Contents lists available at Science-Gate

International Journal of Advanced and Applied Sciences

Journal homepage: http://www.science-gate.com/IJAAS.html

Assessment of urban soundscape to improve environmental quality

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ARTICLE INFO

Article history:
Received 10 November 2015
Received in revised form
26 December 2015
Accepted 27 December 2015

Keywords:
Landscape
Soundscape
Sound
Urban space

ABSTRACT

Urban environment's landscape is all available information of space which is receivable by the senses and is processed in the process of perception. Various environmental, physical, economic, social and factors influence promotion or degradation of urban life quality in various scales from city to different urban spaces and neighborhoods. Sound is an essential part of urban community and soundscape is one of the effective factors in people's experience of places. Soundscape concerns the relationship between hearing and human, social and environmental sound. In this article, we attempted to present various aspects of soundscape by reviewing opinions of thinkers. Also, developing the concept of urban landscape from a purely physical and visual aesthetic one to a more comprehensive one consist the five senses including hearing; and to enhance the desire to be present in space and consequently the quality of urban space. Lack of attention to role of sound has meant that most sounds in urban areas are unpleasant sounds of traffic, building sites, workshops and factories, repair shops etc. and generally the dominance of sound pollution. The method of this study was descriptive-analytic and method of data collection was library and media studies. In this research, description of soundscape, assessment and creation in open urban spaces has been reviewed in an orderly fashion which is in connection with four elements: sound, space, individuals and environment. This article discusses the concept of soundscape as well as explaining its role in the quality of urban environments and reviews the effective factors in assessing the quality of soundscape.

1. Introduction

Transmitted information from urban environments are not just physical and visual, they are information that are conceived by all five senses. Therefore, an urban environment's landscape is all available information of space which is receivable by the senses and is processed in the process of perception. Various environmental, physical, economic, social and etc., factors influence promotion or degradation of urban life quality in various scales from city to different urban spaces and neighborhoods (Saber, 2014). Landscape is one of these factors which can be considered as comprehensive covering all others. Landscape is part of environment or urban form which influences the resident's interaction and results of his/her actions. In fact it is in the urban landscape that part of potential environment information turns to a directly tangible quality (and or actual information). Urban landscape can be divided into three groups of human activities, physical and non-physical factors. Sound is a non-physical component of urban landscape. Existing sounds in urban areas can influence the attractiveness or promotion of quality or repellence of space of an urban area and feelings and perceptions of urban residents although, they do not attract the attention of residents like physical or human phenomenon and they are even used to them. In most studies conducted regarding landscape, the dominant focus is toward physical and visual aspects of environment, but we have to consider that urban soundscape as a non-physical landscape, after people's perception in a mutual relation between environment and individual, forms a particular mental landscape of the environment (Saber et al., 2014). Lack of attention to role of sound has meant that most sounds in urban areas are unpleasant sounds of traffic, building sites, workshops and factories, repair shops etc. and generally the dominance of sound pollution. Thus, the important issue here is to attend to sound quality in urban life and providing solutions to reform and improve urban and neighborhood soundscape. In most developing countries, not only the position of urban

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landscape is not clear in urban strategy and development documents, it is rather faced with superficiality which to some extent, reduces it to an insignificant concept and only attends to executive-operational measures. However, the sound aspects are reviewed in the form of sound limitations (which are required by law) in assessments of the environmental impacts of urban schemes. But, at this stage of planning, considerations relating to soundscape have not had much influence on comprehensive and general schemes and the focus is mostly on reduction of inverse effects from high level of sound on the future of urban residents and only the sound barriers of some large urban spaces (parks, squares, closed quarters and etc.) are considered. Sound pollution is one of the environmental pollutants in cities. This pollutant which has been interpreted mainly as unwanted and unpleasant sounds, usually influences human activities in terms of locative and temporal conditions and may foreclose human serenity and consequently, human presence in the urban spaces by causing physical, mental and social effects (Ramadhan and Talal, 2015). A growing and major environmental problem in the urban areas is the traffic noise. It is estimated that about 80 million people (some 20%) of the European Union countries' population suffer from noise levels which are considered undesirable (noise levels that are over 65db which are called the "black zones") and, 170 million others live in the "grey zones" who are exposed to noise levels of between 55 to 65db (EC, 1996). A research in 2006 showed that noise causes anxiety and anxious people have high accuracy but low speed and this lack of coordination of speed and accuracy causes behavioral disorders and more errors. Noise increases the heart beat and thereupon, leads to hypertension and enhancement of anxious responses (Shariat Panahi, 2003). Integrated approach to land use planning, urban development, urban traffic management and life quality which includes sound, place new viewpoints before us. Population growth, increase of motor vehicles, expansion of industries and the modern life in general along with growing technology in human societies, are accompanied with creating maladaptive sounds. In urban areas, buildings alongside streets, causes complications in the process of sound pollution emissions due to traffic. Existence of buildings causes constant sound echoes, sound dispersion and refraction. At present, most countries have only made some attempts to reduce sound pollution whilst, no attention has been directed towards to soundscape aesthetic design principles in such a way as to attract the city dwellers to space as well as promoting spatial quality.

2. Methods and materials

The present research is fundamental which will be useable as applied research in the future with the help of other research in the relevant field. The method is descriptive-analytic and method of data collection is library and media studies. In this research, description of soundscape, assessment and creation in open urban spaces has been reviewed in an orderly fashion which is in connection with four elements: sound, space, individuals and environment. Influential factors on assessment of soundscape in open urban spaces include Socio-psychological and sound characteristics of various sounds, sound influences of spatial boundaries and elements, demographic and social characteristics of users and usual physical-environmental conditions and subsequently, a system for describing soundscape is created.

3. Results

All objective and subjective features of architectural works, through expression of outer form and contact with memories and mental images, influence the perception and feelings of people. Hence, landscape is considered manifestation and tangible part of form, in which we observe visual, functional and semantic crystallization of elements which form space (Yousif, 2015).

3.1. Soundscape

The term "soundscape" was first defined by R. Murray Schafer (1977) as "environment created by sound". He proves its performance in everyday life. Truax (2001) was in fact the first modern author to attempt a single definition for soundscape "*An environment of sounds (or sonic environment) with, emphasis on the way it is perceived and understood by the individual, or by a society*". The concept of soundscape explicitly includes a subjective component, namely the way in which the environment is perceived and understood by an individual or by a community (Truax, 2001). Therefore, Truax turns his attention from environment to the listener. Whilst in Schafer's view, this concept includes activities such as recording nature's sounds; natural sounds based compositions; research on sounds heard in villages and rural areas; analysis and description of all sound environments and creating artistic sound installations. In 2009, Payne et al. (2009) recommended a definition of soundscape based on recent sound research, in a text written for the Department for Environment, Food & Rural Affairs "Soundscapes are the totality of all sounds within a location with an emphasis on the relationship between individual's or society's perception of, understanding of and interaction with the sonic environment". This definition is based upon original soundscape definitions and landscape descriptions (Schafer, 1997; Schulte, 2002; Truax, 2001). Soundscapes can be studied at the micro (individual place, e.g. urban park, street, room), meso (small area, e.g. residential area, large shopping mall) or macro level (large area, e.g. whole city) (Foale, 2014). Central to the term soundscape is an individual's, or society', perception and

understanding of the acoustic environment (Yang and Kang, 2005; Truax, 2001; Dubois et al., 2006). Thus a soundscape exists through human perception-but always within the context of a particular time, place and activity. The acoustic environment as perceived and understood, by people, in context is a definition of soundscape that may be adopted in future acoustic standards (Axelsson, 2011). The soundscape is perceived in a physical, often outdoor, area/space/location and that place also has certain visual and other properties associated with its natural or human-made environment. The acoustic environment of that place can be described by acoustical parameters such as type of sound sources, levels, spectrum, and temporal pattern. The place is also where people live or occasionally spend time and performs activities, and in which people interacts with the physical environment and with each other (Brown, 2010). A place is where people live and sometimes spend some of their time there and undertake some activities, and they interact with one other and also with the physical environment. The audio and visual elements therefore interact with each other in human perception. Generally, the concept of soundscape takes a more holistic approach than simply considering the unwanted health effects of noise, such as sleep disturbance or annoyance (Botteldooren et al., 2006), and considers the way that environmental sounds are meaningful events that affect people(Schulte, 2002; Dubois et al., 2006). Emphasis on soundscapes is positive at the moment. Therewith, simple elimination of noise is not always desirable and can lead to anxiety. A quality sound environment is an environment in which there is an appropriate coordination between sounds that can be heard and sounds that are expected to be heard, and the dominant sounds which are heard in a place are the sounds which are considered desirable or preferred in that place and the sounds that are not desirable, not to be heard. Soundscape in the urban spaces is a complicated system relating to physical, psychological and social factors. We can define soundscape generally in this way: "a sound environment that is comprehended experienced and/or understood by a person or group of people".

3.2. Soundscape approach and environment sound management approach

The role and application of concept of soundscape, regarding environment sound management, needs explanation. In environmental sound management, sound is a waste product which is controlled to reduce sound emissions which are nuisance to human beings. In turn, soundscape approach considers the sound environment as a source and concentrates on sounds that people want and/or prefer. Truax describes two distinct approaches for outer sound environment: traditional approach, objective based energy model for sound environment (environment sound management) and subjective listener model (soundscape approach) and he believes a coherent model is needed. How these two zones differ, and how they expand and complement each other, requires further review (Brown, 2010). Sound is conceived as a waste product in the environment sound zone which is supposed to be reduced and managed with all other pollution: in source, in the path of emission or by receivers. In contrast, soundscape zone, considers sound as a source-which is with the same management content as other rare sources such as water, air and soil: namely, rational use and promotion and support where it is suitable. Source management has particular concentration on usefulness of source for humans and help to promote life quality for present and future generation. Environmental sound management is rooted in physical environment. Even in audio-psychological research, human perception of sound and response to sound stresses physical descriptive which has contact with human response-noise exposure parameters: surface, amplitude and environmental sound time dimensions. Environmental sound management uses these physical descriptions to set standards for human exposure and subsequently, they are also used for management and sound adjustment design. It acquires importance for participation in sound policy, management and control and objective physical assessment. Most destructive human responses to environment sound are perceived, which are the level of noise exposure function. Although, from soundscape zone, there is increasing conception and acceptance of the fact that the outer sound quality (quality in regard to human preference) cannot be determined by physical assessment. Issues like theme, sound information and people's views and expectations play a vital role in judgments of outer sound quality or, are more important than sound level or do not consider the level (Brown, 2010). These elements are distinct from each other in traditional sound model for study of sound: source, transmitter and receiver. This model is considered as linear and from transmitter to receiver. In contrast, Truax (2001) presents a network of interactions which make up the sound environment including several transmitters and receivers which can alter the roles and have some functions at the same time. Truax's model is used as a guiding model for evaluating audio ecology. The spectrum in this model is designed for transmitters in the audio zone, i.e., space and (or a subject) in which sounds are transmitted and discusses topics about audio features of spectrum in relation to form, space, substance and furniture (Truax, 2001). In addition, spectrum includes transmitters and receivers; spectrum function as exit for these cases, leads to problems in classic programming for land use and conflict of interests and also, some problems regarding design of future essentials and experiences of aesthetics are stated. Soundscape planning includes design or management for creating changes in the sound environment in a way which will improve understanding of the environment.

3.3. Soundscape assessment

This section deals with assessing soundscape in relation to the four main elements that Presented in an article by Mei Zhang and Jian Kang; sound, space, people and interaction between environmental, physical and audio factors:

Sound: there is a positive view toward natural sounds. Research by Yang and Kang (2005) showed that over 75% of interviewees considered the sound of water and birds desirable. Regarding sounds that are culturally approved such as the church bells and street buskers also show a high level of preference among people. For human sounds such as conversations around us, most people do not consider them as irritating neither desirable. The most unusual sounds are mechanical sounds such as construction noises, car radio/music and sounds of vehicles. Schafer (1977) defines sounds thusly: the key notes, foreground sounds and sound marks. Keynotes are in analogy to music, in which a keynote identifies the fundamental tonality of a composition, around which the music modulates. Foreground sounds, also termed `sound signals', are intended to attract attention. Sounds that are particularly regarded by a community and its visitors are called `sound marks', in analogy to landmarks. Natural examples of the latter include geysers, waterfalls, and winds and sounds of traditional activities (Smith, 2000).

Space: in addition to assessing sounds, sound effects of open urban space should also be considered. Sound nuisance is due to higher resonances. There are often various audio regions in the open urban spaces and there is a dominant sound in each region. This point is particularly important for assessment of soundscape when sound is related to users' activities such as group dancing. Also, sounds that are distant are near, or in the vicinity of the users and provide various information which influence the assessment. In researches conducted about sound quality, it has been demonstrated that audio and psychological features are different between steady and transient sounds (Nathanial and Guyot, 2001).

People: judgment of sound and human sensitivity in general toward urban environment depends on human behavioral, psychological and physical condition and also, on physical properties of the audio load. Demographic and social factors of users also have an important role in assessment of soundscape (Yang and Kang, 2005). A survey in Europe showed that there is no significant difference various age groups regarding mental assessment of sound level. It was also deducted that as the age increases, people show more tolerance toward sounds relating to nature, culture and human activities. In contrast, young people show more inclination toward mechanical and music sounds (Bull, 2000). Comparing various countries showed that cultural differences can lead to different audio assessment and sound preferences (Yang and Kang, 2005). Similarly, intercultural comparison of community responses to road traffic sound in Japan and Sweden showed that non audio factors, including various traditions of people who live in different countries and various places of residence, are important for assessment of nuisance. Assessment of sound quality in urban districts is dependent on how people live in those places and how they define the district in relation to dependency on infrastructures and how they are involved in the social life of that district. In fact, noise regulations are on the basis of people's expectations of various sound environments which are dependent on different features of the environment.

Environment: another important aspect of soundscape assessment in open urban spaces is the interaction between audio and physical-environmental conditions. For example, if the open urban space is very hot or cold, acoustic comfort can have more or lesser importance in general assessment of serenity. Based on research results, from analysis of main components for review of relation between general assessment of physical serenity of urban open space and subjective assessment, various physical-environmental reagents include temperature, sunshine, lighting, wind, spectrum, humidity and sound level. Three factors were determined. First factor (22.8%) includes temperature, sunshine, lighting and wind is the most important one. 2nd factor (17.5%) has connections with visual and audio meanings and shows that a sound environment is one of the main influential factors on general serenity in urban open spaces. The 3rd factor (14.8%) has basic relation with humidity and includes humidity and wind (Yang and Kang, 2005). Much research has been conducted regarding visual-audio factors interactions. Research in garden shows that positive assessment of visual perspective; reduces audio perspective nuisance, whilst negative assessment of visual perspective causes annoyance (Maffiolo et al., 1999). For most of environmental sounds which include the singing of birds, sound of crickets, music, sound of water, trees, furniture and waves, it has been proven practically that good or medium perspectives can promote people's feeling of desirability.

3.4. Desirable urban audio environments

Designing a desirable urban soundscape does not create a complete silent environment (as far as possible). In most modern views, absolute silence is not a must and is bad and unwanted in some situations. The ideal urban sound environment is dependent on its own urban settings.

Residential environment: at home, most noises which cause annoyance for people in private spaces are due to electrical appliances. The more we pay attention to these noises, the more they are considered as an annoyance factor. We deduct from this that various traffic noises cause annoyance for the people. Reducing noises via insulation methods require closing all windows and doors which in some case leads to a feeling of limited sense of control and

freedom of the residents and will have inverse and negative consequences. The houses themselves act as a shield against annoying noises – and in some cases act as amplifiers of low audio frequencies (Pedersen et al., 2007). On the one hand, houses can reinforce existing problems and on the other hand, they can reduce internal noises. It has been proven that noisy incidents at the end of sleep can have much effect on the overall quality of sleep and the provisions relating to lack of daily traffic congestion are very effective (Griefahn et al., 2008). Since the cause and effect correlation has been calculated at 75% between exposure and effect of noise on human health for emotional and cognitive factors (Muzet, 2007), urban noise management believes that reduction of audio harassment can lead to reduction of negative effects on people.

Public urban spaces: city dwellers perceive and assess public spaces' soundscape differently to annoying noises in their own home environments. Soundscape quality is assessed and identified on the basis of urban settings and the uses of urban space. In assessing soundscape quality, physical indexes are not very important and the relation between the listeners and the sounds they hear are the priority and important (Dubois et al., 2006). Public urban spaces have various uses: shopping, moving about, recreation, social interactions etc. Obtaining high quality of urban spaces soundscape leads to the enhancement of urban residents' health. Considering the concentration of urban functions, intensity of traffic in city center is high. This can cause high level of noise in urban environments with dense population. Traditional engineering for control of noise, when used alone for reducing and adjusting noise in quite urban districts with recreational applications such as urban roundabouts and parks, has two main advantages. Firstly, traditional methods lead to a reduction of negative effects of audio pressure on other spaces (Schafer, 1977). Secondly, noise control engineering is sometimes considered a negative solution, because not all sounds are necessarily nuisance and some sounds have a harmony with environment and instead of eliminating them, they must be protected so that the environment is suitable and desirable for hearing dimension of people. All functions undertaken in regards to designing urban soundscape are in three groups of audio considerations:

- 1. Reduction, neutralization or remission of sounds which are known as very loud and/or undesirable.
- 2. Maintaining and increasing known existing sounds as desirable.
- 3. Adding audio elements not found in existing settings and this may fulfill urban planning and architectural project aims.

4. Conclusion

Planning and designing soundscape is a complicated process which requires groups and people's participation in various scientific contexts. Urban planners and landscape architectures with the task of promoting urban environment quality are one of these groups who can cause qualitative promotion and management of soundscape to an extent through their attempts. Creating or designing a soundscape in an urban space is considered as a dynamic process. In addition to control of noise pollution, part of urban space qualities is obtained via desirable soundscape with consideration of settings: such as liveliness, feeling of peace of mind, security etc. Since the task of urban planners and landscape architectures is promotion of environmental qualities of an urban space, designing of soundscape is part of their tools for achieving such an objective. The concept of urban soundscape (against noise pollution) is based on this fact that environmental sounds are reflective of human presence and human activities. However, soundscapes are not always assessed in a negative manner and some live and noisy environments are even judged as a positive thing. This research emphasizes that soundscape in open urban spaces is not just about controlling the sound and some other dimensions have to be considered which include socio-psychological features of various sounds, audio effects of space edges and elements, social demographic features of the users and general physical and environmental conditions. This study recommends that by linking Individual perception categories and sociological representations, to concentrate on meanings attributed to soundscapes by the residents and their influences in the cities be considered for creating identity and promotion of urban beauty in architectural and urban planning documentations of the country.

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