

We are IntechOpen, the world's leading publisher of Open Access books Built by scientists, for scientists

6,200

Open access books available

169,000

International authors and editors

185M

Downloads

Our authors are among the

154

Countries delivered to

TOP 1%

most cited scientists

12.2%

Contributors from top 500 universities



WEB OF SCIENCE™

Selection of our books indexed in the Book Citation Index
in Web of Science™ Core Collection (BKCI)

Interested in publishing with us?
Contact book.department@intechopen.com

Numbers displayed above are based on latest data collected.
For more information visit www.intechopen.com



Chapter

Perception of Soundscape in Landscape

Banu Chitra Mookiah

Abstract

Landscape or nature-related design is mostly focused on the visual aspects. As a result of increased urbanization, the exploration of the possibilities of a tranquil environment concerning landscape enhances the positive effect on the quality of the urban population. This can be achieved by understanding and characterizing the sonic environment in such a setting. In connection to the visual landscape aspects, acoustical cognition in terms of perception of the environment is important. In modern scenarios; the concept of soundscape is used to discuss the quality of the environment. In line with this, the chapter reviews the state of the art of literature on various definitions, perceptions, and theories of landscape in conjunction with the theories of the soundscape and classification of soundscape elements. Also, it reviews the soundscape dimension in the landscape through the function of green spaces and its impact on quiet/tranquility in an urban context by understanding the role of natural and manmade landscape elements on sonic perception along with various methods of data collection commonly used for soundscape research.

Keywords: landscape, landscape perception, soundscape, sound mapping, urban environment

1. Introduction

The improvement of the soundscape concept evolves with the concept of human beings who perceive the world in a multisensory manner [1]. Human beings can communicate to the world through the five senses seeing, hearing, smelling, touching, and tasting. However, sounds environ us everywhere. With the rapid growth of urbanization in the 20th century, urban communities are discontented with the quality of the urban environment, especially with the urban acoustic environment. In [2] performed a pioneering field study of the urban soundscape in a sector of central Boston, including several subjects, and tested the perception of sounds and sights. His study strongly suggested a need for sonic planning and designs [3]. The [4] defines soundscape as an acoustic environment as perceived or experienced and/or understood by a person or people in a given context. The soundscape is usually referred to in terms of identifying and describing diverse sound sources in a particular place. In general, the soundscape is the combination of all sounds within a given location with an emphasis on the relationship between an individual's or society's perception [4]. Schafer explained the control of visual aesthetics in present societies, where a series

of hearing exercises intended to create sonic awareness among people through field studies were carried out. These studies were carried out using sound measurements, soundscape recordings, and portraying various sound features. This interest directed him and a few of his soundscape colleagues to invent a few terms as

Keynote: Sounds that are continuously heard in the given location. This is also called background sound (the sound of the train in the railway station).

Sound Signals: Sounds that attract the attention of the people. This is also called foreground sound (e.g. announcements in the railway stations about the train timings, for people to listen)

Sound marks: The sound which serves as a landmark for a particular place.

Lo-fi: The sounds that cannot be heard properly due to the masking of other sounds, which acts as a disturbance

High-fi: Sounds can be distinguished since there is only little masking by other sounds.

In the process of understanding and defining the soundscape environment of a given place, the sensitivity of the people and their preference for a sonic environment decide the overall soundscape quality of that place. As per the studies, with the increase of age people tend to have more inclination toward sounds relating to Nature and human activities whereas the young crowd was tolerant towards mechanical sounds and loud music. The preference criteria for different sounds add to the character of a space. Further, it is also observed from the studies that these sounds have a strong connection with the people's landscape preferences, particularly in the absence or presence of desirable and undesirable sounds, more than in the acoustic environment. In most cases, landscapes of these spaces are designed whereas soundscapes are not designed. [5] in their study explored that there is a strong connection between the preference for soundscape and landscape elements.

2. Characteristics of sound

Sounds are caused due to the vibration created by the motion of a source. The more sounds experienced by people are transmitted through the air [6]. The vibrations created cause oscillation in air pressure which results in sound waves that a human ear can detect [7]. Sounds are considered to carry information from the environment. It acts as one of the major components to communicate with our surroundings [8]. Sound also holds the ability to awaken the emotional response of people both in positive and negative ways. There have been various studies on the various categories of sound based on sound sources [9–12]. The general three categories of sound source classification are natural, technological, and human sounds [12] as shown in **Figure 1**. Based on the perception of the people the sounds from natural sources are considered to be pleasant whereas sounds from technological sounds are considered to be unpleasant and the sounds from human beings are regarded to be tolerable [14–16]. In addition to this, the perception or preference is connected to other physical components such as a source of the sound, the context of the sound, and personal preference [17]. Constant exposure to unpleasant sounds or noise can harm the auditory system along with other nonauditory health effects such as cardiovascular disease, sleep disturbance, annoyance, hypertension, etc. It also leads to mental problems [18]. The constant noise exposure also reduces the quality of the environment [19]. In addition to negative effects on health. As per the World Health Organization [20], there are 1.0 and 1.6 million Disability Adjusted Life Years

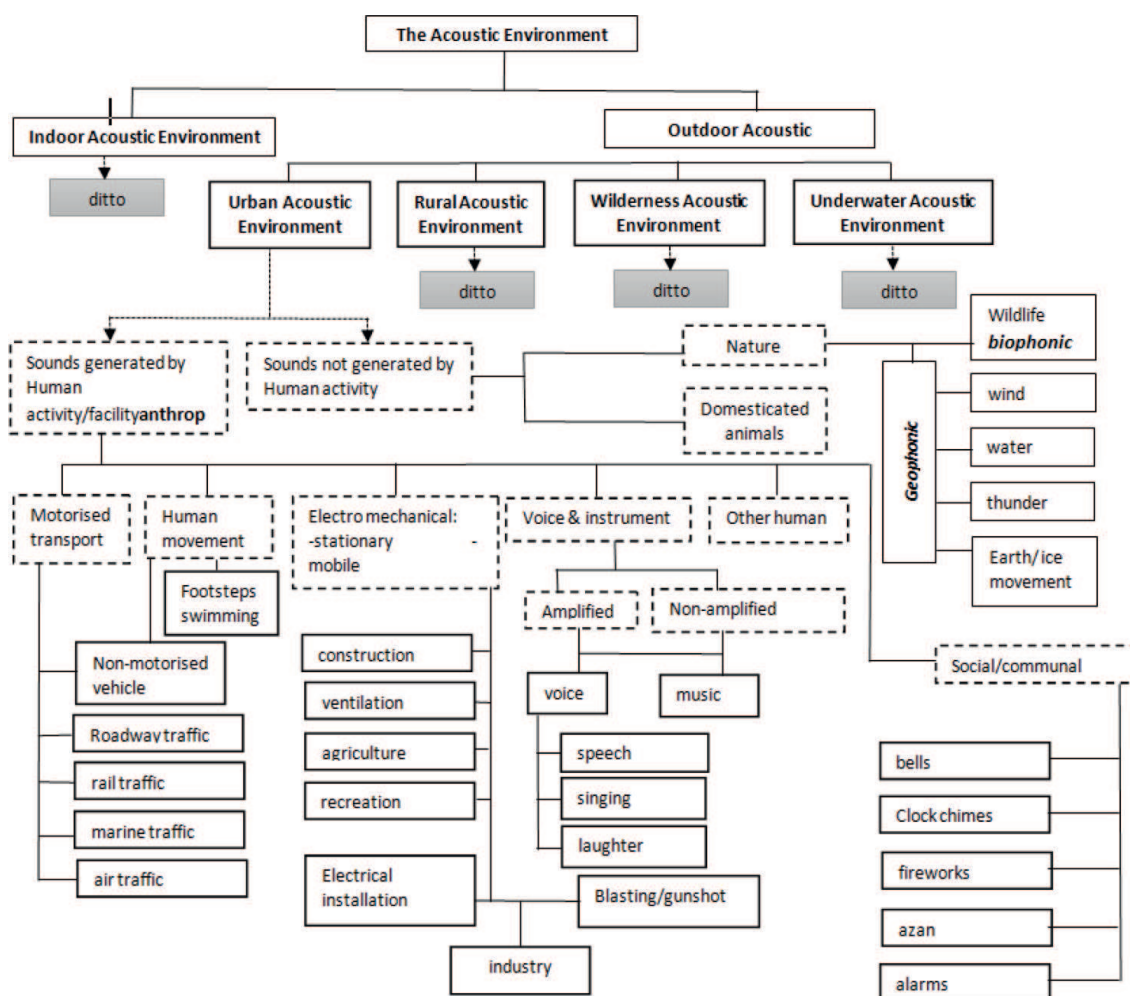


Figure 1.
 Taxonomy of sound source classification (Source: [13]).

(DALYs) annually due to the harmful effects of noise exposure. However, to act as a relief there are a growing number of studies that show that natural sounds such as birds chirping, water sounds, etc, can be used to reduce the stress level [16, 21].

2.1 Theories and concepts of soundscape

Several scholars proved that nature sounds could act as a healing medium in connection to anxiety and stress [22–24]. As an essential component, to relieve the people from the negative impact of urbanization the concept of the soundscape was initially developed by the geographer J. G. Grano in the year 1929 who explained the shifting of sound from animal sound to mechanical sound in the agrarian landscape [25]. In 1969, Southworth carried on the study of the soundscape with different subjects on the perception of sounds and sights [2]. Further his study strongly recommended the need for sonic planning [26]. The Canadian musician Murray Schafer in the year 1977 coined the term soundscape in his book *Tuning of the world* with the summary collected in his *World Soundscape Project* [27]. The project by Schafer and his colleagues recommended the approach, understanding, and development of soundscape by introducing many methods and concepts which form the rationale for soundscape study. Followed by Schafer and Truax in the year 1978 study on the terminological dictionary and also introduces a series of distinctions and conceptualizations that

builds the relationship between soundscape and noise research [28]. Moreover an organization was formed in the year 1993 to coordinate soundscape research is known as World Forum for Acoustic Ecology (WFAE). In the year 2014, the International Organization for Standardization (ISO) defines the soundscape as the “acoustic environment as perceived or experienced and/or understood by a person or people, in context” [3]. Around the 1990s, the focus of noise studies shifted toward soundscape perception. Generally, the human reaction to noise is related to acoustical factors such as sound pressure level. In contrast, non - acoustical factors such as expectations of the users, context, etc also play a vital role [29]. The soundscape approach to noise includes a qualitative perspective which is very constructive from the user’s perspective. As mentioned earlier, the city sound experience was first experimented with in the World Soundscape Project in the 1960s. Southworth, a city planner in the year 1969 investigated the character of the city sounds with visual aspects. He suggests the four strategies to deal with city sounds based on planning as cautious positioning of noisy activities, new kind of street design, unique vehicular design and most importantly masking of unwanted noise by addition of wanted sound [2]. Later in the 1970s, the research institute CRESSON highlighted the relationship between sound, people, and the environment. The most notable publications of CRESSON are Sonic Experience – the wanted and unwanted sounds which can be seen from the sound quality perspective of open spaces. Another approach [29] proposes two ways of observing sound’s sonic activities and spatial aspects. They also suggested the desirable decibel limit of 65-70 dBA above which introduction of new sounds is not appropriate unless the reduction in already existing sound pressure level is exercised. Further, there have been suggestions to introduce the map to illustrate how soundscape can be integrated into the planning process of the UK [30] which was later incorporated by De Coensel et al. integrating various activities such as sound walk and soundscape simulations [31, 32] created a framework to improve soundscape with three stages describing soundscape, factors influencing soundscape, and relating possible design interventions to user's perspectives which were evaluated through the Kano model.

2.2 Tools and techniques used for soundscape studies

There have been various tools and techniques to conceptualize the soundscape to understand the role of the soundscape in experiencing the environment which serves as an influential tool in the assessment of soundscape. One of the models developed by Hedfors in 2003 is the model of prominence which gives the distinction between the total of prominent sounds to the total of background sounds in a given environment [33]. This model characterizes the soundscape as powerful, mild, clear, and crowded to describe the sonic environment. Axelsson et al. included the two dimensions of “pleasantness” and “eventfulness” to understand the variations in the sound environment based on the listening experiment with one hundred listeners. Later a principal component analysis model was developed with the inclusion of soundscape characteristics such as exciting, monotonous, calm, and chaotic [14]. Jennings et al proposed an illustrative framework to describe soundscape perception that considers aspects such as direction, proximity, foreground, and background of the sonic environment [34]. A system based on the evaluation of soundscape in urban open spaces was suggested by Zhang & Kang based on the source, space, people, and environment [29]. Later a detailed taxonomy was proposed to understand the relationship between environment and types of sound sources [35]. Another model was introduced by

Herranz-Pascual et al. to seek the interaction between person, activity, and place in the environment [36]. The approach suggested a broad way of identifying sound sources and improving the soundscape which is based on the identification of wanted and unwanted sounds and the possibilities to control them. Based on the urban scholar and sound artist [37] a tool was established for urban sound design named 'Sonic rupture' which was centered around five approaches for designing addition, subtraction, disclosure, passion, and transformation.

2.3 Methods of data collection in soundscape research

There are various methods for the collection of soundscape data as sound walks, Listening tests, behavioral observations, and narrative interviews

2.3.1 Listening test

The method of listening tests is generally carried out to perform the sound evaluation under the controlled condition without which it may be affected by the external parameters [19]. Generally, this method is broadly used to evaluate the influence of visual aspects without the support of visual material [38]. For carrying out the study, a replica of the outdoor environment is usually created. It gives more focus to the participant's response in response to the sonic environment [39]. This data collection can experiment with a group that has no prior experience and with a varied range of participants [39, 40] who can be recruited through the mail [39, 40]. However, the interpretation of the data collection requires a significant determination of the hearing capacities of the participants.

2.3.2 Interviews

This method is commonly used in assessing the sound environment related to sound quality. This is widely used in evaluating environmental noise and other noise pollution [41]. This method is normally conducted with the interaction of users of the space from the micro-level as residents of the space to the macro-level users of the space as urban space as parks, plazas, squares, etc. This includes the investigation of sound quality along with different parameters based on the objective of data collection [42, 43]. The data collection using interviews was explored in various studies [44–48]. The various parameters used for the interview method was adopted on the basis of soundscape expectation [49, 50], soundscape description [51], soundscape preference [52, 53], soundscape memories [49], soundscape perception [51].

2.3.3 Sound walk

The sound walk method implies the method of conscious listening to the sound environment which helps in exploring the multimodal aspect of the surrounding [54]. This method is carried out through both qualitative and quantitative data collection [16, 46, 47]. As per quantitative data the data collection procedure it varies concerning the measurement (duration, measurement, seasons, etc) and varies with a collection of data based on the various objectives and for qualitative data, it differs with the size of the sample, duration of the sound walk, size of the participants, etc [55, 56]. Sound walk procedure is generally carried out individually or in groups based on the prefix trail routes using a structured protocol [27, 56]. There have been various studies that have

used the sound walk as a tool for the interpretation of soundscapes [57–59]. After the initial learning, most of the scholars used the sound walk as an effective tool for investigating soundscape based on the objective. Many sound walk studies are conducted in groups [30, 58]. While conducting the study it is important to maintain a specific distance between the participants to avoid the effect of footsteps [58]. In contrast to the group sound walk, the individual sound walk can be performed at diverse times and days based on the objectives [59, 60]. In the 1970s the soundscape took place in urban, rural, and different locations. However, recent studies focus mainly on the urban contexts especially urban parks, urban squares, and urban streets [30, 57, 58, 60, 61]. The study of the sound walk is generally conducted in locations where there is a broad range of sound sources [58]. The range of context varies based on the objective of the study.

2.3.4 Focus group

Focus groups are the additional modality of data collection in which the aim is to facilitate discussion based on the specific issue put forth by the scholar. A certain topic of discussion comes out with an unbiased opinion. This method engages the reflective state of mind of the participants about their previous experience of soundscape based on the discussion. It also helps the participants to express their ideas with the agreed response from other participants [46, 62].

2.4 Methods of mapping in soundscape research

There have been various methods of mapping soundscape based on the data collected on the measurements and these maps are found to be an effective tool in the assessment [63]. The noise maps that presently exist and that are recommended by EU Directive are in 2D. For the creation of urban sound maps, the model which is based on numerical methods is broadly used which provides quality inaccuracy [64]. However, these maps have considerable limitations in terms of both sound sources and the dynamics of a sound environment. Sound maps created based on sound measurements helps to improve the mapping of the soundscape [65–67]. Various applications allow participatory sensing to increase the potential of mapping the sound environments in the city based on measurements [68–71]. To know the time and spaced relationship concerning such measurements, certain knowledge of the interpolation methods can be created to produce sound maps that show the spatial and temporal aspects of the sound [72–74]. Studies show that shortening the time of recording proved the 15 min sampling period as relevant [74]. The shortening recording time of 5 min was also found in the literature; however, it should be compensated by a large number of measurements [69]. The dynamics in the urban environment can be explained with the help of spatial characteristics of the environment. He also mentioned that the representativeness in the space based on spatial interpolation of the sound environment is a very important factor. Several types of research on describing the methods have been explored using urban sound level interpolation as Kriging methods, multi quadratic interpolation [67, 75], and (IDW) methods [17, 67, 75]. There have been various studies that created the interpolation of sound maps through fixed sound measurement stations which provides a useful insight for the city level [75, 76]. However, this is not possible as the distance of the measurement station is more and these can be explored by model-based methods. Various studies have been suggested for model-based sound maps for measurements suggesting that spatial interpolation methods can also be based on perceptual assessments [65, 77, 78].

3. Theories and concepts of landscape

The origin of the landscape was traced back to the 5th century A.D by J.B, Jackson in his book “Discovering the Vernacular Landscape” [79]. In the fifteenth century, the reasonable depiction of the landscape which emphasizes the visual character and symbolic meaning was found in Renaissance paintings [80]. There are significant references that define the landscape as a picture representing natural inland scenery [81]. According to the landscape convention of Europe, Landscape is defined as an area perceived by the people, whose character is the result of the action and interaction of natural and/or human factors’ [82]. This landscape became an expression of human thoughts, human beliefs, and human intuition or feelings. Later it was incorporated into different parts of the world. The original intent of the word was to define a specific parcel of land, and later a particular bounded scene as an object for painting. As per Jackson the word ‘land’, means a bordered territory and also refers to soil and territory, and as ‘organized land’ based on the characteristic of the people who made it. Landscape expresses the (visual) expression of territorial identity. It also refers to subjective observation and understanding [83]. In general, the varied definitions imply that landscapes are the portrayal of surroundings and aesthetics. Moreover, there is various understanding through definitions mainly to understand the process of human interaction and to understand the spatial dimension of the surroundings.

3.1 Landscape – A cross-disciplinary overview

The term landscape is used by a varied range of scientific disciplines retaining different definitions. In broad terminology, the landscape is defined as the “total character of an area of the Earth” [84]. However, there are dynamic perspectives for the term based on different disciplinary contexts as shown in **Table 1**. According to the perspective of art, landscape images are the representations of landscape, e.g., as drawings, paintings, or photographs, which are the impressions or illusions which evolve in the mind of the observer as two-dimensional objects with added colored stains [86]. More importantly, landscapes are defined as the perception as demonstrated within the images, however as per archeology landscape was perceived as a backdrop or a setting that is characterized by the interpretation of the artist [87]. In general, as per the observations from the historical perspectives, the landscape is considered in terms of cultural aspects and is interpreted as a cultural landscape that claims landscape as a result of human actions over time which gained its importance in the 1990s. Landscapes that are engaged by people through which the identities are created. Hence as per ecology landscape is defined as the investigation of the human population which induces the changes in the heterogeneity of ecological and landscape components. Geographers investigate landscape in terms of the region with an integrated spatial view followed by region and zone and also different factors such as topography, land use, etc. While the landscape is a representation of a relatively smaller unit as per geography, it serves as the representation of the earth's surface which makes it a more powerful concept for geographers [88]. In explaining the “Principles of Geology” Charles Lyell describes the landscape as the result of external and internal factors acting upon the structure of the earth's surface. Similar to Geographers, Geologists who describe the landscape as a geomorphologic process stumbled upon in a certain environment. The human action of the landscape where the natural landscape was transformed

S. No	Various disciples	Given the meaning of landscape
1	Geographer	Landscape as features in an area
2	Historian	Landscape as a record of history
3	Architect	Landscape as townscape
4	Academic	Landscape as the analysis of meaning in the environment
5	Ideological	Landscape as an expression of property ownership
6	Landscape architect	Landscape as an object

(Source: Edward Relph, [85])

Table 1.
Functional classification of 'landscape' meaning.

into anthropized space as a result of human's fight against space which leads to the exploitation of environment. To conclude according to historian's landscape is an analysis of complex interaction between humans and the natural environment and the investigation of the same.

3.2 Landscape perception

"Landscape is composed of not only of what lies before our eyes but what lies within our heads." [89]. Generally, perception is the process of deriving information through the senses which are an active process between organisms and the environment [90]. The perception of the environment helps us to understand the environment diversely. People usually interact with their environment for a purpose. As a result, we select spatial information related to our purpose [91]. There are two basic modes of perception auto-centric and allocentric as the first one deals with subject-oriented and the second one deals with object-centered [92]. He explains that the components of auto-centric involve the sensory quality whereas the allocentric deals with attention and directionality. The terms of perceiving the physical environment involve not only physiological phenomena by both social and cultural factors as the perception changes based on the individual experience [93]. Hence the perception of our surroundings is dynamic based on the individual [55]. In terms of the perception of the environment landscape architects must play a crucial role in comprehending this relationship.

3.2.1 Visual landscape perception

Although spatial information is received through various senses such as a sense of smell, touch, auditory, etc the sense of sight is assumed to be the most valued sense. Almost 80% of our sensory inputs are perceived visually [92]. Hence in the environmental assessment studies, the evaluation of visual landscape character is mostly taken into consideration [94]. Bourassa 1990 states the two principles of landscape aesthetics as biological and cultural in which biological aesthetics deals with the aesthetic contentment obtained from refuge or prospect whereas cultural aesthetics deals with the aesthetic contentment obtained from the landscape that contributes to cultural identity. The concept of aesthetics has evolved from history based on philosophical context.

3.2.1.1 A brief history of aesthetics in the philosophical context

The picturesque beauty of the landscape serves as a concern for the assessment of the visual quality of the landscape and its preferences. The concept of aesthetics in environmental psychology gained its importance in ancient times. The term aesthetics was coined by a German philosopher [95]. The word aesthetics is derived from the Greek word “aisthanesthai” which represents “to perceive” and aisthet which means “perceptible objects”. Various philosophers connected beauty to truth and symmetry [96]. It was believed that beauty is linked to good and ethics [97]. Aristotle on the other hand, argued beauty in perspective to mathematics [98]. He insisted that beauty was associated with size and order which is carried out in Rome and Greece where the approaches towards landscapes are connected to order, symmetry, proportion, and balance which rose to a concept of classicism. Apart from this, the concept of modern aesthetics defined beauty as a certain composition of colors and Figures giving happiness to the beholder which was subjective [99]. Beauty beyond the expression of pleasure or joy was perceived as the perfection of sensitive cognition based on intellectual directions [100]. Landscape beauty on the other hand is related to our social and natural structure [101]. In the 19th century, beauty was perceived in terms of romanticizing Nature. During this period landscape was viewed as an object which has some intrinsic qualities. However, the perception of objectifying landscape changed during the 20th century as the landscape is perceived as relevant to its subject which is connected to the people’s experience [102]. Mainly in landscape two approaches of visual landscape assessment were observed as subjective and objective. Subjective assessment is the assumption of visual quality in relevance to the observer whereas the objective approach deals with the characteristics and physical characteristics of the environment. Four various prototypes involve the perception of visual assessment of landscape as experts, psychophysical model, experiential model, and cognitive model

3.2.1.1.1 The expert’s prototype

This is a paradigm based on the judgment of the experts based on the visual quality of landscapes. These are based on the characteristics of landscapes as vegetation, texture, color, landform, etc, and based on this model the natural ecosystems gain their aesthetic value. The disadvantage of this prototype is its inefficiency to consider the users’ perceptions [103]. Moreover, the model was criticized due to its consideration of only experts based on the perception of the visual environment; however, it is mandatory to incorporate the people’s opinions about the landscapes which the model failed to do so.

3.2.1.1.2 The psychophysical prototype

In contrast to the expert’s prototype, the visual quality of the landscape is evaluated in terms of public opinion in the psychophysical prototype. The techniques used for evaluating this prototype are ranking and categorizing for evaluating the visual quality of the landscape [104]. The main objective of this model is to perceive the landscape as an external factor without conscious thinking based on its incentive nature.

3.2.1.1.3 The cognitive prototype

The cognitive paradigm centers on the reason to understand why people prefer specific landscapes which are theoretical approaches. This prototype differs from the psychophysical paradigm as it influences aesthetic judgment based on the visual quality of the landscape. Mostly tools such as semantic differential analysis and a checklist of adjectives are considered to evaluate the preferences and meanings of such landscapes. Mostly it is based on the evolutionary theories on environmental perception however it neglects the physical environment and focuses on meanings associated with landscapes

3.2.1.1.4 The experiential prototype

The experiential prototype approach is commonly explored by geographers who practice this prototype in “sense of place” studies. This focus on human-environment interaction is based on their experience. The experiential approach focuses more on

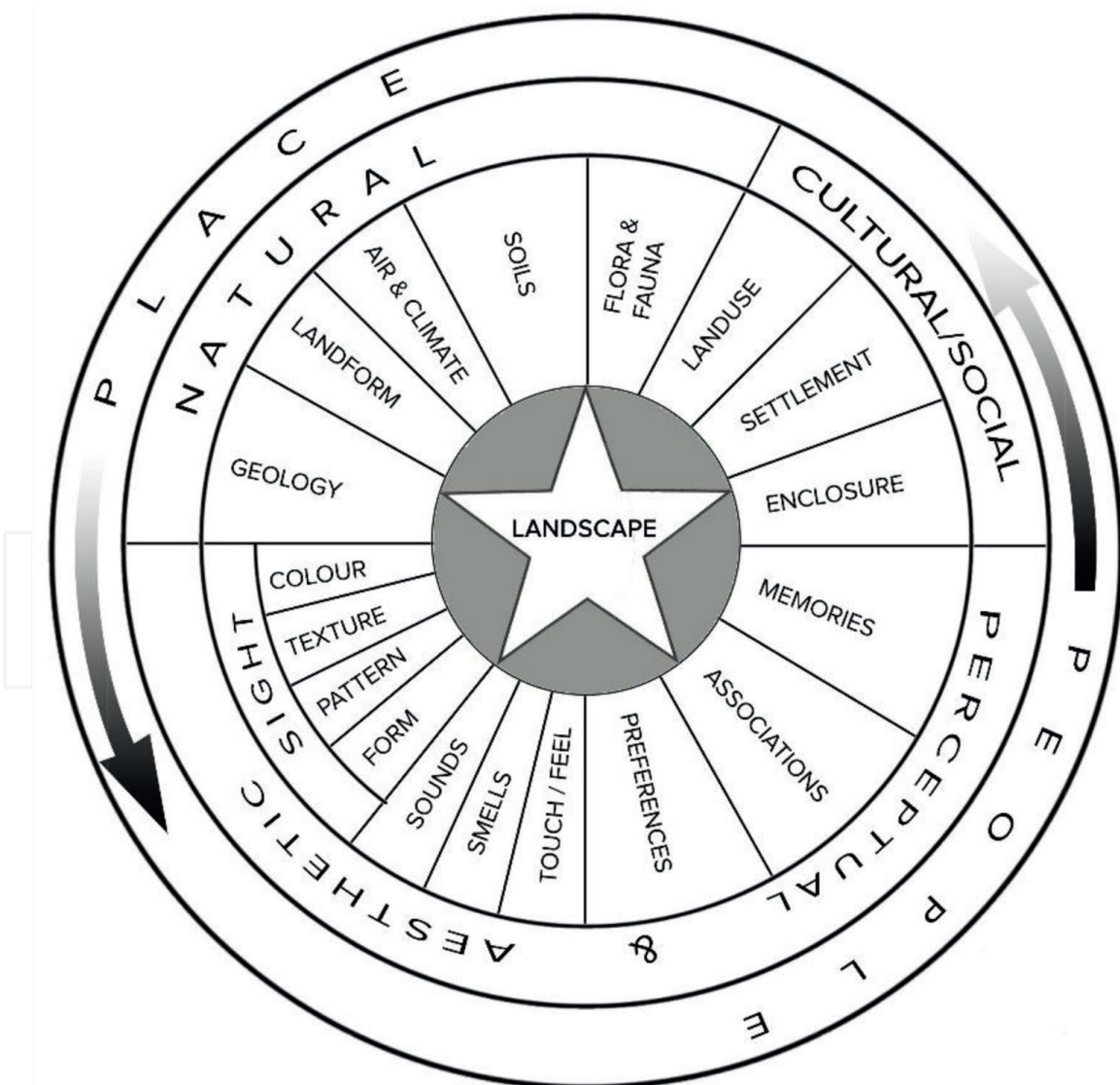


Figure 2. Theories and concepts of Landscape (Source: Carys Swanwick, [109]).

subjective than cognitive and psychophysical paradigms. Hence the measurement of the dependability and validity of the results is tough. The prototypes classified contribute to the overall comprehension of environmental perception. However, making use of the public as the center of the prototype is essential [105] assessed that landscape architects and geographers intend to use a theoretical and a psychological approach in landscape assessment while psychologists use mainly theoretically derived psychometric methods. Hence it is very much essential to relate different disciplines to resolve the conflicts.

3.3 Significance of landscape

Landscapes have a significant role in enhancing the human experience which has a wide range of theoretical perspectives [106]. This landscape serves as a cultural image in which it represents the pictorial way of representing human surroundings [107]. As a result of new concepts and approaches, the landscape ensures a remarkable change [90]. Landscape integrates the dynamic and functional relationship between the components which serves as an expression of an ecological, economic, and social organization [108] as shown in **Figure 2**.

Landscape helps us to perceive and depict the importance of its resources through conservation and enhancement of the same [110]. In general, the landscape originated from the concept of Nature's philosophy in which human beings are considered as a part of nature which is described as ecological humanism. The landscape can be seen as physical geography which is perceived as a concept of space rather than trying to create new boundaries [111]. The authors insisted that landscape can also be perceived as archeology and human geography in which the allocation, distribution, and people were compared and incorporated with the background information of the natural environment. Landscapes are argued as "symbolic environments" which are created by human acts that confer meaning to the environment [112]. Landscape can also act as social constructions that are mediated through the collective human experience as it emerges the people with the social setting with the engagement of people with the material world.

4. Role of green spaces in an urban context

As a result of growing urbanization, the configuration of recreational space in connection to environmental problems such as noise has become a challenge since roads and traffic sounds are inevitable in the urban context. Green spaces have an important role in addressing these issues as they can increase the health and well-being of the citizens in the urban context. They also had the potential to provide habitat for biodiversity, especially in urban parks. Moreover, these spaces bring tranquility to the urban context which is evident in many studies [113] made a specific questionnaire in seeking an answer for quietness in the urban environment. In response to that, a large group of participants responded that they visit green spaces to relax. Therefore, visiting quiet places or going outside actually meets a need for quietness in the urban context. Quiet is not a core requirement for such acoustic preference in the outdoor acoustic environment. Core requirements include congruent soundscape and landscape, and dominant wanted sounds in a place over, and not masked by, unwanted sounds [114]. There have been various efforts taken to protect such places. E.g. a decade ago the Environmental noise Directive 2002/49/EC

suggested the competent authority implement a noise action plan intended to protect the quiet areas as urban parks. There have been various definitions of quiet areas as quiet areas are those that contribute to the society's culture and have a specific character and it does not represent the absence of sound [13]. In addition to that, the END defined the specification of the quiet area as 55 dB L_{day}. It is observed that the possibilities for quiet recreation in urban environments can have a positive effect on the quality of life in the urban setting [13, 115] worked on the first-ever evaluation of the tranquility of open spaces for the characteristics of both acoustic and visual stimuli. They found that the maximum sound pressure level and the percentage of landscape features present at a location were the key factors influencing the tranquility of the urban context. With this, it is evident that green spaces especially urban parks help in exploring the tranquility of the citizens in an urban context.

5. Soundscape dimension in Landscape

As a result of urbanization, more concerns related to sustainability aspects of the landscape are taken into consideration by various scholars. In the early 1960s and 1970s the concept of sustainability under landscape evolve from the ecological point of view which is stated with various concepts such as urban metabolism [116], landscape urbanism [117], and "design with nature" [118]. In general, the aspects of sustainability include aspects of social, environmental, and economic concerns where it could be agreed upon sound, especially in connection to social sustainability [33, 119]. Due to the increased urbanization nature, related places act as a pause for stress and have been important places for restoration [120, 121]. Especially in an urban scenario, these spaces act as a key element in providing tranquility [12]. The extent of landscape architecture is a diversified one. It ranges from the micro level as the design of individual plant beds to the macro level as planning at the city level. In 1847, Sir Joseph Paxton designed Birkenhead Park in England by reclaiming the existing marshland. Landscape architecture as a profession gained its value in the year 1858, after the winning proposal of Calvert Vaux and Fredrick Law Olmsted for the design of the central park, New York [122]. However, the field had its significance much earlier when Geoffrey and Susan Jellicoe portrayed their first recognized examples of landscape designs in cave paintings in France and northern Spain, which dated back between 30,000 and 10,000 BC [123]. The field gained its significance in the direction of environmental-related approaches with the idea of a few works of notable landscape architects as "design with nature" [118]. McHarg gives an ecological concept that is chained to the environmental services which laid the foundation for environmental sciences. Because of the regional environment, the emergence of multifunctional landscape design has become an important paradigm that addresses varied societal pressures such as population growth, and degradation of the environment [124]. Mc Harg's design-with-nature concept is a precursor for the multifunctional landscape design in which he focuses on social, natural, and cultural processes and establishes the relation between man and nature. Various systems address the integration of nature for multifunctional benefits which is the result of Mc Harg Design with nature concept [118]. The main feature of this system is the integration and facilitation of several ecosystems along with consideration of human interventions which becomes an integral part of the ecosystem [118]. With this evolved the concept of landscape urbanism which is considered to be an aspect of sustainable consideration [117]. As an inspiration from McHargian landscape planning, landscape urbanism focuses

on natural science with the conception of ecology as the main theme. It attempts to engage the natural and cultural system which is on par with the McHargian concept which explains the best fit between culture and nature. In his book, design with nature he defined landscape architecture as the process of superimposing and synthesis land information. He also incorporated sound data as a source of noise [33]. It has been proved that the landscape architects are well-thought-out of sound in their experiments. For instance, on the measurement of Lascaux and other caves, [125] found that the image representing animals was placed in such a way where the aural qualities of such caves would reverberate sound which makes it feasible for the animals to come alive. Moreover, the conscious embellishment of garden design features such as water features in Renaissance Italy, suikinkutsu in Edo-era Japan, and mechanical singing birds of oriental gardens were a few interesting examples of how sound was incorporated into the landscape. In line with other aspects of landscape architecture, perception, understanding, and function of sound-space associations have undeniably diverse among practitioners. Soundscape planning a resemblance to landscape planning involves design or management to influence the acoustic environment of a place to improve the human perception of such an environment. These environments are continuously shaped by both social and cultural characteristics of society. In general, the urban environment is an ecological entity that comprises three factors landscapes, soundscapes, and people [57]. Hence, the diverse human senses and the physical environment should be considered together in interpreting urban environments [126].

5.1 Influence of natural and manmade landscape elements on soundscape perception

Landscape factors have been well-thought-out in numerous studies about sound and soundscape perception [2, 115, 127]. People's landscape preferences play a vital role in a significant correlation with the sounds, especially in the presence or absence of wanted and unwanted sounds more than acoustic characters [128]. The classification of sound sources according to [129] is shown in **Figure 3**. Biophony refers to the sounds which are produced by biological organisms such as birds and insects [10]. Geophony refers to running streams, rain, and waves whereas anthrophony refers to sounds produced by humans. Among all these sound sources, anthrophonic sounds are considered the most dominating sounds because of their capacity to produce high energy [129]. It is also considered to mask biophony and geophony sound sources due to its high energy. In broad terms, sound sources mingle and interact with one another.

Biophony involves the sounds which are produced by living organism as birds and insects that are considered to be the most frequent biophonic sound producers [10]. The pitch and frequency of their songs depending on whether they are habitat to the natural or urban environment. In general, some birds in an urban setting have been observed to sing more at the night due to the less intrusive anthropogenic sounds [129]. Correspondingly geophony may have an impact on biophony as wind or rain which suppresses the bird's sound or biophony. In many cases, anthropogenic sounds are considered to be the dominant as they mask the biophony and Geophony due to the strong energy produced. The high influence of these sounds can be mitigated by camouflaging them with the addition of positive sounds because relatively enhancement of pleasant sounds was found to reduce the perceived loudness and botheration of the receivers. In urban scenarios sounds from nature are typically taken as a means

	Biophony	Geophony	Anthrophony
Sounds produced by	biological organisms	geophysics	humans
Examples	Birds, insects, amphibians mammals	Wind, running streams, rain movements of earth, thunder, waves	Machines, vehicles, sirens bells, traffic, music, language
Annotations	signals are complex because they carry information	driven mostly by climate	more common during the daylight hours

Figure 3.
Classification of sound sources (Source: [129]).

to enhance the acoustic quality [130, 131]. Factors such as the presence of trees and natural features contribute to psychological perception by users, even in areas with higher sound limits than those that define as quiet areas. Natural sounds are those which are produced by organisms (biophony) or by the physical environment (geophony) [43]. It is proved from various studies that good soundscape quality areas are those with highlighted natural sounds whereas low soundscape quality areas are those with highlighted technological sounds [132, 133]. These factors cannot be neglected in the soundscape assessment of urban spaces according to [52]. Through interviews, [134] showed that natural sounds such as birds twittering and the wind are the most expected sounds than sounds from road traffic and aircraft fly-over which are considered to be most annoying. Natural sounds and landscape features have a significant part to play role in improving the perception of the soundscape [16, 135].

5.1.1 Role of water body in soundscape perception

There have been various categories of water bodies that have a significant contribution to the enhancement or masking of sounds. In an ecological waterscape, acoustic comfort is an important element associated with landscape experience. The water sounds such as streams and waves of lake sounds were selected as effective natural sounds to mask urban noises. In general ponds, lakes, pools, and puddles fall into the still-water category whereas waterfalls, rivers, brooks, fountain jets, and cascades fall into the moving water category [136]. The level of the water sounds should be similar to or not less than 3 dB below the level of urban noises [46]. It is observed from various literatures that water elements such as jets, fountains, running water, etc. have some influence on the soundscape of an urban environment, especially in urban parks. It has been noted that sounds from water features improve the urban soundscape also mask the unwanted background noise in parks [13]. They can also be used to effectively mask other irritating sounds [134]. Brown in 2003 suggested that rushing water can be used as an acoustic camouflage of traffic sounds [137, 138] experimented with fountains and proved that water sounds may have an indirect impact on soundscape quality by camouflaging the cap urban of hearing the road-traffic noise.

They conducted a field experiment to explore whether water sounds from a fountain had a positive impact on soundscape quality in a downtown park. In total, 405 visitors were recruited to answer a questionnaire on how they perceived the park, including its acoustic environment. Meanwhile, the fountain was turned on or off, at irregular hours. Water sounds from the fountain were not directly associated with ratings of soundscape quality. Rather, the predictors of soundscape quality were the variables “Road traffic noise” and “Other natural sounds”. The former had a negative and the latter had a positive impact. However, water sounds may have had an indirect impact on soundscape quality by affecting the audibility of road traffic and natural sounds. Traffic noise reduction can be achieved by the introduction of water-oriented sound in urban open spaces. [31] suggested that adding fountain sound with low temporal variability reduces the loudness of road traffic whereas, the addition of bird sound enhanced soundscape pleasantness and eventfulness. The addition of the latter was more effective in curbing traffic noise. They also agree with the results from laboratory studies that water sounds may mask road traffic sounds, but that this is not straightforward. Thus sound should be brought into the design scheme when introducing water features in urban open spaces especially since flowing water can improve the restoration experience [139].

5.1.2 Role of greenery in soundscape perception

As water features influence the soundscape, the greeneries also help to influence the soundscape [140] suggested that tree belts help with noise reduction in open spaces and urban parks which decreases the stress on environmental noise for people. Besides, [141] proved through experimental research that the effects of hedges, as a result, of a combination of physical noise reduction, influence people’s perception. The acoustical effect produced by the hedges can be understood as a combination of physical noise reduction and its influences on perception. In a study that involved the measurement of light vehicle noise reduction by hedges, thick dense hedges were found to provide only a small noise reduction at low speeds. Whereas, higher noise reductions were found to be associated with an increased ground effect. It is also proved that even the trunks could disperse sound [29]. Acoustically soft material, for instance, as found in vegetated soil can be used to reduce unwanted sounds while at the same time producing other ecosystem services [133]. New physical structures of densified urban spaces, if planned appropriately, can be used as screens that separate city spaces acoustically [142, 143] proved that viewing natural landscapes as vegetation and other natural elements generally creates a stronger positive health effect than viewing urban landscapes as concrete, buildings, and other man-made structures. This is proved by quantitative (EEG evaluation) and qualitative (the questionnaire survey) methods which indicate that landscape plants can cause inflated levels of noise reduction and psychological noise reduction. There have been various researches that show the impact of vegetation on soundscape [128, 144, 145] with the help of different methods of data collection. This shows that acoustic dynamics can be linked to vegetation structure, even on a micro-scale.

6. Conclusion

The paper reviews the state of the art of literature on various definitions, perceptions, and theories of landscape in conjunction with the theories of the soundscape

and classification of soundscape elements. Also, it reviews the soundscape dimension in the landscape through the function of green spaces. In the modern scenario, most conservation aspects are focused on the preservation of natural biodiversity, however, diminutive thought is provided to the acoustic heritage which greatly contributes to the sense of the place. The same can enhance the social character of the place. Moreover, the tranquil ambiance is an essential aspect to appraise the concerned environment, especially in urban areas. In terms of landscape, the auditory sense provides visual awareness in terms of activities. A better consciousness of sound and other senses generates a more pleasant understanding of the surrounding landscape. Hence the integration of landscape and soundscape considerations has to be incorporated at the planning level in terms of the design of urban spaces. In this paper, the landscape element of vegetation and water body has been discussed. However, further research can be extended to understand the impact of other landscape elements as different footpath materials, soil, seating, hoardings, etc. in relation to soundscape.

Conflict of interest

There is no conflict of interest.


IntechOpen

Author details

Banu Chitra Mookiah
School of Planning and Architecture, Vijayawada, India

*Address all correspondence to: banuvipin@gmail.com

IntechOpen

© 2022 The Author(s). Licensee IntechOpen. This chapter is distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/3.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. 

References

- [1] Lindquist M, Lange. Sensory aspects of simulation and representation in landscape and environmental planning: A soundscape perspective. In: *Innovative Technologies in Urban Mapping*. Champions: Springer; 2014. pp. 93-106
- [2] Southworth M. The sonic environment of cities. *Environment and Behavior*. 1:49-70
- [3] ISO I. 12913-1: 2014. Acoustics—Soundscape Part 1: Definition and Conceptual Framework. ISO: Geneva, Switzerland; 2014
- [4] Truax B. Soundscape composition as global music: Electroacoustic music as a soundscape. *Organised Sound*. 2008;13(2):103-109
- [5] Ren X, Kang J, Zhu P, Wang S. Effects of soundscape on rural landscape evaluations. *Environmental Impact Assessment Review*. 2018;70:45-56
- [6] Long M. *Architectural Acoustics*. London, UK: Elsevier; 2005
- [7] Moore BC. *An Introduction to the Psychology of Hearing*. London, UK: Brill; 2012
- [8] Bechtel RB, Marans RW, Michelson WE. *Methods in Environmental and Behavioral Research*. Michigan, US: Van Nostrand Reinhold Co; 1987
- [9] Aiello LM, Schifanella R, Quercia D, Aletta F. Chatty maps: Constructing sound maps of urban areas from social media data. *Royal Society Open Science*. 2016;3(3):150690
- [10] Krause B. *The Great Animal Orchestra: Finding the Origins of Music in the World's Wild Places*. London, UK: Hachette; 2012
- [11] Matsinos YG, Mazaris AD, Papadimitriou KD, Mniestris A, Hatzigiannidis G, Maioglou D, et al. Spatio-temporal variability in human and natural sounds in a rural landscape. *Landscape Ecology*. 2008;23(8):945-959
- [12] Nilsson ME, Berglund B. Soundscape quality in suburban green areas and city parks. *Acta Acustica united with Acustica*. 2006;92(6):903-911
- [13] Brown AL, Muhar A. An approach to the acoustic design of outdoor space. *Journal of Environmental Planning and Management*. 2004;47(6):827-842
- [14] Axelsson Ö, Nilsson ME, Berglund B. A principal components model of soundscape perception. *The Journal of the Acoustical Society of America*. 2010;128(5):2836-2846
- [15] Van Renterghem T, Vanhecke K, Filipan K, Sun K, De Pessemier T, De Coensel B, et al. Interactive soundscape augmentation by natural sounds in a noise polluted urban park. *Landscape and Urban Planning*. 2020;194:103705
- [16] Chitra B, Jain M, Chundelli FA. Understanding the soundscape environment of an urban park through landscape elements. *Environmental Technology and Innovation*. 2020;19:100998
- [17] Hong JY, Jeon JY. Influence of urban contexts on soundscape perceptions: A structural equation modeling approach. *Landscape and Urban Planning*. 2015;141:78-87
- [18] Beutel ME, Jünger C, Klein EM, Wild P, Lackner K, Blettner M, et al. Noise annoyance is associated with depression and anxiety in the general population—the contribution of aircraft noise. *PLoS One*. 2016;11(5):e0155357

- [19] Yang W, Kang J. Acoustic comfort evaluation in urban open public spaces. *Applied Acoustics*. 2005;**66**(2):211-229
- [20] World Health Organization. Burden of Disease from Environmental Noise: Quantification of Healthy Life Years Lost in Europe. World Health Organization, Regional Office for Europe; 2011
- [21] Hägerhäll C, Taylor R, Cerwén G, Watts G, Van den Bosch M, Press D, et al. Biological mechanisms and neurophysiological responses to sensory impact from nature. In: van de Boch M, editor. *Oxford Textbook of Nature and Public Health*. Oxford, UK. 2018. pp. 79-88
- [22] Annerstedt M, Jönsson P, Wallergård M, Johansson G, Karlson B, Grahn P, et al. Inducing physiological stress recovery with sounds of nature in a virtual reality forest—Results from a pilot study. *Physiology & Behavior*. 2013;**118**:240-250
- [23] Medvedev O, Shepherd D, Hautus MJ. The restorative potential of soundscapes: A physiological investigation. *Applied Acoustics*. 2015;**96**:20-26
- [24] Saadatmand V, Rejeh N, Heravi-Karimooi M, Tadrissi SD, Zayeri F, Vaismoradi M, et al. Effect of nature-based sounds' intervention on agitation, anxiety, and stress in patients under mechanical ventilator support: A randomised controlled trial. *International Journal of Nursing Studies*. 2013;**50**(7):895-904
- [25] Granö JG, Granv JG. *Pure Geography*. Baltimore, US: Johns Hopkins University Press; 1997
- [26] Porteous JD, Mastin JF. Soundscape. *Journal of Architectural and Planning Research*. 1985;**1**:169-186
- [27] Schafer RM. Notes for an Experimental Music Course. Ontario: Berandol Music Limited; 1967
- [28] World Soundscape Project, Truax B. *The World Soundscape Project's Handbook for Acoustic Ecology*. Arc Publications, Simon Fraser University; 1978
- [29] Zhang M, Kang J. Towards the evaluation, description, and creation of soundscapes in urban open spaces. *Environment and Planning. B, Planning & Design*. 2007;**34**(1):68-86
- [30] Adams MD, Bruce NS, Davies WJ, Cain R, Jennings P, Carlyle A, Cusack P, Hume K, Soundwalking as a methodology for understanding soundscapes
- [31] Coensel BD, Vanwetswinkel S, Botteldooren D. Effects of natural sounds on the perception of road traffic noise. *The Journal of the Acoustical Society of America*. 2011;**129**(4):EL148-EL153
- [32] Cain R, Jennings P, Poxon J. The development and application of the emotional dimensions of a soundscape. *Applied Acoustics*. 2013;**74**(2):232-239
- [33] Hedfors P, Berg PG. The sounds of two landscape settings: Auditory concepts for physical planning and design. *Landscape Research*. 2003;**28**(3):245-263
- [34] Cain R, Jennings P, Adams M, Bruce N, Carlyle A, Cusack P, et al. SOUND-SCAPE: A framework for characterising positive urban soundscapes. *The Journal of the Acoustical Society of America*. 2008;**123**(5):3394-3392
- [35] Brown AL, Kang J, Gjestland T. Towards standardization in soundscape preference assessment. *Applied Acoustics*. 2011;**72**(6):387-392
- [36] Herranz-Pascual K, Iraurgi I, Aspuru I, Garcia-Pérez I, Santander A, Eguiguren JL. Integrating soundscape

- criteria in urban sustainable regeneration processes: An example of comfort and health improvement. *Sustainability*. 2022;**14**(6):3143
- [37] Lacey J. *Sonic Rupture: A Practiced Approach to Urban Soundscape Design*. New York, USA: Bloomsbury Publishing; 2016
- [38] Bjerre LC, Larsen TM, Sørensen AJ, Santurette S, Jeong CH. On-site and laboratory evaluations of soundscape quality in recreational urban spaces. *Noise & Health*. 2017;**19**(89):183
- [39] Guastavino C, Katz BF, Polack JD, Levitin DJ, Dubois D. Ecological validity of soundscape reproduction. *Acta Acustica united with Acustica*. 2005;**91**(2):333-341
- [40] Sudarsono AS, Lam YW, Davies WJ. The effect of sound level on perception of reproduced soundscapes. *Applied Acoustics*. 2016;**110**:53-60
- [41] Bassarab R, Sharp B, Robinette B. An updated catalog of 628 social surveys of residents' reaction to environmental noise (1943-2008). *Novum*. 2009;**2009**:9-18
- [42] Kogan P, Turra B, Arenas JP, Hinalaf M. A comprehensive methodology for the multidimensional and synchronic data collecting in soundscape. *Science of The Total Environment*. 2017;**580**:1068-1077
- [43] Rehan RM. The phonic identity of the city urban soundscape for sustainable spaces. *HBRC Journal*. 2016;**12**(3):337-349
- [44] Kang J, Zhang M. Semantic differential analysis of the soundscape in urban open public spaces. *Building and Environment*. 2010;**45**(1):150-157
- [45] Kogan P, Arenas JP, Bermejo F, Hinalaf M, Turra B. A Green Soundscape Index (GSI): The potential of assessing the perceived balance between natural sound and traffic noise. *The Science of the Total Environment*. 2018;**642**:463-472
- [46] Jeon JY, Lee PJ, You J, Kang J. Acoustical characteristics of water sounds for soundscape enhancement in urban open spaces. *The Journal of the Acoustical Society of America*. 2012;**131**(3):2101-2109
- [47] Fiebig A. Acoustic environments and their perception measured by the soundwalk method. In: *Internoise 2015 Proceedings*. San Francisco, USA; 2015
- [48] Marry S, Defrance J. Analysis of the perception and representation of sonic public spaces through on site survey, acoustic indicators and in-depth interviews. *Applied Acoustics*. 2013;**74**(2):282-292
- [49] Patelli P. A field is to play. Enacting mental images of the soundscape. *Emotion, Space and Society*. 2017;**25**:44-53
- [50] De Coensel B, Botteldooren D. The quiet rural soundscape and how to characterize it. *Acta Acustica united with Acustica*. 2006;**92**(6):887-897
- [51] Axelsson Ö, Nilsson ME, Hellström B, Lundén P. A field experiment on the impact of sounds from a jet-and-basin fountain on soundscape quality in an urban park. *Landscape and Urban Planning*. 2014;**123**:49-60
- [52] Brambilla G, Gallo V, Asdrubali F, D'Alessandro F. The perceived quality of soundscape in three urban parks in Rome. *The Journal of the Acoustical Society of America*. 2013;**134**(1):832-839
- [53] Liu J, Kang J, Behm H, Luo T. Landscape spatial pattern indices and

soundscape perception in a multi-functional urban area, Germany. *Journal of Environmental Engineering and Landscape Management*. 2014;**22**(3):208-218

[54] Staško-Mazur K. Soundwalk as a multifaceted practice. *Argument: Biannual Philosophical Journal*. 2015;**2**:439-455

[55] Lee SA. Environmental perception, preferences and the designer. In: *Proceedings of the Lund Conference Architectural Psychology*. Boston, USA. 1973. pp. 26-29

[56] Fiebig A, Herweg A. The measurement of soundscapes-a study of methods and their implications. In: *INTER-NOISE and NOISE-CON Congress and Conference Proceedings 2017 Dec 7*. Hong Kong: Institute of Noise Control Engineering; 2017

[57] Jeon JY, Jo HI. Soundscape assessment with classification of human perception to sound environment. In: *INTER-NOISE and NOISE-CON Congress and Conference Proceedings 2020 Oct 12*. Seoul, South Korea: Institute of Noise Control Engineering; 2020

[58] Schulte-Fortkamp B, Fiebig A. Soundscape analysis in a residential area: An evaluation of noise and people's mind. *Acta Acustica United with Acustica*. 2006;**92**(6):875-880

[59] Venot F, Sémidor C. The soundwalk as an operational component for urban design. In: *PLEA*. Genève; 2006

[60] Semidor C. Listening to a city with the soundwalk method. *Acta Acustica United with Acustica*. 2006;**92**(6):959-964

[61] Berglund B, Nilsson ME. On a tool for measuring soundscape

quality in urban residential areas. *Acta Acustica United with Acustica*. 2006;**92**(6):938-944

[62] Bruce NS, Davies WJ. The effects of expectation on the perception of soundscapes. *Applied Acoustics*. 2014;**85**:1-1

[63] Liu Q, Liu Z, Jiang J, Qi J. A new soundscape analysis tool: Soundscape Analysis and Mapping System (SAMS). *Applied Acoustics*. 2020;**169**:107454

[64] Kephelopoulos S, Paviotti M, Anfosso-Lédée F, Van Maercke D, Shilton S, Jones N. Advances in the development of common noise assessment methods in Europe: The CNOSSOS-EU framework for strategic environmental noise mapping. *The Science of the Total Environment*. 2014;**482**:400-410

[65] Zambon G, Roman HE, Smiraglia M, Benocci R. Monitoring and prediction of traffic noise in large urban areas. *Applied Sciences*. 2018;**8**(2):251

[66] Asensio C. Acoustics in smart cities. *Applied Acoustics*. 2017;**117**:191-192

[67] Harman A, Dimitrov H, Ma R, Whitehouse S, Li Y, Worgan P, et al. Notifall: Ambient sonification system using water. In: *Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems*. Bristol, England. 2016. pp. 2667-2672

[68] Aspuru I, García I, Herranz K, Santander A. CITI-SENSE: Methods and tools for empowering citizens to observe acoustic comfort in outdoor public spaces. *Noise Mapping*. 2016;**3**(1)

[69] Guillaume G, Can A, Petit G, Fortin N, Palominos S, Gauvreau B, et al. Noise mapping based on participative measurements. *Noise Mapping*. 2016;**3**(1)

- [70] Maisonneuve N, Stevens M, Niessen ME, Steels L. NoiseTube: Measuring and mapping noise pollution with mobile phones. In: Information technologies in environmental engineering. Berlin, Heidelberg: Springer; 2009. pp. 215-228
- [71] Issarny V, Mallet V, Nguyen K, Raverdy PG, Rebhi F, Ventura R. Dos and don'ts in mobile phone sensing middleware: Learning from a large-scale experiment. In: Proceedings of the 17th International Middleware Conference. New York, USA. 2016. pp. 1-13
- [72] Geraghty D, O'Mahony M. Urban noise analysis using multinomial logistic regression. *Journal of Transportation Engineering*. 2016;**142**(6):04016020
- [73] Morillas JM, Gozalo GR, González DM, Moraga PA, Vílchez-Gómez R. Noise pollution and urban planning. *Current Pollution Reports*. 2018;**4**(3):208-219
- [74] Morillas JM, González DM, Gozalo GR. A review of the measurement procedure of the ISO 1996 standard. Relationship with the European Noise Directive. *The Science of the Total Environment*. 2016;**565**:595-606
- [75] Segura-Garcia J, Calero JM, Pastor-Aparicio A, Marco-Alaez R, Felici-Castell S, Wang Q. 5G IoT system for real-time psycho-acoustic soundscape monitoring in smart cities with dynamic computational offloading to the edge. *IEEE Internet of Things Journal*. 2021;**8**(15):12467-12475
- [76] Liu J, Kang J, Luo T, Behm H. Landscape effects on soundscape experience in city parks. *The Science of the Total Environment*. 2013;**454**:474-481
- [77] Wei-Ming C, Liang RH. Listening is believing: Exploring the value of sounds in an audio drama board game for shaping technology futures. *International Journal of Design*. 2021;**15**(2):55
- [78] Aletta F, Kang J. Soundscape approach integrating noise mapping techniques: A case study in Brighton, UK. *Noise Mapping*. 2015;**2**(1)
- [79] Jackson JB. *Discovering the Vernacular Landscape*. Connecticut, USA: Yale University Press; 1984
- [80] Vos J, Buchta E. Quantification of context effects in the determination of source-specific annoyance ratings for shooting and road-traffic sounds. *Proceedings Internoise*. 2000;**3**:1597
- [81] Cosgrove D. Prospect, perspective and the evolution of the landscape idea. *Transactions of the Institute of British Geographers*. 1985;**4**:45-62
- [82] Council of Europe Publishing. *European Spatial Planning and Landscape Series*. Piestany, Slovak Republic: Council of Europe Publishing; 2000. p. 72
- [83] Lowenthal D. Past time, present place: Landscape and memory. *Geographical Review*. 1975;**1**:1-36
- [84] Humboldt AV. *Ansichten der Natur*
- [85] Relph E. *Rational Landscapes and Humanistic Geography*. London: Croom Helm; 1981
- [86] Gombrich EH. The Earliest Description of Bosch's Garden of Delight. *Journal of the Warburg and Courtauld Institutes*. 1967;**30**(1):403-406
- [87] Kant I. *Prolegomena to Any Future Metaphysics that Will be Able to Present Itself as a Science*. Indianapolis, USA: Manchester University Press; 1966
- [88] Fairbridge RW. *Encyclopedia of Geomorphology*. London, UK. 2006

- [89] Meinig DW. *The Interpretation of Ordinary Landscapes: Geographical Essays*. USA: Oxford University Press; 1979
- [90] Kaplan A. Landscape architecture's commitment to landscape concept: A missing link? *Journal of Landscape Architecture*. 2009;4(1):56-65
- [91] Forster PM. A brief introduction to environmental psychology. *Date of Access*. 2010;22(01):2012
- [92] Porteous JD. *Environmental Aesthetics: Ideas, Politics and Planning*. London, UK: Routledge; 2013
- [93] Knox P, Marston SA. *Places and Regions in Global Context Human Geography*, 3. Baski
- [94] Palmer J. Research agenda for landscape perception. In: *Trends in Landscape Modelling, Proceedings at Anhalt University of Applied Sciences*. Virginia, USA. 2003
- [95] Baumgarten A, Chapter I. The history of philosophy as conceptual archaeology. Types of reading of the Anselmian argument. *The Infinite Argument*. 2012;1:13-33
- [96] Sapir G, Barak-Erez D, Barak A, editors. *Israeli Constitutional Law in the Making*. New York, USA: Bloomsbury Publishing; 2013
- [97] Lothian A. Landscape and the philosophy of aesthetics: Is landscape quality inherent in the landscape or in the eye of the beholder? *Landscape and Urban Planning*. 1999;44(4):177-198
- [98] Zagris N. Aristotle (384-322 BC): The beginnings of Embryology. *The International Journal of Developmental Biology*. 2022;66(1):5-8
- [99] Carson E. Locke's account of certain and instructive knowledge. *British Journal for the History of Philosophy*. 2002;10(3):359-378
- [100] Gross SW. The neglected programme of aesthetics. *The British Journal of Aesthetics*. 2002;42(4):403-414
- [101] Vandenabeele B. Burke and Kant on the social nature of aesthetic experience. In: *The Science of Sensibility: Reading Burke's Philosophical Enquiry*. Dordrecht: Springer; 2012. pp. 177-192
- [102] Zube EH, Sell JL, Taylor JG. Landscape perception: Research, application and theory. *Landscape Planning*. 1982;9(1):1-33
- [103] Lekagul A. *Toward Preservation of the Traditional Marketplace: A Preference Study of Traditional and Modern Shopping Environments in Bangkok, Thailand*. Virginia, USA: Virginia Polytechnic Institute and State University; 2002
- [104] Isling B. A typology for the parks of Stockholm. *Garden History*. 2004;1:248-260
- [105] Fenton DM, Reser J. The assessment of landscape quality: An integrative approach. In: Nasar J, editor. *Environmental Aesthetics: Theory, Research and Applications*. Cambridge, UK
- [106] Swaffield SR. Theory and critique in landscape architecture: Making connections. *Journal of Landscape Architecture*. 2006;1(1):22-29
- [107] Palka EJ. Coming to grips with the concept of landscape. *Landscape Journal*. 1995;14(1):63-73
- [108] Brunetta G, Voghera A. Evaluating landscape for shared values: Tools, principles, and methods. *Landscape Research*. 2008;33(1):71-87
- [109] Swanwick C. *Landscape Character Assessment. Guidance for England and*

Scotland; The Countryside Agency and Scottish Natural Heritage: Inverness, UK, 2002

[110] Stiles R. Landscape theory: A missing link between landscape planning and landscape design? *Landscape and Urban Planning*. 1994;**30**(3):139-149

[111] Braun R, Knitter D. Landscape as concept of space. *eTopoi. Journal for Ancient Studies*. 2021;**9**:37-53

[112] Greider T, Garkovich L. Landscapes: The social construction of nature and the environment. *Rural Sociology*. 1994 Mar;**59**(1):1-24

[113] Booi H, Van den Berg F. Quiet areas and the need for quietness in Amsterdam. *International Journal of Environmental Research and Public Health*. 2012;**9**(4):1030-1050

[114] Brown AL. A review of progress in soundscapes and an approach to soundscape planning. *International Journal of Acoustics and Vibrations*. 2012;**17**(2):73-81

[115] Pheasant R, Horoshenkov K, Watts G, Barrett B. The acoustic and visual factors influencing the construction of tranquil space in urban and rural environments tranquil spaces-quiet places? *The Journal of the Acoustical Society of America*. 2008;**123**(3):1446-1457

[116] Wolman A. The metabolism of cities. *Scientific American*. 1965;**213**(3):178-193

[117] Waldheim C. *The Landscape Urbanism Reader*. New York, USA: Princeton Architectural Press; 2006

[118] McHarg IL. *Design with Nature*. New York: American Museum of Natural History; 1969

[119] WCED SW. World commission on environment and development. *Our Common Future*. 1987;**17**(1):1-91

[120] Hartig T, Mitchell R, De Vries S, Frumkin H. Nature and health. *Annual Review of Public Health*. 2014;**35**:207-228

[121] Stigsdotter UK, Palsdottir AM, Burls A, Chermaz A, Ferrini F, Grahn P. Nature-based therapeutic interventions. In: *Forests, Trees and Human Health*. Dordrecht: Springer; 2011. pp. 309-342

[122] Turner T. *City as Landscape: A Post Post-Modern View of Design and Planning*. London, UK: Taylor & Francis; 2014

[123] Jellicoe GA, Jellicoe S. *The landscape of man: Shaping the environment from prehistory to the present day*. expanded and updated, Rev. and enl. 1995

[124] Hill K. *Urban Ecologies: Biodiversity and Urban Design*. Munich, Germany: Prestel;

[125] Waller SJ. Sound and rock art. *Nature*. 1993;**363**(6429):501

[126] Herranz-Pascual K, Aspuru I, García I. *Proposed Conceptual Model of Environmental Experience as Framework to Study the Soundscape*. Lisbon: InterNoise; 2010

[127] Viollon S, Lavandier C, Drake C. Influence of visual setting on sound ratings in an urban environment. *Applied Acoustics*. 2002;**63**(5):493-511

[128] Ren X, Kang J. Interactions between landscape elements and tranquility evaluation based on eye tracking experiments. *The Journal of the Acoustical Society of America*. 2015;**138**(5):3019-3022

[129] Pijanowski BC, Farina A, Gage SH, Dumyahn SL, Krause BL. What is

soundscape ecology? An introduction and overview of an emerging new science. *Landscape Ecology*. 2011;**26**(9):1213-1232

[130] Yang W, Kang J. Soundscape and sound preferences in urban squares: A case study in Sheffield. *Journal of Urban Design*. 2005;**10**(1):61-80

[131] Lam KC, Brown AL, Marafa L, Chau KC. Human preference for countryside soundscapes. *Acta Acustica united with Acustica*. 2010;**96**(3):463-471

[132] Curcuruto S, Asdrubali F, Brambilla G, Silvaggio R, D'Alessandro F, Gallo V. Socio-acoustic survey and soundscape analysis in urban parks in Rome. *Proceedings of the Institute of Acoustics*. 2011;**33**(2):830-837

[133] Nilsson M, Bengtsson J, Klæboe R. Environmental methods for transport noise

[134] Maffei L. Urban and quiet areas soundscape preservation. In: *InVICongresoIberoamericano de Acústica*. 2008

[135] Chitra B, Jain M, Chundeli FA. Understanding city park soundscape through ISO/TS 129132: 2018 sound walk (Method B) in association with landscape elements. In: *INTER-NOISE and NOISE-CON Congress and Conference Proceedings*. Seoul, South Korea: Institute of Noise Control Engineering.; 2020

[136] POUYA S. The role of landscape architecture on soundscape experience. *Turkish Journal of Forest Science*. 2017;**1**(2):183-193

[137] Brown AL. Using the sound of water in the city. *Landscape Australia*. 1994;**2**:103-107

[138] Nilsson ME, Alvarsson J, Rådsten-Ekman M, Bolin K. Auditory

masking of wanted and unwanted sounds in a city park. *Noise Control Engineering Journal*. 2010;**58**(5):524-531

[139] Zhao J, Xu W, Ye L. Effects of auditory-visual combinations on perceived restorative potential of urban green space. *Applied Acoustics*. 2018;**141**:169-177

[140] Fang CF, Ling DL. Guidance for noise reduction provided by tree belts. *Landscape and Urban Planning*. 2005;**71**(1):29-34

[141] Van Renterghem T, Attenborough K, Maennel M, Defrance J, Horoshenkov K, Kang J, et al. Measured light vehicle noise reduction by hedges. *Applied Acoustics*. 2014;**78**:19-27

[142] Hellström B, Nilsson ME, Axelsson Ö, Lundén P. Acoustic design artifacts and methods for urban soundscapes: A case study on the qualitative dimensions of sounds. *Journal of Architectural and Planning Research*. 2014;**1**:57-71

[143] Yang F, Bao ZY, Zhu ZJ. An assessment of psychological noise reduction by landscape plants. *International Journal of Environmental Research and Public Health*. 2011;**8**(4):1032-1048

[144] Chojnacki B, Piechowicz J, Matys M, Piotrowski K. Noise control in urban parks in Cracow

[145] Song X, Lv X, Yu D, Wu Q. Spatial-temporal change analysis of plant soundscapes and their design methods. *Urban Forestry & Urban Greening*. 2018;**29**:96-105