

## Soundscape planning as a tool for urban planning

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### ABSTRACT

Dealing with noise is one of the major challenges cities are facing. Spatial planning and noise legislation in Germany is commonly based on the idea of noise avoidance and noise control, whereby noise is treated as a waste product. At the same time, there is consensus that quantitative noise reduction is not enough to address the acoustic environment. Therefore a readjustment of the instruments and methods of spatial planning is necessary. As a suitable alternative in thinking about noise the soundscape approach might open up new, more holistic perspectives by considering the acoustic environment as a resource. However, there is currently a lack of practical approaches to include the idea of soundscapes in spatial planning. This study asks the question: *How can a soundscape planning approach be integrated as an instrument for spatial planning in Germany?* To answer the research question, a systematic review of existing literature and a summary of German noise-related policy instruments will provide a framework of how sound and noise is treated in Germanys legal system and give insight into how a soundscape approach could be integrated into the German spatial planning system.

Keywords: Soundscape Planning, Urban Planning, Spatial Planning Instruments

### 1. INTRODUCTION

Dealing with noise is one of the major challenges cities are facing, as noise is one of the greatest environmental risks to human health today. So far, planning practice has focused on the approach of reducing, avoiding and combating noise. The acoustic environment is considered from the viewpoint of noise as a waste product to be reduced. The sound level is the decisive and often exclusive assessment criterion. Also, dealing with the issue is understood as a restriction of the planning process. At the same time, there is a consensus in many disciplines that this quantitative noise reduction is not sufficient to address the acoustic environment (1). In order to find a suitable way of dealing with urban sound environments in the future, it will be necessary to readjust the instruments and methods of spatial planning (2). There is a demand for new approaches to understand the acoustic reality, which aim at a more differentiated and holistic consideration. The soundscape approach is discussed in the literature as a suitable alternative approach to the consideration of acoustic environments (3). The soundscape is the acoustic environment as perceived by humans, whose character is determined by the action and interaction of natural and human factors (4). By focusing on the individual position of the listeners, additional knowledge about the acoustic environment can be gained. The measurable physical sound properties are supplemented by the specification and differentiation of desired and unwanted sounds. If the listening experience becomes the subject of design, the acoustic environment can be actively included in the planning and design process (5). The soundscape approach not only offers an analysis tool, but can also be used in the planning process. Soundscape planning aims to design and improve the soundscape of a place. The approach can therefore be a sensible supplement to noise avoidance and noise abatement measures as well as a contribution to a positive acoustic design of places (6). Contrary to the theoretical agreement, practical approaches on how to integrate soundscape planning into planning are currently lacking. The existing gap between theory and practice in including the sound environment in planning and design indicates a need for research in order to find holistic approaches for a sustainable handling of urban soundscapes (3,7).

The overall goal of this research is to provide new inputs to spatial planning based on the

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soundscape approach and to discuss options for the integration of soundscape planning as a planning tool in Germany. The following research question will therefore be investigated: *'How can the approach of soundscape planning be integrated as a planning instrument into spatial planning practice in Germany?'*. Sub-questions are also formed: A1: *'What role does the acoustic environment play in spatial planning practice in Germany today?'*; A2: *'What are the current approaches to integrating the soundscape approach into planning practice?'*; A3: *'What challenges and opportunities result from the integration of the soundscape approach into planning practice in Germany?'*.

The relevance of the topic for spatial planning and the legal foundations and planning instruments for dealing with noise in planning practice in Germany are laid out in section 2. In addition, an insight into soundscape research will be given. This will be followed by a discussion of sub-question A1. Section 3 forms the analytical part of the study, that shows how the soundscape approach can be integrated into planning processes on the basis of the systematic literature research. Since extensive literature exists on the individual subject areas of soundscape and noise in spatial planning, but only a few publications consider both subject areas together, the literature search aims to examine the interface more closely. The databases Scopus, Web of Science and SAGE Journals were searched on the basis of various keyword terms. In addition, the specialist database JASA Express Letters was included. The search was limited to articles that have been published in English or German in the last 10 years and are freely accessible to students of the TU Dortmund. The search results were initially narrowed down by screening the titles and abstracts of the articles. In order to avoid relevant literature not being covered by the search grid, a reference search was carried out. In this procedure, 30 publications were identified. Based on the general content analytical process model according to P. Mayring, the literature was systematically evaluated (8). The material was filtered using defined categories which include the spatial outline of the planning. Furthermore, the methodological approach of the soundscape approaches was examined and whether qualitative or quantitative methods or a combination of both were applied. Finally, it was examined whether reference was made to existing planning instruments. Thus, the current state of research regarding the integration of the soundscape idea into planning processes is mapped and a contribution is made to answering sub-question A2. Based on the insights gained, expert interviews were conducted with the authorities responsible for noise abatement planning in the three cities of Bochum, Duisburg and Essen. Starting points for the soundscape idea in the planning process were discussed and possible opportunities and challenges for integration into practice were examined. The results are listed in section 3.2 along with the discussion of sub-question A3.

## **2. THEORETICAL BIAS**

### **2.1 Relevance of soundscape approach for spatial planning**

People's health and well-being depend on many factors and can only be influenced by politics and administrative action to a certain extent. But it is precisely the decisions of spatial planning that have an effect on the living and working environment over long periods of time that can have a decisive influence on people's lives. Spatial changes are often accompanied by burdens on health and the environment. Noise has been shown to cause a number of health problems and these effects do not only occur at a certain noise level, but can also be caused by low and long-term noise exposure (9). According to the WHO, health is a 'state of complete physical, mental and social well-being' (10), in order to maintain and promote health, it is necessary to preventively minimize the risks and burdens. At the same time, it is important to strengthen the individual health resources available to people to cope with stress. These are largely determined by the everyday living environment. Following the Ottawa Charter of the WHO, health promotion serves to create healthy living environments and thus also healthy cities. Health care and health promotion are an important field of spatial planning (11). Spatial planning can be understood as the totality of measures to develop guiding principles for an ideal state of the space to be striven for and to create the prerequisites for its realization. Thus, spatial planning is faced with complex problems that require an interdisciplinary approach and the inclusion of different perspectives (12). As the acoustic space is omnipresent and has a decisive influence on health, well-being and human possibilities of action, an interdisciplinary approach to the acoustic environment can therefore lead to increased acoustic awareness in spatial planning.

## 2.2 Noise-related policy in Germany

Noise protection regulations are anchored in European Union (EU) law as well as at the federal level in Germany. EU legislation primarily includes noise legislation on emission sources. Noise reduction at the point of immission is addressed by the Environmental Noise Directive (END) and the Directive on Environmental Impact Assessment. In the 1970s, the first source-related noise regulations were introduced at European level by Directive 70/157/EEC which includes permissible decibel limit values for different vehicle types. This was followed by further regulations for various noise sources. In 2002, the END addressed noise pollution more strongly on the recipient side for the first time (13). The END aims directly at improving the noise pollution situation of people by identifying problem areas and developing action plans to solve them. Environmental noise is defined as unwanted or harmful outdoor noise caused by human activity. The main tasks of the END are the uniform presentation and assessment of noise in the form of noise maps, the identification of quiet areas, the establishment of noise management action plans to reduce noise and the provision of information to the public on the effects of environmental noise (14). Another relevant requirement for area-related noise protection is the environmental assessment, which is regulated in two EU directives. The Environmental Impact Assessment Directive (EIA Directive) and the Directive on the assessment of the effects of certain plans and programs on the environment (SEA Directive) are intended to ensure that the effects of individual projects, plans and programs are recorded and assessed. Noise is also one of the relevant impacts in the EIA and SEA directives (13).

In Germany there is no comprehensive noise protection law at the federal level. The provisions applicable to noise protection are sectorally based on various noise sources. However, the regulations diverge with regard to the limit values laid down and the legal situation is particularly complex (13,15). Noise abatement regulations are primarily to be found in public law and can be distinguished between source-based and area-based approaches. Regarding source-related approaches, the Federal Immission Control Act (Bundes-Immissionsschutzgesetz BImSchG) is of central importance. The BImSchG aims to protect people from harmful environmental impacts and to prevent the occurrence of these. Harmful environmental impacts are defined as immissions that are likely to cause hazards, considerable disadvantages or considerable nuisance to the general public or the neighborhood, and noise can be classified as such an immission. Further concretization does take place in subordinate ordinances and administrative regulations, through different limit values for individual noise sources like trade and traffic. The separate consideration of the source-related approaches is contrasted with the area-related regulations. In the context of urban land-use planning, noise is an object of consideration. Urban land use planning serves to prepare and manage the structural and other use of land in the municipality. Urban land-use planning includes the Land Use Plan (Flächennutzungsplan, FNP), which is to be drawn up for the entire municipal territory, and the Development Plan (Bebauungsplan, B-Plan) to be developed from it, which regulates the development of land plots. The Federal Immission Control Ordinances and the DIN standard 18005 can serve as orientation aids in the weighing process. The binding nature of the orientation aids, however, depend on the respective planning situation. The limit values for noise vary, so that no uniform noise protection is guaranteed in spatial planning (13,16,17). Whereas urban land-use planning only reacts to noise in relation to building sites, the national implementation of the END offers the instrument of noise abatement planning (Lärminderungsplanung LMP). In contrast to the assessment of noise as a harmful effect on the environment in the BImSchG, the concept of environmental noise no longer presupposes the materiality of a disadvantage and a nuisance, so that the threshold for assessing a sound as noise is lowered. Noise maps for the presentation of the noise situation are defined as instruments, which serve as the basis for noise action planning. Within the framework of noise action planning, noise abatement measures are to be laid down. The determination of the measures is at the discretion of the municipality. Likewise, 'quiet areas' are to be designated. However, noise reduction plans do not result in an obligation to implement. In addition to the source-related and area-related regulations, noise is also the subject of environmental assessments (EIAs). These are intended to integrate environmental concerns in procedural terms. The European requirements for the environmental assessment can be found in national law in the Environmental Impact Assessment Act (UVPG) and in the Building Code (BauGB). The subject of the Environmental Impact Assessment is the environmental impact on the objects of protection defined in § 2 UVPG, such as people and their health. The relevant impacts also include noise. Environmental assessment instruments include the environmental impact assessment (EIA) and the strategic environmental impact assessment (SEA).

## 2.3 Planning instruments

At the local level, the legal bases find their practical application. Planning instruments are understood in this paper as tools to be able to realize planning (18). The planning instruments are divided into formal and informal instruments. Formal instruments include legally binding plans and programs, while informal instruments are not legally binding. In addition the procedural instruments examine the environmental and noise impacts when drawing up plans and programs and deciding on the admissibility of projects. The formal instruments of noise protection is the urban land-use planning with the FNP and the B-Plan. Even at the FNP level, noise conflicts can, to a limited extent, be dealt with at an early stage. The FNP has no direct legal effect on third parties and private individuals, but it is the basis for the B plan. A significantly more effective handling of noise can be regulated in the B plan, as it has a direct legal effect as a statute. The scope of the B-Plan is limited to building areas. Likewise, as shown in the previous chapter, there are no fixed assessment standards for noise. Since various guidelines are referred to for the limit and orientation values, there is a range for the definition of measures and the weighting of noise in the consideration process (13,19,20). Informal instruments include noise maps and noise action maps, which offer the possibility of a conceptual and community-wide approach to acoustic environments. For this purpose, the municipalities have a variety of measures to choose from. In addition, the information content regarding the acoustic situation vis-à-vis the public should be emphasized. The implementation of the noise action planning is restricted by the lack of binding effect (13,14). The process-oriented instruments of environmental audits ensure that environmental protection concerns are considered and, in this context, the noise effects are also taken into account. The EIA instrument starts with the planning of concrete projects and must be included in the assessment process via admissibility. Within the scope of the EIA, the effects of projects on the protected goods are examined. Environmental assessments ensure that noise impacts are taken into account in the decision-making on the admissibility of projects and plans. Noise is only one of many environmental impacts that are considered. The environmental assessments do not have any direct legal effect. They are only to be taken into account when drawing up plans (13).

## 2.4 Soundscape Research

R. Murray Schafer takes up the term soundscape in the 1970s and coins the meaning of its content in connection with the concept of landscape. Landscape can be understood as an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors" (21,22). Consequently, the soundscape can also be described as the acoustic environment of a place whose character is determined by the action and interaction of natural and/or human factors. According to Schafer, the sounds of the environment refer to reality, so the soundscape as a whole of all perceived sound events becomes a readable sign system.

Soundscape research opens up various analytical perspectives on the acoustic environment. There are approaches that cover the physical structure, the human perception of sound (1,23). Regarding the physical structure of the acoustic environment, the research area of Acoustic Ecology provides a set of quantitative methods. Acoustic Ecology deals with the relationships between humans, flora, fauna and the acoustic environment. Several acoustic indices have been developed in recent years. Although the soundscape indices were primarily developed for the analysis of natural sound environments, they can also be used in an urban context. In addition to the soundscape indices, psychoacoustic parameters can also be used to describe acoustic environments. These include sharpness, roughness, fluctuation and tone. These can be determined on the basis of an analysis of a questionnaire in ISO 12913-2, and a wide range of additional information can be obtained from such soundscape analysis (1,6). With regard to subjective evaluation, the interface of social science and psychological research areas provides a number of qualitative methods. The premise is pursued that human perception is a suitable evaluation yardstick. An analysis of the language used to describe the soundscape, targeted questionnaires and sound walks provide insights into the listener's relationship to the environment (23,24). Soundscape research thus offers a range of qualitative and quantitative research methods that can lead to a comprehensive data basis, also for the investigation of urban quarters.

In addition to the analytical dimension, soundscape research also includes the question of long-term design, improvement and maintenance of the acoustic environment. By also considering desired sounds, visions and objectives for planning can be derived. The terms soundscape planning/design/management/policy result from the analogy to the landscape term and imply the idea of a conscious and active handling of the acoustic environment (4,6).

Soundscape research has been characterized by a process of harmonization and standardization

with regard to the research framework and the use of terminology in recent years. An example of the harmonization efforts is the ISO 12913-1 and ISO/TS 12913-2, which provides uniform definitions as well as methods for data collection. Due to the growing standardization of the research field, the willingness to integrate the soundscape concept into the planning processes is increasing (25,7).

## **2.5 Interim conclusion**

The first sub-question A1 can be answered to the effect that acoustic environments are considered from the point of view of noise in planning practice. Noise conflicts are to be avoided through limit and orientation values. With regard to the instruments, it can be seen that noise is taken into account both in binding urban land-use planning and in procedural environmental assessments, but only as a matter of consideration. This results in a wider, but not clearly defined, scope of action for planning. Only the LMP aims specifically at improving the acoustic environment. However, the LMP does not make it compulsory to implement noise protection measures. The specialist literature contains various points of criticism of the existing planning practice. One point of criticism is the lack of uniform legislation in Germany. Because noise sources are considered separately, there are no suitable assessment criteria for the interaction of different noise sources and combined acoustic effects (15). Another point of criticism relates to quantitative and technical noise assessment, which, on the one hand attempts to objectify noise contradicts what noise is, namely a subjective reaction, and on the other hand it has been shown that the sound level as the single decisive basis for evaluation has only little informative value. There is a demand for additional assessment criteria (17,20,27). Finally, the necessity of finding holistic and interdisciplinary approaches becomes apparent. Overall spatial planning concepts and multi-sectoral approaches can lead to noise problems being addressed at an early stage. Based on these problems, the soundscape approach is described by various sides as a new paradigm for noise protection policy. The Federal Institute for Research on Building, Urban Affairs and Spatial Development (Bundesinstitut für Bau-, Stadt- und Raumforschung, BBSR) and the European Environment Agency also propose using the soundscape approach as a basis for assessing noise within the framework of LMP (20,28).

## **3. ANALYSIS**

### **3.1 Practical soundscape approaches**

The literature research shows that there are already various approaches integrating the soundscape approach into spatial planning, namely as individual pilot projects. A uniform and standardized approach does not yet exist. To answer the sub-question A2, the evaluation of the literature research makes it clear that the soundscape approach can be integrated into planning both on a small scale and on a large scale and is characterized by a combination of qualitative and quantitative methods. On a large scale, the soundscape approach primarily serves the differentiated analysis of the acoustic situation. In the landscape area and on an urban level, a combination of quantitative and qualitative methods is used to analyze the acoustic situation. The combination of these methods enables a differentiated evaluation and allows conclusions to be drawn about quality, animation, perception and environmental quality. In most cases, the data are considered in connection with other georeferenced information, such as spatial structure, traffic density, and proximity to surrounding uses. The analysis is usually presented in the form of sound maps, psychoacoustic maps and soundscape maps reflecting the perceived acoustic environment. On a small scale, the soundscape approach can be applied not only to analyze but also to concretize measures. The focus is often set on public parks, green spaces and squares. Here, too, the analysis of the acoustic environment is carried out using both quantitative and qualitative methods. The integration of space users can on the one hand provide important information and at the same time lead to an increased acceptance of planning. The combination of the methods allows a differentiated characterization of the acoustic environment. Thus, on the one hand, it is possible to distinguish between desired and unwanted sounds, and on the other hand, site-specific and identity-creating sounds can also be recorded. Concrete measures can be derived from psychoacoustic analysis, which consider both desired and unwanted sounds. It is also possible to locate possible areas for a small-scale sound design, such as the integration of water sounds or the use of sound attenuation structure. Since both scale levels are covered, it can be seen that the soundscape approach can be used independently of scale. The combination of the methods shows that the soundscape approach can be a useful supplement to the quantitative noise assessment of current noise protection policies. The quantitative methods are supplemented by the repertoire of social science methods of surveys and

interviews. Since the methods primarily serve the analysis of the acoustic environment, they are used at the beginning of the planning processes. The resulting measures go beyond noise reduction and include the highlighting of positively perceived sounds. The publications show that the methodological repertoire of soundscape research can provide an important basis for planning. As most publications are linked to noise abatement planning, this reinforces the proposal of the BBSR and the European Environment Agency (29-56).

### **3.2 Perspectives of noise abatement practice**

The evaluation of expert interviews indicated that noise mapping is a suitable instrument for recording focal points of noise. Noise action planning has only a minor effect, as the financial means for implementing the measures are often lacking. The noise indices on which noise mapping is based form a suitable basis for identifying noise focal points. However, the municipalities also consider other data bases to be useful for noise assessment. Online surveys are already used to identify 'quiet areas'. This shows the potential for further evaluation methods. This assessment coincides with the criticism of the purely quantitative and technical noise assessment and the demand for more differentiated assessment criteria listed in section 2.5. The authorities show a fundamental openness towards new approaches such as the integration of the soundscape idea. Sub-question A3 can be answered to the effect that the integration of the soundscape approach can be seen as an opportunity for a differentiated consideration of the acoustic environment. The approach is also seen as an opportunity to better communicate the noise situation to the population. Restrictions can be seen in the fact that the authorities lack the financial means for further measures. It also shows that the focus should continue to be on reducing and avoiding traffic noise.

## **4. CONCLUSIONS**

The main research question can be answered to the effect that soundscape planning can be integrated into planning practice in Germany as a supplement to the instruments of LMP. Noise mapping is an important tool for identifying noise focal points. In addition, the soundscape approach could be used for a deeper analysis of the acoustic environment. The combination of quantitative and qualitative methods of soundscape research allows a more detailed characterization of the acoustic environment, taking into account all the noise sources involved. On the one hand, the use of soundscape indices and psychoacoustic parameters allows an investigation of the physical composition of the sound environment beyond the noise level, on the other hand subjective evaluations are included and made easier to handle for planning. Thus, the view on possible options for action is widened by considering not only the negative aspects of noise, but also the positive aspects of sounds. Noise maps can be supplemented with psychoacoustic maps, sound maps and soundscape maps. The increasing standardization of the methods by ISO 121913-2 can help to increase the acceptance of soundscape methods for planning (25). The soundscape approach can be used in a meaningful way, especially with regard to the identification of 'quiet areas'. Looking at the positive aspects of a sound environment makes it possible to capture the advantages, benefits and information content of the acoustic environment and the importance of acoustic environments for health and well-being can be emphasized. By understanding the acoustic environment as a resource, a contribution can be made to the preservation, care and protection of good quality soundscapes.

The increasing noise pollution in cities has causes that are rooted in the patterns of life and behavior in our society. Noise management must therefore continue to focus on noise reduction in order to counter traffic noise in particular. The soundscape approach can at least open up a new perspective and create a greater awareness of the importance of the sound environment. The interdisciplinarity of soundscape research can provide a suitable framework for discussions on the question 'How does a healthy city sound?'. Based on the results of this research, further open questions arise. A comparative study of the legal framework and noise abatement practices of other countries could reveal new approaches to dealing with noise. Further research is also needed on the application of quantitative soundscape methods in urban space. Especially the soundscape indices should be further tested and improved with regard to their applicability in urban space. The health effects of a soundscape should be taken into account. Finally, important design criteria for urban planning and development could be derived from the findings of soundscape research. A soundscape design guide could help to integrate the acoustic environment into the planning and design process and thus contribute to more livable and healthier cities.

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