the EC-sponsored study that was carried out on the definition, identification and preservation of urban and rural quiet areas (Ref. 16).

WG-AEN recommendations

Whilst it recognises that a quiet area in an agglomeration could be delimited by an indicator such as L_{den}, the EU Working Group on the Assessment of Environmental Noise (WG-AEN) recommends that other criteria be used when needed. In addition, the use of absolute levels, in any indicator, may not be appropriate for the delimiting of such areas. A relative approach may be more suitable, such as that recommended in the END (Annex VI (1.5)) for the identification of quiet façades.

Although it is true that a quiet area in an agglomeration could be a private garden or a large private estate, for example, it is recommended that special emphasis be placed on recreational areas normally accessible to the general public, areas which can provide respite from the high noise levels often experienced in busy urban environments.

It is strongly recommended that the protection of quiet areas be made an integral part of the

(2) Version 2, 13 January 2006 (former EEA Working Group on the Assessment of Exposure to Noise, WG-AEN).
(3) Daytime noise level.
(4) Evening noise level.

development of action plans for agglomerations, rather than be treated merely as an 'add-on' to be addressed once other issues have been resolved.

2.49 Quiet areas in open country

Formal END definitions

Article 3(m)

A 'quiet area in open country' shall mean an area, delimited by the competent authority, that is undisturbed by noise from traffic, industry or recreational activities.

Discussion

When a competent authority opts to delimit a quiet area in the open country, 'quiet' is considered to be 'undisturbed by noise from traffic, industry or recreational activities'. This is more or less a qualitative acoustical definition and consequently, the WG-AEN does not propose the use of formal criteria at present.

It should also be noted that the END does not require the acquisition of data on recreational noise, which can be quite significant in the open country.

Furthermore, in the open country, there is no requirement to acquire data on industrial noise and on non-major roads, railways and airports. The EC is required by the END to submit to the European Parliament and the Council a report on the implementation of the END, which may include proposals regarding the protection of quiet areas in the open country. This was to be completed by no later than 18 July 2009.

WG-AEN recommendations

In the interim period prior to the EC reports on END implementation in 2009, the WG-AEN recommends that Member States use the EC-sponsored study on the definition, identification and preservation of urban and rural quiet areas (Ref. 16) as their starting point for defining quiet areas in rural environments.

Further research into quiet areas (in both urban and rural contexts) needs to be undertaken at European level. The WG-AEN has made relevant recommendations.

Annex 6 Proposed methodology to represent quiet areas suitability outside urban areas

In order to help the EEA assess potential quiet areas in Europe, the European Topic Centre for Spatial Information and Analysis (ETC/SIA) utilised data reported in accordance with the END as well as data related to other criteria that inform this process.

The resulting methodology was tabled during a dedicated break-out session at the Eionet meeting of the National Reference Centres for Noise on 26 and 27 September 2013. The methodology is summarised below.

Objectives

Determine a quietness suitability index (QSI) outside urban areas at national level, to be derived at European level in the upcoming stage. Such index is based on the Member States' mapping results being delivered to the EC and EEA according to Environmental Noise Directive (END) specifications. Databases covering the whole European territory should then be used to derive the European map and figures, as END only covers the European territory partially.

In Annex VI of the END, the 55 and 65 dB noise contours are requested to be provided to the EC for major roads, major railways and major airports. In the case of agglomerations, this information could also be provided but on voluntary basis.

Given the fact that one of the main objectives of the END is 'to preserve environmental noise quality where it is good', it makes sense to develop this quietness' suitability analysis inside agglomerations and outside agglomerations.

Nevertheless, the presented index will be based on 'quiet areas in open country' defined in the END as 'an area, delimited by the competent authority, that is undisturbed by noise from traffic, industry or recreational activities', due to the fact that several exercises for delimitation and protection of quiet areas inside agglomerations have been already developed at country level.

Assumptions

The use of information delivered by EEA member countries under the END specifications, as well as national database would provide results with higher resolution.

The methodology proposed could, in an upcoming stage, be generalised to other countries not providing the requested END data sources to have a complete European picture.

All the areas being included in the noise contour maps above 55 dB L_{den} has been considered 'noisy' areas for the analysis undertaken. Below this noise level, a decreasing gradient on decibels is being assumed: more distance to noise sources implies more quietness.

Data sources

- END: Major roads, major railways and major airports noise contour maps;
- END: Location of major roads and major railways and major airports;
- Urban Morphological Zones;
- E-PRTR register: industries location and attributes
- Corine Land Cover and Land Use data 2006 (CLC) (100 x 100 meters grid);
- GEOSTAT: Urban-Rural typology (1 000 x 1 000 meters grid);
- GISCO: roads, rails and airports infrastructure;
- Natura 2000 sites (2009) to undertake a further analysis on protected areas.

All raster analyses are performed using a pixel size of 100 x 100 metres.

Methodology

A multidimensional approach is applied to calculate an index stating the quietness suitability degree concerning areas outside urban areas.

Two dimensions have been taken into account to define and evaluate quietness:

- Noise disturbance as a result of noise propagation (objective criteria, quantitative data): threshold distances are determined considering not-disturbing noise levels (areas exposed to less than 55 dB L_{den}).
- The perceptive dimension of quietness by human beings (subjective criteria, qualitative data): this dimension is related to the importance given to natural elements, to landscape configuration, etc. The output data summarizing this perceptive dimension will be: (1) a reclassified CLC data based on the hemeroby index to obtain the so-called 'degree of naturalness' and (2) a layer indicating the degree of ruralness based on urban-rural typology of the studied country.

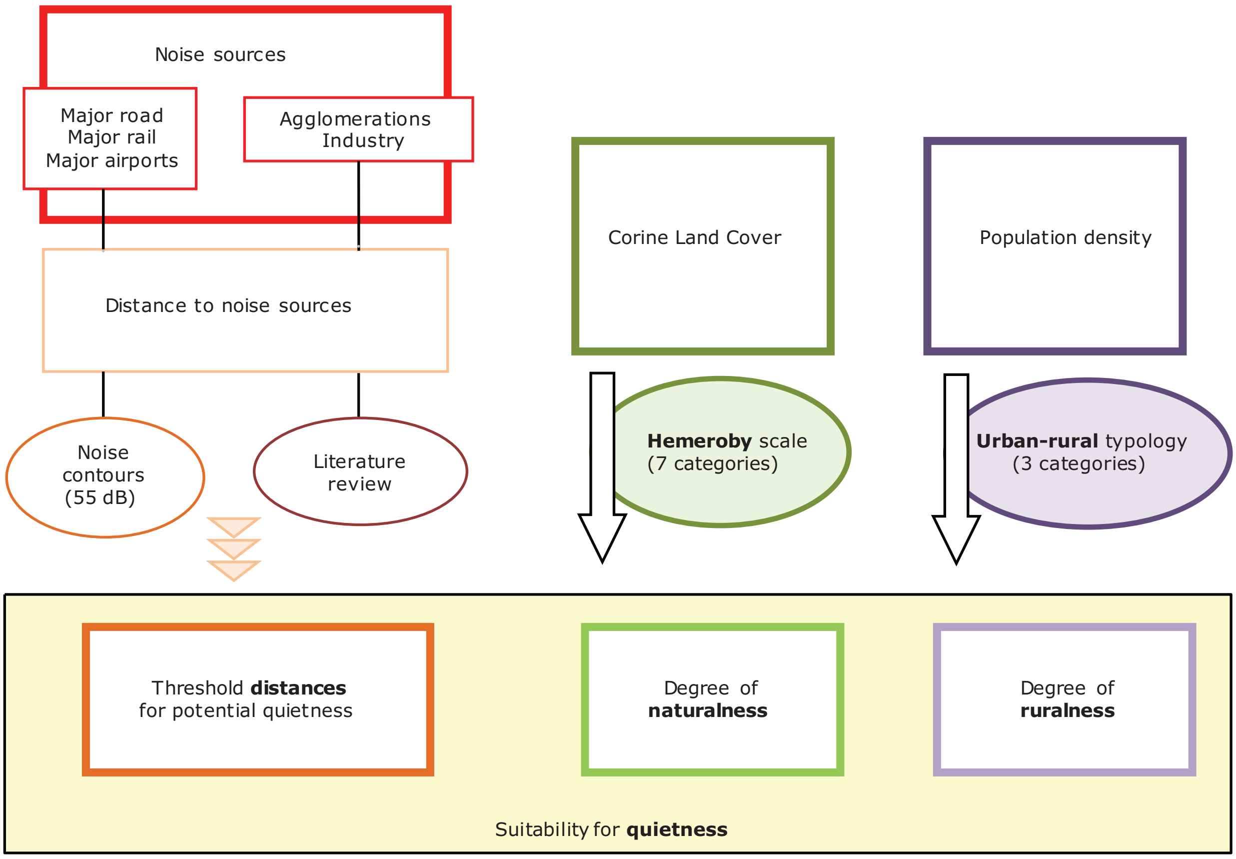
Both dimensions are going to be combined to obtain the final quietness suitability index, as shown in Figure A6.1.

Calculation of noise disturbance

Input data

- END: Major roads, major railways and major airports noise contour maps;
- END: Location of major roads and major railways and major airports;
- Urban Morphological Zones;
- E-PRTR register: industries location and attributes;

Figure A6.1 Methodological approach followed to obtain the quietness suitability index



Source: ETC/SIA, UAB, 2013.

- Corine Land Cover and Land Use data 2006 (CLC) (100 x 100 meters grid);
- GISCO: roads, rails and airports infrastructure.

Calculation of threshold distances to noise transport sources: major roads, major railways

This procedure is applied to those countries with available input data.

1. An Euclidean distance map (pixel size = 100 m) has been calculated per each noise transport source: major roads, major railways and major airports.
2. Overlay of the Euclidean distance map with noise contour maps per each source to calculate basic statistics concerning distance to noise source per decibel band: minimum distance, maximum distance, standard deviation, etc.
3. Mean and maximum distance to noise source for the 55 dB noise contour taken as reference to build the distance suitability map for quietness, for all the countries with data available. EEA mean is calculated based on country data available.
4. Suitable distance layer from noise sources built following a fuzzy approach ([5]), calculating the 'membership' to the quietness range (0–1) by means of a linear relationship, considering the mean value obtained as no suitable (= 0) and maximum distance obtained as suitable (= 1). The distance values between not suitable (mean value) and suitable (maximum value) will be reassigned with a new value between 0 and 1 following a linear equation.

To be taken into consideration that information concerning the location of noise barriers is not being requested by the END specifically, therefore, not taken into consideration for the development of the methodology proposed. This methodological proposal could be further refined at country level if information on noise abatement measures (and its location) is available at national or regional scale.

Calculation of threshold distances to major airports

1. Countries delivering major airports' noise contour maps: 55 dB L_{den} noise contour has been used as a mask: area below 55 dB is considered suitable (= 1) and area above 55 dB is considered not suitable (= 0).
2. Countries not delivering major airports' noise contour maps:
   - Selection of CLC 2006 class 124, related to airports;

Table A6.1 Distances to noise sources from noise contour maps (in meters)

	Major road distances			**Major rail distances**		
	Maximum	Mean	StDev	Maximum	Mean	StDev
Switzerland	1 310	140	227	1 000	262	196
Germany	1 082	459	224	447	103	74
Spain	1 400	290	200	200	59	64
Ireland	1 005	386	192	632	59	66
Lithuania	1 393	269	125	No major railways > 30 000 train passages per year		
Luxembourg	1 105	347	229	361	87	73
Malta	640	132	119	No major railways > 30 000 train passages per year		
Norway	728	107	86	707	254	155
Poland	1 487	171	111	539	107	71
Sweden	1 044	272	203	1 200	312	215
EEA mean	**1 119**	**257**	**172**	**636**	**155**	**114**

Note: StDev = Standard deviation.

Source: ETC/SIA, UAB, 2013.

([5]) The production of threshold distance layers around noise sources has been made following a fuzzy approach rather than obtaining a buffer with sharp limits. Membership to a 0-1 range has been obtained according to a linear function.

– Distinction between those considered major airports by the END and the rest of airports by overlaying both data sources;

– Buffer of 1500 metres applied to polygons considered as major airports and buffer of 900 metres applied to the rest of CLC class 124 polygons (distances applied extracted from literature: Votsi et al., 2012);

– Buffers used as a mask: areas in the buffered area considered not suitable (= 0) and areas outside the buffered area considered suitable (= 1).

Calculation of threshold distances to industrial noise sources

1. In the case of industrial sites, noise contour maps are only available for industrial areas located inside agglomerations, and therefore, not useful for this analysis, reason why E-PRTR database and CLC 2006 have been used.

2. Selection of CLC 2006 classes labelled as industry, mine, dump and construction sites.

3. Euclidean distance map calculated from the georeferenced E-PRTR database and from CLC polygons selected (pixel size = 100 m)

4. Threshold distance values to establish the fuzzy membership to the quieteness index based on literature (Votsi et al., 2012). Distance values below 500 meters will be considered not suitable (= 0) and distance values above 1 100 meters will be considered suitable as potentially quiet (= 1). Values between 500 and 1 100 meters will be reassigned with a new value between 0 and 1 following a linear equation.

Calculation of threshold distances to agglomerations

1. In the case of urban agglomerations, the urban morphological zones (UMZ) ([6]) with more than 100 000 inhabitants have been chosen as input data. END urban agglomerations have been discarded due to the great variation of delineations reported by the different EEA member countries, ranging from administrative delineations until detailed urban polygons. Instead, UMZ based on CLC database, are available and harmonised for all Europe.

2. Euclidean distance map calculated based on the UMZ polygons

3. Threshold distance values to establish the fuzzy membership to the quieteness index based on literature (Votsi et al., 2012) . Distance values below 1000 meters will be considered not suitable (= 0) and distance values above 1 500 meters will be considered suitable as potentially quiet (= 1). Values between 1 000 and 1 500 meters will be reassigned with a new value between 0 and 1 following a linear equation.

Result: final threshold distances layer

Once threshold distance layers have been obtained separately, they are merged together by multiplying them. The output layer will range between 0 and 1.

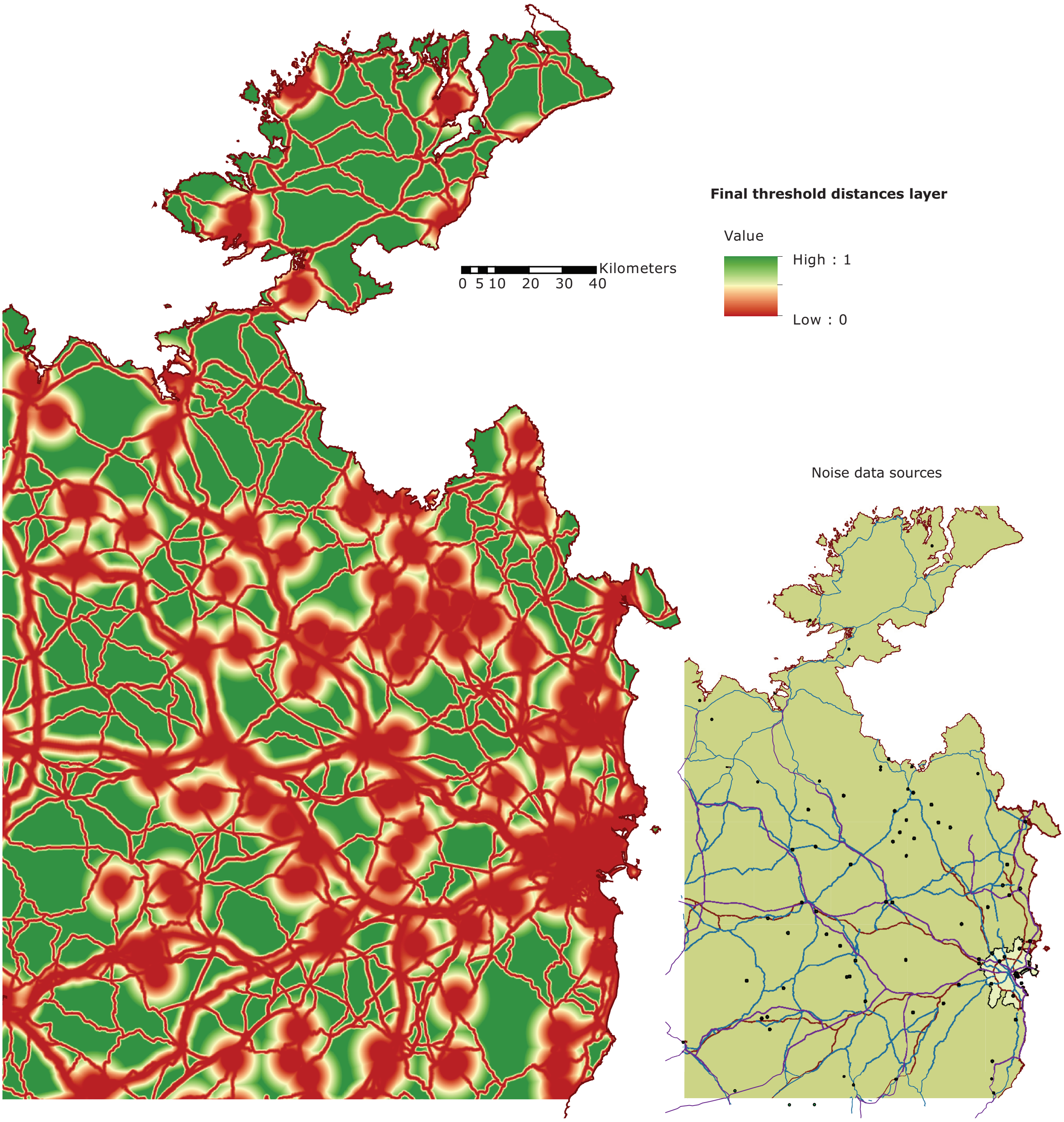
Calculation of noise perception

The notion of quietness has a multidimensional character. Quietness is not only defined according to objective criteria (noise levels), measured by quantitative data, but also by a subjective component linked to perception. In this way, and beyond noise exposure, quietness is related to a series of elements which are perceived as positive and which are usually related to human cultural construction of naturalness.

Subjective references to quietness are largely referred to in literature (Waugh et al., 2003; MacFarlane et al., 2004; Botteldooren and De Coensel, 2006). They are linked to environmental and socio-cultural factors: low population density, low intensity agriculture, environmental quality, landscape quality (i.e. non visual intrusion of transport infrastructures, culturally valued landscapes, 'natural' landscapes). Public consultations have showed the subjective nature of quietness, as independent on each person. However, there is a common element which arises continuously: quietness as related to nature (green elements, water, animals and wildlife, remoteness, panoramic views, weather, etc.) (Rendel, 2005; Pheasant et al. 2006; Cordeau and Gourlot, 2006).

([6]) http://www.eea.europa.eu/data-and-maps/data/urban-morphological-zones-2006.

Figure A6.2 Distance thresholds to noise sources



Source: ETC/SIA, UAB. Data sources: END noise sources and noise contour maps, UMZ, E-PRTR register, CLC 2006.

Therefore, the subjective dimension of quietness will be added to quietness mapping taken into account two elements: the degree of naturalness and the rural-urban character. This latter factor is ultimately related with population density, economic activities and landscape configuration.

Degree of naturalness

Input data:
Corine Land Cover and Land Use data (2006)

Reclassification of CLC 2006 polygons into an adjusted degree of naturalness
The natural character of land covers is addressed through the hemeroby concept (Jalas, 1955; Blume and Sukopp, 1976), which measures the degree of artificiality of land, after human activities have altered the ecosystem from the potential natural condition. Hemeroby scale ranges from level 1 ('ahemerob', i.e. no human impact) to level 7 ('metahemerob', i.e. destroyed originally biocenosis).

Land cover types defined in Corine datasets have been translated to the hemeroby scale (Table A6.2) following previous experiences, as is the case of Steinhardt et al., 1999; Zebisch et al., 2004; Paracchini and Capitani, 2011).

Once being reclassified into the degree of naturalness indicated by the hemeroby scale, the naturalness values of Corine Land Cover have been rescaled to values between 0 and 1.

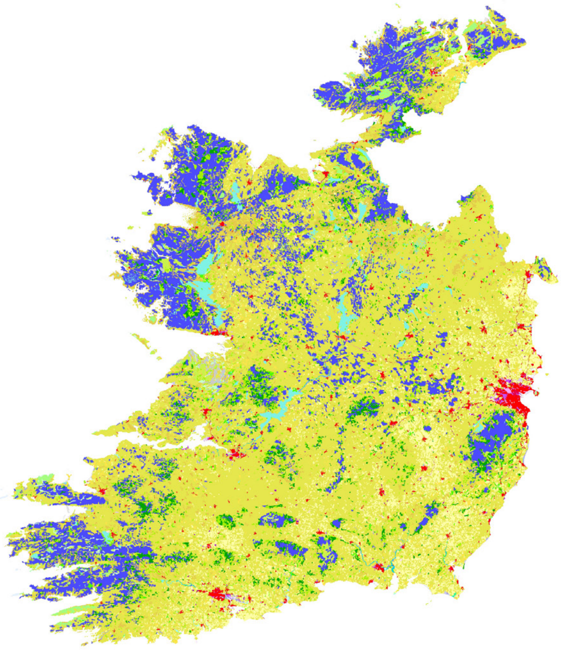
Table A6.2 Reclassification of Corine Land Cover categories into the hemeroby scale

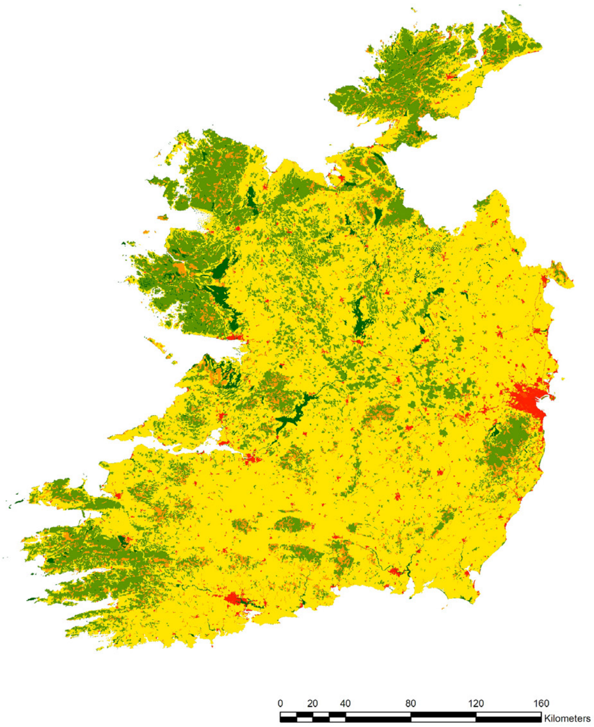
CLC	Hemeroby	Label 1	Label 2	Label 3
111	7	Artificial surfaces	Urban fabric	Continuous urban fabric
112	7	Artificial surfaces	Urban fabric	Discontinuous urban fabric
121	7	Artificial surfaces	Industrial, commercial and transport units	Industrial or commercial units
122	7	Artificial surfaces	Industrial, commercial and transport units	Road and rail networks and associated land
123	7	Artificial surfaces	Industrial, commercial and transport units	Port areas
124	7	Artificial surfaces	Industrial, commercial and transport units	Airports
131	6	Artificial surfaces	Mine, dump and construction sites	Mineral extraction sites
132	6	Artificial surfaces	Mine, dump and construction sites	Dump sites
133	6	Artificial surfaces	Mine, dump and construction sites	Construction sites
141	6	Artificial surfaces	Artificial, non-agricultural vegetated areas	Green urban areas
142	6	Artificial surfaces	Artificial, non-agricultural vegetated areas	Sport and leisure facilities
211	4	Agricultural areas	Arable land	Non-irrigated arable land
212	5	Agricultural areas	Arable land	Permanently irrigated land
213	5	Agricultural areas	Arable land	Rice fields
221	5	Agricultural areas	Permanent crops	Vineyards
222	5	Agricultural areas	Permanent crops	Fruit trees and berry plantations
223	4	Agricultural areas	Permanent crops	Olive groves
231	4	Agricultural areas	Pastures	Pastures

Table A6.2 Reclassification of Corine Land Cover categories into the hemeroby scale (cont.)

CLC	Hemeroby	Label 1	Label 2	Label 3
241	4	Agricultural areas	Heterogeneous agricultural areas	Annual crops associated with permanent crops
242	4	Agricultural areas	Heterogeneous agricultural areas	Complex cultivation patterns
243	4	Agricultural areas	Heterogeneous agricultural areas	Land principally occupied by agriculture, with significant areas of natural vegetation
244	4	Agricultural areas	Heterogeneous agricultural areas	Agro-forestry areas
311	3	Forest and semi natural areas	Forests	Broad-leaved forest
312	3	Forest and semi natural areas	Forests	Coniferous forest
313	3	Forest and semi natural areas	Forests	Mixed forest
321	3	Forest and semi natural areas	Scrub and/or herbaceous vegetation associations	Natural grasslands
322	2	Forest and semi natural areas	Scrub and/or herbaceous vegetation associations	Moors and heathland
323	2	Forest and semi natural areas	Scrub and/or herbaceous vegetation associations	Sclerophyllous vegetation
324	2	Forest and semi natural areas	Scrub and/or herbaceous vegetation associations	Transitional woodland-shrub
331	2	Forest and semi natural areas	Open spaces with little or no vegetation	Beaches, dunes, sands
332	1	Forest and semi natural areas	Open spaces with little or no vegetation	Bare rocks
333	2	Forest and semi natural areas	Open spaces with little or no vegetation	Sparsely vegetated areas
334	5	Forest and semi natural areas	Open spaces with little or no vegetation	Burnt areas
335	1	Forest and semi natural areas	Open spaces with little or no vegetation	Glaciers and perpetual snow
411	2	Wetlands	Inland wetlands	Inland marshes
412	2	Wetlands	Inland wetlands	Peat bogs
421	2	Wetlands	Maritime wetlands	Salt marshes
422	5	Wetlands	Maritime wetlands	Salines
423	1	Wetlands	Maritime wetlands	Intertidal flats
511	1	Water bodies	Inland waters	Water courses
512	1	Water bodies	Inland waters	Water bodies
521	1	Water bodies	Marine waters	Coastal lagoons
522	1	Water bodies	Marine waters	Estuaries
523	1	Water bodies	Marine waters	Sea and ocean

Figure A6.5 Corine Land Cover (left) reclassified according to the hemeroby scale (right), adjusted to 0 to 1 values (from lower to higher hemeroby, red to dark green respectively)





Source: ETC/SIA, UAB. Data sources: CLC 2006, EEA.

Degree of ruralness

Input data
GEOSTAT Urban-Rural typology (grid)

Reclassification of the land cover surface into an adjusted degree of naturalness

The Urban-rural typology (⁷) layer classifies the territory into:

- predominantly urban/urban grid cells;
- intermediate urban/rural grid cells;
- predominantly rural/rural grid cells.

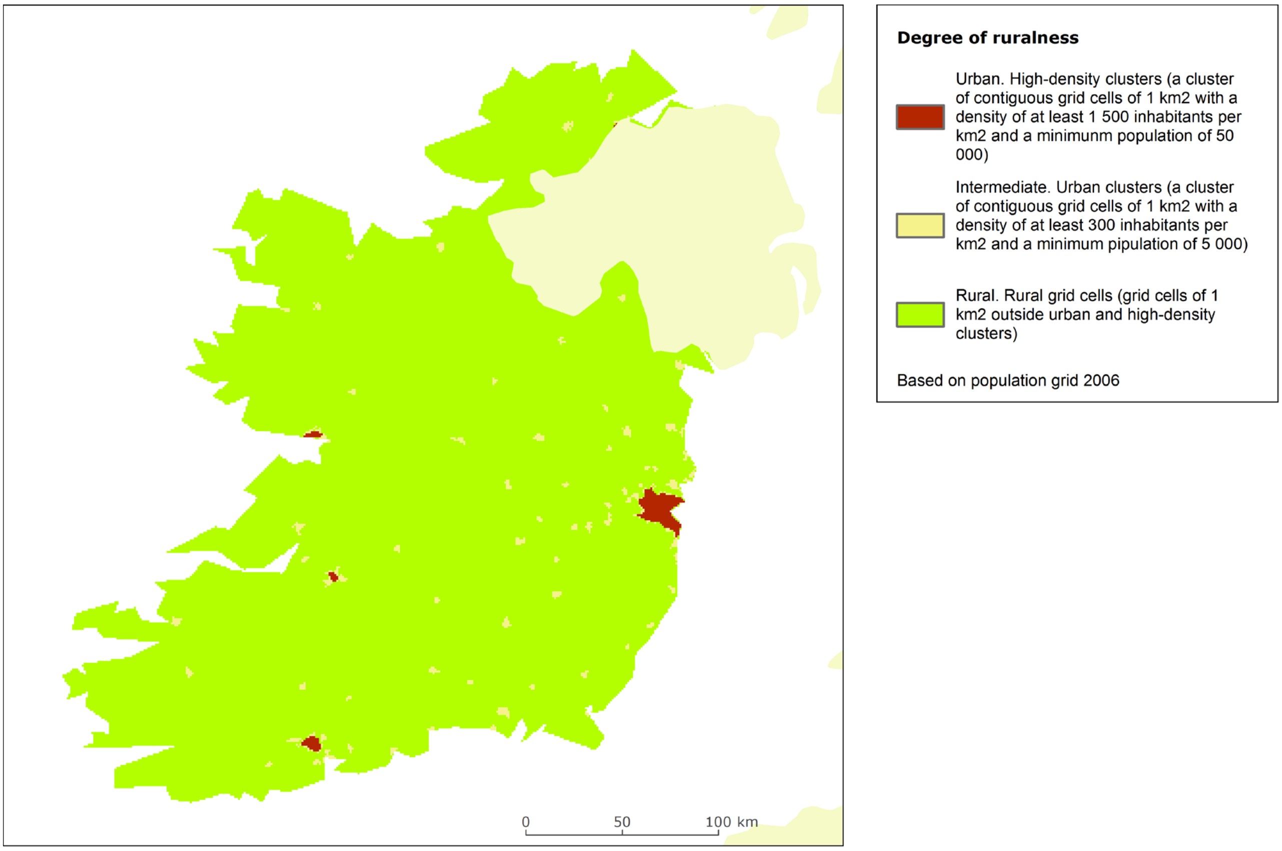
This European typology of 'predominantly rural', 'intermediate' or 'predominantly urban' regions is based on a variation of the OECD (⁸) methodology. The aim of this new typology is to provide a consistent basis for the description of these three distinct types of regions in all European Commission communications, reports and publications, including Eurostat statistical analyses.

Values indicating the urban/rural character of every grid cells are rescaled to 0 to 1 values:

- 0 value is assigned to urban areas;
- 1 value is assigned to rural areas;
- 0.5 values are assigned to urban/rural intermediate grid cells.

(⁷) http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Urban-rural_typology.
(⁸) The Organisation for Economic Co-operation and Development.

Figure A6.6 **Degree of ruralness. Urban-rural typology is shown as follows: urban (red), intermediate (yellow) and rural (green) grid cells**



Source: ETC/SIA, UAB. Data sources: Eurostat, JRC, EFGS, REGIO-GIS.

Results

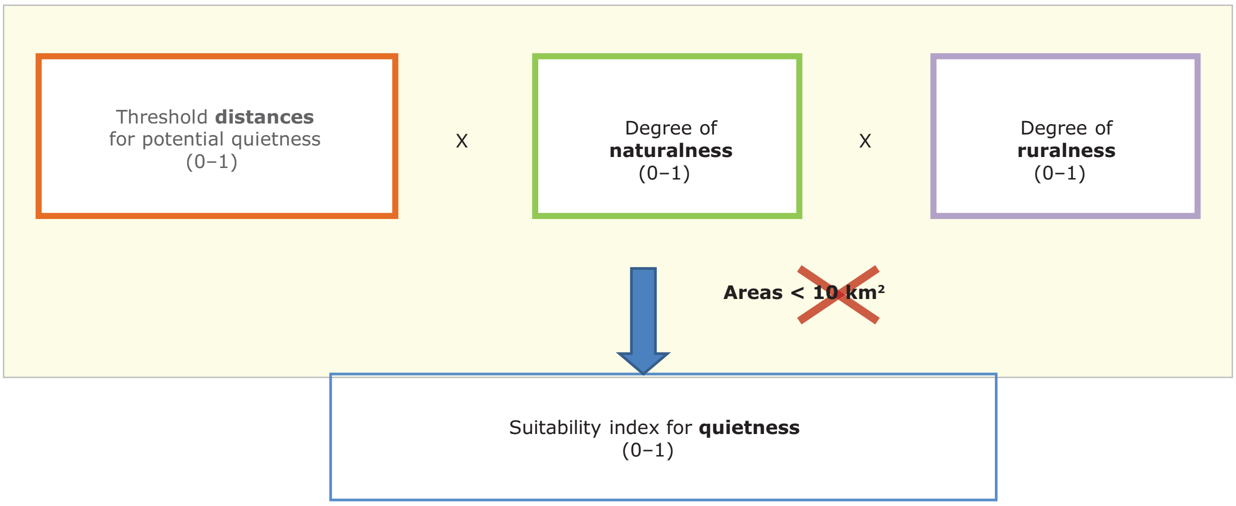
The three layers obtained in the previous steps at country level (threshold distances, degree of naturalness and degree of ruralness) are multiplied to obtain the final quietness suitability index, with values ranging from 0 (not suitable at all) to 1 (maximum suitability).

A previous step to the final result consist in filtering all those potentially quiet areas (> 0) showing an area smaller than 10 km^2 (Votsi et al., 2012).

This methodological proposal is aimed at supporting decision making. With the help of available data and relatively simple and direct analysis, it gives a first indication on the most suitable areas which could be defined as quiet (and therefore protected) at the national level.

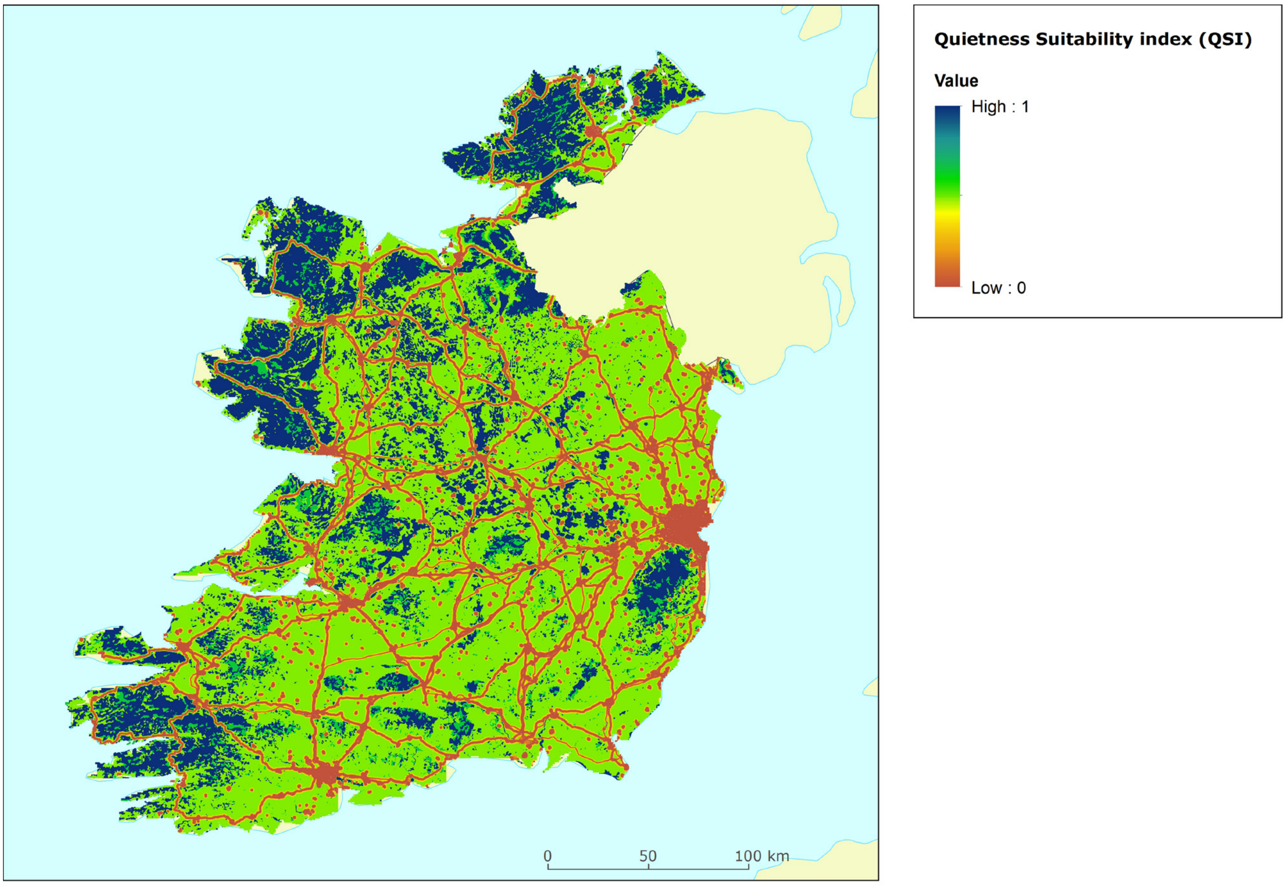
By using the EEA mean calculated, this methodology could also be implemented at European level.

Figure A6.7 Calculation of the final suitability index for quietness



Source: ETC/SIA, UAB, 2013.

Figure A6.8 Suitability for quietness index at country level (example: Ireland)



Source: ETC/SIA, UAB.

Potentialities

Table A6.2 shows basic statistics for the obtained quietness suitability in Ireland considering different data ranges.

But the availability of georeferenced data offers numerous chances to further analyse the obtained spatial information on quietness.

As a matter of example, the results of combining the quietness suitability map for Ireland with the Natura 2000 sites declared in that country could be analysed (example in Table A6.3). In this way, potentially quietness in such kind of protected areas can be studied resulting in potential specific measures to preserve quietness, or to analyse at country level how much potentially quiet areas are already protected.

Next steps

Improvements that could be applied to the methodology are, in first term, related to data availability and data quality.

Further variables, as the case of visual analysis, could also be included in the methodology but applying it at a more detailed scale, due to required computational capacity.

The quietness suitability index map for the whole Europe is going to be developed in the upcoming stage, including those countries with data not available. In these cases, European georeferenced databases and the calculated EEA mean concerning distances will be applied, and statistical analysis at country and at EEA level could be foreseen as in the example of Ireland shown in this methodological document.

Table A6.2 Basic statistics of the quietness suitability index (QSI) for Ireland

	QSI	QSI > 0.25	QSI > 0.5	QSI > 0.75
Parameter	Value	Value	Value	Value
Mean	0.416	0.616	0.681	0.867
Standard deviation	0.312	0.180	0.156	0.041
% area	100	65.07	50.46	18.69

Source: ETC/SIA, UAB. Data sources: CLC 2006, EEA.

Table A6.4 Selection of Natura 2000 sites declared in Ireland with the analysis of mean values of potentially quietness calculated within their limits

Site code	Minimum	Maximum	Mean	StDev	Area
IE0000831	0.571429	0.571429	0.571429	0	542978.7
IE0000849	0.571429	0.857143	0.59127	0.072631	1468955
IE0000859	0	0.857143	0.410311	0.304965	2788821
IE0000869	0.571429	0.857143	0.840336	0.067227	356497.7
IE0000919	0.28422	0.848384	0.553587	0.108768	164826.9
IE0000925	0.857143	0.857143	0.857143	0	299371.3
IE0000930	0.428571	0.571429	0.47205	0.065733	234920.9
IE0000934	0.428571	0.857143	0.588877	0.114426	1340378
IE0000939	0.857143	0.857143	0.857143	0	248456.2
IE0000979	0.428571	0.857143	0.853022	0.041822	1105035

Note: StDev = Standard deviation.

Source: ETC/SIA, UAB. Data sources: CLC 2006, EEA.

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Sub-annex

Distance statistics for distances from noise contours (dB) to noise source distance values are expressed in metres.

Motorway					
ID	**dB**	**Min.**	**Max.**	**Mean**	**StDev**
1	55	0.0	1 004.9	386.2	192.4
2	60	0.0	1 004.9	178.9	165.9
3	65	0.0	1 000.0	108.6	165.3
4	70	0.0	1 000.0	79.2	177.0
5	75	0.0	921.9	124.1	216.5

Rail					
ID	**dB**	**Min.**	**Max.**	**Mean**	**StDev**
1	55	0.0	3 794.7	404.2	957.5
2	65	0.0	3 700.0	1 359.6	1 449.9
3	75	1 720.5	2 863.6	2 292.0	571.5

Primary road					
ID	**dB**	**Min.**	**Max.**	**Mean**	**StDev**
1	55	0.0	1 044.0	279.5	203.3
2	60	0.0	1 063.0	225.2	181.6
3	65	0.0	1 063.0	98.3	143.4
4	70	0.0	1 044.0	60.6	134.3
5	75	0.0	670.8	37.9	81.6

Airports					
ID	**dB**	**Min.**	**Max.**	**Mean**	**StDev**
1	55	0.0	9 717.0	**3 135.9**	**2 664.4**
2	60	0.0	4 741.3	1 221.1	1 274.4
3	65	0.0	1 581.1	267.5	358.4
4	70	0.0	200.0	27.5	51.7
5	75	0.0	100.0	2.1	14.2

Secondary road					
ID	**dB**	**Min.**	**Max.**	**Mean**	**StDev**
1	55	0.0	806.2	196.9	162.1
2	60	0.0	538.5	80.5	91.8
3	65	0.0	447.2	57.4	77.3
4	70	0.0	728.0	74.6	136.8
5	75	0.0	400.0	67.3	104.1

Note: Min. = Minimum; Max. = Maximum; StDev = Standard deviation.

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