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TOWARDS A FRAMEWORK FOR EVALUATING AND INTEGRATING QUIET AREAS INTO URBAN PLANNING

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Abstract

Existing EU approaches for quiet area identification often rely on noise level assessment, giving less weight to *in situ* measurements and subjective data. Recent research, alongside EEA and ETC/ATNI reports, recognises quiet areas through acoustic conditions, spatial qualities, visual attributes and cultural context. While emerging studies acknowledge quiet areas as multidimensional constructs, they do not provide a structured methodology that links spatial metrics, acoustic indicators and user experience. This paper proposes a mixed-methods framework that integrates objective and subjective data for quiet area evaluation and their integration into urban planning. Combining soundwalk and space syntax methods with natural and cultural heritage evaluation will enable a multi-layered interpretation that considers accessibility, land-use compatibility and heritage value. Relating soundscape perception to inherent spatial configuration and built structure, will reveal areas where physical form and sensory experience converge to achieve conditions for urban quietness and pleasantness. Particular attention is given to layers of urban forests and cultural heritage whose characteristics shape spatial networks and experiential characteristics of the city. The proposed methodology aims to support a more comprehensive understanding of quiet areas as socio-spatial constructs and contributes to the development of context-sensitive urban planning strategies to enhance overall quality of life.

Keywords: *soundwalk, space syntax, urban forests, cultural heritage*

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1. Introduction

Rapid urbanisation increases exposure to noise highlighting the need for preserving (auditory) restorative spaces within cities. Traditionally, environmental acoustics has concentrated on mitigating unwanted noise, but recent soundscape research advocates a broader perspective that considers people's perception and experience. Therefore, quietness is increasingly recognised as a positive environmental quality that contributes to urban well-being and sustainable development.

Directive 2002/49/EC of the European Parliament and of the Council of 25 June 2002 introduced the concept of quiet areas requiring Member States to identify and protect them. However, implementation of these requirements differs substantially between countries. Existing methodologies rely largely on noise maps, which do not fully capture spatial characteristics and accessibility, and overlook aesthetic value and human perception.

In Croatia, strategic noise maps are being made, but quiet areas are recognised only in national legislation and are not yet systematically delineated. Systematic integration of quiet areas into urban planning and decision-making processes remains limited.

Aim of this paper is to expand the understanding of quiet areas as multidimensional urban landscapes and contributes to the development of a more comprehensive approach for their identification, evaluation, preservation, enhancement and planning by integrating physical, spatial and acoustic measures, perceived qualities and inherent values of urban forests and cultural heritage.

2. Quiet areas beyond noise mapping

Sounds are a constant and dynamic component of urban landscapes that play a crucial role in how people value them [1]. Although generation and propagation

of sound is rooted in physical processes, its perception is an environmental and psychological phenomenon [2] and thus can't be fully understood only through quantitative measures. Soundscape studies build on this perspective by exploring the acoustic environment through people's experience within context [3] focusing on both positive and negative outcomes related to well-being and quality of life [4]. Research on the sonic environment has previously been dominated by negative impacts of noise pollution, but in recent years soundscape approaches are emerging within urban planning discourse [5]. Despite this, the potential benefits of soundscape in urban planning remain underexplored, particularly in the context of sustainability and resilient urban development. Therefore, it is essential to approach environmental acoustics in a constructive and proactive manner that doesn't only fixate on identifying undesirable conditions but rather recognizes soundscape elements that need to be preserved and promoted [6].

Aforementioned Directive 2002/49/EC of the European Parliament and of the Council of 25 June 2002 [7] and Good practice guide on quiet areas [8] distinguish between quiet areas in an agglomeration and open country. ''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.'' [7, p. 14]. From 2005, EU Member States are legally obliged to produce strategic noise maps and noise action plans at least every five years, which also includes the delineation of quiet areas. However, the directive allows each country to develop its own methodology for identifying quiet areas and does not dictate a unique approach of preserving quietness which has resulted in different interpretations and implementations [9]. Scandinavian countries and Wales for example, have made commendable progress regarding mapping quiet areas. In Sweden about 41% of municipalities include them in planning documents, but only a small share have advanced implementation strategies. Moreover, interest in quiet areas does not seem to be directly related to the EU requirements but is instead inspired by previous regional initiatives [10]. In Croatia, strategic noise maps have been made according to the requirement, but quiet areas have not yet been officially designated. Although quiet areas are formally recognized and defined under the Noise Protection Act (Official Gazette 14/21), they have not yet been integrated into spatial or urban planning documents, thereby preventing their practical protection. Mapping of potential quiet areas was carried out only in Zagreb in 2018 as part of the Noise Action Plan 2018–2023, selecting candidates based on the following criteria: noise level, appropriate land use and a minimum area of 10 ha [11]. Conventional noise maps don't explicitly show quiet areas; they only indicate areas where noise levels are below predefined thresholds. Noise data are obtained through predictive modelling complemented where possible with *in situ* measurements. This normally includes only road and railway traffic noise, industrial noise and noise in the vicinity of airports, but doesn't take into account all sounds produced by humans [12].

3. Multidimensional understanding of quiet areas

Physical characteristic and spatial patterns have been shown to affect soundscape perception [13]. Quietness is a subjective multi-sensory concept shaped by low noise levels, dominance of natural sounds and visual quality with naturalness and distance from noise sources being key factors in perceived tranquillity. The European Environment Agency (EEA) and the European Topic Centre on Air Pollution, Transport, Noise and Industrial Pollution (ETC/ATNI) apply a state-of-the-art approach for identifying quiet areas that combines noise maps with geospatial land use and land cover data using GIS tools. As a result, a specific composite indicator, the Quietness Suitability Index (QSI), was developed [14]. To provide a more comprehensive quiet area assessment additional relevant criteria may be considered, including size, accessibility, vegetation, perception and other elements (e.g. paths, opportunities for recreational activities). Landscape, archaeological, architectural, historic, artistic and scenic values are briefly mentioned [15], [16] suggesting gradual incorporation of cultural dimensions into the concept of quiet areas. Most recent studies [17] show that, in specific public spaces, natural and cultural soundscapes interact to shape people's experience. Natural sounds (e.g., birdsong, wind, water) generally enhance perceived tranquillity and environmental quality [18], while cultural sounds (e.g., human activity, heritage-related sounds) contribute to place identity and contextual meaning. Furthermore, in spatially segmented environments (such as a street next to an urban forest), people perceive and evaluate sounds differently depending on the context. For example, a given sound level may be perceived as acceptable on a street but intrusive in a forest. This shows that the division of space into distinct environments with different characteristics plays a key role in how soundscapes are experienced [17].

The identification of quiet areas is increasingly being addressed through multidisciplinary approaches that combine knowledge from acoustics, geography and environmental psychology. However, such approaches remain fragmented, with individual studies emphasizing different dimensions of quietness. For example, research in Poland [19] demonstrates the application of spatial analysis in the process of quiet area assessment.

Despite limited scholarly attention to this topic, research in urban planning is especially important because it supports effective integration of quiet areas into land use planning, green infrastructure networks and sustainable urban development strategies. Emerging research [16] emphasises that evaluation of quiet areas through the analysis of inherent spatial characteristics, both auditory and visual, is crucial. Furthermore, accessibility is a relevant dimension

because the benefits of quiet areas don't depend only on their existence but also on their availability. Studies highlight that proximity, connectivity and ease of access significantly influence the use and perceived value of quiet spaces [20]. In that sense, accessibility should be explored as a functional spatial component. On the other hand, landscape architecture and environmental psychology demonstrate that landscape structure, vegetation, spatial enclosure and visibility interact with acoustic conditions to influence perceived tranquillity [21]. In this regard, urban forests are particularly significant, as they combine ecological, spatial and perceptual functions. They enhance visual screening, improve environmental quality and provide restorative experiences [22]. At the same time, cultural heritage can be considered a relevant spatial category in the assessment of quiet areas [23]. Values of heritage complexes and immovable cultural property are produced out of the interaction with the context (they don't emanate from the artifact itself) [23]. Protected status and spatial settings of such sites can help limit intensive development and noise exposure, while their visual and spatial qualities are closely interconnected with acoustic conditions.

Overall, the reviewed literature on quiet areas highlights several gaps in existing approaches, including reliance on conventional noise maps and the limited consideration of human perception, spatial context, functional and cultural aspects, accessibility, and planning perspectives. These limitations indicate the need for a more comprehensive identification and planning of quiet areas.

4. Proposed research methodology

To address the limitations of existing approaches, this paper proposes a development of an interdisciplinary methodological framework that combines spatial analysis, environmental acoustics, soundscape research and methods from urban planning to capture both the physical characteristics of space and the way it is experienced by users. The (doctoral) research proposal consists of four complementary components: 1) spatial analysis, 2) soundscape assessment, 3) expert perspectives, 4) synthesis and method development. Together, they enable the triangulation of quantitative and qualitative evidence, providing a robust basis for an integrated planning methodology.

An important feature of the proposed framework is the complementary use of space syntax and soundwalk methods. Both methods examine space from a human-centred perspective, enabling understanding of quiet areas through patterns of movement and users' experience of space and sound.

4.1 Syntactic, morphological and functional analysis proposal

Spatial characteristics influencing the planning of quiet areas will be examined using software for geospatial analysis such as QGIS™ [24], [25]. Spatial analyses will be conducted using remote sensing data and geospatial datasets (e.g., Sentinel-2 imagery, Urban Atlas and City of Zagreb Geoportal) focusing on both existing conditions and planned development. This will enable a robust multilayered approach that will cross-examine land use, protected natural and cultural heritage, noise maps etc. Another set of GIS data will be generated applying space syntax as a method for analysing spatial relationships in the built environment to understand various accessibility potentials and its social outcomes [26]. In this approach, the urban morphological layouts are represented through axial maps of urban spatial configuration as a network of streets and open spaces composed of axial lines (the longest and fewest straight lines which capture visual corridors and routes of physical accessibility) [27]. Axial maps form the basis for calculating spatial metrics such as syntactic integration/mathematical closeness ('how close each segment is to all others under each definition of distance) and syntactic choice/mathematical betweenness ('how many distance-minimising paths between every pair of segments each segment lies on under different definitions of distance') [28]. These metrics will be computed using software depthMapX™ and overlapped in QGIS™ with other available spatial data. As a tool for analysing spatial configurations and integration patterns, space syntax will inform the assessment of locations in relation to their potential quietness.

In summary, the proposed analysis aims to identify spatial characteristics of quiet areas. Syntactic characteristics provide insights into movement patterns and accessibility, examining how quiet areas relate to surrounding spaces and wider spatial networks. Morphological characteristics examine the physical structure and configuration of spaces, revealing how spatial form and scale contribute to quietness. Functional characteristics assess land use, natural and cultural values, helping to determine the role, significance and compatibility of potential quiet areas.

4.2 Acoustic and perceptual analysis proposal

Spatial characteristics of urban forests and cultural heritage that can be perceived in quiet areas will be investigated *in situ* using a mixed-methods approach. Soundwalk, a practice that emerged from the work of R. Murray Schafer and was developed by Hildegard Westerkamp, will be used to identify and analyse soundscapes and their components as in Adams [29]. Data consisting of physical measurements and subjective insights will be collected in correspondence with three core components of the soundscape framework: the acoustic environment, human perception and contextual factors. This approach - triangulation - is in line with the ISO 12913 [30]. The soundwalk method involving a structured questionnaire is planned to be carried out in potential quiet areas in Zagreb and London allowing soundscape assessment that provide insights into how spatial and cultural features influence people's experience of quietness.

Sound and video recordings will be made using a portable audio recorder and a 360-degree camera. These recordings will provide additional contextual

information about the investigated locations and support the interpretation of participants' responses. In addition, a virtual soundwalk using virtual reality, combined with eye-tracking, will examine the role of immovable cultural heritage as a characteristic of the landscape and its influence on participants' attention. The virtual soundwalk results will be used to confirm and validate the results obtained *in situ*.

Soundwalks will involve 15 to 30 adult participants (per experiment), aged 18 to 75, including experts in urban and spatial planning, residents and tourists. Different participant groups will enable comparison between professional assessments and everyday users' perception. Soundwalk survey data will be processed in Soundscapy™, an open package of Python functions that enable calculation of basic statistics and visualise the distribution of responses within the soundscape circumplex [31].

In summary, the proposed analysis aims to identify soundscape characteristics associated with the perceived quietness and the role of spatial settings in shaping the experience of quiet areas. The expected outcomes include the identification of relevant soundscape indicators, as well as a better understanding of the relationship between soundscape and characteristics of urban forests and cultural heritage.

4.3 Stakeholder Perspectives

Semi-structured interviews are planned with experts from relevant fields, including but not limited to urban and spatial planning, architecture, acoustics, protection of nature and cultural heritage, forestry, environmental sciences and sociology. Their expertise will provide insight into spatial and perceptual dimensions of quiet areas, supporting the identification of criteria and indicators that are relevant for the development of proposed methodology.

4.4 Synthesis and method development

Results of syntactic, morphological, functional, acoustic and perceptual analysis along with stakeholder perspectives will be combined through triangulation and synthesis to identify relationships between different data sources. A structured process relying on coding and interpretation of quantitative and qualitative data will establish spatial and soundscape indicators (patterns) associated with quietness in urban environments while also defining the criteria relevant for identification, evaluation, preservation, enhancement, and planning of quiet areas. Key findings will provide an evidence-based understanding of spatial, environmental, and cultural factors influencing the perception and use of quiet areas. Based on these findings, an interdisciplinary method for urban planning of quiet areas will be developed (Fig. 1).

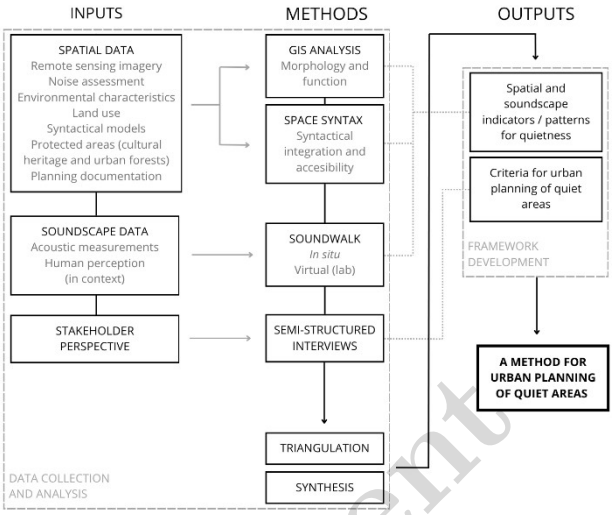

Figure 1. Diagram of proposed research methodology.

5. Discussion and concluding remarks

The concept of quiet areas is gaining attention in scientific research and policy development reflecting the need for sustainable, healthier, and more liveable urban environments. While the European legislation provides a framework for identifying and considering quiet areas, scientific research has demonstrated that quietness cannot be defined solely by low noise levels. Recent soundscape research emphasises that quiet areas extend beyond acoustic conditions as their significance also derives from landscape qualities and human experiences. Consequently, quiet areas should be understood as complex multidimensional spaces shaped by interactions emerging from spatial structure, overall landscape, and user experience. However, despite this broader understanding, current approaches remain primarily focused on identifying quiet areas through acoustic criteria, with limited consideration of their spatial and experiential dimensions. This limitation is particularly evident in Croatia, where urban quiet areas are legally recognised but have not yet been systematically incorporated into urban planning documentation, expert discourse or professional practice.

Addressing these limitations requires a shift from noise-based delineation toward a more integrated understanding of quiet areas. The proposed framework responds to this need by combining GIS-based spatial analysis, space syntax, soundscape assessment, and qualitative evaluation within a single planning methodology. By integrating these interdisciplinary approaches, the framework provides planners with information to support the preservation of existing quiet areas and the creation of new opportunities for urban tranquillity during future development.

The framework presented in this paper is conceptual based on literature review and emerging case studies. Its practical applicability will be empirically validated as part of future doctoral research. The research will focus on comparative case studies in Zagreb, Croatia,

and London, UK, combining spatial analysis, soundwalks, and stakeholder engagement to evaluate the proposed methodology and assess its adaptability across different urban contexts. By integrating legislative requirements, scientific knowledge, and planning practice, the proposed framework provides a foundation for a more comprehensive and interdisciplinary approach for the planning and protection of urban quiet areas.

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