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(EPA Network)

Interest Group on Noise Abatement



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Quiet areas, soundscaping and urban sound planning

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EPA Network Interest Group on Noise Abatement members are the Environmental Protection Agencies from these countries:

Germany (co-chair), Switzerland (co-chair), Norway, The Netherlands, Italy, Denmark, Czech Republic, Slovakia, Austria, Slovenia, Malta, Hungary, North Ireland, Luxembourg, and the European Environment Agency



This position paper is the result of the work of the EPA Network's Interest Group on Noise Abatement. While it reflects the inputs of all participants of the Interest Group, it is only endorsed in this form, including policy recommendations, by those Agencies mentioned above.

Summary

In the battle against noise pollution, policy makers concentrate on limiting and bringing down noise levels. Decibels describing noise levels are, however, only one of many parameters that determine the way people experience sound in their day to day lives. This report looks beyond the decibel and focuses on improving the acoustic environment as a whole: by preserving it where it is good, and optimizing it there where it could be better.

Quiet areas are locations in which unwanted sounds from traffic and industrial installations do not dominate. Although quiet areas have been included in the European Environmental Noise Directive since 2002, they receive only limited attention from national and local authorities. Few authorities recognize the importance of restorative spaces. Planning authorities who do appreciate their significance for health and quality of life are looking for good definitions to identify such areas.

Quiet areas are not meant to be totally silent. Many sounds are pleasant or informative, and relaxing or exciting depending on the situation one is in. The perception of a soundscape depends on the local context and on the human perception and valuation of sounds in that context.

The task of managing and improving the acoustic environment within the scope of urban planning projects is called urban sound planning. It is important that municipalities, urban planners and landscape architects take into account the acoustic component in their design choices. This should be done at an early stage: all too often, the aspect of sound is considered only after relevant decisions concerning the design have been made, leaving little options for optimization of the soundscape. If areas are inevitably exposed to high noise levels, the existence of nearby quiet and tranquil places is even more important, providing an opportunity for people to restore.

This report contains an anthology of the way in which quiet areas, soundscaping and urban sound planning are dealt with, on national and local scale. Our examples are based on a literature search and on input from different sources, such as the members of the IGNA. We describe relevant legislation and regulations in several European countries and regions. We illustrate the ample variety of implementation options through a selection of interesting case studies. Furthermore, we provide information on the benefits, both from a public health and an economic perspective, of preserving quiet areas.

It is clear from the examples and efforts that the acoustic community is creative and that there are many, mainly local authorities that are not afraid to follow new and innovative approaches to improve the acoustic environment. This report may serve as a guidance for other acousticians, policy makers and urban planners who have the ambition to try a new approach to the long existing noise problem.

Here, we summarize the conclusions that arise from this report:

- Acoustic quality is more than the absence of noise. Unwanted sources of noise are brought down because there are others sounds we *do* want to hear.
- Even in quiet areas, people will want to hear sounds. However, there are typical sound sources such as traffic and industry, that are generally disliked and should be constrained.
- Quiet areas are appreciated by the public and have a positive effect on people's well-being. However, we have no evidence of regulations ensuring that quiet areas designated today, will still be quiet tomorrow. Many local authorities do mention specific measures that may be taken to this end.
- The soundscape approach is being translated into guidelines and ISO standards. Evidence of legislation regarding the approach has been found in a few hopeful recent examples.

- Even without legislation, a lot of effort is done across Europe to create and preserve pleasant soundscapes and quiet areas. Especially with regards to quiet areas, ample examples can be found.
- An unambiguous set of prerequisites describing a quiet area does not exist. Apart from acoustic criteria, quiet areas should have green qualities and be easily accessible at no cost.
- Identification of quiet areas can be achieved through GIS based methods and by involving the public. Especially when trying to identify smaller urban oases, residents' participation could be advantageous.
- Urban sound planners should be aware of other tools to reduce noise annoyance and health impacts besides reducing the level at the most exposed facade. Useful improvements in highly exposed areas are the availability of a quiet side to a dwelling and the presence of green nearby, preferable visible through the window.
- Such tools include new soundscape descriptors, such as Pleasantness or Eventfulness, that will help to quantify soundscapes beyond their long-term average noise levels.
- Through synergy with other environmental topics, such as air quality, biodiversity and climate change, the business case of protecting quiet areas could be made stronger. Further research to quantify the economic and health benefits of quiet areas would be beneficial as well.
- By including sound in their planning procedures, urban planners and authorities can significantly improve the living environment. In this process, the focus should not be solely to bring down noise levels, but to optimize the acoustic environment as a whole.
- The emerging field of Citizen Science, aiming to involve and empower the citizens by taking them aboard research and policy development projects, is particularly promising for environmental acoustics. After all, the impact of sound on public health and well-being is subject to the attitude of the people exposed to it, perhaps more so than for other environmental polluters.

Key messages

Quiet Areas

- have a positive effect on people's wellbeing
- should create a contrast to the noisy environment
- benefit from being green, clean and accessible
- are regularly defined, but more efforts should be taken to preserve them
- require more evidence of their value to withstand housing demand and economic development

Soundscaping

- helps to quantify the acoustic environment as experienced by its users
- provides planners with tools to design and improve the quality of the acoustic environment as a whole

Urban Sound Planning

- should be about acoustic quality, not just about dB's
- should consider nearby quiet areas
- should strive to create a quiet side to noise-exposed dwellings
- should consider green in the surroundings to reduce noise annoyance

And synergy: strengthen the business case for improving acoustic quality by partnering up with other environmental topics: **1 + 1 = 3!**

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1 Introduction

1.1 Background

The EPA Network is an informal grouping bringing together the directors of environment protection agencies across Europe. The network exchanges views and experiences on issues of common interest to organisations involved in the practical day-to-day implementation of environmental policy. In the September 2010 EPA-Network meeting in Krakow the Interest Group on Traffic Noise Abatement (IGNA) was created and in 2017 its mandate was renewed for 2017-2022 at the EPA plenary meeting in Rome. The key activities of IGNA will focus on recommendations for actual and long term objectives, mainly to the following issues:

- Harmonization of noise-monitoring: harmonization and standardization of methods for monitoring and evaluation of noise exposure and remedial measures;
- Noise abatement measures at source and quiet areas: Information and exchange of successful measures to limit noise at sources and to protect quiet areas; exchange knowledge on action plans with stringent regulatory and incentive measures at sources such as for vehicles and machines;
- Critical levels: harmonized critical levels (limit values) that trigger specific remedial measures;
- Economical instruments: cost-benefit aspects and application of financial instruments in order to compensate external costs and to set incentives for measures at sources.

1.2 Motivation and goal for this report

Previous activities and reports by the IGNA have focused on the most important sources of environmental noise: road, rail and air traffic. The state of the art in noise abatement measures has been described, and a separate report on costs and benefits for noise abatement has been published. The latest IGNA report provides an overview of noise limits in the European region, in relation to the 2018 WHO environmental noise guidelines.

However, absolute dB-values describing noise levels are only one of many parameters that determine the way people experience sound in their day to day lives. What is more, there could be a pitfall if too much focus is put on reduction of high noise levels: traffic and other sources may be forced to spread out over the area, leading to medium noise levels everywhere – a ‘noise blanket’, as it is called in the Netherlands.

This report therefore chooses three different angles towards the improvement of the acoustic environment, focusing not on bringing down noise levels but rather on preserving the acoustic environment in areas where it is considered to be good, and optimizing it there where it could be better – regardless of absolute noise levels in dBs. “Good” in this case primarily means quiet, as in quiet areas in which unwanted sounds from road, rail, air and water traffic, industry and installations do not dominate. Such areas are not meant to be totally silent. Sound in itself is indispensable, as it contains vital information about one’s current environment. Many sounds are considered pleasant and may be relaxing or exciting, depending on the situation one is in. The valuation of the local soundscape depends on the local context and on the human perception of sounds in that context. That leads to the last subject of this report, urban sound planning. Modern cities are full of sounds, both wanted and unwanted. It is important that municipalities, urban planners and landscape architects take into account the

acoustic component in their design choices. When developing or restructuring a city area, they should think about how it is going to sound, and how the new design and function themselves will change the local soundscape. And for those areas where the noise cannot be overcome, people will value even more the existence of nearby quiet and tranquil places, providing an opportunity to escape and restore.

The report starts with our definitions of ‘quiet areas’, ‘soundscaping’ and ‘urban sound planning’. Then, we provide an anthology of national and local examples of legislation on these subjects, followed by a selection of interesting case studies. These examples serve as inspiration and background for policy makers, authorities and experts who want to learn about these emerging topics and discuss them in their own countries and organisations. Furthermore, we provide some information on the benefits, both in a public health and an economic sense, of preserving quiet areas. The Appendix provides an overview of relevant research projects that have been done in recent years or that are ongoing, to show the developments in the field and provide sources of further information.

1.3 Definitions

1.3.1 Quiet Areas

The Commission already recognized the need to protect quiet areas in their 1996 green paper on noise [25]. The 2002 Environmental Noise Directive [24]¹ states in general that the environmental noise quality should be preserved where it is good. More explicitly, it is stated that

¹ The original END (2002/49/EC) was published in 2002. Several modifications have been made by subsequent separate directives, including replacement of Annexes II and III. A consolidated version of the 2002/49/EC Directive is available as of 25 March 2020.

quiet areas should be preserved, and that action plans shall also aim to protect quiet areas against an increase of noise. This regards quiet areas in agglomerations as well as in open country, which are separately defined in the END:

- ‘*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;
- ‘*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.

Furthermore, the END states (Art. 8) that action plans should also aim to protect quiet areas against an increase in noise, and (Annex V) that any measures to preserve quiet areas in the next five years must be reported.

Although quiet areas are as such included in the END, a very specific definition of ‘quiet’ is not given. This leads to a variety of definitions used throughout Europe (see box ‘Environmental Noise in Europe’). Often, it is agreed that the soundscape in quiet areas is not dominated by unwanted human-induced noise. Quiet areas do not need to be free of any sound. On the contrary, as follows from studies related to soundscaping, quiet areas contain many positive sounds (e.g. nature). There is a bit of a language issue for some Member States: in Dutch, ‘quiet’ translates to “stil”, the same word used for ‘silent’. In Italy quiet areas are labelled “zone silenziose”, which translates to ‘silent area’ as well. However, the definition of these ‘silent areas’ will be refined within the scope of the Italian Guideline that is currently being drawn

up regarding the identification and management of quiet areas. The alternative ‘calm’ has been proposed, but, like ‘quiet’, this could also be interpreted as ‘not busy’ / ‘low in activity’ which is not exactly the same as ‘low noise’.

In addition to noise levels, non-acoustic factors such as green and accessibility are often mentioned as relevant factors. It has been shown that green has a positive effect on human wellbeing [51], and nearby access to quiet places and green places has been shown to positively contribute as well ([29], [74]). Several studies, by individual Member States or on a EU level, have proposed uniform definitions, which are described in the different chapters below. Most often these are based on absolute or relative sound levels, but sometimes also (in combination with) ways to determine how an area is perceived by the public. In that respect, there is a clear link with the soundscaping approach, as the definition of ‘quiet’ should discriminate between wanted and unwanted sounds, especially in more dynamic urban areas where there is a mixture of both. In rural areas, absolute, measurable sound levels or L_{den} are more appropriate as loud noises are more likely to come from traffic and industry, which are generally unwanted by everyone.

1.3.2 Soundscaping

A “soundscape” is defined as an *acoustic environment as perceived or experienced and/or understood by a person or people, in context* (ISO12319-1 [37]). The term “soundscape” is usually attributed to R. Murray Schäfer [69] who certainly played an important role in defining it, although others have used the term before him. More recently, researchers have reached consensus on its definition and conceptual framework, which are now described in the ISO12913-1 standard from 2014 [37].

Environmental Noise in Europe

Early 2020, the European Environment Agency (EEA) published their report *Environmental Noise in Europe – 2020*, assessing the degree of noise exposure of the European population [29]. One chapter of the report is dedicated to quiet areas. Based on a questionnaire, the EEA reports how governmental institutions throughout Europe make use of an ample variety of definitions and criteria for the selection of QAs. Often, characterization is based on absolute background sound levels, where a wide range of limit sound levels and indicators are used (see figure below). Also non-acoustic factors are used, such as visual qualities, area size and accessibility.

Table 6.1 Range of noise levels and noise indicators used to designate quiet areas in agglomerations

	≤ 30	≤ 35	≤ 40	≤ 45	≤ 50	≤ 55	≤ 60	≤ 65
L_{den}								
L_{day}								
L_{night}								
Evening								
$L_{max, day}$								
$L_{max, night}$								

Source: ETC/ATNI (2019c).

Where the ‘landscape’ is the perception of the visual environment, the soundscape is the perception of the acoustic environment. The difference between the soundscape-approach and other, more traditional approaches to environmental noise is that soundscaping focuses on improving the quality of the acoustic environment as it is perceived by the ‘user’ at that time and place, whereas in environmental acoustics the focus is usually on bringing the actual noise levels down. Soundscaping starts from the fact that sound in itself is not a bad thing and that many sounds are wanted because

they are pleasant or informative. Also, sounds give character to a particular place and time, just like a certain smell, view, etc.

In the ISO12913, the term ‘sound’ is used throughout rather than the term ‘noise’, as the latter is already a subjective qualification of the soundscape. It could be imagined that ‘sound’ becomes ‘noise’ when there is a mismatch between the soundscape and the further local context and people’s expectations and perception of the place, based on the landscape, land use, activities, etc. A soundscaping approach to a particular area would focus on creating a pleasant acoustic environment, which could be done by adding wanted sounds just as well as by removing unwanted sounds (noise). Typical ‘wanted’ environmental sounds are sounds of nature (wind, birds, water). But, depending on the context, this also includes people talking, children playing, church bells chiming. In a different context or for a different listener, however, these same sounds could be unwanted.

Research and application of soundscaping comes with its own vocabulary and definitions. This includes terms such as:

- “Hi-Fi” and “Lo-Fi”:
 - a Hi-Fi acoustic environment has low background noise, allowing discrete sounds to be heard clearly. A rural area is generally more Hi-Fi than a city because the natural landscape allows sounds from nearby and afar to be heard;
 - a Lo-Fi environment, obscures most sound signals by too many other sounds, and perspective is lost within the broadband of noises. In a Lo-Fi environment, one can only listen to immediate and loud encounters
 - Hi-Fi and Lo-Fi are related to the ‘signal-to-noise’ ratio. These are quality-free terms, even though many Lo-Fi environments will not be appreciated.

- “Soundmark”: a typical sound that is unique to a certain area and is identified by many as a recognizable feature or that location; similar to ‘landmark’.
- “Sonotope”: the total of all sounds in a particular area, usually a blend of
 - “geophony”: non-living natural sounds (wind, water, ...);
 - “biophony”: non-human biological sounds, mainly animals;
 - “androphony” or “technophony”: man-made sounds and sounds from human-driven activities (mechanical sounds, traffic, industry).

As the soundscape depends strongly on the context and the perception of the people in it, this means that a description in terms of dB is not appropriate. Neither are the use of common acoustic tools such as sound level meters or acoustic calculation models. While the field progresses, however, soundscape descriptions are more and more objectified and quantified, see also paragraph 3.3.4. Common instruments used to characterise the sonic landscape are soundwalks, questionnaires and (guided) interviews, all of which can be considered as ‘measurement by person’ rather than ‘measurement by instrument’. Part 2 of the ISO12913 ([38], from 2018) describes how such methods should preferably be applied: it provides default soundwalk instructions, interview questions and a taxonomy that provides a common categorisation of different sounds. A third part of the ISO-standard, describes how these data should be analysed and interpreted [39]. The professionalization of the soundscape field in recent years also leads to more and more real-life applications of the concept, to improve people’s relation with their sonic environment. Examples are given in Chapter 3.

1.3.3 Urban Sound Planning

The concept of Urban Planning has been long ago established and refers to the *design and regulation of the uses of space that focus on the physical form, economic functions, and social impacts of the urban environment and on the location of different activities within it* [32]. With that in mind, *Urban Sound Planning* would intuitively refer to the incorporation of sound into the process of developing and designing the urban environment. The concept therefore reaches beyond microscopic mitigation methods such as silencers, noise barriers or sound insulation at the façade. Rather it describes the way in which sound, or noise, is incorporated in the decision making with regards to urban planning, preferably at an early stage.

The term *Urban Sound Planning* was formulated during the research project SONORUS, within the Commissions Seventh Framework research programme. Within this project, Urban Sound Planning is described as a holistic approach that aims not to make the area quieter but to define policies to value, introduce and preserve the characteristics of a good sonic environment [47]. The word ‘sound’ in *Urban Sound Planning* refers to both the physical concept of propagating mechanical waves and to its alternative meaning of ‘healthy’, ‘in good condition’.

The SONORUS approach is meant to enable planners and architects to actively take into account acoustic planning, and includes prediction models, soundscaping and noise control. Human perception and a context-dependent understanding of the sonic landscape are an indispensable part of the approach. The evident link to the field of soundscaping also becomes apparent from the description of Urban Sound Planning given in [49]:

An emerging trans-discipline between acoustics, soundscape, and urban planning with the aim of designing holistic acoustically

favourable environments suitable to the context from the perspective of the ‘users of the space’ and their expectations.

However, for the purpose of this report, the term Urban Sound Planning is used in a broader definition: in the context of *including the aspect of sound or noise in urban planning*. Even without a reference to the soundscape, the incorporation of sound in the process of land use planning is an important and interesting topic that deserves to be addressed. This relates both to the large and the small scale: including both planning the design of an entire area and building design.

One of the conclusions resulting from an urban sound planning process could be that additional requirements to the sound insulation of buildings are in place. For example, there where environmental noise levels are high, a minimum degree of sound insulation or a maximum indoor noise level may be required. However, the details of these insulation requirements and corresponding regulations are not considered in this report as part of urban sound planning.

Some concrete topics that can be considered as relevant with respect to urban sound planning are the following:

- urban and territorial planning (at small and large scales)
- architectural design of streets
- optimized design of the building layout
- building façade design
- quiet sides
- quiet outdoor spaces
- quiet areas
- spatial zoning
- city structures at small and large scale
- transport design
- traffic management
- numerical prediction of the sound field

- auralisation of the sound field
- consideration of the human perspective

As becomes apparent from this list, the topics of quiet areas, soundscaping and urban sound planning are very much intertwined.

With regards to the topics named above, the Environmental Noise Directive [24] makes a reference to both quiet areas (see chapter 1.3.1) and to the quiet sides of dwellings. As to the latter, the END states in Annex VI that the data sent to the Commission in each noise mapping round should contain, if available, how many persons in each of the noise level bands (55-59 dB L_{den} , 60-64 dB, etc.) live in dwellings that have:

- special insulation against the noise in question, meaning special insulation of a building against one or more types of environmental noise, combined with such ventilation or air conditioning facilities that high values of insulation against environmental noise can be maintained,
- a quiet façade, meaning the façade of a dwelling at which the value of L_{den} four metres above the ground and two metres in front of the façade, 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} .

The positive effects of a quiet façade or quiet side in highly noise-exposed dwellings has been shown in several studies. Öhrström et al. show in [60] that the availability of a quiet side in dwellings, defined in this case as an absolute quietness ($L_{Aeq,24h} \leq 45$ dB), reduces the adverse noise effects (including annoyance) by 30 to 50%, equivalent to a reduction of noise levels at the most exposed façade by 5 dB.

The effect of quiet sides has been studied also in the QSIDE project, see e.g. [20]. It was shown [83] that the chance of being at least moderately annoyed decreases from 53% to 25% if the dwelling has

side that is significantly more quiet than the most exposed façade (difference > 20 dB(A)), as opposed to dwelling with a level difference less than 10 dB(A). Furthermore, positive effects on sleep disturbance were shown if the bedroom is placed at the quiet side.

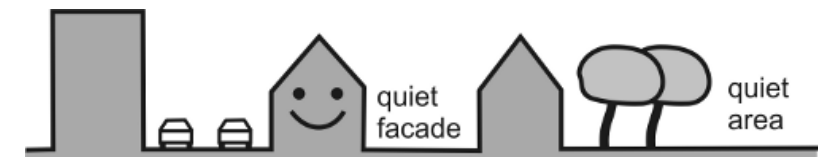


figure 1 Quiet facades and quiet areas (from QSIDE²)

Lastly, we point out a recent trend that is relevant for the way in which the living environment is shaped and understood: Citizen science – the participation of citizens in research. More and more often, citizens get actively involved in the process of understanding and evaluating the acoustic environment and its impact on health and wellbeing. By letting citizens initiate or participate in research projects regarding their own living environment, they get involved and engaged in policy-making, which leads to empowerment and environmental awareness. In addition, significant contributions may be made to (scientific) research projects. Although not the main topic of this report, we consider Citizen Science an important trend which is particularly relevant for acoustics, as it allows to not only investigate the way in which the acoustic environment is physically shaped, but also the way in which it is experienced.

² <http://www.qside.se/proj/index.html>

2 Examples of national legislation

2.1 Introduction

Traditionally, legislation meant to protect citizens to the harmful effects of noise focusses on limiting noise levels at and around people's homes. In this chapter, we analyse how legislation relates to the acoustic characteristics of the entire outdoor environment and to the improvement of the sonic landscape more broadly. Related topics – such as quiet areas, soundscaping and urban sound planning – are being extensively researched and are gaining popularity in- and outside the acoustic community. However, as these topics are still relatively young, and as their implementation is less straightforward than setting one-valued limits, one could expect less national legislation to be available regarding the subject.

To get an idea of what legislation does or does not exist, we provide an anthology of legislation from a selection of countries. The non-exhaustive overview presented below has been established based on the input provided by IGNA members, supplemented with input from the authors. The purpose of this chapter is not to provide a complete list of all legislation available, but to present exemplary regulations that illustrate possible ways to include the topics of quiet areas, soundscaping and urban sound planning in national legislation. In paragraph 2.12, a summary of the information is provided.

2.2 Czech Republic

The main piece of Czech noise legislation is contained in Act No. 258/2000 on protection of public health. Quiet areas are mentioned in the section on strategic noise mapping, implementing the END. Quiet

areas in agglomerations can be appointed by regional authorities, whereas quiet areas in open country can be appointed on a national level by the Ministry of the Environment. For the latter, a decree is under preparation. The requirements for quiet urban areas seem to be less strict than for rural areas, as the urban Qas are defined as areas in the agglomeration not influenced by any noise higher than the limit value, whereas for rural Qas these should be 'undisturbed' without mentioning a limit. The National Reference Laboratory for Environmental Noise has prepared a methodology, updated in 2018, for strategic noise mapping including recommendations how to identify quiet areas, inspired by a TRL report for DEFRA (UK) [57]. It is not mandatory to designate any Qas in the action plans and no Qas have been defined yet.

In urban planning, any building permit issued must comply with the 258/2000 and the associated noise limit values. Noise impact assessments are part of any permission proceedings when planning projects, before issuing permits.

As for soundscaping, the ISO standard has been implemented in a Czech national standard. It is, however, not a part of any legislation and is not considered useful by the Ministry of Health. The Ministries of Environment or Regional Development may use it as a tool for spatial planning purposes.

2.3 France

In January 2021, the French government has published a new law which aims to protect the French "sensory heritage". More specifically, the Loi no 2021-85 [67] modifies the Environmental Code such that it defines and protects sounds and smells typical for the French countryside. These legislative changes are the result of an increased

amount of disagreements between long-term residents of rural communities and new inhabitants, mostly from the city, who find themselves irritated by senses such as crowing roosters or the smells of manure. More and more often, those social conflicts led to litigation processes and lawsuits. A symbolic example is the trial of rooster Maurice in 2019, who got taken to court by new residents of the village Saint-Pierre-d'Oléron for his crowing at dawn. A petition was signed by 140.000 people to save the rooster. The court of Rochefort rejected the neighbours complaints of noise pollution. This and other conflicts encouraged the French government to create a better legislative basis to protect such characteristics of the rural environment.

The law introduces sounds and smells as characteristics of natural spaces, such that along with biodiversity, air quality and landscapes, amongst others, they are part of the nation's heritage. In addition, law gives regional heritage inventory services the task to identify and qualify such characteristics. In future conflicts, local officials may rely on the established definitions when settling a dispute. The above mentioned regional services are responsible for the identification and documentation of elements of cultural heritage.

Conflicts between new inhabitants and long-term residents regarding sounds are not limited to rural areas. An example of the protection of urban sounds is found e.g. in the Netherlands, see paragraph 2.8.3.

2.4 Germany

2.4.1 Urban sound planning

In Germany, noise abatement is an essential part of land use planning. Land use planning is regulated in the Federal Building Code [14] and consists of two stages: realisation of the preparatory land use plan, in which the municipal area is divided by means of a zoning plan, and the

development plan, in which the area is set up in sub-areas. In both planning steps, noise protection can be taken into account based on acoustic guidelines given in Supplement 1 [22] of the DIN 18005 "Noise abatement in town planning" [21]. The DIN 18005 standard provides information for municipalities, city planners and architects on the consideration of noise abatement in urban planning. The acoustic guidelines consist of *target* values; compliance is "desirable in order to meet the expectation of adequate protection against noise pollution" [21]. For residential areas target values range from 50 to 60 dB during the daytime (L_{day}) and 35 to 50 dB during the night (L_{night}). According to the Supplement, noise abatement is a more important planning principle than other aspects, such as for example the preservation of traditional urban structures.

2.4.2 Quiet areas – national legislation

In Germany, the implementation of the Environmental Noise Directive (END) [24] is completed in the Federal Immission Control Act [15]. In Section 47 of this Act, the obligation to create Noise Action Plans is established. In accordance with the END, it is stated that the aim of these plans should also be to protect quiet areas against an increase in noise. The law states that also in the case that there are no noise problems, it is possible to draw up a noise action plan for the protection of quiet areas. Quiet areas are determined by the authority responsible for drawing up the action plan; in most cases this is the municipality.

Instructions on how to designate quiet areas have been published by the Federal / State Working Group on Immission Control (LAI). These "LAI Guidelines on Noise Action Planning" differentiate between quiet areas in the country and quiet areas in metropolitan areas [13]. In the guidelines, criteria are provided for the designation of quiet areas for both types.

Quiet areas in the country

According to the LAI guidelines, quiet areas in the country are large areas that are not exposed to anthropogenic noises (e.g. traffic, industrial, commercial or leisure noise), with the exception of noises due to forestry and agricultural use of the areas. As long as these noises are not relevant in the area, it is in principle irrelevant whether the areas are built-up or undeveloped. This means that purely residential areas may also be considered as quiet areas.

Selection of quiet areas can be carried out based on local knowledge of the prevailing noise pollution or by calculation using a noise model. Areas with L_{den} values lower than 40 dB(A) could well be considered.

Quiet areas in metropolitan areas

In metropolitan areas, areas qualify as quiet areas if they are of natural, agricultural or forestry use, and if they are continuously accessible to the public. As a starting point, a selection criteria is used based on a maximum L_{den} value of 50 dB(A) in the majority of the area. Alternatively, a maximum L_{den} value of 55 dB(A) along the periphery of the area indicates the possible identification of a quiet area, as long as there are no significant noise sources inside the area.

Provided that people experience an inner-city recreation area as calm, these smaller urban regions may also be designated as quiet areas by the authorities. For instance, these could be spa areas, hospital areas, residential areas as well as natural areas, cemeteries and allotment areas. For this purpose, no maximum L_{den} values are considered.

2.4.3 Quiet Areas – an overview of municipal legislation

Many German municipalities have local regulations or policy on the designation and management of quiet areas in their region. In table I,

a non-exhaustive list is provided of several municipalities and the relevant policies. The information comes from two sources ([43],[79]).

A couple of things trigger the attention:

- Often, a minimum area size is defined as a prerequisite of being designated as quiet area.
- In the city of Verden, areas are identified based on the type of recreation taking place there, rather than on maximum noise levels.
- In Verden, in the case of Active Recreational areas, it is defined that a quiet area should be free of admission.

table 1 Examples of German cities with legislation on quiet areas. Sources [43], [79].

City	Types of quiet areas defined	Description	Maximum noise level?	Identification & Measures (for all types of QAs defined)
Berlin [79]	1) Quiet areas	Green areas / forests / parks with minimum size of 100 ha	5 dB(A) L_{den}	<ul style="list-style-type: none"> check city and traffic planning avoid expansion of settlements create buffer zones a list is made available of possible noise remedial measures
	2) Inner-city recreational areas	Recreational areas within walking distance and at least 30ha in size	Core \geq 6 dB less than most heavily used area	
Bremen [79]	1) Quiet landscape areas	Open spaces in the surrounding of cities of at least 30 ha in size	\leq 50 dB(A) L_{den}	<ul style="list-style-type: none"> take quiet areas into account in land use planning and approval procedures actively improve the noise situation in the case of "quiet urban spaces" and "urban oases"
	2) Quiet urban space	Inner-city green and open spaces of at least 3 ha in size. Aim is to reduce noise to 50 dB(A) in the future.	< 55 dB(A)	
	3) Urban oases	As in 2), but smaller or more heavily used. Either $Leq > 55$ dB(A) with minimum size 1 ha, or Core \geq 6 dB less than edge (in which case Leq could exceed 55 dB(A)) with minimum size 3 ha.	Not limited	
Hamburg [43]	1) Large open space	Either "quiet" or "particularly quiet". Based on empirical data from noise maps it was found that for Hamburg, a 55 dB(A) SPL could be achieved at a distance of 160 m from major roads. Therefore, 'quiet' open spaces have a minimum edge length of 320 m; for 'particularly quiet' open spaces this is 3400 m.	45 dB(A) or 55 dB(A) in core of the area	<ul style="list-style-type: none"> Identification through noise maps, in the case of QAs type 1, 2 and 3. Identification of 'urban oases' areas is achieved through public consultation.
	2) Relatively quiet open spaces in city centre	Relatively quiet area in city centre. In order to achieve a 6 dB reduction in the core, areas have a minimum edge length of 200 m.	Core \geq 6 dB less than surroundings	
	3) Quiet footpaths	Footpaths in attractive surroundings aside major roads with a length of at least 1 km.	Not limited	
	4) Urban oases	Urban spaces that are perceived as "quiet" by its users.	Not limited	

Norderstedt [79]	1) Landscape areas	Large natural areas of agricultural or forestry use.	$\leq 55 \text{ dB(A)} L_{\text{den}}$	<p>Identification</p> <p>Apart from the maximum noise levels, other selection criteria were defined and included during a public participation phase. These criteria include spatial proximity to residential areas, “unsettling threats” such as road traffic, and area size.</p> <p>Measures</p> <p>include the QAs in the ordinances of protected areas in the landscape plan</p> <p>take into account the positive effect of a QA when considering to take measures to relevant noise sources</p>
	2) City oases	Quiet areas in settlements.	$\leq 55 \text{ dB(A)} L_{\text{den}}$	
	3) Quiet axes	Quiet connecting green routes for pedestrians and cyclists.	$\leq 60 \text{ dB(A)} L_{\text{den}}$	
Verden (Aller) [79]	1) Nature recreation	Areas that serve “the stay and recreation of people” with a minimum size of 100 ha and a minimum distance of 500 m from commercial and industrial areas.	$\leq 55 \text{ dB(A)} L_{\text{den}}$	<p>Measures</p> <p>check effect on quiet areas in the case of spatial-, traffic- and urban planning</p> <p>in some areas, noise barriers should be installed to improve the situation</p>
	2) Inner-city relaxation	Green / open spaces in the city with a minimum size of 0,1 ha.	$\leq 55 \text{ dB(A)} L_{\text{den}}$	
	3) Active recreation	Inner-city areas used for active recreation such as sports with a minimum size of 0,5 ha. Accessibility should be without admission.	$\leq 60 \text{ dB(A)} L_{\text{den}}$	

2.5 Italy

2.5.1 Urban sound planning

In Italy, concerning urban planning, noise aspects must be taken into account at different levels of interventions. The Framework law on noise n.447/95 establishes that all municipalities must adopt the acoustic classification of the territory, defining six zones characterized by different noise limit values, based on the presence and the typology of transports infrastructures, the population density, the residential areas and the presence of industrial sites. Buffer zones must be designed for road and rail networks, with related specific limit values.

For projects subject to an Environmental Impact Assessment procedure, this assessment must be drawn up in compliance with the requirements for protection from noise of the nearby population. A noise impact assessment must be made relating to the project, for modification or enhancement of airports, roads, railways, discotheques, sports centres, private clubs and commercial locations with noisy machinery or installations. It is mandatory to produce a forecast evaluation of the acoustic climate of the areas involved in the construction of schools, hospitals, nursing homes and rest homes, urban and extra-urban public parks, new residential settlements close to transport infrastructures, commercial businesses, sport centres and discos.

The applications for the building permits relating to new plants, production activities, sports and recreational facilities and commercial locals must contain an assessment of the noise impact. In addition to noise impact assessments, there exist limit values related to passive acoustic requirements.

2.5.2 Quiet areas

On a national level, Italy currently has no specific law that regards quiet areas other than the Decree transposing the END into Italian law. In absence of mandatory and strictly defined criteria, agglomerations have suggested and adopted different approaches in their action plans, and Italy has been active in EU-funded projects on the subject. The National Institute for Environmental Protection and Research (ISPRA) has established a working group aiming to look at common identification and management methods for quiet areas in agglomerations and open countryside, to be submitted as a proposal to the Ministry of the Environment. Also, the current Italian National Framework Law 447/1995 on environmental noise prescribes the municipal acoustic classification plan, that includes six classes of areas with related $L_{A,eq}$ noise limits. Here, Class I “protected areas” identifies areas which uses require quietness: hospitals, schools and rural residential areas, but also public parks. Class I noise limits are 50 dB L_{day} and 40 dB L_{night} , with additional values of 47 dB L_{day} and 37 dB L_{night} for higher quality areas. Many areas in agglomerations and open country that fall under Class I have been considered by some agglomerations as quiet areas.

At a regional level, Tuscany has approved a decree to cover the subject, and Emilia Romagna adopted a guideline. The national END transposition mentions that rural quiet areas may belong to several regions and an appropriate agreement should be made between them. The Tuscany regional law 89/1998 provides criteria for the identification and designation of quiet areas, which involves acoustic classification criteria, existing land use designations and/or public participation. Candidate areas are

- urban areas of at least 1000 km² (0,1 ha) where at least 50% of the area exhibits L_{day} noise levels not exceeding 55 dB(A). Also, the

number of events (railway, aircraft) above 70 dB(A) L_{max} , expressed by the NA_{70} , should not exceed 12 during the day period;

- rural areas with high natural, historic or cultural value, with an L_{day} not exceeding 50 dB(A) and an NA_{70} not exceeding 12. Rural quiet areas should only be accessible by local roads. Major infrastructure, even flight areas, should not be closer than 300 m. Once designated by the regional or local authorities, the regional law requires that if the above noise or distance limits are not met, an action plan with appropriate interventions is required. In the EU LIFE+ project HUSH, an approach introducing the L_{day} and NA_{70} was the base for the implementing decree of the Tuscany Regional Law. Another interesting approach was also developed using a priority index, based on the weighted number of calculated grid point levels above a defined limit value, see [11].

2.5.3 Soundscaping

In Italy, environmental and territorial regulations are devolved to Regions. In the region of Campania, where Naples is located, a proposal of Regional Law regarding soundscaping is currently under parliamentary debate. The Regional Government is trying to pass legislation with a bid on "[Protection and Valorisation of the Soundscape in the Campania Region](#)". If approved, the law would require amongst others the creation of a soundscape archive of urban and rural soundscapes in the Campania Region, which should be digitally and publicly accessible. In addition, it will delegate City Councils to identify and promote "community soundscapes" and "soundscape footprints" for specific locations. This goes beyond quiet areas, which are already required via the Environmental Noise Directive. The text of the bid explicitly mentions the ISO 12913-1 standard described in 1.3.2. Approvement of the document could mean a first mention of the soundscape concept in an effective regulatory text, not being a policy document or guideline.

2.6 Luxembourg

2.6.1 Quiet areas

Luxembourg has no specific legislation on quiet areas, except the END requirements. However, a national map indicating identified potential quiet areas can be found on the national geoportal (<http://emwelt.geoportail.lu>). These potential quiet areas are not yet designated but are publicly available for other authorities to consider in their spatial and urban planning. Some parts of the potential quiet areas overlap with Natura2000 areas, and are thus under environmental protection. More about these potential QAs in Luxembourg in paragraph 3.2.2.

2.6.2 Urban sound planning

With regard to urban planning the responsibilities lie with the local communal authorities. Luxembourg is split into 102 communes; each has their own general development plan which is a set of regulatory requirements in graphic and written form applicable across the territory of the commune. The general development plan may contain special noise zones ("zone bruit") where constructions of dwellings conditionally requires special measures, including noise insulation if necessary. These noise zones are usually based upon strategic noise mapping. Details on building measures required to obtain a building permit in these zones can be found in the building regulations of the communes. Every commune can set up their own building regulations, but the Ministry has provided standard building regulations [34] which the commune may use to write their own. These include requirements on facade insulation and indoor noise levels. In addition, the Spatial Planning Department has elaborated the "Planungshandbuch", a guide with the aim to support planners and architects involved in the design of urban projects. Noise abatement is also addressed in this guide.

2.7 Malta

The Maltese Planning Authority (PA) needs to take into account national environmental policies in deciding on development proposals and planning permits. This is required by the 2016 Development Planning Act and its main strategic planning document. To-date, the current spatial planning policy of the Strategic Plan for Environment and Development (SPED), approved by the Parliament in 2015, mainstreams noise related issues in a set of strategic policies under the SPED Thematic Objective 6: *To safeguard environmental health from air and noise pollution and risks associated with use and management of chemicals by*

- 1 *controlling the location, design and operation of development;*
- 2 *identifying and designating pollution hotspots including air and water quality, noise and land contamination and focusing resources for positive action and improvement;*
- 3 *protecting vulnerable areas from sources of pollution;*
- 4 *promoting alternative modes of travel such as walking, cycling and waterborne travel.*

Through these policies, once the Competent Authority responsible for environmental noise regulations determines the spatial location of vulnerable areas and hotspots, then this information would be incorporated into the spatial planning process.

As Malta has small island state status, with limited territory and overlapping uses, there is need for a place-based approach. Moreover, the PA issued a Development Control Design Policy, Guidance and Standards 2015 (DC2015) which lists a number of noise policies and guidelines related to the planning process, including:

- how to preserve existing healthy acoustic environments;
- separating adjacent areas with different land use, e.g. residential and non-residential, by creation of accessible urban open spaces to provide distance between such areas, aiming to suppress noise

while doubling up as green enclaves. Such transition solutions require appropriate spatial layout and noise source reduction;

- to reduce introduction of new soundscape pollutants by creating physical buffer zones between different developments or uses;
- policies relating to banning truck garages in Urban Conservation Areas (UCAs) and residential areas located in environmentally sensitive locations;
- the integration and screening of services which may give rise to annoyance and which may raise the ambient noise levels particularly at night in adjoining bedrooms of dwellings.

Additional Subsidiary Legislation regulations are in place that limit noise from construction sites (S.L. 552.09) and that limit the business hours for entertainment (S.L. 441.08), with references to noise as a source of nuisance and negative impact on the overall soundscape of an area.

Malta has not yet identified or designated any quiet areas. However, the Draft Noise Action Plan includes a measure to protect quiet areas. A first step would be to determine green spaces within Malta's END agglomeration, where the strategic noise maps indicate noise levels below 55 dB L_{den} and 45 dB L_{night} .

2.8 The Netherlands

2.8.1 Urban sound planning

In the Netherlands, the incorporation of the aspect of noise in urban planning is mandatory. The first step in the process of land use planning is spatial zoning. If the construction of buildings sensitive to noise – houses, schools, hospitals and some other functions – is

considered, then the construction is only directly permissible if distances to traffic and industrial noise sources are sufficiently large.

For roads and train tracks, the width of the noise zone depends on road/train characteristics. For roads, this depends on the number of lanes and on whether roads are located within or outside of built-up areas. For trains, the width of the zone depends on the noise level at reference points, determined with regards to monitoring obligations.

For industrial activities, the zone is defined per activity type and can be found in an extensive list provided [online](#). Spatial zoning in case of traffic is established by law [58], whereas industrial zoning is described in a document prepared by the association of Dutch municipalities[86]. The latter has no official legal status, however through jurisprudence the contents of this document can be considered as such. If new residences or other noise sensitive buildings are planned within the determined spatial zones, then extensive acoustic assessment has to be done to demonstrate that legal noise limits are met. A similar procedure holds in the case of the construction of new traffic infrastructure or the establishment of new industrial companies.

Preferably, urban planning does not merely oblige municipalities or developers to meet noise limits regarding absolute noise levels at the facades of buildings. Although a national legal foundation for a more extensive consideration of the acoustic environment does not exist, many municipalities possess a noise policy in which they define supplementary terms for the development of residences or likewise the establishment of new noise sources. These noise policies are in general considered only in the case that minimum national noise limits are exceeded. Exceedance of the minimum noise limit up to a maximum value is possible if motivated and relatively common in the Netherlands. It is common, for example, for municipalities to include in their municipal policy the prerequisite of a quiet side. In some cases, it

has been defined that at least one or two bedrooms should be located on the quieter side of the building, or that a certain percentage (often 30%) of the living/sleeping areas should be located on this side. Of course, in order for the policy to be enforceable, a definition of 'quiet side' is provided by each of the municipalities. Lastly, municipal policies often include some additional terms with regards to cumulation of noise if more than one relevant noise source is present.

2.8.2 Quiet areas

In the Netherlands, quiet areas are defined on the province level or by municipalities. Provinces may designate a certain area to be a "stiltegebied" (area of silence, see figure 2) and prescribe specific regulations, e.g. no motorised traffic is allowed other than activities related to maintenance of the area itself. Provinces may also include quiet areas as part of their environmental policy planning, which follows a four-year evaluation cycle. These policy plans include the possibility to designate areas that require environmental protection, including noise; these areas include, for instance, Natura2000 areas. For municipalities, quiet areas may be designated by local ordinance in a similar way.

The national legislation implements the END and prescribes that any quiet areas designated by provinces and municipalities should be included on the noise maps and action plans. For the noise maps for major roads and railways, this obligation is limited to areas within 2,5 km distance. A national map indicating quiet areas can be found through this [link](#).

There are no national regulations as to how the QAs should be identified and preserved. Some good practices are available, including a report from the National Health Council [36] that indicates 40 dB(A)

as a noise level³ belonging to unaffected nature areas. Indeed, in several provincial action plans including Noord-Holland and Limburg, this 40 dB(A) level is set as a target value; Limburg also indicates in which QAs this level is exceeded and for which % of the surface area. The National Health Council report describes that, presumably, visiting quiet areas adds to one's health by providing (1) restoration and compensation from higher noise exposure in daily life around one's residence and (2) the positive effect of exposure to low levels of pleasant and desired sounds (which cannot be heard elsewhere).



figure 2 Quiet area sign in NL: “pursuing the provincial ordinance, it is forbidden to disturb the silence in this area”

A recent scientific fact sheet about sustainable air traffic, written for the Dutch parliament [64], relates to the effects of air traffic on quiet areas and states that this effect is largely overlooked. For 41 designated QAs in the Noord-Holland province (which encompasses Schiphol airport), 26 do no longer fulfil the noise criteria, and for 19 of those this is solely due to aircraft noise. Also, an possible expansion from 6000 to 19000 flights for Maastricht-Aachen airport is estimated to cause 23 to 70 M€ damage to tourism in the surrounding quiet and nature areas

³ The indicator for the 40 dB(A) target is not specified, but it is likely that L_{day} or L_{24h} is intended

which. Following the noise criteria, those quiet areas would be largely lost.

2.8.3 Soundscaping

In paragraph 2.3 we saw that in France, a new law has been approved which allows for a sound to be identified as cultural heritage. This allows authorities to protect these sounds at court. In the Netherlands, examples of sounds being valued and protected exist as well. For example, in October 2020 the city of Amsterdam decided (again) that the sound of church bells of the centrally situated Westerkerk would not be limited during nighttime, regardless of complaints from new inhabitants who declared being sleep deprived because of the ringing of the bells each half hour and the melodies of the carillon played every 15 minutes. In the municipality's reply to public views on the concept Noise Action Plan, the officials stated that no action will be taken to reduce noise levels, even though possible from a legal perspective. The playing of the carillon is cultural heritage in the Netherlands and Flanders. And more importantly, in past discussions regarding the Westerkerk's ringing the majority of local residents indicated the great importance of the church's sounds to them, also during nighttime. About the melodies played at night, the municipality writes the following: “For new residents and tourists it sometimes takes some getting used to, but the experience is that people have gotten used to it for centuries. As much as we understand that this will not apply to everyone, as the speaker indicates, we will not take any action on this point.”

2.9 Switzerland

In Switzerland, the Lärmschutzverordnung (LSV) (English: Noise Abatement Ordinance (NAO)) is the leading piece of legislation regarding environmental noise [77]. The NAO does not currently cover quiet areas or soundscaping. Switzerland plans to revise this legislation, however, and first steps to investigate and recognize the importance of quiet areas and other attractive soundscapes have been taken, see 3.2.6.

Regarding urban planning, the NAO describes a system of different noise limits that apply when building or revising installations (infrastructure, industry, etc.) or dwellings. For each situation, depending on the sensitivity level of the zone, a planning value, impact threshold and alarm value are successively defined in dB for each noise source. Here, the relevance of a quiet side is recognised: Upon exceedance of the impact threshold, *new buildings and significant modifications to buildings with rooms sensitive to noise may only be authorised if the values can be complied with: by locating the rooms sensitive to noise on the side of the building away from the source of the noise, or by structural or design measures which shield the building against noise.* (NAO Art. 31).

Furthermore, the NAO formulates requirements for soundproofing of buildings and windows. Near airports used by large aircrafts, for instance, compliance with planning values and impact thresholds at night requires bedroom windows to close automatically between 22:00 and 24:00.

Switzerland has a legal basis for defining protected natural Parks⁴ that have to fulfil certain quality standards. However, noise is not contained

⁴ <https://www.bafu.admin.ch/bafu/de/home/themen/landschaft/fachinformationen/landschaftsquilitaet-erhalten-und-entwickeln/landschaften-von-nationaler-bedeutung/paerke-von-nationaler-bedeutung.html>

in the criteria catalogue as it is supposed that the areas are all in quiet regions.

2.10 Wales

In Feb – May 2020, a new Technical Advice Note covering soundscape, noise and air quality was given under consultation by the Welsh Government. Technical Advice Notes (TANs) provide policy guidance and technical advice to support the Planning Policy Wales, of which a new revision was published in 2018. The new planning policy focusses on the role of an integral approach. In line with this perspective, the revision of the 11th TAN on Noise is meant to incorporate the concept of soundscape. The administration stresses that a healthy soundscape should be an integral part of the planning process [87]:

“It is no longer acceptable to merely regard air quality and noise as technical matters to be mitigated at the end of the process, rather, they are integral to the design, functioning, health, amenity and well-being of places. (...)

Our own noise maps suggest that the homes of more than 200,000 people across Wales are exposed to road traffic noise levels exceeding the WHO’s 2009 night noise guidelines. This evidence leads to the conclusion that noise has a significant impact on the well-being of our citizens, and we must improve decision-making in this area. But the last thing the Welsh Government wants is a Wales that is silent. Our lives are enhanced by conversation, laughter and cheering, music and the sounds of nature. A healthy acoustic environment is

more than simply the absence of unwanted sound, and noise management must have a broader focus than simply clamping down on the decibels. We need to create appropriate soundscapes, meaning the right acoustic environment in the right time and place. The towns and cities, in which most of us live, serve us in a variety of ways, and should therefore contain a variety of soundscapes appropriate to the place. There should not be a one-size-fits-all urban soundscape, which we experience wherever we go, any more than every street and building should look alike.”

The Welsh Government explicitly included the Soundscape approach in its 2018 – 2023 action plan, it’s central noise policy document regarding noise [88]. This single noise action plan combines the action plans of all three agglomerations within the country, including not only the action plans required by the Environmental Noise Regulations (incorporating European regulations), but information on other Wales-wide policies regarding noise as well.

Regarding urban sound planning, the 2018 – 2023 action plan says the following [88]:

“When noise-sensitive buildings such as residential properties are introduced into an area subject to high levels of environmental noise, planning authorities should protect the future occupants by imposing appropriate conditions or obligations on the developer at the planning stage, for example, to avoid placing bedrooms, living rooms and gardens on the exposed side of a property. In many cases, this could lead to a higher value property at little or no extra cost.”

In the action plan, a chapter is dedicated to quiet areas within agglomerations as well, referred to as ‘tranquil green spaces in the built environment’. Here, tranquillity is understood as ‘*an untroubled state, characterised by peace and calm and free from unwanted disturbances.*’ The document stresses the importance of improving not

just the acoustic characteristics of a ‘quiet area’, but visual characteristics as well:

“If a space open to the public is ugly or feels unsafe, then relatively little benefit will be felt from its being quiet. An area may offer peace and quiet, or a positive soundscape where natural sounds such as flowing water, birdsong, the wind in the trees and human conversation are more prominent than background traffic noise. However, the benefits of such qualities of place may be fully realised only when they coincide with visual beauty, a sense of security and ease of access. (...) By the above reasoning, an area may possess a good soundscape but require specific improvements in terms of landscape, nature, safety or access before it can act as an effective refuge from traffic noise. In such cases, addressing those deficiencies may be just as beneficial in tranquillity terms as seeking to quieten a noisy space.”

Although no specific project examples are known that follow from the inclusion of the soundscape concept in Wales’ TAN, it has created awareness of these topics and of the ISO standard. As a result of the new policy document, planners and consultants are more and more considering to apply the soundscape approach in their research and advice.

2.11 Slovak Republic

Legislation in the Slovak Republic regarding urban planning and land development is distributed between local and regional municipalities and state departments of different Ministries (Ministry of Investments, Regional Development and Informatization, Ministry of transport and construction, Ministry of Environment with the mandatory cooperation of regional authorities of the Ministry of Health). For land use plans and formal land use decision making, with regard to noise exposure the Act of the National Council of the SR 355/2007 Z.z. is applied, which is about the protection, promotion and development of public health. In

addition, the Decree of the Ministry of Health of the SR 549/2007 Z.z. presents limit values of outdoor noise (see [62]).

The implementation of the notion of Quiet Areas in the END 2002/49/EC in Slovakia is established in the framework in the Act of the National Council of the SR 2/2005 Z.z. on Environmental Assessment and Control of Noise with the Regulation of the Government of the SR 43/2005 Z.z. laying down details of strategic noise maps and action plans including so called action values.

Responsibilities of Quiet Areas lie partly at regional municipalities, and partly at:

- the Ministry of Health (Noise in relation to human beings)
- the Ministry of Environment (Quiet areas in open country and rural areas).

The division of authority and responsibilities is not yet well defined. In addition, the way in which Quiet Areas are to be designated is not yet defined and probably requires legal regulation in relation to land use planning.

The Regulation of the Government mentioned above, determines target or action values for noise exposure of human beings, especially in residential areas, in public parks or other quiet areas near schools, hospitals and other buildings and areas sensitive to noise, including in open country.

The main purpose of today's legislation is to establish noise indicators L_{den} and L_{night} according to the END as target values in urban planning and land development on a national level, to be applied in action plans by means of strategic noise mapping.

In the case of potentially Quiet Areas in agglomerations it is possible to apply the values published in the mentioned Regulation as one necessary noise criterion for the outdoor environment. Special

protection against noise exists for spa and treatment areas, amongst others. There are no conditions or acoustic criteria for the designation of Quiet Areas in Slovakia and currently no Quiet Areas are officially declared.

Discussion

At present, there is a discussion ongoing about future legislation in the agglomerations of Bratislava and Kosice. The discussion is about principles and rules of land-use planning which would contain conditions for the declaration of Quiet Areas, including sustainability, better defined responsibilities of local authorities, and sanctions. Discussions of experts are conducted mainly on the following topics:

- Methods for identifying Quiet Areas based not only on noise mapping, but including questionnaire mapping and medical and public health expert assessments;
- Soundscaping acoustic criteria, which should be based not only on the above mentioned long-term limits for L_{Aeq} or L_{den} , but also on different zone noise limit values (for example based on the main transport infrastructures), and in special cases with some other annoyance indicators (loudness, unpleasantness, tonality, sharpness etc.) on the one side and positive sounds on the other side;
- Necessity of locating Quiet Areas in residential zones and around apartment buildings, using a criterion like a walking distance of about 10-minutes. And the necessity of realizing a proportion of quiet facades in block of flats or housing estates, etc.;
- Other synergy "green deals" factors of stated areas that are important for human health, regeneration and relaxation, such as the amount of sunshine, quality of air pollution, biodiversity and the possibilities of children's activities and leisure-time activities without increased noise;

- Health benefits of Quiet Areas as a long term economic value, presented for example by using Disability Adjusted Life Years (DALYs).

The main effort is to prepare methodological material for urban sound planners in agglomerations, based on expert and society-wide consensus. It is important to adopt different approaches using international experience while respecting regional possibilities and practice. The responsible local authorities and relevant state departments should participate in this process and develop legally binding legislation accordingly.

2.12 Summary

From this chapter we conclude that indeed, legislation regarding quiet areas, soundscaping and urban sound planning exists.

With regard to soundscaping, a few fairly recent examples of legislation are found focusing explicitly on protecting the soundscape, rather than on noise limits. The country of Wales explicitly mentions the soundscape approach in the central legal document on noise. In addition, a legal technical note including the soundscape approach recently went into consultation. In Italy, the Campania region is developing legislation that aims to build an archive of soundscapes. Recent French legislation tries to protect characteristic sounds that contribute to existing soundscapes. It will be interesting to see how sounds (and smells) will be identified, qualified and protected in upcoming practice. An example of protecting a specific urban soundmark was also found in the development of the Amsterdam noise action plan.

Also with regard to quiet areas, some legislation exists. Of course, all EU Member States have implemented the END and therefore at least define the term 'quiet area'. Some countries do not provide further reference to the topic, while others do. In Germany, for example, an extensive guidance document exists and many municipalities have designated quiet areas, each of them coming up with their own set of identification criteria. However, neither in Germany nor in other countries have we seen any hard regulations that explicitly oblige authorities to keep noise levels in designated quiet areas under a maximum value, or oblige them to take action if noise levels appear to rise.

With regard to urban sound planning, we found that several countries include the aspect of noise in land use planning, for instance through spatial zoning. In some countries the planning of new houses is forbidden above certain defined noise limits. However in our understanding urban sound planning is more than merely prohibiting or permitting the construction of housing based on noise levels at the most exposed facade. Both quiet sides and quiet outdoor spaces are mentioned in some national legislation as well, and in some countries legal requirements are presented regarding these measures on a national or local scale.

3 Case studies & lessons learned

3.1 Introduction

From chapter 2, we have learned that legislation on the topics of quiet areas, soundscaping and urban sound planning exists at least in a selection of countries. Implementation of this legislation for specific situations is not always straightforward. Authorities that want to come to a practical implementation of the topics at hand often are free to develop a working procedure as they see fit. But where to start, which choices to make? In this chapter we provide a selection of case studies in which quiet areas, soundscaping and urban sound planning are put to practice. These practical examples are presented to inspire and provide guidance to authorities and experts in the field. In section 3.5 we summarize the most interesting findings and lessons learned.

3.2 Quiet areas

3.2.1 EEA reports on quiet areas

With regards to quiet areas, the European Environment Agency (EEA) included a chapter on the topic in their recent Environmental Noise in Europe report [29]. This chapter is based on two main research items. Firstly, a questionnaire was conducted through the EEA partner network (EIONET), asking countries, regions and cities about their quiet areas. Secondly, the EEA analysed GIS data provided by 17 European cities to investigate the availability as well as the accessibility of urban quiet areas.

⁵ based on the CORINE Land Cover inventory, see e.g. <https://www.eea.europa.eu/data-and-maps/data/copernicus-land-monitoring-service-corine>

The questionnaire, see also [65], shows that the majority of responding countries has defined criteria for the identification of quiet areas, and about 60% of responding countries has designated at least one QA. Acoustic criteria vary widely: besides a wide range of absolute noise levels, see the box in 1.3.1, it is also reported that relative differences between the core of the quiet area and the surrounding city are used, with values ranging from 6 to 15 dB(A). The questionnaire also provides a list of measures that are taken to protect QAs, which corresponds quite well with common noise measures applied to reduce noise levels elsewhere in the city. The EEA also reports respondents indicating that there is limited interest of the population in their existence and concludes that more awareness and promotion is needed.

The GIS analysis focuses on the accessibility of available quiet urban areas. The accessibility in this case is defined by the percentage of inhabitants that is able to reach a quiet urban area ($L_{den} < 55$ dB) within a 10 minute walk, selected from areas with a green landcover⁵. The analysis shows that many people in the city have no access to a quiet area near their home. The percentage of people without access ranges from 60% to 99%, even though several cities with low accessibility do in fact have relatively large areas that are quiet. As the positive health impact of quiet areas requires that these areas are visited and used, their presence alone is not enough.

Earlier, the EEA has published two reports on quiet areas:

- The 2014 Good Practice Guide on Quiet Areas [28] highlights the importance of quiet areas and shortly describes their potential health benefits and economic benefits. It recognises that several member states have initiated or intensified their policies with

respect to quiet areas, yet it is a research area under development and clear criteria and guidelines for protection are lacking. The report itself presents a set of selection criteria that may be used regarding acoustics, function, size and, for rural areas, the minimal distance to infrastructure and settlements. These criteria have helped member states further, see e.g. the example of Luxembourg in 3.2.2. The report also explains that the EEA's Electronic Noise Data Reporting Mechanism (ENDRM) accommodates the reporting of spatial data for designated quiet areas and also data for population exposure in buildings with quiet facades on a non-mandatory basis.

- The 2016 Quiet Areas in Europe report [30] follows the 2014 report with an elaboration of a GIS-based assessment method based around the Quietness Suitability Index (QSI), which is a combination of acoustic data, from the END noise maps, and data on the 'naturalness' of the location based on an analysis of the EEA's own Corine data on land cover. The report also addresses the accessibility of areas with high QSI values and then presents the results per country. The result for the whole of Europe is presented in figure 3.
- Based on a questionnaire amongst over 20 countries and 45 cities, the EEA concludes in [65] that many authorities make an effort to protect quiet areas. 60% of the cities indicate that they apply some mitigation or management measures. These measures include restriction of certain activities, monitoring of noise levels, traffic mitigation measures, noise barriers and pedestrianisation of an area, for instance. It is unclear whether authorities have defined any 'hard' regulations which ensure that noise levels will stay below designated limits.

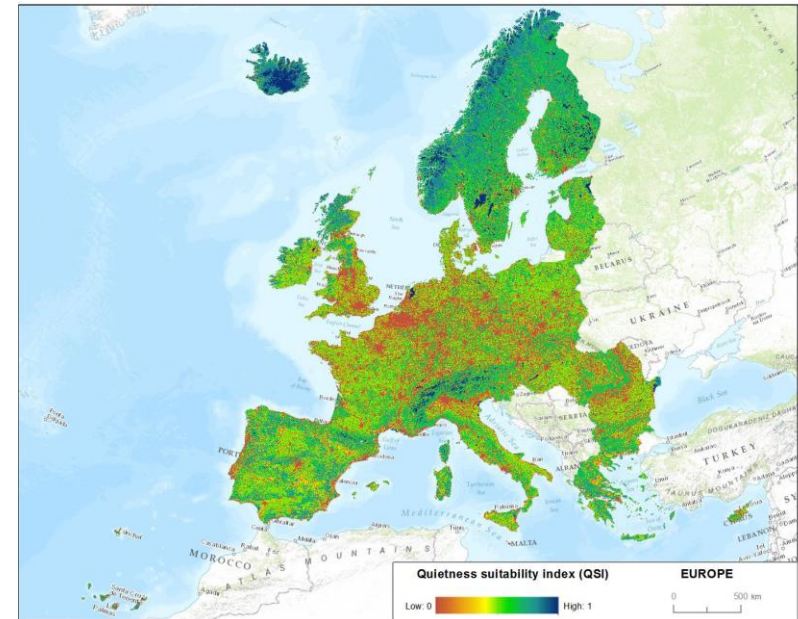


figure 3 Quietness Suitability Index values for the European region (from [30])

3.2.2 Potential quiet areas in Luxembourg

The Ministry of Environment in Luxembourg has commissioned a series of three consecutive studies on the identification of potential quiet areas. The first report was published in 2015 [91] and describes the detailed methodology that was followed to identify three types of quiet areas:

- potential quiet rural areas: large coherent open spaces of national importance with high recreational function, e.g. for long walks uninterrupted by noisy spaces;

- potential quiet urban areas: relatively large urban areas, in or close to the city, of at least regional importance with high recreational function and important value in compensating the noisy and densely populated city areas, e.g. for longer walks with only limited and isolated intersections by noise spaces;
- potential quiet urban oases: publicly accessible green and open spaces, well-designed with high quality of stay, within walking distance from residential and work locations, e.g. for short walks from home or office.

The 2015 study addressed all three types of urban areas but with a main focus on rural areas which were found in the north of Luxembourg. A 2018 study [92] specifically regarded the southern part of the country which is characterised by higher economic activity (e.g. commercial and industrial areas) than the north. Then, the 2019 study focused on the urban areas and oases within the agglomeration of Luxembourg city [93]. Figure 4 shows the locations of the areas that were found to be potentially identified as quiet areas, urban or rural.

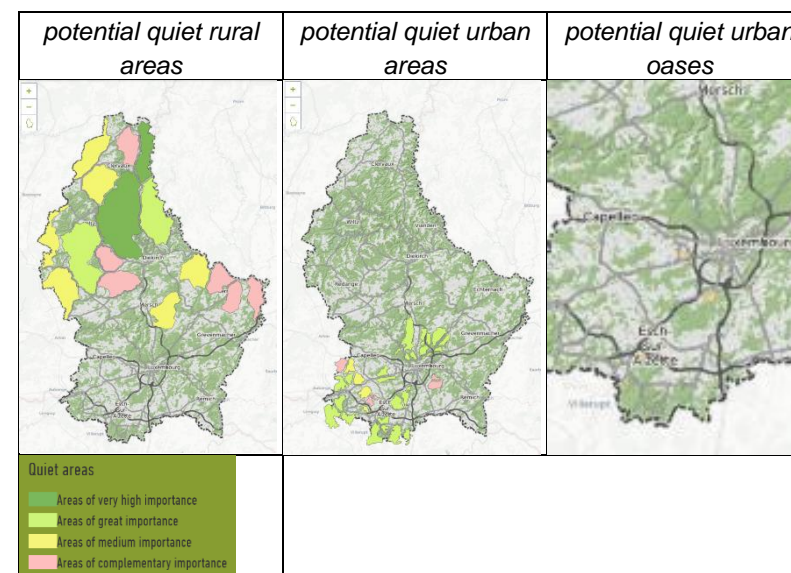


figure 4 Potential quiet areas in Luxembourg; see <http://q-o.lu/3/Meje>

The Ministry's goal for identification of potential quiet areas is to achieve areas in the densely populated as well as in the open country regions where people looking for relaxation and recreation can spend their time free from noise as much as possible. Besides noise maps, further qualitative selection criteria are needed to assess the recreational and restorative value of quiet areas.

As a basis for the analysis, the Luxembourg study used the 2014 EEA Good Practice Guide [28] described in paragraph 3.2.1, with slightly modified acoustic criteria:

- As noise levels below 55 dB L_{den} were not available, the EEA-suggested criterion of 30-40 dB for rural areas was replaced by a criterion of < 55 dB.

- For urban areas, as noise levels inside the dense and dynamic Luxembourg agglomeration are quite high, the acoustic criterion was set to select *relatively* quiet areas with a 6 dB lower noise immission than their surroundings.
- For the quiet urban oases, there was no criterion for the noise immission levels in dB. Instead, areas have been selected that exhibit *noise reducing properties* such as vegetation or noise screening due to topography or existing buildings.
- *Aircraft noise* from Findel airport was not taken into account, under the assumption that aircrafts are single events and only disturb the quiet area function on limited occasions.
- *Industry noise* maps were not available. Instead, zones designated as industrial or commercial (“Zones d’activités économiques”) were assumed to be not suitable.

Besides acoustic criteria, the study considered several quantitative as well as qualitative criteria regarding non-acoustic properties:

- *landscape fragmentation*: areas were ‘cut’ by overlaying roads (> 1000 vehicles/day), settlements and the airport. Railways were not regarded other than those already included in the END noise mapping, as their noise impact is limited to only few occasions.
- *minimal area size*:
 - for quiet rural areas: $\geq 40 \text{ km}^2$ (4.000 ha),
 - for quiet urban areas: $\geq 0,5 \text{ km}^2$ (50 ha),
 - for quiet urban oases: $\geq 5 \text{ ha}$;
- *accessibility*, by regarding the presence of roads or public transport that enable traveling to the areas;
- any planned development projects that will cause future noise: wind turbine parks, road projects, installations;
- overlap with higher-level planning zones: areas that are designated as nature reserves or that are part of the national ecological network; such designations indicate that the area is likely to be protected from future economical developments.

As a result of the study, 16 potential rural quiet areas (863 km² in total), 5 potential quieter urban areas (63 km²) and 8 potential relatively quiet urban oases (3 km²) were identified. In total, this is 36% of the total Luxembourg country area. Each area was graded in different levels of importance (see figure 4). Fact sheets were created for each potential quiet area.

Some guidelines are also formulated to protect and further develop these areas, mainly:

- the designation of these areas in zoning and planning
- taking noise abatement measures to retain or improve the noise levels
- improving the accessibility of suitable areas for the public.

For inner city areas, city planners should in addition regard:

- screening effects of buildings for the green areas behind
- possibilities to increase recreational value for all target users and
- further interconnection of urban quiet areas/oases by walking/cycling paths.

As follow-up, the Luxembourg Ministry has made the potential quiet areas available online for strategic environmental assessment purposes. In 2020, noise measurements were conducted at 10 selected immission points representative of a potential quiet area, with the goal of characterizing in further detail each type of zone and determining the impact from road traffic noise or other sounds. Measurement results are available online, see <http://g-o.lu/3/N6sD>.

3.2.3

Dublin City Council

In their National Planning Framework 2040 [35] Ireland has set the National Policy Objective 65 to *promote the pro-active management of noise where it is likely to have significant adverse impacts on health and quality of life and support the aims of the Environmental Noise*

Regulations through national planning guidance and Noise Action Plans. Part of this policy objective is to place an extra value on quiet areas, areas with low or relatively low sound levels that can assist to achieve environmental quality and the consequential impact on quality of life and health.

As a good example, the Dublin City Council have designated eight QAs which are to be protected from future increases in environmental noise. Sites were selected based on their noise levels as well as on the value they provide for the citizens of Dublin. The proposal for the eight areas to be designated [23] puts forward three criteria for identifying the first tranche of candidate QAs:

- Public parks, with pathways, to which the public have right of access and which are maintained by Dublin City Council will be considered.
- The L_{den} for environmental noise within the area is equal to or below an L_{den} of 55dB(A), as indicated by the Dublin City Council Noise Maps (2011) of all road sources.
- A relatively Quiet Area will be considered if the difference between the L_{den} levels outside and within an area is at least 10-15 decibels or greater.

Noise sources other than road noise have not been taken into account in terms of L_{den} . It is recognized that parks primarily used as children's play grounds, football fields or for other sporting activities are not suitable as QA. Yet, it is also clear that these areas are meant to be visited and used for recreation by the citizens of Dublin and that it is not the intention to discourage the 'noise' from such social and recreational activities. As the Dublin City website⁶ puts it: *It is not envisaged that these quiet areas will be required to be quiet in the way*

some may consider a library to be quiet. And also: It is not intended for these areas to be put up on a pedestal with people looking in from afar, admiring how quiet it is.

Eight quiet areas within Dublin City have been selected, ranging in size from 0,5 to 550 ha (5,5 km²). These eight areas are mentioned in the Dublin City END noise action plan and their designation will be reviewed every 5 years. It is considered that there should be minimal or no financial implications to their first designation. However, there are implications for future developments, as in the planning process for proposed developments, proposals may not impinge on the criteria used for the designation.

The South Dublin County Council has stated in their 2018-2023 noise action plan [75] the requirements for QAs and mentions that they have started a process to identify and propose actual candidate locations for quiet areas, to be continued in 2020.

3.2.4 Kilkeny County

A hundred kilometres southwest of Dublin, the County of Kilkeny is working on the identification of quiet areas, as well. No quiet areas have been designated yet in the noise action plan, but a proposal has been written in which two quiet areas in open country are suggested [42]. Regarding the assessment of the proposed areas, the document recommends *not* to make use of noise level meters, but a qualitative assessment by ear instead. Interestingly, the council notes that events such as festivals and shows do not have to be excluded from quiet areas and instead might actually be beneficial for a successful usage of the areas:

⁶ <http://www.dublincity.ie/main-menu-services-water-waste-and-environment-noise-maps-and-action-plans/proposal-designate-areas> [retrieved 29 April 2020]

The anticipated integration of the quiet area and the festival will provide a positive synergy by promoting community activities, environmental awareness and improving physical health and well being of the public. The festival also helps to promote the location as a destination to people who may not otherwise have been aware of Woodstock House and Gardens.

Other types of environmental noise, such as industrial noise, road noise and recreational noise, should according to the council be limited to meet the requirements of the European Directive. In addition, areas to be considered ought to have good access, be easily navigable, ideally have a pathway and feature benches and seats.

3.2.5 Scotland

The Scottish Government has provided a Technical Guidance report [76] that describes how candidate quiet areas (CQAs) can be identified, as well as what the analysis and decision making process should look like what the analysis and decision making process should look like to process from candidate to ‘final’ Quiet Area (QA) status. This process shows five steps, including mapping and analysis steps, location visits, inventory of future plans and public consultation. Both Edinburgh and Glasgow have identified CQAs in their 2014 noise action plans, but not yet any QAs. With regards to the protection of QA’s, the 2009 action plans for both agglomerations state (e.g. [27]) that the designation of QAs should prevent that noise levels increase or the QAs area decreases, and that noise prevention is preferred to noise removal. QAs, however, should not be regarded in isolation but rather as incorporated into the local authority’s planning, protected via the process of development control. That implies that the 55 dB L_{den} used to identify the CQAs is not strictly enforced as a noise limit for

these areas. The presence of the QA is a variable in decision making, and decisions can be made to allow higher levels in the future.

3.2.6 Switzerland

The Swiss Federal Office for the Environment (FOEN) commissioned a series of six case studies that examine the suitability of public spaces, both urban and rural, for quiet and relaxation. These six studies are referenced and summarized in conference papers [53][54]. The studies were performed by different contractors with interdisciplinary teams including urban and spatial planners, sociologists, landscape and building architects. The investigated areas are mainly Swiss, but also include German (Karlsruhe) and Dutch (Mergelland) locations. The examples are mostly parks or green country areas, but also include a city courtyard (Ehrenhof, Karlsruhe [44], see figure 5) and a town square (Gallusplatz, St. Gallen [31]).

Each study contains one or more examples of areas that are perceived as ‘quiet’ places that have a high recreational and restorative value. Each of these places is described in terms of their acoustics as well as their use and function, landscape, visual properties, etc. The textual descriptions are attractive, vivid and illustrative, sometimes even picturesque, e.g. [56]. However, the quality criteria and noise levels are generally not quantified or at all quantifiable. That is actually one of the key points of the studies: the perceived quality of a quiet area depends strongly on the context of the area and the degree to which the area correlates with its surrounding inhabitants and visitors. This needs to be assessed specifically per location and on site. “Sound quality is a local experience perceived by the listeners, and not a measurement” (from [54]). A GIS-based analysis is considered a good starting point, but for a final evaluation local assessment, e.g. from soundwalks, is needed.

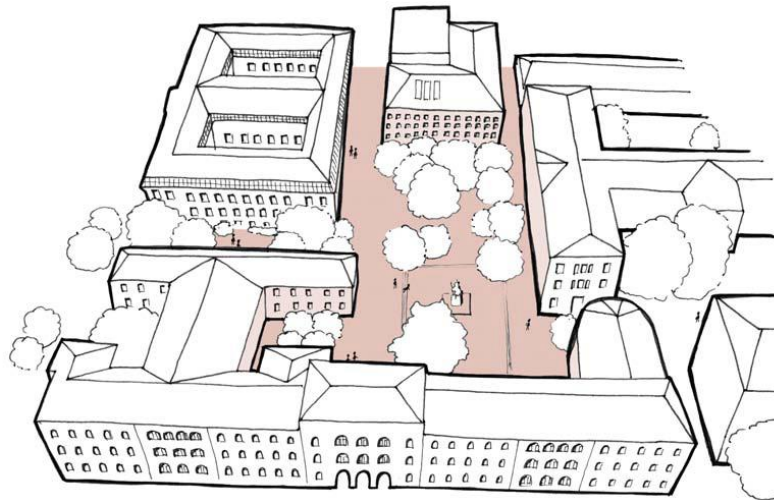


figure 5 Drawing of Ehrenhof courtyard at Karlsruhe Institute for Technology (KIT), from [44]

Nevertheless, some general conclusions from these case studies are:

- A common factor for public spaces experienced as quiet is the positive contrast to their surroundings. Such places provide literally an “escape” from a busy, hectic city life. In fact, a quiet area only exists by grace of its counterpart, noise, being present nearby.
- “Quiet” areas are quiet not only in terms of noise, but are also more generally “calm”, in terms of movements, the general view and visual elements, trees and other vegetation, and natural materials, e.g. sandstone rather than concrete.
- Acoustically, sound levels from unwanted sources such as traffic, industry, building activities and other mechanical noise should be low. The audibility of nature sounds, such as trickling water, rustling trees and singing birds *is* valued and actually contributes to the sense of quiet rather than disturb it. Man-made sound, such as

people walking, talking and children playing are accepted and, up to a certain decency level, valued.

- Quiet areas need to be publicly accessible and welcoming. Visitors must be allowed and stimulated to actively use the area: sit and talk, play, sport and “chill out”. Walking paths, free benches and playgrounds invite people to stay in the area and enjoy it.
- Quiet areas do not necessarily have to be large, and larger quiet zones may be crossed by a busy road or city square here and there without losing its value. Different areas are preferably interconnected to each other, forming a coherent public space that is connected to the city’s foot and bicycle infrastructure, or the public transport network.

There is a clear association between residential green and quiet urban areas: quiet areas are positively affected by the presence of green as it increases the quality of quiet areas, and vice versa: quietness increases the quality of parks and other green areas. Also, as shown in a recent Swiss study [70], the mere presence of green reduces noise annoyance compared to other non-green areas with similar noise levels. More info on quiet and green is presented in section 4.4 below.

With these considerations in mind, FOEN realises the importance of quiet and green areas in or near the urban areas and the fact that these should be included in a holistic urban planning approach. They suggest that such areas should be required in case residential buildings cannot meet the noise immission limits. In such cases, and only when buildings are sufficiently insulated to obtain low interior levels, an exceedance of the outside limits may be compensated by accessible nearby quiet areas [54]. It is mentioned, however, that even though recreational space has shown to positively impact people’s well-being, there is not yet scientific proof of the fact that adverse health effects in one noisy place can be compensated for by relief in a quiet area elsewhere.

3.2.7 Sweden

The implementation of END requirements regarding quiet areas was investigated for all Swedish municipalities in a study from 2017, commissioned by the Sound Environment Center and reported by Cerwén and Mossberg in [17]. From the study, it was found that 118 out of the 290 Swedish municipalities (40%) mentioned the concept of quiet areas in their general plans. Only a handful of these were related to quiet areas in an urban setting; the vast majority of municipalities focus on quiet areas in rural areas. The authors categorised the municipality's description of quiet areas into three categories based on the extensiveness of the initiatives: brief, unclear, elaborate. Roughly 65% of the municipalities had 'brief' plans, meaning that apart from a general remark on the notion of quiet areas, mostly no particular areas were designated. About 30% of the plans were categorised as being 'unclear' in the sense that they seemed to confuse 'quiet areas' with other planning concepts. About 5% of the municipalities (16) included specific plans for implementation, including a definition of quiet areas, maps of designated areas, and sometimes descriptions to maintain quiet areas in the future. 94% of these plans (15) had already been preceded by regional plans regarding quiet areas before implementation of the END requirements in Swedish law. For 'brief' and 'unclear' descriptions, those percentages are significantly lower (43% and 31%, respectively).

Besides statistical background information on the implementation of quiet areas in Sweden, a couple of examples are provided in the Cerwén and Mossberg paper illustrating the way in which quiet areas are approached. From the examples, it appears that several municipalities assumed areas to be quiet based on characterizations that do not by definition relate to noise levels. For example, areas

designated as "nature reserves" or other recreational areas. The authors believe this can be problematic and emphasize the importance of using terms that refer specifically to the acoustic aspects of an area, such as "quiet area" or "noise-free area".

The small rural municipality of Nybro designated four quiet areas in its general plan, and included the statement that they should remain quiet in the future. According to the municipality, the designation led to a review of permits and has prevented exploitation of wind turbines in the area. In the municipality of Hörby, designated quiet areas are protected with a detailed plan which states, for example, that shooting ranges, wind farms and sawmills are to be avoided. Then, in the city of Helsingborg, a benchmark for quiet areas is included in the noise action plan based not only on noise levels, but also on accessibility. The plan states that all residents should have a green area at a maximum of 300 meters from their home, and that half of the area should have a noise level below 50 dB(A). In figure 6, a map from the action plan is presented, showing regions where this benchmark is met.

From the questionnaire, authors have been able to retrieve reasons for municipalities *not* to designate quiet areas. Some of the explanations provided were the following: 1) municipalities saw no need for quiet areas because they are remotely situated, with little human activity, 2) municipalities thought quiet areas to be useless because of the high noise exposures, and 3) municipalities found the term ambiguous or stated to have insufficient knowledge on the topic.

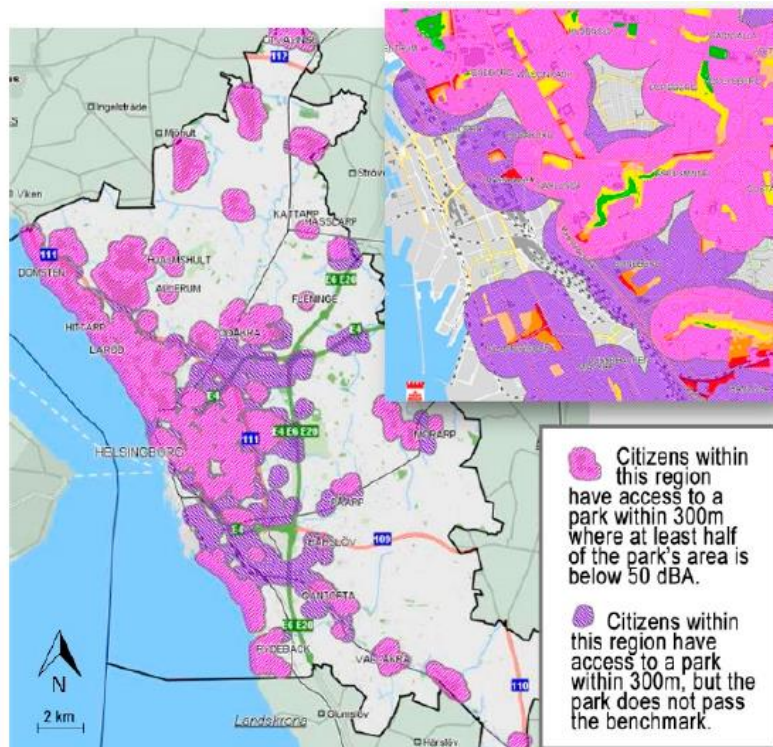


figure 6 Accessibility of parks and 'quiet' parks in Helsingborg as presented in the Noise Action Plan. From [17].

3.2.8 QUADMAP pilot areas in Florence, Italy

The [QUADMAP](#) (Quiet Areas Definition & Management in Action Plans) methodology contains a broad set of tools that can be applied to select, analyse and manage quiet urban areas. It is a practical

approach, including acoustic and non-acoustic criteria, e.g. behaviour, perception and accessibility.

For authorities in the exploration phase, the method provides tools to identify potential quiet areas, based on an assessment of acoustic and non-acoustic criteria by a team of local experts and officials. Once quiet areas have been identified, tools are available to analyse and evaluate their characteristics, using for instance measurements and questionnaires. For QAs that are assessed as actually 'quiet' or only 'potentially quiet', possible actions for preservation and improvement of these areas are provided.

The QUADMAP method as a whole is extensive and comprehensive. It is also possible to select and apply only some of the tools presented.

The city of Florence has been an active member in the EU project of QUADMAP. The QUADMAP approach has been applied in ten pilot areas, at different scales: six school gardens in Florence (Italy), two parks in Rotterdam (The Netherlands) and a square and a green path in Bilbao (Spain). In Florence each of the school areas was identified as a homogeneous urban area (HUA) for which quietness was important. As a result of the pilot, interventions have been done for each of these locations and their effect on the perceived acoustics was evaluated by questioning the users. Interventions were acoustic, such as noise barriers and speed reduction, as well as non-acoustic, such as the placement of trees, new seats and outdoor games.

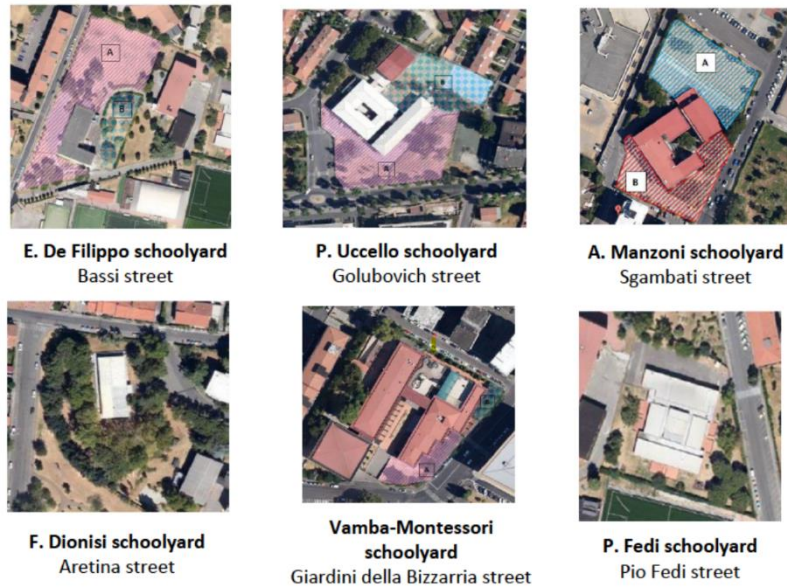


figure 7 Six schoolyards, selected as pilot quiet urban areas in Florence

A particular example is the Dionisi schoolyard, a 3500 m² school garden, where acoustic measurement results and simulations carried out showed the need to protect the garden from the noise from the nearby road. In accordance with the user's suggestions provided by questionnaires, a noise barrier (2.5 m height and 94 m length) was placed, featuring coloured elements of play for children (blackboards), see figure 8. This screen, in addition to the acoustic purpose, it has been specifically requested by users in order to discourage people from outside the area to approach and call the children, providing additional social security.

Schoolyards are places frequented by teachers, students and parents and can host activities for the neighbourhood. We note that, even if they are freely accessible to other people, it is not likely that these areas would be used by other people searching for quiet.



figure 8 Noise barrier at F. Dionisi schoolyard, with integrated blackboards

3.3 Soundscaping

3.3.1 Sheaf Square, Sheffield

As a famous example of soundscaping put to practice, we consider Sheaf Square in Sheffield. Being such a typical illustration of the topic, we included an image of the square on the front cover of this document. The square is surrounded by a heavily used car network. Before a redesign of the area, Sheaf Square consisted mainly of a car park. While the road traffic stayed, a new design of the square was

deployed involving a 90 meter long and 5 meter high steel noise barrier / sculpture “Cutting Edge”, whose profile changes from circular on one end to blade-shaped on the other. As water is running from the sides, this difference in profile also results in a different acoustic spectrum. The barrier both blocks noise from the major roads and masks the remaining noise.

From the 1990’s, the city of Sheffield started regenerating the city centre by embedding waterscapes in a variety of squares, thereby strengthening the memory of the river’s role in the history of the city. The resulting soundscape has been reviewed by professor Jian Kang through measurements of the acoustic environment [40]. Based on questionnaires it was found that users of the public spaces most preferred the sound of water (~80%) over for example, the twittering of birds (~75%), the bells of a church (~50%) and music being played on the street (~45%). From Kang’s measurement, it is found that there is a large variety of spectrum and dynamic processes within the different water features.

3.3.2 Valletta, Malta

Mediterranean city soundscapes are somewhat different from other, more Northern parts of Europe. As people tend to be outside more, their acoustic environment is to a larger extent based on activities outside (streets, markets, balconies, city squares and parks). And also, the impact of the people themselves on the outside soundscape is larger, as they are partly the sources that form their own soundscapes. Soundwalks and other methods have been applied to study some of these soundscapes, among which the urban areas of Malta [78]. For the particular case of Malta’s capital, Valletta, an extensive study has been performed and described in a thesis from Wageningen University (NL) [33]. This thesis provides a good example of the actual application of a soundscaping approach to study and

improve the acoustic urban environment, showing what the work of a ‘soundscape architect’ would behold.

The residents of Valletta, often there for multiple generations, are seeing and hearing their city change as a result of gentrification, i.e. the increased economic activity leading to steeply increasing house prices and rents, as well as traffic, industry, commerce and tourism. While good for the Maltese economy, this is driving away local residents. The Planning Authority is now looking for possibilities to ‘regenerate’ the city while preserving and reviving the original cultural identity.

From interviews with local residents, it is clear that certain sounds (soundmarks) are clearly associated with their own idea of how the city *should* sound. Residents value traditional sounds, such as bells, fireworks related to parish feasts and street vendors; even loud discussions between people outside have positive connotations, and the Valletta people define themselves as being traditionally loud and noisy. And, just as elsewhere, nature sounds are positively valued, although Valletta has very limited amounts of green space, so that nature sounds are limited to free or caged birds and sound of the ocean. Sounds that are associated with the gentrification process are, generally, negatively valued by the residents. These include sounds from the increased traffic, catering and shopping malls, modern music and party boats in the harbour. The result is that local residents complain about noise, but also indicate that wanted sounds, both nature and traditional city sounds, are missed.

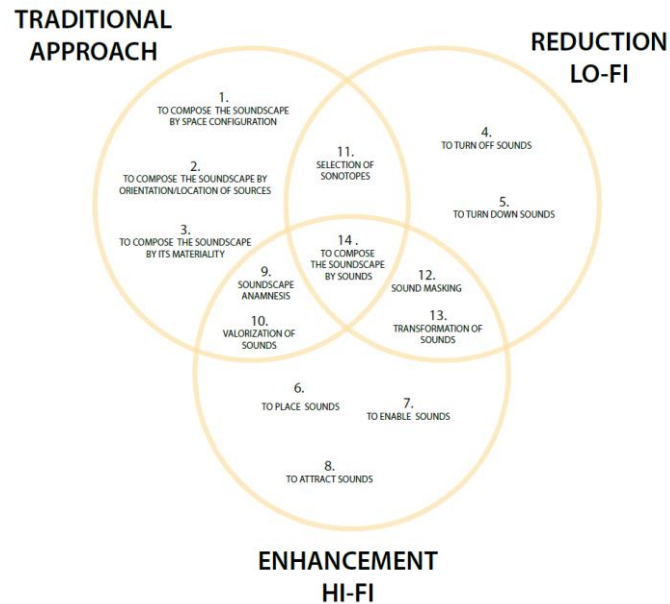


figure 9 *Toolbox containing 14 design principles for soundscape design, clustered by three different intentions*

The soundscape study presents different ways how urban architects can influence the soundscape (figure 9). This categorisation into three design intentions was taken from the work of Cerwén et al. [16]. In the traditional approach, soundscapes are formed by the location of the sources and the configuration of the public space. In the last decades, focus has been to reduce Lo-Fi sounds, i.e. ‘noise abatement’: removing or reducing unwanted sounds. Lastly, there are options to enhance Hi-Fi sounds, which is a rather recent idea introduced by the soundscape approach. Examples are to place actual sources (e.g.

fountains), or to enable or attract sounds: placing trees enables leaves rustling in the wind and attracts whistling birds. And then, there are tools that combine different intentions, such as masking a Lo-Fi sound with a Hi-Fi sound, or enhancing a Hi-Fi sound by changing nearby reflections and diffusion (valorisation). A website *Soundscape Design* by Mr. Cerwén provides examples of various actions within the three design intentions, as well as good examples of projects around soundscaping concept, see <https://soundscapedesign.info/>.

Starting from the information about which sounds are wanted and unwanted by the local residents, the various design tools in the toolbox have been applied by Eleonora Fiorin to suggest 10 smart improvements to the Valletta soundscape (see [33] Chapter 6). One example is placing an acoustic mirror (e.g. a parabolic reflecting wall or shape) to reflect and project the sound of the ocean towards a certain residential location. Another example is removing music speakers in one of the streets with tourist restaurants and replacing these by hanging birds’ cages, which would remove Lo-Fi sounds and introduce Hi-Fi nature sound to the local residents, while creating a tourist attraction at the same time.

3.3.3 Nauener Platz, Berlin

A well-known example of soundscaping is the Nauener Platz in Berlin. Upon the remodelling of this city park, researchers and designers have had a specific focus on improving the soundscape in order to increase the park’s attractiveness. The project has won the European Soundscape Award in 2012⁷ and was praised for its highly participative approach, including the participation of local residents, young and old, into the design process through workshops, interviews and soundwalks. The result is a park in a busy city location that is

⁷ <https://www.eea.europa.eu/highlights/berlin-park-wins-award-for>

valued by locals as a place to relax, sit and play. In order to create this atmosphere, the consortium of soundscape experts applied some special measures (figure 10):

- a relatively low and visually non-intrusive gabion wall that reduces the noise levels between 200 Hz and 1 kHz by 6 dB, with benches viewing the playground placed directly behind it to maximize the effect;
- the addition of artificial sounds in “audio-ring” seats and “ear benches”: while sitting on the bench, nature sounds (water, birds, trees) are played through the speaker, masking the noise of the surrounding traffic;
- the addition of playgrounds, sports areas and green areas to attract sounds from human activities, which helps to mask traffic noise.

The combination of these measures thus creates an attractive soundscape by reducing the Lo-Fi sounds while enhancing Hi-Fi sounds, by attracting as well as adding them. Evaluation of the end result showed that the area and the applied measures are positively evaluated by users from all ages. One point of improvement was the fact that the sounds from the football field were considered to be annoying by some other users of the park.



figure 10 City park at Nauener Platz, Berlin⁸

⁸ pictures from <https://www.eea.europa.eu/highlights/berlin-park-wins-award-for-nauener-park-soundscape-approaches-european>

3.3.4 Research on soundscape descriptors

As we have seen, multiple examples of soundscaping put to practice exists. Several soundscape researchers have identified that the field of soundscaping needs to have clear and unified descriptors to quantify and assess the soundscape quality of places (e.g. [5] and [8]). Researchers find, e.g. in the EU projects SONORUS and HOSANNA and other national work, that a soundscape can be largely described by combining two dimensions: *Pleasantness* and *Eventfulness*, see figure 11. These two dimensions have been found to be the two main principal components that are able to capture a very wide range of other descriptors. A third component could be ‘familiarity’, but the researchers acknowledge that not many unfamiliar soundscapes exist and the added value is limited. Alternatively, other researchers have come up with similar descriptors such as *Calmness* and *Vibrancy*, which could be seen as the orthogonal $\pm 45^\circ$ axes in the same space.

The determination of the two soundscape axes highlights the fact that soundscaping is indeed different from ‘noise control’ as it does not aim for low noise level per se. A pleasant environment could be uneventful (calm), as would be the case for many quiet areas, but also eventful environments can be pleasant, when a person seeks excitement. However, if the eventful environment is filled with unpleasant sounds, it is considered annoying (chaotic). And uneventful environments could also be considered unpleasant, if they are monotonous, perhaps ‘boring’ or ‘somber’.

The researchers also show, from a large listening experiment, that the correlation between these descriptors and traditional acoustic or perceptual quantities is quite low. For example, little correlation is found with traditional quantities such as the L_{Aeq} in dB, the loudness in sone or the dynamics ($L_{A10} - L_{A90}$ or $L_C - L_A$). This indicates that

traditional noise measurements or noise modelling may not adequately describe the soundscape (the acoustic environment as it is experienced by the user in context). However, a correlation with the soundscape descriptors *is* found with the *occurrence* of particular sound sources in the environment (e.g. the amount of sounds of ‘technology’, ‘nature’ and ‘humans’). A consequence could be that noise measurements, monitoring and modelling should focus more on quantifying the contributions of these sources rather than on the levels, spectrum and dynamics of the acoustic environment as a whole, when trying to describe the acoustic quality of a place.

More research on soundscape descriptors and indices is currently ongoing in the [SSID project](#), see also the Appendix.

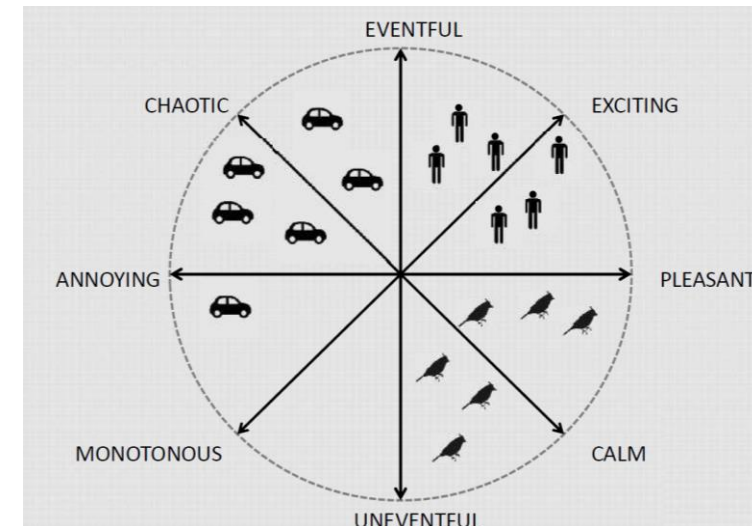


figure 11 Two principal components of soundscape description: pleasantness (horizontal) vs. eventfulness (vertical), from [7]

3.4 Urban Sound Planning

3.4.1 The tender tool

In the Netherlands, the acoustic quality of a new residential area is generally considered only in the last stages of the developmental process. By that time, decisions regarding location, layout and building design have already been made, meaning that options to improve the acoustic environment are limited and compliance to noise regulations is often achieved by taking measures at the facade. A shame, as a more qualitative acoustic living environment could be created if sound would be taken into account from an early start.

To help municipalities motivate project developers to include sound at an early stage, M+P developed a tool that allows for inclusion of the acoustic quality in tender procedures. The tool enables an objective comparison between plans. It takes into account not only noise levels at the most exposed facade, but also incorporates the presence of a quiet side, a quiet outdoor space and whether or not one or multiple bedrooms are located on a quiet side of the house. As a first step, noise levels at the most exposed facade are divided into classes and weighted according to the degree of annoyance corresponding to that specific class. The weighting of the classes is shown graphically in figure 12. The positive impact of a quiet outdoor space is incorporated by a multiplication factor corresponding to a rough 5 dB decrease in noise level at the most exposed facade, as suggested for quiet sides in [81]. The positive impact of providing one or two quiet bedrooms is incorporated by a multiplication factor corresponding to roughly 2 and 3 dB decrease in noise level at the most exposed facade, respectively.

By bringing all these different quantities down to a single number, the so-called tender score, development plans can be easily compared from a health-based perspective.

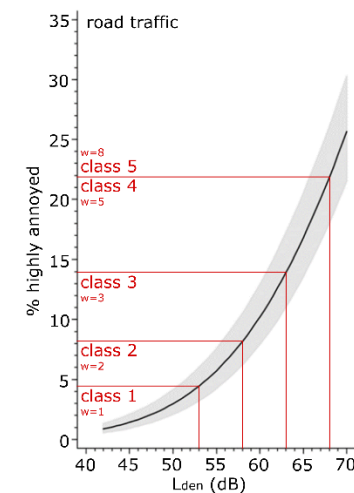


figure 12 Weighting factors corresponding to 5 dB classes of noise levels at the most exposed facade of the building

Up till now the tender tool has been applied in two cases, of which we will discuss one here.

In the municipality of Hoofddorp, the city council incorporated sound in the tender procedure by means of the above described tender tool. Development plans were assessed not only based on price, architecture and public space, but also on the aspect of sound. Developers were obliged to calculate the tender tool score, which was taken into account in the evaluation process. This way, developers

were rewarded for optimizing the building layout with regards to sound and for taking additional noise mitigating measures.

The tool served its purpose as it led to better acoustic designs. For example, several development plans included the realization of noise barriers. However, when the city council had to take the final decision on which plan would be granted the contract, they did not manage to weigh the aspect of noise appropriately with respect to other aspects like architectural design and, most importantly, price. In the end, the plan that got chosen was the one with the best price. Lesson learned: city councils should consider how to weigh the aspect of noise compared to other factors, when granting the contract. On the bright side, every single development plan, including the winner, did to a greater or lesser extent optimize its quality with regards to sound.

The tender tool was developed by M+P for use in its own projects, for a variety of clients. Additional information can be found on the [website](#). More information on calculation methodologies, for example, can be requested there.

3.4.2 Citizen Science: the Hush City app

Citizen science refers to the participation of the public in scientific research. This participation of non-professionals may contribute, for example, through data collection used for monitoring purposes. However, citizen science initiatives can partake in other phases of the research process as well, such as quality assurance, data analysis and interpretation, problem definition and the dissemination of results [19]. Apart from contributing to research, citizen science is appreciated for stimulating public engagement in policy-making and raising awareness of environmental issues.

Many citizen science initiatives have been set up worldwide relating to environmental noise. These initiatives sometimes consist of non-

professionals conducting sound measurements – either through continuous monitoring or by active recording, for example through mobile phones. Alternatively, initiatives may consist of volunteers providing their opinion on the acoustic environment with regards to a specific location.

With regards to quiet areas, soundscaping and urban sound planning, one citizen science initiative is particularly well-known: the [Hush City app](#). This smartphone app, developed by dr. Radicci at the TU Berlin, enables participants to map and evaluate 'everyday quiet areas' that they encounter within their everyday living and working environment. Participants can submit an audio record of half a minute, after which the average sound level of the location is evaluated. In addition, the participant can answer a series of questions to further describe the soundscape of the area and the way that they experience it. The first block of questions regards the perception of the acoustic field. The second block of questions relates to the types of activities that can be performed in that location. Lastly in the third block other conditions of the area are defined, such as cleanliness, accessibility etc. In figure 13 a series of screenshots of the App is shown.

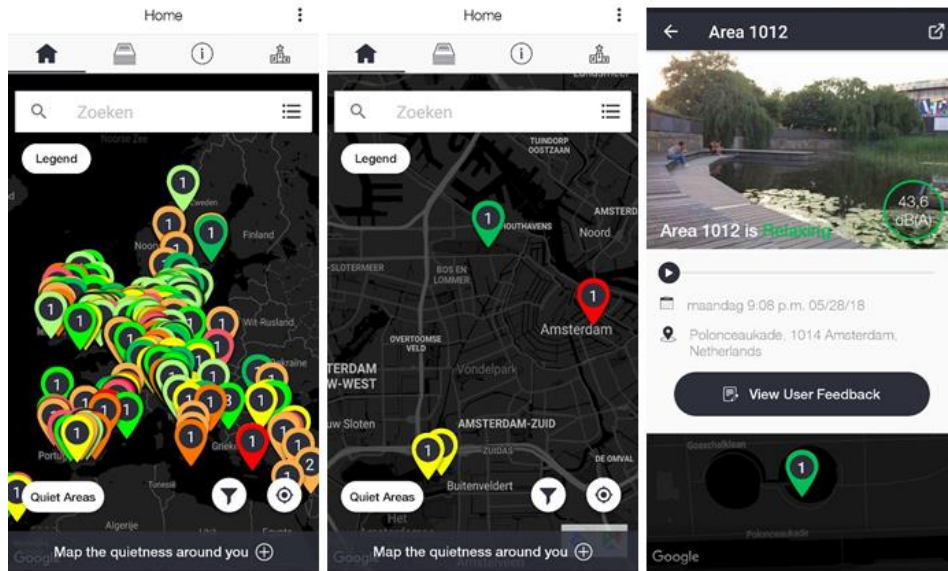


figure 13 Screenshots of the Hush City App. Quiet area registrations in Europe (left); quiet areas registered in Amsterdam (middle); the quiet area indicated in green in Amsterdam (right).

Because ‘everyday quiet areas’ registered with the Hush City App are within walking distance of the direct living environment of the people, these can be valuable additions to the often big parks and green areas defined by authorities. This was recognized by the city of Berlin, that made use of the Hush City App for the formation of the Noise Action Plan 2019 – 2023 [71]. In the former 2008 Action Plan, two types of “quiet areas” had been defined: 11 larger “quiet areas” with a minimum size of 100 hectares, and 26 “inner-city recreational areas”. See section 2.4. However, both through the entries in the Hush City App [73] as through a process of public participation regarding the Noise

Action Plan [72], it was found that city inhabitants register far more urban ‘retreats’ (areas of quiet and relaxation) than the authorities did in 2008 (see figure 14). Therefore, in the 2019 – 2023 Action Plan, the city proposes a new approach for the selection of urban retreats that goes beyond the END approach based on noise maps. The outlined procedure will be tested through pilot projects during the stage of noise action planning due in 2023. In the noise action plan 2023-2028, the pilot results will then be presented and a city-wide approach will be described.

From the public participation process described in [72], the criteria for urban retreats based on the opinions of the participants is given. According to the 226 participants, the most important criteria are green (90%), followed by water (56%) and not being frequented by visitors much (46%). We note that acoustic criteria were not amongst the proposed answers in the survey. About the importance of inner-city resting places, the public was very clear: 94% found these areas very important, another 6% found these important. However, the survey was performed through the participation platform of the city website and on two noise-related events and a course at the TU Berlin related to noise protection [72]. A survey carried out within a random sample of city inhabitants could possibly yield different results.

To meet the experience of the public found from the public participation process and the Hush City App, the new approach proposed to include a third category of urban “quiet areas” supplementary to the two categories of quiet areas and inner-city recreational areas mentioned above. This new category concerns “urban rest and relaxation space for short-stay”. The aimed spaces are typically located within lively working- and/or shopping areas. Particularly important in these areas is a clear contrast to the immediate surroundings with regards to noise and design [71]. Both these types of areas as the inner-city areas should be identified not

merely through land use planning maps and noise maps, but in addition through findings from public participation. Data records from the Hush City App are also mentioned specifically as a possible source of supplementary information on possible urban rest and relaxation spaces [73]. Based on site visits, a set of assessment criteria should be checked. Who and how exactly these visits should be carried out, will be further described in the 2023 noise action plan.

The Hush city app can be freely downloaded from [Google Play](#) or the Apple [App Store](#).

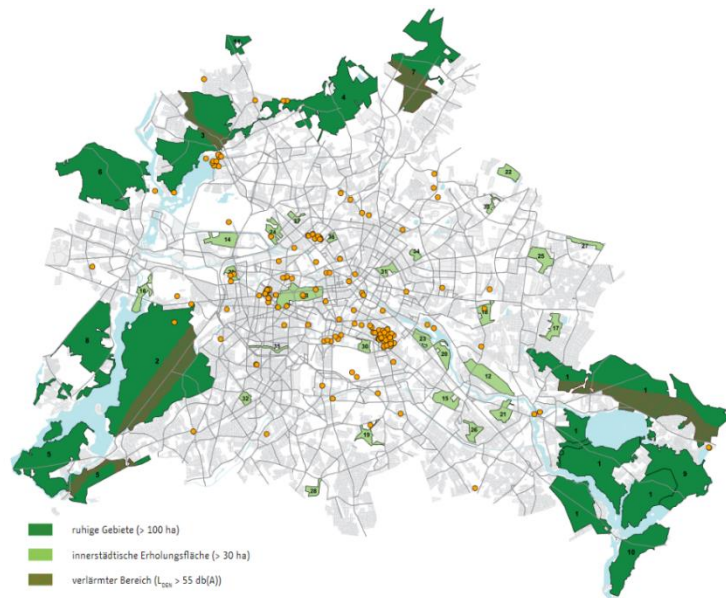


figure 14 Urban areas characterized as not being noisy in the Hush City App (orange). More areas are identified through this app than by the Senate of Berlin in the 2008 Noise Action Plan (light and dark green).

3.4.3 Amsterdam Sounds

Waag in the Netherlands is a *Future Lab* for technology and society. It is a foundation that performs and promotes research on how technology affects people and vice versa. It tries to involve and empower the public as much as possible, promoting open, transparent and inclusive use of technology now and in the future. Waag subdivides its work through thematic research labs, one of which is the Smart Citizens lab. It aims to strengthen citizens' position in relation to governments and corporations through citizen science projects. These projects enable and encourage people to adopt sensor technology and measure and analyse their environment, thereby increasing their knowledge and involvement in decision making.

One of the Smart Citizens projects is [Amsterdam Sounds](#). Here, Waag is working together with the City of Amsterdam and the regional public advocate (ombudsman). Waag has distributed IoT noise sensors to participating citizens in two pilot areas (Leidsebuurt, Marie Heinekenplein) to monitor leisure noise from nearby bars and restaurants, and other neighbourhood noise sources such as the tram line, garbage collection, etc.

The noise sensor kits are built and developed by Waag themselves, using low-cost hardware which is publicly documented along with the open-source data acquisition and analysis software. People are stimulated and supported to install their own sensors, leading to better understanding and less suspicion of the technology used. Noise measurement data are shown on an interactive map, see figure 15. Participating citizens keep a log of notable events, to document their subjective experience that can later be related to the sensor data.

Waag also facilitates the dialog between the city, local enforcement staff, the local businesses, noise experts and the citizens. The data acquired then provide an objective means and a common base to start

the discussions and explore solutions together. It gives insight in the most important sources of local annoyance, which can then be prioritised in taking action. During the project, joint meetings are organised where participants share their experience and discuss the results.

The first pilot in the Leidsebuurt ran in 2019-2020. The second pilot at the Marie Heinekenplein started in March 2021 and is currently ongoing. A similar, larger citizen science project for air quality is also ongoing, called [Hollandse Luchten](#).

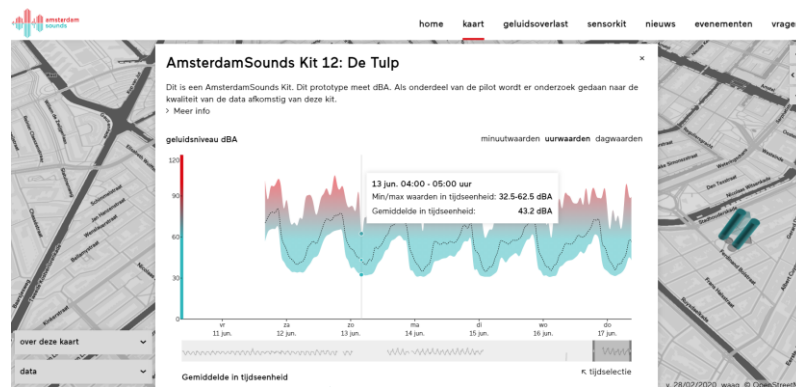


figure 15 Interactive map with real-time sound measurement data (<https://amsterdamsounds.waag.org/kaart/>)

3.4.4 Valley Gardens: soundscape co-creation

The Valley Gardens project in Brighton & Hove (UK) is an example of Urban Sound Planning put to practice. It involves the transformation of a 1.5 km long stretch running from the seaside into the city [3]. The area is depicted in figure 16. Because it is an important entering point for accessing the seaside and the city, the area is dominated by the

view on traffic and by high noise levels ($L_{den} > 65 \text{ dB(A)}$) [47]. The green parts of the stretch were not used by citizens for leisure activities. The goal of the project was to transform Valley Gardens into an attractive park area that would be frequented and valued by pedestrians.

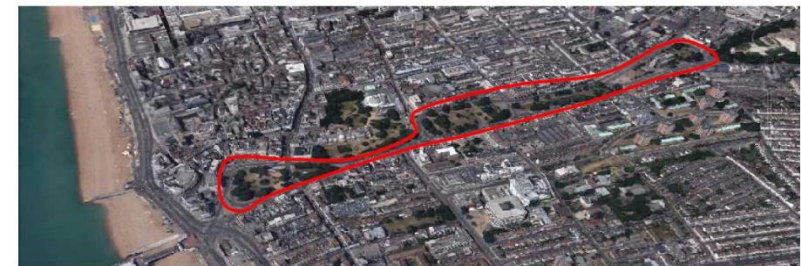


figure 16 Valley Garden, Brighton & Hove (UK). From [2].

The city of Brighton & Hove chose to include the area as a test site for 14 researchers trained under the SONORUS consortium [2]. As a benchmark of the intervention outcomes, a soundwalk was performed, through which the overall quality of the sound environment and the appropriateness to the place was characterized. The results: The acoustic environment was generally dominated by the sound of road traffic, with an absence of perceived sounds from human activities. In addition, the soundscape was experienced to being inappropriate to the place.

To provide a visual qualitative description of the urban sound environment, in addition to classic noise maps the SONORUS team created soundmaps representing the geographical distribution of six perceptual attributes of the soundscape: pleasant, calm, eventful, annoying, chaotic and monotonous, see figure 17 from [41]. These perceptual attributes were extracted from recorded data through sound

sources recognition and profiling based on the dominance of a sound source. This dominance was characterized by both the intensity and the duration over time of a specific source. As input variables for the model, the results of the soundwalk were used, where participants evaluated both the presence of sound sources and the level of the perceptual attributes under consideration.

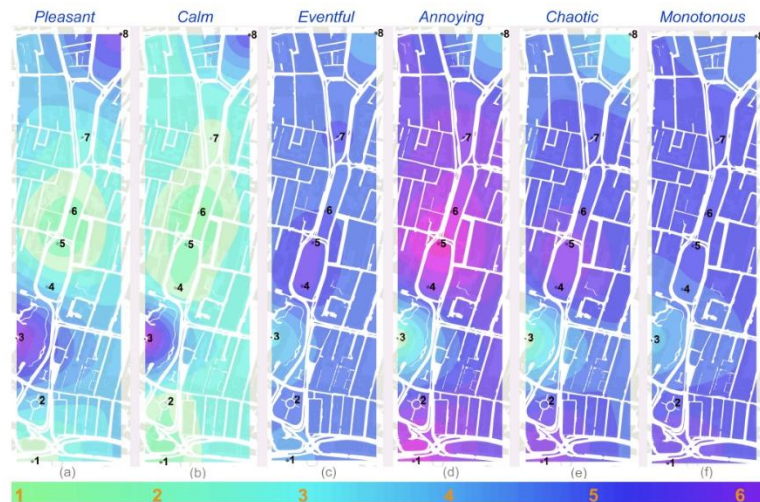


figure 17 Mapping the soundscape of Valley Garden based on six perceptual attributes. From left to right: Pleasant, calm, eventful, annoying, chaotic, monotonous. From [41].

Because the design of the future Valley Gardens was already in place, options for interventions were limited. The design team came up with a proposal: simplifying the roundabouts layout and redirecting all private traffic to the east and all buses to the west. The SONORUS team calculated, however, that the overall effect on noise levels would be negligible. The SONORUS team then came up with an idea: As a

masking strategy, the walking paths could be made from beach gravel. The advantages: the sound of the people’s footsteps on the gravel would mask the noise of road traffic. However, the proposed layout was dismissed by the design team. The reason: the design did not comply with accessibility requirements, it was demanding in terms of maintenance and there was a limitation of multifunctional use of the space.

The soundscaping approach dictates that the introduction of wanted sounds can be a valid replacement of or addition to noise mitigation measures. However, in noisy environments like in the case of Valley Gardens, it is advised to reduce noise levels before taking soundscape measures [47]. The city design team came up with several options to mitigate noise levels, which the SONORUS team investigated further. Firstly: avoid all reflections from buildings. This turned out to be helpful in theory, but not realizable in practice. Secondly: a reduction of the maximum velocity to 20 mph. This would have been easy to implement but models showed that it hardly had any effect on overall road traffic noise levels. Thirdly: implementation of absorbent noise barriers. That would be very effective but was seen as having a negative effect on the appreciation of the landscape. And a fourth option: removing heavy traffic and buses from the site. This would yield significant reductions, however this is practically moving the problem elsewhere.

As a last step in the process, an investigation of the spatial distribution of *wanted* sounds was conducted: both of water sounds and of birdsongs. Based on these maps, the most optimum location for park benches was derived, i.e. closest to the highest levels of wanted sounds. Sadly, it appears that not all of the water features of the original design made it to the final version, as can be seen from these [videos](#) taken after completion of the first two stages of the Valley Gardens project.

In [this video](#), Dr Francisco Aletta, member of the SONORUS Educational program, mentions three lessons learned within the scope of the Valley Gardens project:

- Soundscape was taken on board relatively late. The design was already in place, leaving limited options for interventions. Soundscape should be considered from very early stages.
- What acousticians and soundscape consultants consider as high priority is not necessarily as high priority for the professionals who handle the whole process.
- It is important to come up with solutions that can provide soundscape benefits at relatively limited costs.

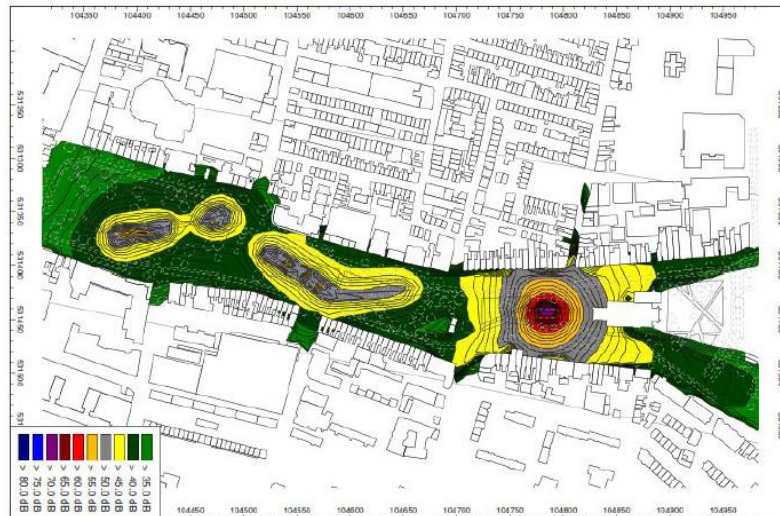


figure 18 Sound level contours calculated for water features (from [6])

3.5 Summary

From the case studies presented above, we summarize some of the most interesting findings.

3.5.1 Regarding quiet areas

Firstly, some conclusions can be drawn with regards to the criteria that found most relevant when identifying quiet areas.

We find that the presence of green is often mentioned. Green came out as the most important feature in a survey amongst public participants of the Berlin Noise Action Plan participant process (3.4.2). In Dublin, only parks are considered possible quiet urban areas (3.2.3). The EEA also limits itself to areas with a green landcover when assessing possible quiet urban areas in a GIS analysis (3.2.1). A Swiss study by Schäffer et al. [70] concludes that an increase in residential green is associated with reduced road traffic and railway annoyance, yet increased aircraft annoyance (3.2.6). The study as well as the relation between green and quiet are discussed further in 4.4 below.

Apart from greenery, the accessibility of an area is an important criterion, as is stressed both by the EEA (3.2.1), a series of studies from Luxembourg (3.2.2) and by the Kilkenny Council who believes it is not only important to have good access but also to be easily navigable (3.2.4). The Swedish municipality of Helsingborg includes accessibility as a benchmark for quiet areas, and state that all residents should have a green area at a maximum of 300 meters from their home, with noise levels in half of the area below 50 dB(A) [17]. Furthermore, from the above mentioned Swiss study by Schäffer et al. [70], it was found that in urban situations the accessibility of quiet

areas is in fact more important than their quietness, in terms of reducing road/railway annoyance. This does not hold in rural areas.

Several case studies show that human activities are not believed to get in the way of creating a pleasant quiet area. Kilkenny Country stresses the importance of pathways and benches, such that the quiet area can be enjoyed. They even consider festivals to be a possible positive activity to be permitted in quiet areas, as it helps to promote the location as a destination people might otherwise not have been aware of, and as a way of promoting community activities and environmental awareness (3.2.4). The Dublin City Council also stresses that quiet areas are not there to be admired from the outside, but to be used and enjoyed (3.2.3).

Lastly, with regards to criteria for urban quiet areas, it is mentioned various times that not just absolute noise levels are relevant, but rather that there should exist a pronounced contrast with the acoustic and visual environment that surrounds it. We recognize this thought in the results of a series of Swiss studies (3.2.6), in the Luxembourg studies (3.2.2) and in the results of the questionnaire deployed by the EEA, where several respondents indicate that relative, rather than absolute, differences in noise levels are used as a criterion when designation quiet areas (3.2.1).

From the Swedish study described in paragraph 3.2.7, it was found that municipalities are at times unclear in their definition of quiet areas. For example, several municipalities did not provide definitions at all but merely assume all “nature reserves” and other recreational areas to be quiet. Ambiguity of the term “quiet areas” is also mentioned by some municipalities as a reason not to designate QAs at all. Other reasons not to work with QAs are that regions are remotely situated, with little human activity, or that they have such high noise exposures that they believe it is useless.

When considering the identification of quiet areas, several possible methodologies have been described. In many cases, noise maps are used as a basis of further research. The EEA proposes a method based purely on GIS data to further narrow down potential quiet areas (3.2.1). In Scotland, a five step process includes location visits and public consultation in addition to noise mapping (3.2.5). The city of Berlin found, through the use of citizen science initiative Hush City App and through a public participation process, that citizens know of many more quiet urban retreats than can be identified based on noise maps and calculation methods (3.4.2). They therefore intent to include these ‘everyday quiet areas’ located directly within the direct living environment of its citizens. The city council of Kilkenny proposes that quiet areas should by definition *not* be identified based on noise levels, but always by means of auditive inspection by the human ear (3.2.4).

As soon as quiet areas are identified, they should also somehow be protected. The city of Dublin has mentioned their eight quiet areas in the END noise action plan, such that they will be reviewed every 5 years (3.2.3). This alone does not ensure however, that noise levels and/or other valuable characteristics of the quiet areas are preserved. Luxembourg formulated a set of general guidelines for city and regional planners to protect quiet areas, including the designation of the areas in zoning and planning, taking noise abatement measures and possibilities to increase recreational values (3.2.2). However, no actual regulations are introduced. In Scotland, the noise action plans of Edinburgh and Glasgow state that QAs should be protected via the process of development control, implying that the 55 dB Lden limit used to identify potential QAs is not strictly enforced, but rather that the presence of QAs is a variable in decision making.

Overall, from the case studies we conclude that none or hardly any strict enforcement of quiet areas is put to place, or at least that no examples of such enforcement have been found.

3.5.2 Useful tools

From the case studies, a set of practical tools can be extracted, which can be used when improving on an urban soundscape, when identifying quiet areas, or when embedding Urban Sound Planning into a project.

- From the Valley Gardens test project, we have learned that it is possible to create soundmaps offering a geographical representation of the perceptual attributes of the soundscape. This provides a visual qualitative description of the urban sound environment, as opposed to noise maps that indicate merely overall noise levels of the overall sound field or of specific sources. See section 3.4.4.
- From the redesign of Nauener Platz, we discovered that the addition of audio signals can be added to public spaces, for example by incorporating speakers to benches, such that masking natural sounds can be added artificially to the environment. See section 3.3.3.
- Actual natural masking sounds can be added as well: for example by adding water features, as in Sheaf Square in Sheffield (3.3.1), or by adding beach gravel to the walking paths such as in Valley Gardens (3.4.4).
- In order to identify small urban quiet areas, policy-makers and other interested parties could make use of the data collected by the Hush City App (3.4.2). Through this app, citizens map and evaluate their favourite “everyday quiet areas” that they encounter within their living environment. These small retreats are not easily identified using traditional methods such as the use of noise maps

and GIS data. The Hush City App is an example of Citizen Science. The field of Citizen Science could help to involve people much more closely in interpreting (urban) soundscape and improving the situation with other stakeholders, as shown by the Amsterdam Sounds project (3.4.3).

- Authorities that want to incorporate the aspect of sound in a tender procedure through which the development of a new residential area is granted, can make use of the Tender tool. This tool enables an objective comparison between plans, taking into account not only noise levels at the most exposed facade, but incorporating factors such as the presence of a quiet side and quiet bedrooms as well, bringing all these different quantities down to a single number. Alternatively, the tender tool can be used by developers to demonstrate their design performs better than others from a health-based perspective. See section 3.4.1.
- A toolbox with possible design instruments for urban planners to influence and improve the soundscape has been described in 3.3.2 and applied to the city of Valletta.
- The QUADMAP methodology contains a set of tools that can be applied to select, analyse and manage quiet urban areas. For example, it includes tools to identify potential quiet areas based on acoustic and non-acoustic criteria assessed by a team of local experts. Furthermore, questionnaires and measurement methods are provided for the characterization of these areas. See section 3.2.8.

3.5.3 Lessons learned

Although much more can be understood from the presented case studies, there are several explicit lessons learned that stand out.

- The aspect of sound should be included from a very early stage in the design and planning process. If that does not happen,

decisions relevant to the acoustic environment, such as decisions regarding traffic flows and the layout of buildings and public spaces, will already been made, leaving very little options for optimization.

- By involving the public in policy making, valuable information can be retrieved. For example when it comes to identifying quiet areas, inhabitants of a region often know better which pleasant retreats of relaxation and quiet exist in their direct environment.
- To quantify the soundscape, noise levels in dB are insufficient. Other soundscape indicators such as *eventfulness* and *pleasantness* have been proposed and are being developed further (3.3.4).
- When comparing the quality of the acoustic environment to other aspects relevant to the design of a residential area, for example, it important to beforehand decide how to weigh the importance of one aspect to other. Specifically, it has to be determined how acoustic quality will be related to financial factors.
- Alternatively, the aspect of sound can also be combined with other environmental aspects to create more support, for example when it comes down to the protection of quiet areas.

4 Benefits of quiet areas

4.1 Introduction

It is clear from the legislative examples and case studies above that there are many efforts on EU, national and local level, to identify and protect quiet areas in cities and in open country. However, the preservation of quiet areas has to compete with other societal demands. Quiet and green areas require space which, especially in urban areas, is a scarcity: given increasing population and urbanisation, the pressure for local authorities to build more housing is large. And there is also an economic competition: managing and reducing noise levels in quiet areas costs money to take adequate noise abatement measures, and not developing real estate in an otherwise empty area may be considered as a missed opportunity for property developers and tax collectors. The competition will be lost if there is insufficient tangible proof of the social and economic value of quiet areas.

In this chapter, we present an overview of what is known with regard to health benefits and economic benefits of quiet areas. As is clear from the previous chapters, quiet areas are closely related to soundscaping and urban sound planning. Therefore, in the paragraphs below, we also present some limited evidence of health and economic benefits related to positive soundscapes in general. Furthermore, we touch upon the mutual benefits of green and quietness.

4.2 Health benefits

One of the guiding principles identified by the WHO environmental noise guidelines is to “reduce exposure to noise, while conserving

quiet areas” ([89], page xv). People need (relative) quietness for psychological restoration, which benefits their mental as well as physical health. Good summaries of existing evidence on the positive effects of quiet areas exist and need not be repeated here. In particular, we recommend the EEA reports on quiet areas [28][30] and the work done by and for DEFRA UK [57][80].

A recent UK publication [60] investigated self-reported, perceived health benefits from visitors to three different urban quiet areas (a park, garden and square). Two of the three areas showed measured L_{day} noise levels higher than the 55 dB threshold set for candidate quiet areas by the authorities, yet all three areas were perceived as ‘calm’ by visitors and two of them were perceived as ‘quiet’. The authors mention that people do expect as well as experience psychological restoration from such areas, yet they conclude that a relation with the actual noise levels is not straightforward. They suggest that “sound level measurements can be a good proxy to help identify places (perceived) as *quiet*, but it cannot determine the *quality* of the acoustic environment”.

When asked, most people will share the opinion that it should not be noisy everywhere and that the environment needs places that are (relatively) quiet. For instance, among residents in Amsterdam, 75% indicate that quiet in or around the house is important, and 50% state that quiet in the neighbourhood is important [12]. Half of the respondents visit a quiet area in their neighbourhood one or more times per week. Figure 19 shows what people actually do in these areas (if anything), clearly indicating activities aimed at reduction or avoidance of stress, at recovery and freedom.

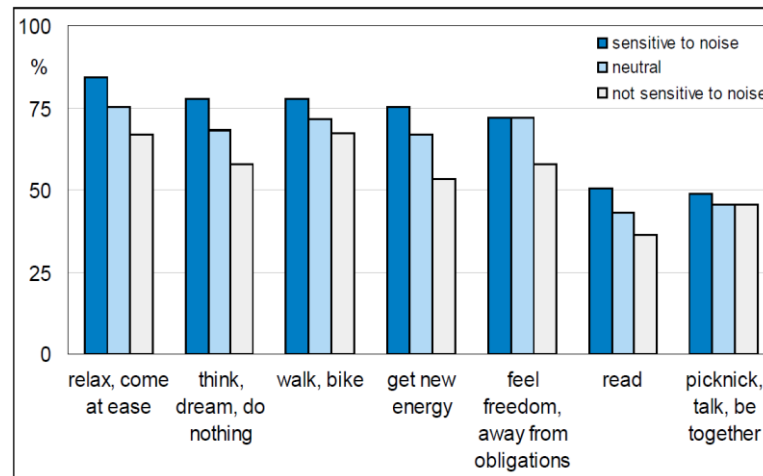


figure 19 What the people of Amsterdam do when visiting a quiet area; survey responses grouped by people considering themselves sensitive, neutral or not sensitive to noise (from [12])

Apart from the absence of noise, quiet areas are thought to have a positive effect on health because lower background noise levels allow people to distinguish sounds they *do* want to hear. These ‘positive sounds’ may be children playing, or natural sounds such as the running of water or the chirping of birds. As discussed in the chapters above, this is a key insight from the field of soundscaping. Several studies indicate that ‘positive soundscapes’ may have a positive effect on public health [3]. For example, two similar laboratory experiments conducted by Alvarsson in 2010 [7] and Medvedev in 2015 [55] investigated the effect of soundscapes on stress recovery by measuring the Skin Conductance Level (SCL) of participants during and after they performed a stressful arithmetic task. After completing the task, participants were exposed to different environmental soundscapes, such as nature sounds, traffic noise or construction

noise. The sounds were characterised by the participants in terms of soundscape indicators such as pleasantness, eventfulness and familiarity. Both studies showed that the decrease in SCL was faster when exposed to the soundscapes that were rated as most pleasant and most familiar. From this, the authors conclude that recovery from stressful events can be facilitated by exposure to positive soundscapes.

4.3 Economic value of QAs

A more difficult subject to study is if, and how much, quiet actually translates into people’s behaviour and consumer preferences. What is particularly challenging is that the quietness is just one attribute of the area’s attractiveness, along with visual attractiveness, valuation of green and nature, facilities and infrastructure, cleanliness, etcetera.

The economic effects of environmental noise in general have been extensively studied, see for instance the 2017 IGNA report on cost/benefit methods [63]. New external noise cost values for transport have been published in 2019 by the Commission based on the work of CE Delft [26]. Even though uncertainties and margins around the actual values exist, it is clear that monetary values (€) can be attached to every dB of noise reduction, and that these values increase at higher noise levels. So, given a noisy situation, people are willing to pay for a reduction of the noise, which is reflected for instance in higher house prices in areas with lower environmental noise levels. These values, however, do not directly apply to quiet areas, as they are based on the noise levels at people’s own homes and do not reflect the value of an area further away, accessible to everyone. Also, the monetary values represent a *change* in noise level rather than an absolute level, and the relatively low levels in quiet areas will be on the

lower extremes of the studied noise level ranges, where statistical error margins are large.

Two Swiss studies [50][66] looked at whether location and environmental quality, among which also green spaces, result in changes in property value. The report on house rents [50] shows a clear relation between rent price and noise exposure: -0.11 to -0.26% per dB L_{day} above 50 dB, depending on the noise source. There is also a relation between house rents and the presence of green within 100 meters (+0.4%). That implies that the presence of green has a similar effect on rents as a noise reduction of 1.5 to 3.5 dB. There is no data on the influence of a quiet area nearby, or on the influence of the noise level in the green area.

DEFRA UK [80] (or Rowcroft et al.[68]) have suggested and tried a few different approaches. The most successful approach regards the economic value of open and green space in general, estimating the number of users that visit and use it and then make an educated guess how many users would stop using the area if would become too noisy. Public green areas in general have the following economic values:

- direct use value: the benefits for visitors using an area's facilities and enjoying its positive characteristics;
- indirect use value: benefits of the area's existence for the local ecosystem, such as reduction urban heat or providing screening and absorption of noise sources;
- non-use value: the willingness to pay for the satisfaction of knowing that the area exists and is preserved, even if it is not used by oneself or others, for instance because it is considered to be good for nature and climate, or out of a general feeling of responsibility that the area should be there for generations to come. Even though somewhat abstract, studies are mentioned that indicate the non-use values could be around 40% of the total economic value [52].

The DEFRA approach is then applied to the Westbourne Green open space in central London, presenting a value of £1.18 to £7.40 per visit, and 0.8 to 5.4 million £ per year for all visitors. Assuming then, based on a field survey, that 1/3 of visitors would stay away if the space would be subject to high traffic noise levels, the value of the quiet for this area is estimated between 0.3 and 1.8 million £ per year. A further extrapolation to the whole of England amounts to a total value for all quiet areas between £19 million and £1.4 billion per year. These estimates only include the direct use values, not include indirect and non-use values as indicated above.

Upon inquiry, DEFRA have indicated that they are planning a follow-up study to start in 2020, starting with improving definitions of 'quiet' and 'non-quiet' and including other descriptors regarding positive soundscapes and 'tranquillity'.

Most of the quiet areas people use are public areas, free of entrance. So people do not actually pay for quiet areas directly. Direct economic value may come from an increase of touristic activities by visitors in or around the area, but mostly from a general increased quality of the neighbourhood. Such improved quality attracts residents, leading to increased demand of housing and higher prices as a result. Hedonic pricing methods may be used to quantify this. As an example of economic value of green public space, figure 20 shows a result from statistical analysis of UK real estate and green space, showing that property prices are to 3% higher when publicly accessible green space is nearby, with higher values when the green space is larger.

Hedonic pricing is a common technique to discover the monetary value of environmental noise. What is different for quiet areas, however, is that it is more indirect, as the area itself is not owned or rented by the residents themselves and they have no control over its quality, acoustic and otherwise. One may expect that the willingness to pay for the quiet area is lower than for noise reduction at the dwellings.

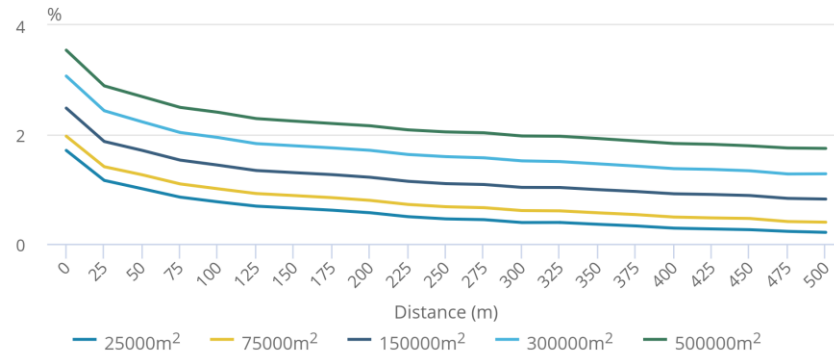


figure 20 Partial dependency of real estate property price on distance to nearest publicly accessible green space and the green space area, from [59]

On a larger scale than local quiet and green spaces that provide benefits for inhabitants, quiet areas may provide economic value by positively affecting tourism.

The [Interreg Europe](#) (Thematic Trail Trigger) investigates eco-tourism, aiming to maximise the potential of natural and cultural heritage sites, by setting up or improving thematic trails. Nine European regions have gathered good practices, performed study visits to interesting areas and published draft action plans. One of the participating regions is Central Finland, who have identified as one of their good practices ‘Silence as a tourism attraction’. 8% of the Central Finland area, 1575 km² divided over 36 locations of >50 ha, has noise levels below 35 dB. As figure 21 shows, many quiet areas overlap with recreational and cultural attraction areas. Some existing water, land or snow tracks run through, although the study visit showed that some of these areas are not easily reachable or accessible. Central Finland has in their ThreeT action plan identified quiet (‘silence’) as a particular strength of the region and as an added value to tourism, which is promoted for well-being and health, along with attractive forest nature and the sauna

culture. It is claimed that “Silence connected to nature values together with tourism and recreation potential offers more value and significance to the region.”, although references to underpinning research are not given. It is a good example of showing the added value of quiet for tourism and, consequently, regional economy.

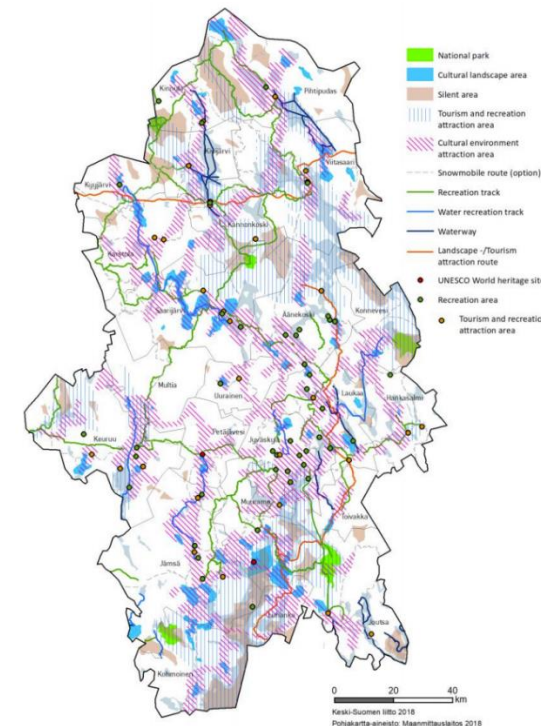


figure 21 Map of quiet areas, heritage sites, recreation areas and routes in Central Finland (from [9])

Besides only quiet areas, positive soundscapes in a more general sense also have economic value. A recent study by Wu et al. [90] derived the economic value of the soundscape of tourist destination Qiantang River by separating it statistically from the overall economic value. The soundscape's contribution turned out to be a rough 15% compared to the overall economic value of a tourism destination. As the loud breaking of the waves due the river's tide is actually the main attraction, and this sound dominates the area, the example may attribute a relatively high value to the soundscape compared to other tourist destinations.

4.4 Quiet and green areas

From the examples in Chapter 3, it is clear that many quiet areas are green areas: parks and fields in the city, forests and natural landscapes in rural areas. Not neglecting the importance of urban courtyards and other non-green quiet areas, the relation between green areas, vegetation and noise deserves special attention. In general, quietness is only one of the properties that determine the quality and value of green urban and rural areas.

An interesting study to investigate the influence of noise on the attractiveness and the use of such an area was done in Norway upon the relocation of Oslo's main airport in 1998, from Fornebu to Gardermoen. Both in the old area and in the new location, there was a recreational area used mainly by local residents. The move of the airport provided an opportunity to study the effect of a decrease in aircraft noise around the old location (Bygdøy forest) and an increase in the new location (Romeriksåsen forest). Krog et al. [45][46] have analysed the results of a large-scale telephone survey among ca. 500 visitors for each area, counting only the people that made use of the area before as well as after the airport relocation. Additionally, the

survey included a few hundred people that started or stopped visiting. Besides the frequency of use, the perceived quality of the area was quantified. The researchers conclude that:

- People that indicated the aircraft noise as a reason not to visit Bygdøy, started to use it more frequently after the relocation. Also, of the people not using the Romeriksåsen forest, the percentage indicating aircraft noise as a reason no to do so, more than doubled. Still, the total effect on the area use was not significant: many people tend to keep visiting the area.
- More convincingly, the perceived quality of the areas largely improved among their visitors. At Bygdøy, the percentage of visitors indicating high annoyance from aircraft noise decreased from 49% to 0.3% after the relocation, whereas in Romeriksåsen this increased from 16% to 43%. People also indicated a clear increase or decrease of the overall quality of the area. Strikingly, at Bygdøy after the relocation, people were also less annoyed by factors *other than* noise, such as litter, crowding or careless cyclists.

This example shows that green areas benefit from being quiet. And as shown from several cases in Chapter 3, quiet areas also benefit from being green, so these are mutually reinforcing benefits.

Even outside quiet areas, there is quite some evidence of the positive effects of green areas and vegetation on reduction of annoyance from noise. Even if the green area itself is not necessarily quiet, its mere presence leads to lower annoyance ratings for noise. An extensive literature review by Van Renterghem [85] in 2019 describes such evidence. A strong effect is found from the direct visibility of green from inside the dwellings through the window, which reduces the annoyance from road noise by the equivalent of a 10 dB reduction [84] while the actual noise immission is the same. Other effects that contribute to the restorative potential of green are the attraction of

nature sounds (birds, rustling trees). Also, at medium and lower noise levels, visually hiding the noise source by means of vegetation has a positive effect on annoyance. This does not hold for high noise levels as the incongruency between the visual and auditory perception leads to increased annoyance or stress.

Another study by Schäffer et al. in 2020 [70], commissioned by FOEN, found that increasing residential green is associated with reduced road traffic and railway noise annoyance, but also with increased aircraft noise annoyance. The fact that dwellings are in an area with ‘a lot of green’ versus ‘not much green’ leads to a reduction of road noise annoyance equivalent to a decrease of 6 dB L_{den} . The negative effect on aircraft annoyance is equivalent to an increase of 10 dB L_{den} . With respect to the properties of the green areas, it is concluded that in urban situations the accessibility of these areas is more important than their quietness, in terms of reducing road/rail noise annoyance. For rural areas, the quietness of the green areas is more important than the accessibility.

4.5 Synergy with other topics

Quietness is an important property determining the quality and attractiveness of an area, and consequently the value of an area may be increased by taking appropriate measures to limit or reduce the noise levels. To build the business case for such measures, it would be good to include other environmental topics, such as:

- air quality: protection or reduction measures aiming to reduce noise from traffic and industry, particularly the measures to reduce the noise emission at the source, can also reduce the emissions of air pollutants, such as nitrogen oxides (NO_x) and ammonia, particulate matter (PM), microplastics and CO₂;

- biodiversity: the promotion and protection of green and vegetation, in the city as well as in rural areas and nature protection sites, increases opportunities for biodiversity, both flora and fauna. There is a direct relation between noise and biodiversity, as noise does not only affect humans but also animals. The EEA’s recent Environmental Noise in Europe report [29] justly dedicates a chapter to the effects on wildlife: anthropogenic (human-made) noise gives communication problems and stress for birds and mammals, leading to increased mortality, lower reproductive success and emigration. And there is also an indirect synergy between the promotion of quiet areas and biodiversity, as both goals support the protection and increase of green and nature areas;
- climate change: as mentioned under ‘air quality’, noise reduction measures may also lead to lower air emissions, including CO₂, thereby contributing to prevent climate change. Also, the promotion of urban vegetation and green areas reduces noise annoyance, see 4.4, while at the same time urban vegetation helps to manage water drainage under extreme weather, to bring down the air temperature and reduce the effect of urban heat islands.

The possible benefit arising from a synergy with other environmental topics was mentioned with regards to the protection of quiet areas in the Luxembourg studies presented in section 3.2.2: The studies reasoned that quiet areas that overlap with higher-level planning zones, such as nature reserves, are likely to be protected from future economical developments.

One example of the synergy between noise and air quality is the Horizon2020 project NEMO⁹ started in 2020. The project focuses on in-situ identification of “high emitters”: road vehicles that emit high levels of noise, NO_x, PM and/or CO₂. Through an autonomous measurement system, the most annoying and polluting vehicles in the traffic stream are identified, warned and possibly sanctioned. Also, mitigation measures that reduce noise as well air emissions are investigated, such as noise reducing porous asphalt that also captures nitrogen oxides and stores tyre-road wear particles (TRWP).



figure 22 *Symbiotic relationships in the animal kingdom: The cattle egret removes ticks and bugs off the water buffalo’s back. By working together, the water buffalo is freed from the annoying bites of bugs, and the egret has a full stomach. Photo: Katie Hunt, [Flickr](#)*

⁹ <https://nemo-cities.eu/>

Another example is the recent nitrogen problem in the Netherlands. The Dutch State Council in 2019 ruled the current policy to reduce nitrogen emissions (NO_x and ammonia) invalid, leading to a sudden full stop on all building permits for housing, industry and infrastructure. As a quick countermeasure, the maximum speed on all Dutch motorways was reduced from 130 to 100 km/h, which immediately solved some of the noise issues for the national road authority, at least for the short term. Also, for the longer term, this will lead to a better protection of nature areas, which can also increase the protection of quiet areas. And, vice versa, the part of the public that holds negative opinions towards overly protecting nature areas may be convinced if the same area is promoted as a *quiet* area that improves human health.

In conclusion, the point is that environmental policy for different topics may be stronger when combined. The business case for an area may be insufficient when regarding quietness, nature recreation, biodiversity or climate alone, but can be made quite attractive when all these topics are regarded in combination for the same area.

4.6 Summary

It is clear that open and green areas have a social and economic value, improving the perceived quality and health of the urban environment. Many inhabitants use parks and other open areas for rest, relaxation and an escape from busy and noisy houses and workplaces. Such activities require a quiet and tranquil environment that feels safe, looks good and clean, and is relatively undisturbed by

unwanted noise. That must imply that higher noise levels in these areas will lead to a loss of value also in an economic sense, although there are few studies that are able to present accurate monetary values. Better quantification of this effect, based on objective proof and data, would be very valuable to convince policy makers and urban planners, and may be indispensable for the future of quiet areas.

It is also clear that quiet is just one property of an area, and that successful quiet areas should have more to offer than quietness alone. It is an important property, however, to make parks and nature areas more attractive to visitors. And if quietness leads to people making more use of these areas, to relax, walk or exercise, that also will have a positive effect on their health and well-being. Furthermore, this notion should be expanded also to positive soundscapes in general: quiet areas are one form of soundscapes that people value and need, but other, more eventful soundscapes present economic and health benefits just as well.

Because of the above mentioned reasons, the noise community must not work alone, but join forces with the other environmental topics, as the noise aspect may help to build their business cases, and vice versa.

5 Conclusions

This report is about acoustic quality of the environment. As we have seen, acoustic quality is more than the absence of noise. We want to bring down the unwanted noise because there are other sounds that we *do* want to hear. We like to hear the nature around us, or the specific soundmarks that characterise the areas we visit. We may like to hear the other people around us, or the liveliness and energy of the city, but this should not be disturbed by noisy traffic. The valuation of the soundscape depends on the user and the context, and its enhancement is therefore more complex than a straightforward stride towards absolute silence.

The benefit of a pleasant soundscape has been shown in several case studies. The realisation that sounds can be put into place is a welcome approach to the field of acoustics and becomes increasingly more important as cities tend to densify and expand. Good efforts to translate the soundscape approach into practical guidelines, new quantities and descriptors, and also new improvement measures are described in this report. The further development of the ISO12913 will help to a further objectification and quantification of soundscapes.

A legislative approach based solely on dB-values may no longer be adequate. However, looking at legislation in Chapter 2, we have not found much evidence of regulations meant to manage the soundscape in public spaces. The concept of soundscaping has not yet been explicitly incorporated in most national legislation covered, but some fairly recent examples such as in Wales, France and Campania show that first steps are being taken. We have also shown some examples of cities (e.g. Dublin, Valletta) that appreciate the importance of enabling and attracting wanted sounds.

Even in quiet areas people like to hear sounds. For instance, the sound of birds, trees or water. Still, there are categories of sounds that are negatively valued as 'noise' by practically everyone, including the noise sources identified in the END: road, rail and air traffic and industry. These are sounds that are predominantly annoying and can seriously impact people's health and well-being. A more positive attitude towards some environmental sounds should not lead to lower efforts to combat noise from traffic and industry. The soundscape approach should not be used to downplay the need for noise abatement. For all the END sources, it is clear that people benefit from lower levels, down to the WHO recommended levels or even below.

Quiet areas are valued by people and are beneficial for their quality of life and health. As required by the END, all national legislation of EU Member States we have seen includes some definition of the term 'quiet area'. Examples in Chapter 2 show that countries provide the legal grounds for regional or local authorities to designate these. Yet, "designation" itself may behold nothing more than simply *mentioning* the existence of a currently quiet rural or urban area in the action plan, and does not guarantee that quiet areas will still exist and be just as quiet in the next action plan, five years later. Several action plans do mention measures to be taken to protect quiet areas. It is unknown whether such measures have actually been implemented; the END does not legally require to do so. One positive example was found in Sweden, where local authorities have prohibited wind turbines and other new installations in designated quiet areas.

The incorporation of noise in urban planning seems to be relatively common. For example, the presence of quiet sides or quiet outdoor spaces has been mentioned in local policy, although certainly not in all countries considered in Chapter 2.

Legislation is not the only road to success. Although regulations regarding the creation and preservation of pleasant soundscapes and quiet areas are limited, we find that across Europe a lot of effort is being done to come to a practical implementation of these concepts. Especially with regards to quiet areas, ample examples can be found. Local authorities and policy makers that have the ambition to apply soundscaping and quiet areas can learn from these good examples and create their own.

For quiet areas, an unambiguous set of requirements could be helpful to urban planners. Moreover, authorities will need to have a crystal clear description as soon as legislation does come into play: it is not possible to enforce a minimum level of quality without prescribing what this quality is. General requirements do not exist, although guidance is given by the EEA. For undisturbed nature areas, 40 dB(A) is generally regarded as a 'golden standard'. Some case studies and action plans show that in open country areas, low noise levels exist and are identified by the authorities. In cities, however, such levels are almost nowhere to be found. Here, higher noise levels can be considered acceptable, as can be seen from the criteria presented by German municipalities, for example, where noise limits for quiet areas go up to 60 dB(A) – and in some cases are not defined at all.

Urban residents, as several surveys have shown, greatly value areas close by their homes and workplaces (within a 10 minute walk) where they can relax, rest and restore. These urban quiet areas do not necessarily have to be so quiet, as long as they are relatively quiet with respect to the noisier city areas around; relative differences of 6 to 15 dB(A) are reported as standards. Also - or perhaps even more important - are visual aspects, the presence of green and blue, and available facilities (benches, playgrounds, walking and bicycle paths). It is important that these areas are accessible to everybody. Some authorities explicitly require quiet areas to be free of charge. Quiet

areas do not necessarily have to be large, although many existing guidelines prescribe a minimum area size. In some case studies we have seen recommendations to interconnect several of these areas, in a coherent structure together with walking and bicycle paths. It is good to realize that not only parks and green spaces form potential quiet areas, but also attractive courtyards and squares.

With regards to the identification of quiet areas, several studies have presented GIS-based methods, combining noise maps with other data regarding land use, accessibility and infrastructure, etcetera. Such 'desk' methods are primarily suitable to identify open country areas; for urban areas the situation is more complex and context-sensitive, and identification of areas appreciated by the public requires a higher level of public participation and local function. Several authorities, such as Luxembourg and Scotland, describe a two-step process in which 'candidate' quiet areas are identified first, using mainly desk and GIS methods, and where final designation of quiet areas involves area visits, public participation, soundwalks and/or noise measurements, including an assessment of non-acoustic criteria. In Berlin, plans are to involve the residents through public surveys and a smartphone app that enables users to map and evaluate favourite urban quiet areas.

Even though several case studies have effectively identified quiet areas, there is less evidence of tangible efforts to protect and preserve these. Measures to do so include well-known active noise abatement techniques to bring down the noise levels in-situ: noise reducing pavements and rail tracks, noise barriers. But certainly, measures on the level of traffic planning are important: lowering speeds, rerouting traffic and introducing pedestrian or bicycle zones. We have not found any evidence of active noise abatement measures being applied specifically for quiet areas. There are examples of restrictions for noisy activities in quiet areas, e.g. in the Netherlands.

The business case of designating and protecting quiet areas could be enhanced if the benefits from their quietness would be combined with other benefits, such as improved air quality and a counterforce to climate change. Many (candidate) quiet areas are also green areas, such as parks and forests, and many rural quiet areas will overlap with nature protection sites. For urban areas, bringing down noise levels will enhance the overall quality of the neighbourhood. It is also clear that green and vegetation has a significant positive effect on annoyance, a fact that should be brought to the attention of urban planners. To strengthen the position of quiet areas and to convince policy and decision makers, the research field could help by extending efforts to quantify their value, in economic terms and/or health metrics.

The above also applies to other positive soundscapes than quiet areas. As we have seen from several case studies and from the research into soundscape descriptors, there certainly are sounds that we do want to hear and specific soundmarks that need to be protected. Some, yet limited, evidence shows that there are health and socio-economic benefits, including tourism, attached to such attractive soundscapes.

The acoustic community should strive to convince and to help the authorities and the urban developers to include sound in their planning. Some urban planners should become 'urban sound planners' or 'soundscape architects'. There are more and more ideas for city and neighbourhood design to positively influence the outdoor acoustic environment. Strategically placing the less sensitive buildings near the road can create quietness for the residents behind. Also, dwellings in noisier areas should have a quiet side, so as to create a quiet micro-area in their own backyard or balcony. Fortunately, the importance of quiet and positive soundscapes in our environment, is gaining awareness. And more and more, authorities are getting

convinced that their focus should not lay solely on bringing down noise levels, but on optimization of the acoustic environment as a whole.

To conclude, we summarize our most important findings:

- Acoustic quality is more than the absence of noise. Unwanted sources of noise are brought down because there are others sounds we *do* want to hear.
- Even in quiet areas, people will want to hear sounds. However, there are typical sound sources such as traffic and industry, that are generally disliked and should be constrained.
- Quiet areas are appreciated by the public and have a positive effect on people's well-being. However, we have no evidence of regulations ensuring that quiet areas designated today, will still be quiet tomorrow. Many local authorities do mention specific measures that may be taken to this end.
- The soundscape approach is being translated into guidelines and ISO standards. Evidence of legislation regarding the approach has been found in a few recent examples.
- Even without legislation, a lot of effort is done across Europe to create and preserve pleasant soundscapes and quiet areas. Especially with regards to quiet areas, ample examples can be found.
- An unambiguous set of prerequisites describing a quiet area does not exist. Apart from acoustic criteria, quiet areas should have green qualities and be easily accessible at no cost.
- Identification of quiet areas can be achieved through GIS based methods and by involving the public. Especially when trying to identify smaller urban oases, residents' participation could be advantageous.
- Urban sound planners should be aware of other tools to reduce noise annoyance and negative health impacts besides reducing the noise level at the most exposed facade. Useful improvements in highly exposed areas are the availability of a quiet side to a

dwelling and the presence of green nearby, preferably visible through the window.

- Such tools include new soundscape descriptors, such as Pleasantness or Eventfulness, that will help to quantify soundscapes beyond their long-term average noise levels.
- Through synergy with other environmental topics, such as air quality, biodiversity and climate change, the business case of protecting quiet areas could be made stronger. Further research to quantify the economic and health benefits of quiet areas would be beneficial as well.
- By including sound in their planning procedures, urban planners and authorities can significantly improve the living environment. In this process, the focus should not be solely to bring down noise levels, but to optimize the acoustic environment as a whole.
- The emerging field of Citizen Science, aiming to involve and empower the citizens by taking them aboard research and policy development projects, is particularly promising for environmental acoustics. After all, the impact of sound on public health and well-being is subject to the attitude of the people exposed to it, perhaps more so than for other environmental pollutants.

6 Recommendations

From this report, several recommendations arise for individuals and organizations aiming to improve the acoustic living environment. Our recommendations are ordered in the main target groups: national and local authorities, urban planners, acoustic experts or citizens.

Recommendations for authorities:

- Besides legislation, authorities and policy makers can have a positive impact on the acoustic quality of an area by implementing strategies from the soundscape approach or by designating and protecting quiet areas.
- Learn from others and learn by doing. We recommend all authorities to read the case studies in this report and start to take some initial steps. Positive experiences may evolve into the necessary legislation for future developments.
- When designating Quiet Areas, think about their location, not just their noise level: Are they accessible, close enough to the residents' houses? And do people know about them? The more that quiet areas are used, the bigger their positive health impact.
- Think about other factors than sound: ideally QAs are green, have facilities and infrastructure available such as walking or bicycle paths, are interconnected, and are free to enter.
- When including QAs in legislation, or in action plans, clearly describe the minimum requirements, in a SMART way: specific, measurable, achievable, realistic and timely. Without a quantified definition, enforcement is hard.
- Desirable noise levels may differ significantly upon the area (urban vs. rural). Regular noise mitigation measures and strategies can be applied to reach lower levels. Make sure to include monitoring and regulations to ensure that quiet areas stay quiet.

- When trying to improve the acoustic quality of a public space: do not focus on reducing noise levels alone, but think about the sounds that people may want to hear. Which soundmarks characterize a certain neighbourhood or region? Are these positive sounds to all or to a specific part of the population? Is there a need to actively preserve these sounds?
- However, a focus on positive sounds should not decrease effects to reduce those noise sources that are negatively valued by practically everyone, such as road, rail and air traffic and industry. We recommend to always strive to reduce their related noise levels.
- As the acoustic quality of the environment is typically subjective in nature, involving local citizens in the design and assessment of the soundscape will help authorities to decide on improvements that are worthwhile to the community.

Recommendations for urban planners:

- Consider the aspects of sounds early in the design process, when the area layout and building placement is not yet fixed.
- Consider sound when drawing up neighbourhood layouts: non-inhabited buildings near a noise source can create acoustic shadow zones for houses and other noise sensitive buildings.
- Consider quietness near to residences: quiet sides and quiet outdoor spaces. Not only do these improve people's wellbeing, they also positively affect the attractiveness of an area and increase housing value.
- In addition, consider green in the surroundings, preferably visible from the window. Again, these have a positive effect on the attractiveness and housing value.

Recommendations for experts in the field of noise and health:

- Further investigate ways of defining, objectifying and quantifying soundscapes. This should allow an objective assessment of improvement measures and the development of legislation.
- Build a stronger business case for improving the acoustic quality by investigating and stressing the synergies with other environmental or economic factors: air quality, climate adaptation and resilience (e.g. water drainage), biodiversity, attractiveness of an area and tourism.
- Strengthen the position of quiet areas and help to convince policy makers by extending efforts to quantify their value, in economic terms and/or health metrics, to support cost-benefit decisions.
- Similarly, the health and socio-economic benefits of attractive soundscapes, other than only quiet areas, should be investigated and better understood.

Recommendations for citizens:

- Be aware of the advantages of quiet areas. Try visiting existing some local quiet areas, as research shows this may help you to release stress.
- Be aware of the advantages of quiet sides to your home. Think of what you can do to reorganise your main living space: create your bedroom at the quiet side of your house.
- Get involved in the realisation of your own attractive living environment: talk to your municipality and make use of existing opportunities to participate, such as citizen science projects.

References

- [1] ACI Europe, “Addressing the future of aviation noise”, Aircraft Council International Europe, Brussels (2018) - [link](#)
- [2] Aletta F., “Co-creation of urban soundscapes (including methods for getting people’s opinion)”, PowerPoint presentation used during the Smart City Sound Summer School in Ghent, 7 September 2019
- [3] Aletta, F. et. al., “Associations between positive health-related effects and soundscapes perceptual constructs: a systematic review”. International Journal of Environmental Research and Public Health, 2018 - [link](#)
- [4] Aletta F. et al., “Characterization of the soundscape in Valley Gardens, Brighton, by a soundwalk prior to an urban design intervention”, Proceedings of Euronoise 2015 - [link](#)
- [5] Aletta F. et al., “Soundscape descriptors and a conceptual framework for developing predictive soundscape models”, Landscape and Urban Planning, February 2016 - [link](#)
- [6] Aletta, F. and Kang, J., “Soundscape approach integrating noise mapping techniques: a case study in Brighton, UK”, Noise Mapping Volume 1, May 2015 - [link](#)
- [7] Alvarsson, J.J.; Wiens, S.; Nilsson, M.E., “Stress recovery during exposure to nature sound and environmental noise”. International Journal of Environmental Research and Public Health, 2010, 7, 1036–1046 - [link](#)
- [8] Axelsson Ö and Nilsson M., “A principal components model of soundscape perception”, Journal of the Acoustical Society of America, volume 128 issue 5, November 2010 - [link](#)
- [9] Bergius L. et al., “ThreeT Thematic Trail Trigger – Good Practices documented”, workshop presentation, Doc 4C-3T-30, March 2019 - [link](#)
- [10] Booi H., van den Berg F., “Quiet Areas and the Need for Quietness in Amsterdam”, International Journal of Environmental Research and Public Health, volume 9 issue 4, April 2012 - [link](#)
- [11] Borchì F. et al., “LIFE+2008 HUSH project results: a new methodology and a new platform for implementing an integrated and harmonized noise Action Plan and proposals for updating Italian legislation and Environmental Noise Directive”, Noise Mapping, De Gruyter open journal, volume 3 issue 1, May 2016 - [link](#)
- [12] Brand A.E., van den Berg G.P., “Stille gebieden in de stad – De stad is stiller dan je denkt...”, Dienst Milieu en Bouwtoezicht, Municipality of Amsterdam, final report, June 2009 (in Dutch)
- [13] Bund/Länder-Arbeitsgemeinschaft Immissionsschutz (LAI), “LAI-Hinweise zur Lärmaktionsplanung, Zweite Aktualisierung”, March 2017 - [link](#)
- [14] Bundesministerium der Justiz und für Verbraucherschutz, “Baugesetzbuch in der Fassung der Bekanntmachung vom 3. November 2017 (BGBl. I S. 3634), das durch Artikel 6 des Gesetzes vom 27. März 2020 (BGBl. I S. 587) geändert worden ist”, November 2017 - [link](#)

- [15] Bundesministerium der Justiz und für Verbraucherschutz, "Bundes-Immissionsschutzgesetz in der Fassung der Bekanntmachung vom 17. Mai 2013 (BGBl. I S. 1274), das zuletzt durch Artikel 103 der Verordnung vom 19. Juni 2020 (BGBl. I S. 1328) geändert worden ist", May 2013 - [link](#)
- [16] Cerwén G. et al., "Soundscape actions: A tool for noise treatment based on three workshops in landscape architecture", *Frontiers of Architectural Research*, volume 6 issue 4, December 2017
- [17] Cerwén, G., Mossberg, F., "Implementation of Quiet Areas in Sweden", *International Journal of Environmental Research and Public Health*, 2019 - [link](#)
- [18] Christidis Y., Quinton M., "Exploring the Urban Mediterranean Soundscapes in Cyprus and Malta: A Comparative Study", *Interference Journal*, 2016 - [link](#)
- [19] Commission Staff, "Best Practices in Citizen Science for Environmental Monitoring", Commission Staff Working Document, Brussels, 27 July 2020 - [link](#)
- [20] De Kluizenaar Y. et al., "Road Traffic Noise and Annoyance: A Quantification of the Effect of Quiet Side Exposure at Dwellings", *International Journal of Environmental Research and Public Health*, vol. 10 issue 6, June 2013 - [link](#)
- [21] DIN 18005-1, "Noise abatement in town planning: calculation methods" - [link](#)
- [22] DIN 18005 Supplement 1. "Noise abatement in town planning: calculation methods. Acoustic orientation values in town planning." - [link](#)
- [23] Dublin City Council, "Proposal for the Designation of Quiet Areas within the Dublin City Council Region", 2013
- [24] EC, "Directive 2002/49/EC of the European Parliament and of the Council of 25 June 2002 relating to the assessment and management of environmental noise", consolidated text 25 March 2020 - [link](#)
- [25] EC, "Future Noise Policy", European Commission Green Paper, COM(96) 540 final, November 1996 - [link](#)
- [26] EC, "Handbook on the external costs of transport", version 1.1, report prepared by CE Delft for the European Commission, DG MOVE, ISBN 978-92-76-18184-2, January 2019 - [link](#)
- [27] Edinburgh Agglomeration Working Group, "Noise action plan for the Edinburgh agglomeration", revised December 2010 - [link](#)
- [28] EEA, "Good practice guid on quiet areas", Technical report No. 4/2014, ISBN 978-92-9213-424-2, 2014 - [link](#)
- [29] EEA, "Environmental noise in Europe – 2020", Report No. 22/2019, ISBN 978-92-9480-209-5, Copenhagen (2020) - [link](#)
- [30] EEA, "Quiet Areas in Europe – The environment unaffected by noise pollution", Report No. 14/2016, ISBN 978-92-9213-745-8, Copenhagen, 2016 - [link](#)
- [31] Eigenmann T., Gaudenz J., "Städtische Ruhe-Orte, Fallbeispiele St. Gallen", ERR Raumplaner AG, prepared for Bundesamt für Umwelt (CH), St. Gallen, August 2014
- [32] Fainstein, S. "Urban planning", article provided by the Encyclopedia Britannica, last thorough revision January 2007 - [link](#)

- [33] Fiorin E., “Valletta Soundscape Regeneration - Exploring the Soundscape Approach in designing urban landscapes”, MSc Thesis Landscape Architecture, Wageningen University, October 2018 - [link](#)
- [34] Gouvernement du Grand-Duché de Luxembourg, Ministère de l’Interieur, “Règlement-type sur les Bâtisses, les Voies publiques et let Sites”, Version 2018 - [link](#)
- [35] Government of Ireland, “Project Ireland 2040 – National Planning Framework”, February 2018 - [link](#)
- [36] Gezondheidsraad, “Stille gebieden en gezondheid” (Quiet areas and health), report with English summary by Health Council of the Netherlands, Nr. 2006/12, ISBN 978-90-5549-608-2, July 2006 - [link](#)
- [37] ISO, “Acoustics – Soundscape – Part 1: Definition and conceptual framework”, ISO 12913-1:2014, September 2014 - [link](#)
- [38] ISO, “Acoustics – Soundscape – Part 2: Data collection and reporting requirements”, ISO/TS 12913-2, August 2018 - [link](#)
- [39] ISO, “Acoustics – Soundscape – Part 3: Data analysis”, ISO/TS 12913-3, December 2019 - [link](#)
- [40] Kang, J., “On the diversity of urban waterscape”, Acoustics 2012, France, April 2012,
- [41] Kang, J. et. al., “A model for implementing soundscape maps in smart cities”, Journal Noise mapping, Volume 5, Issue 1, June 2014 - [link](#)
- [42] Kilkenny County Council, “2019 – 2023 Noise Action Plan. Quiet Area Proposals 2020”, May 2020
- [43] Kloth M. et. al., “Practitioner handbook for local noise action plans. Recommendations from the SILENCE project” - [link](#)
- [44] Krass Ph., Berchtold M., “Lärmschutz und Stadtplanung – Städtische Ruheorte, Fallbeispiele in Karlsruhe”, berchtoldkrass space&options, prepared for Bundesamt für Umwelt (CH), Karlsruhe, August 2014
- [45] Krog N.H. et al., “Effects of Changed Aircraft Noise Exposure on the Use of Outdoor Recreational Areas”, International Journal of Environmental Research and Public Health, volume 7 issue 11, November 2010 - [link](#);
- [46] Krog N.H. et al., “Effects of Changed Aircraft Noise Exposure on Experiential Qualities of Outdoor Recreational Areas”, International Journal of Environmental Research and Public Health, volume 7 issue 10, November 2010 - [link](#);
- [47] Kropp, W. et. al., “ Urban Sound Planning – the SONORUS project”, project report of the SONORUS project, Sweden, 2016 - [link](#)
- [48] Ku, W., Liu, P. and Nie, Z., “Estimating the economic value of soundscapes in nature-based tourism destinations: a separation attempt of a pairwise comparison method”. *Sustainability*, 13, 1809, 2021.
- [49] Lavia, L. et. al., “Non-Participant Observation Methods for Soundscape Design and Urban Planning”, Chapter 4 of the *Handbook of Research on Perception-Driven Approaches to Urban Assessment and Design* by F. Aletta and J. Xiao, IGI Global, January 2018
- [50] Leupp R.M., Walker U. et al, “Ruhe bitte! – Wie Lage und Umweltqualität die Schweizer Mieten bestimmen”, report by Zürcher

- Kantonalbank (ZKB) and Bundesanstalt für Umwelt (BAFU), June 2011 - [link](#)
- [51] Li H.N. et al., “Can Surrounding Greenery Reduce Noise Annoyance at Home?”, *Science of the Total Environment*, vol. 408 issue 20, September 2010
- [52] Lockwood M., Tracy K., “Nonmarket Economic Valuation of an Urban Recreation Park”, *Journal of Leisure Research*, volume 27 issue 2, 1995
- [53] Maag T., “The quiet city – planning and designing public urban spaces that meet people’s needs”, proceedings *Internoise 2016*, Hamburg
- [54] Maag T., “Integrated urban sound planning – From noise control to sound quality for the everyday city”, proceedings *Internoise 2017*, Hong Kong
- [55] Medvedev, O., Shepherd, D., Hautus, M.J., “The restorative potential of soundscapes: A physiological investigation.” *Applied Acoustics*, 2015, 96, 20–26.
- [56] Menzel C., Thiry V., “Lärmschutz und Freiraumplanung, Fallbeispiele ausserstädtischer Ruheorte – Das Mergelland (Niederlande)”, Menzel sprl., prepared for Bundesamt für Umwelt (CH), Liège, January 2016
- [57] Morgan, P.A. et al., “Research into Quiet Areas: Recommendations for Identification”, TRL published project report PPR158, Final Version, prepared for UK Department for Environment, Food and Rural Affairs (DEFRA), September 2006
- [58] Nederlandse overheid, “*Wet geluidhinder*, Staatsblad 99 van 16 februari 1979 inclusief wijzigingen tot en met de Staatsblad 131 van 3 april 2017”, February 1979 - [link](#)
- [59] Office for National Statistics (UK), “Valuing green spaces in urban areas: a hedonic price approach using machine learning techniques”, online article, October 2019 - [link](#)
- [60] Öhrström E. et al., “Effects of road traffic noise and the benefit of access to quietness”, *Journal of Sound and Vibration*, volume 295 issues 1-2, August 2006 - [link](#)
- [61] Payne S.R., Bruce N., “Exploring the Relationship between Urban Quiet Areas and Perceived Restorative Benefits”, *International Journal of Environmental Research and Public Health*, volume 6 issue 9, May 2019 - [link](#)
- [62] Peeters B., Nusselder R., “Overview of critical noise values in the European Region”, M+P report M+P.BAFU.18.01.1 revision 4, prepared for EPA Network Interest Group on Noise Abatement (IGNA) (2019) - [link](#), with Executive summary - [link](#)
- [63] Peeters B., van Blokland G.J., “Decision and cost/benefit methods for noise abatement measures in Europe”, M+P report nr. M+P.BAFU.15.02.1 revision 6, prepared for the EPA Network Interest Group on Noise Abatement, February 2018 - [link](#)
- [64] Peeters P., Melkert J., “Toekomst verduurzaming luchtvaart: een actualisatie”, scientific fact sheet for the Dutch parliament, June 2021 - [link](#)

- [65] Peris E. et al., “Assessment of quiet areas in Europe”, proceedings of the 23rd International Congress on Acoustics ICA, Aachen, September 2019 - [link](#)
- [66] Rapp I., Bröhl A., “Wie Lage und Umweltqualität die Eigenheimpreise bestimmen – Hedonisches Modell für Stockwerkeigentum”, prepared by Zürcher Kantonalbank (ZKB) for Bundesanstalt für Umwelt (BAFU), July 2012 - [link](#)
- [67] République Française, “LOI n° 2021-85 du 29 janvier 2021 visant à définir et protéger le patrimoine sensoriel des campagnes françaises (1)” - [link](#)
- [68] Rowcroft P. et al., “Is quiet the new loud? Towards the development of a methodology for estimating the economic value of quiet areas”, proceedings of ICBEN 2011, London, July 2011 - [link](#)
- [69] Schäfer, R.M. “The soundscape: Our Sonic Environment and the Tuning of the World”, Destiny Books, Vermont, 1977
- [70] Schäffer B. et al., “Residential Green is Associated with Reduced Annoyance to Road Traffic and Railway Noise but Increased Annoyance to Aircraft Noise Exposure“, Environment International 143, October 2020 - [link](#)
- [71] Senatsverwaltung für Umwelt, Verkehr und Klimaschutz Berlin, “Lärmaktionsplan Berlin 2019 – 2023. Nach Maßgabe des § 47d Bundes-Immissionsschutzgesetz”, Berlin, June 2020 - [link](#)
- [72] Senatsverwaltung für Umwelt, Verkehr und Klimaschutz Berlin, “Lärmaktionsplan Berlin 2019 – 2023. Berlin wird leiser. Auswertungsbericht der Öffentlichkeitsbeteiligung”, Berlin, March 2019 - [link](#)
- [73] Senatsverwaltung für Umwelt, Verkehr und Klimaschutz Berlin, “Lärmaktionsplan Berlin 2019 – 2023. Anlage 10: Ruhige Gebiete und städtische Ruhe- und Erholungsräume”, Berlin, June 2020 - [link](#)
- [74] Shepherd D. et al., “Do Quiet Areas Afford Greater Health-Related Quality of Life than Noisy Areas?”, International Journal of Environmental Research and Public Health, vol. 10 issue 4, April 2013 - [link](#)
- [75] South Dublin County Council, “Dublin Agglomeration Action Plan Relating to The Assessment and Management of Environmental Noise December 2018 – November 2023 (Noise Action Plan), Volume 4 South Dublin County Council”, December 2018 - [link](#)
- [76] Scottish Government, “Technical Guidance - Noise Action Plans, Candidate Quiet Areas to Quiet Areas”, November 2009
- [77] Swiss Federal Council, “Noise Abatement Ordinance (NAO)”, English translation of the “Lärmschutzverordnung (LSV)” of 15 December 1986, status 7 May 2019 - [link](#)
- [78] Quinton M., McGregor I., “An Introductory Study of the Maltese Soundscape”, proceedings Invisible Places – Sound, Urbanism and Sense of Place, Portugal, July 2014 - [link](#)
- [79] Umwelt Bundesamt, “Technisch wissenschaftliche Unterstützung bei der Novellierung der EU-Umgebungslärmrichtlinie. Arbeitspaket 3: Ruhige Gebiete”, December 2014 - [link](#)
- [80] URS/Scott Wilson, “The Economic Value of Quiet Areas”, Final Report, prepared for UK Department for Environment, Food and Rural Affairs (DEFRA), March 2011 - [link](#)

- [81] Van Kempen, E.E.M.M., Van Beek, A.J. “*De invloed van een stille zijde bij woningen op gezondheid en welbevinden*”, RIVM Briefrapport, 2013 - [link](#)
- [82] Van Moppes R., Elbers F., “Geluidsdeken smooit Nederland” (Noise blanket smothers the Netherlands), magazine article by dBvision in Tijdschrift Milieu, in Dutch, June 2017 - [link](#)
- [83] Van Renterghem T., Botteldooren D., “Focused Study on the Quiet Side Effect in Dwellings Highly Exposed to Road Traffic Noise”, International Journal of Environmental Research and Public Health, vol. 9 issue 12, November 2012 - [link](#)
- [84] Van Renterghem T., Botteldooren D., “View on outdoor vegetation reduces noise annoyance for dwellers near busy roads”, Landscape and Urban Planning, vol. 148, April 2016 - [link](#)
- [85] Van Renterghem T., “Towards explaining the positive effect of vegetation on the perception of environmental noise”, Urban Forestry and Urban Greening, vol. 40, April 2019 - [link](#)
- [86] Vereniging van Nederlandse Gemeenten, *Handreiking Bedrijven en Milieuzonering*, June 2009
- [87] Welsh Government, “*Call for Evidence: Review of Technical Advice Note 11 Noise, to incorporate Air quality and Soundscape*”, February 2020 - [link](#)
- [88] Welsh Government, “*Noise and soundscape action plan*”, 2018 - [link](#)
- [89] WHO, “Environmental Noise Guidelines for the European Region”, World Health Organisation Regional Office for Europe, ISBN 978 92 890 5356 2, Copenhagen, October 2018 - [link](#)
- [90] Wu, K. et al., “*Estimating the Economic Value of Soundscapes in Nature-Based Tourism Destinations: A Separation Attempt of a Pairwise Comparison Method*”, journal Sustainability, volume 13 issue 4, February 2021 - [link](#)
- [91] Zeyen+Baumann, “Quiet Areas – Definition einer Gebietskulisse für ruhige Gebiete in Luxemburg”, report prepared for Administration de l’Environnement, Luxembourg, February 2015
- [92] Zeyen+Baumann, “Quiet Areas – Ruhige Gebiete im Süden Luxemburgs”, report prepared for Administration de l’Environnement, Luxembourg, April 2018
- [93] Zeyen+Baumann, “Quiet Areas – Ruhige Gebiete in der Agglomeration Luxemburg”, report prepared for Administration de l’Environnement, Luxembourg, April 2019

Appendix - Current research

- “Soundscape Indices (SSID)” - Research project aiming to develop prediction models for the perception of the soundscape. University College London (UK), Institute for Environmental Design and Engineering, research group led by Prof Jian Kang. Project funded by the ERC Advanced Grant. - [link](#)
 Contact person: Dr Francesco Aletta
- Urban sound planning is one of the research subjects at the research group WAVES from Ghent University (Belgium), part of the Department of Information Technology. Several related topics of interest are listed on the website, including fast and accurate sound mapping at shielded (quiet) urban locations, modelling and calculations of the quiet side, modelling of the acoustic effect of building envelope greening, etc. Another research subjects is the interaction of sound with green and vegetation. - [link](#)
 Contact person: Dick Botteldooren / Timothy van Renterghem
- Research on psychoacoustic parameters describing the relationship between audio signal properties and psychoacoustic characteristics such as tonality or impulsiveness, are studies at the Faculty of *Verkehrs- und Maschinensysteme, Strömungsmechanik und Technische Akustik*, at the Technische Universität Berlin (Germany).
 Contact person: André Fiebig
- Soundscapes and quiet areas are studied at the Acoustics Research Group from the University of Salford, UK. Research projects on the topic of [psychoacoustics](#), among which projects regarding positive soundscapes and policy applications of soundscapes, have been carried out before. Recently an experimental study was done involving soundscape assessment tools to investigate industrial noise in a quiet area - [link](#)
- CEDR-project FAMOS, “Factors moderating people’s subjective reactions to road noise” – project aiming to quantify the way in which acoustic factors of road noise modify people’s reactions, by reviewing former annoyance surveys - [link \(http://famos-study.eu/\)](http://famos-study.eu/)
- “Noise indicators and health” – working group that aims to investigate and promote the use of other indicators than the classical LAeq and Lden. These indicators refer solely to the intensity of sound sources, which does not provide sufficient information on health effects as the stress response caused by sounds varies with the type of sound involved. Different researchers collaborate on this project, and related publications can be found on Mark Brink’s lab on researchgate - [link](#)
- “RESTORE” project – Restorative potential of green spaces in noise-polluted environments, Swiss Federal Institute for Forest, Snow and Landscape Research (WSL). The project aims to assess the effects of green spaces as facilitators and noise as impediment to recover from stress: How are perceived and physiological stress associated with noise, what are the effects of visiting or living near green spaces on short- and long-term stress, and what audio-visual requirements do green spaces need to have for this? Research techniques include recreation of the audio-visual environments in a laboratory setting, physiological measurements and questionnaires - [link](#)
 Contact person: Silvia Tobias (WSL), Jean Marc Wunderli, Beat Schäffer (EMPA)
- “DeStress” project – Exploring & creating urban places & soundscapes: their impact on your health & wellbeing, Heriot-Watt University, Scotland, funded by the Engineering and Physical Sciences Research Council, in the UK [EP/R003467/1]. The project website includes an [Environment Simulator](#) in which users can design and experience their own audio-visual environment based on several choices. - [link](#)
 Contact person: Sarah Payne