EREM 78/4

Journal of Environmental Research, Engineering and Management
Vol. 78 / No. 4 / 2022
pp. 39–51
DOI 10.5755/j01.erem.78.4.31244

Evaluation of Soundscape Variations through the Open Public Spaces in Saharan Cities: A Case of Biskra, Algeria

Received 2022/04 | Accepted after revision 2022/10

http://dx.doi.org/10.5755/j01.erem.78.4.31244

Evaluation of Soundscape Variations through the Open Public Spaces in Saharan Cities: A Case of Biskra, Algeria

Tallal Abdel Karim Bouzir*
Institute of Architecture and Urban Planning, Blida University, Blida, Algeria

Djihed Berkouk
Department of Architecture, Biskra University, Biskra, Algeria
School of Design and Architecture, Dar Al-Hekma University, Jeddah, KSA

Sara Khelil, Mohamed Elhadi Matallah, Noureddine Zemmouri
Department of Architecture, Biskra University, Biskra, Algeria

Samiha Boucherit
Department of Architecture and Industrial Design, Università degli Studi della Campania "Luigi Vanvitelli", Aversa (CE), Italy

***Corresponding author:** bouzirtallal@gmail.com

This study aims initially to evaluate the quality of different soundscapes in the public space of the city of Biskra, in Algeria. A total of 35 participants took part in a laboratory experiment, where 28 sound clips of one-minute duration taken from public spaces in the city were used as stimuli. The A-weighted equivalent continuous sound pressure level ($L_{Aeq,1min}$) was calculated. The participants rated the quality of the soundscape using attribute scales provided in their own native language. The results of the questionnaire on the recorded soundtracks confirm that the immediate environment affects the ambient sound level and the quality of the sound environment, where the sound environments of the areas located near the roads, with a high mechanical flow, are considered the most unpleasant and noisy, with a high A-weighted equivalent continuous sound pressure level ($L_{Aeq,1min}$). The findings of this study indicate that there are statistically significant correlations between pleasantness and loudness, presence of mechanical sounds, presence of non-mechanical sounds, and a sound exposure level. In addition, this study shows that there is a significant positive correlation between pleasantness and the presence of non-mechanical sounds. The results also showed an inverse relationship between the presence of mechanical and non-mechanical sounds, and that the absence of mechanical sounds allows natural and human sounds to be more audible, making the soundscape more pleasant and calm according to the results of the questionnaire. From this study, the duality $L_{Aeq,1min}$ and the components of the soundscape are very representative indicators of the quality of the soundscape.

Keywords: binaural recording, soundscapes, questionnaire, soundscape perception, noise measurement, public space.

Introduction

Since ancient times, the good quality of the urban environment has always been essential for the comfort of human beings (Lloyd and Auld, 2003; Parfect and Power, 1997), and nowadays it has become an emergency due to the impact of rapid urbanization and population growth on urban environments (Buhaug and Urdal, 2013; Liang et al., 2019; Yu et al.,., 2018, 2019). During the last decade, the development of a sustainable urban environment has been at the heart of the majority of research projects and the main objective for a resilient human habitat.

This study focuses on the city of Biskra in Algeria, representative of the desert cities of the North African region, which is characterized by a harsh climate with hot and very dry summers as well as cold and dry winters, having average temperatures that vary between 0°C and 45°C depending on the season (Berkouk et al., 2019; Farhi, 2008; Matallah et al., 2020). Similar to most cities in the Sahara, it suffers from a mismatch between the contextual conditions of the arid regions, as well as the urbanization and management models that have been adopted in the northern regions of countries with a Mediterranean climate. The large boulevards, multi-story buildings with glass facades, and less dense neighborhoods contrast with the streets, alleys, covered passages and dead ends, and dense neighborhoods with irregular plans of the old cities, which have influenced the environment in these areas (Farhi, 2008; Bouzir et al., 2019). Therefore, these desert cities have been the subject of several studies recently, focusing mainly on the effect of the urbanization mode and the transformation of these oases into Saharan cities on energy consumption, indoor and outdoor thermal comfort, which remains a great challenge, especially in the severe climatic conditions of the region, as well as indoor and outdoor luminous comfort, etc. However, the issue of urban acoustics despite its importance is still a gray area in the context of desert cities, especially in North Africa. It is therefore urgent to shed more light on the current situation of the sound environment in order to: (i) better understand and characterize the soundscape of these regions, (ii) assess the noise pollution level in these oases and desert cities, especially facing the current urbanization, (iii) understand the relationship between the subjective evaluation of the soundscape quality by the inhabitants and the measured noise level as well as to determine the main noise pollution sources in these cities. This is particularly important in the face of current urbanization because high noise pollution can be responsible for many dangerous pathologies (Begou and Kassomenos, 2021; Huang et al., 2021; Selmat et al., 2021; Wokekoro, 2020) such as anxiety, hearing loss, cardiovascular and even mental diseases (Baxter et al., 2013; Lercher et al., 2000; Śliwińska-Kowalska and Zaborowski, 2017; Van Kempen et al., 2018; Yuen, 2014), and it also has negative effects on biodiversity and the fragile urban ecosystem (Bouzir et al., 2019; D'Odorico et al., 2008; Fairbrass et al., 2017).

Acoustic urban environment research is divided into two main areas. The first one focuses on the phenomenon of noise pollution, which is one of the most dangerous types of environmental pollution for human health after air and water pollution (WHO, 1999; Grant et al., 2000; Morillas et al., 2002; Zannin et al., 2006; Bouzir et al., 2022). This axis focuses on environmental sounds as sources of the nuisance that need to be fought against because of their harmful effects on comfort, health, and the environment. In this field of research, researchers measure the physical indicators of acoustics, namely the equivalent sound pressure level (L_{eq}) or the day-evening-night level (L_{den}), etc., and compare them to the maximum noise limits proposed by the international environmental and health protection agencies (Berglund et al., 1999; Passchier-Vermeer and Passchier, 2000) to assess the noise pollution rate in the study area (Zannin et al., 2006; Bouzir et al., 2018). However, these decibel values cannot represent a soundscape which is a vast concept and depends on many non-measurable parameters (Berglund et al., 1999; Berkouk et al., 2020). After the emergence of the new concept of soundscape developed by the Canadian researcher Schafer in 1977 in his book "The Soundscape: Our Sonic Environment and the Tuning of the World" (Schafer, 1993; Schafer and Gleize, 1979), a new line of research has been developed. It focuses on the sounds of the environment as an atmosphere, their quality linked to the nature of these sources and dependent on the sensation of the human beings who live the sound experience (Bouzir et al., 2018; Ma et al., 2018). Despite very interesting research published recently (Aletta et al., 2016; Bild et al., 2018; Gozalo et al., 2015; Herranz-Pascual et al., 2017; Maristany and Recuero Lopez, 2010), our research stems also from a notable lack of studies in the scientific literature that studies the urban soundscape by examining the association between the two previous axes to understand the relationship between human sound perception and the measured physical indicators of sound, in the urban environment, in particular in developing countries including North Africa.

This study first aims to assess the quality of different representative urban soundscapes extracted from the city of Biskra, through binaural sound recordings (Xu and Kang, 2019), and by using questionnaires on reactivated listening. Secondly, this research seeks to understand by correlation tests (Chi-square and Spearman) the relationship between the calculated A-weighted equivalent continuous sound pressure level ($L_{Aeq,1min}$), the subjective description of urban soundscapes and soundscape components.

Methods

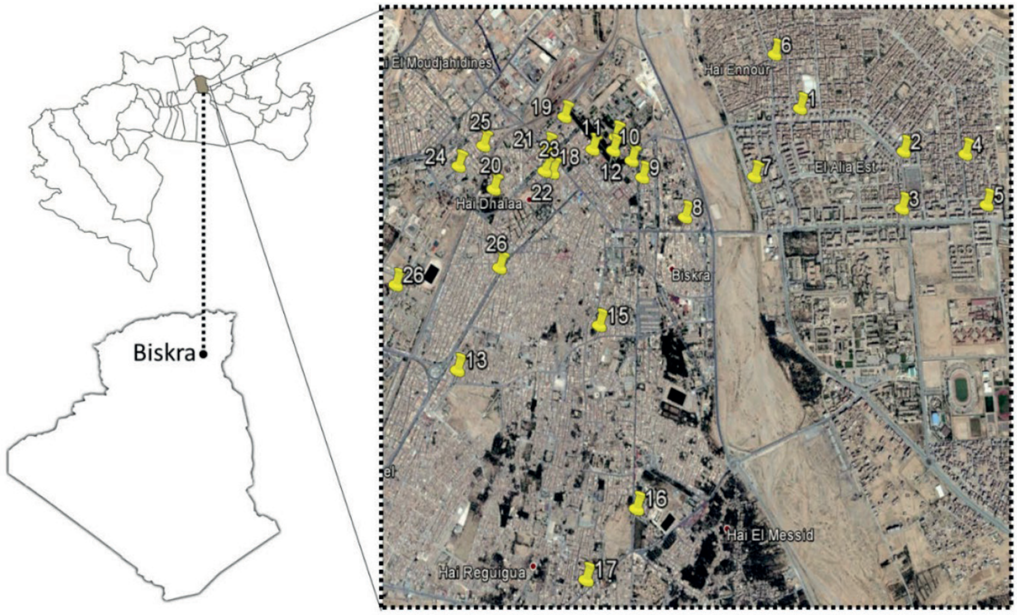
This study is being carried out in the city of Biskra, located northeast of the Algerian Sahara (34 ° 51 ′ 00 ″ N 5 ° 44 ′ 00 ″ E). In total, 26 sound recording stations were chosen to cover the various soundscapes representative of the city. Thus, pathways, gardens, public squares and the residential districts as well were investigated (*Fig. 1*). This research was structured in three phases. During the first phase, binaural sound recordings were made in situ using a professional sound recorder (zoom H4) coupled to a binaural microphone (Soundman OKM II Classic). The sampling rate and the bit depth of the audio recording were 48 kHz and 24 bits, respectively. Binaural recordings were made to reflect the human binaural hearing system, allowing the 3D spatial characteristics of the recorded acoustic environments to be reproduced. In addition, a questionnaire was conducted among city users to assess the perceived quality of the soundscapes studied in the second phase of this study. During the third phase, the correlation tests by Chi-square and Spearman model were established using SPSS software to provide the relationship that may exist between $L_{Aeq,1min}$, the chosen perceptual indicators (pleasantness, loudness), and the rate of presence of mechanical and non-mechanical sounds).

Recording data collection

In order to decide on the locations for the audio-visual recordings, preliminary soundwalks across the city were carried out. Twenty-six soundscapes were recorded for 5 minutes in the twenty-six selected stations (*Table 1*), using the H4 zoom recorder coupled to a binaural microphone (Soundman OKM II Classic). For the laboratory experiments, an audio excerpt of 60 seconds was selected from each of the 28 binaural recordings by using STx acoustic software (S_TOOLS-STx version 4.2.2) as well as the equivalent continuous sound pressure level A-weighted ($L_{Aeq,1min}$) was calculated (*Table 1*). The recordings were made during working days, and excluding peak hours. The sound environment during the weekend and peak hours in the city of Biskra is often considered particular (Bouzir, 2018; Bouzir et al., 2017; Bouzir and Zemmouri, 2018) since it does not reflect the sonic atmosphere in general, but rather represents extreme sound events over short periods.

The recording campaign was taken in ideal climatic conditions, with no wind or rain, considering these

Fig. 1. *Location of 26 studied points across the city*



two phenomena can influence significantly data accuracy (Bouzir and Zemmouri, 2018; Boyes, 2009; Malchaire, 2001; Raimbault and Dubois, 2005).

Questionnaire

To assess the quality of a soundscape, several types of approaches have been developed since the 1980s, including closed and open questionnaires, interviews, commented tours, and soundwalks (Axelsson et al., 2010; Lee, 2010; Pérez-Martínez et al., 2018; Tse et al., 2012). In this study, a reactivated listening questionnaire was used, a technique widely applied in recent studies, in which respondents listen to an audio recording and answer questions about it (Axelsson et al., 2010; Brambilla et al., 2013; Brinkmann et al., 2014; Lindau, 2014; Nilsson et al., 2012; Jeon et al., 2018).

Participants

In total, 35 university students participated in the experiments (master's, bachelor's and PhD students). The age distribution of the participants ranged from 20 to 27 yrs (mean age = 23.4). They were recruited as volunteers through an open invitation. The subjects reported that they had no hearing problems.

Questionnaire process

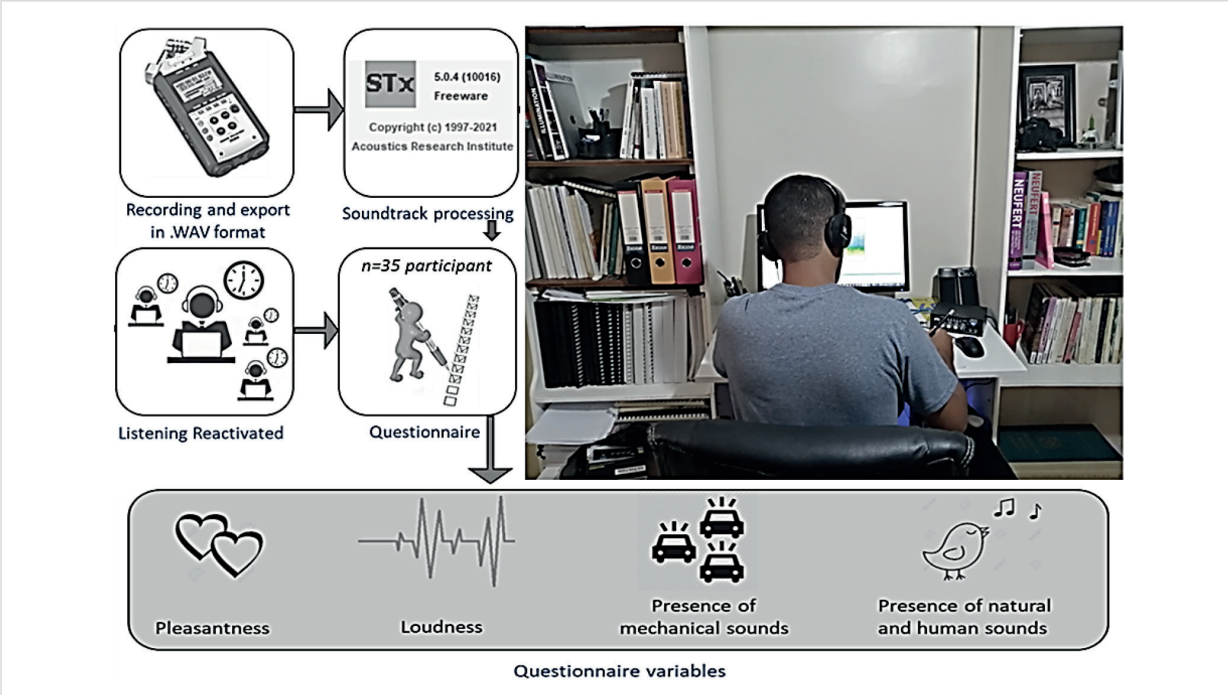
Fig. 2 represents the questionnaire process. During this questionnaire, the sound reproduction was made using headphones (Sony MDR-ZX660AP) (Binauralization) (Arnaldi et al., 2018; Arras et al., 2003; Hong et al., 2019). For soundtracks longer than 10 seconds, the overall judgment of the sound environment is strongly linked to sound events of the last moments. Thus, this is why extreme sound events in the last seconds of the recordings have been avoided.

After an introduction of the purpose, the type of questions, and the available choices, the participants begin this investigation by listening to all the recorded audiotapes to get an idea of the sound environments that to be evaluated. Then, each participant was invited to answer four questions after having listened to

Table 1. *Description of the assessment locations and the calculated ($L_{Aeq,1min}$) [dB]*

No.	Morphology	Activities	$L_{Aeq,1min}$ [dB]	N	Morphology	Activities	$L_{Aeq,1min}$ [dB]
1	Large tow-lanes traffic street with high flow rates, high speed	Commerce on one side of the street	75.1	14	Street with interrupted traffic	Commerce	70
2	Large tow-lanes traffic street	Commerce on one side of the street and neighborhood parking	70.5	15	Two-way traffic street with high flow rates, street trade	Commerce	72
3	Large tow-lanes traffic street; urban crossroads	Commerce on one side of the street	72.2	16	Two-way traffic street with high flow rates	Hospital, clinic and bus station	71
4	Street without traffic	Residential area	69.5	17	Street with moderate traffic flow rates	Commerce and bus station	66.8
5	Large tow-lanes traffic street	Commercial area	76	18	Downtown small park	Relaxation and meeting space	58.8
6	Two-way traffic street with high flow rates, low speed	Commerce	68	19	Quiet pedestrian street	Residential area	56.7
7	Park alongside a street	Small commerce and relaxation jogging, and meeting space	62	20	Large park	Small commerce and relaxation, jogging and meeting space,	53.3
8	Two-way traffic street with high flow rates	Commerce and two important bus stations	72	21	Street with moderate traffic flow rates	Small commerce	65.1
9	Two-way traffic street with high flow rates, low speed	Administration, commerce and school	67.9	22	Street with moderate traffic flow rates	Commerce and cafe, terraces	62.3
10	Street with moderate traffic flow rates, low speed	Bank, coffee shop and jogging space	62.3	23	Street with moderate traffic flow rates	Commerce, cafe and shopping center	63.4
11	Large park	Small commerce and relaxation, jogging and meeting spaces	55.9	24	Street without traffic	Residential area	56.1
12	Street with moderate traffic flow rates	Administration, residential area and jogging space	65.2	25	Street with moderate traffic flow rates	Residential area and school	56.8
13	Two-way traffic street with high flow rates	Small commerce on one side of the street	67.5	26	Street with moderate traffic flow rates	Commerce and bus station	57.9

Fig. 2. *Questionnaire process*



the one-minute soundtrack. The participant was free to hear the sound as many times as necessary. The subjects answered directly in an Excel file previously prepared exclusively for this survey.

Questions

The questions in this survey are organized into two sections (*Table 2*). The first (Q 1, 2) concerns the evaluation of the soundscape quality which contains two

Table 2. *Questionnaire questions*

Section 1					
Q1	How do you rate this sound track in terms of pleasantness?				
	Very unpleasant	Unpleasant	Moderately pleasant	Pleasant	Very pleasant
	غير ممتع جدا غير سار جدا	غير ممتع غير سار	حيادي	ممتع سار	ممتع جدا سار جدا
Q2	How do you rate the overall loudness?				
	Very noisy	Noisy	Medium	Calm	Very calm
	صاخب جدا	صاخب	متوسط	هادئ	هادئ جدا
Section 2					
Q3	How do you rate the presence of mechanical sounds (cars, motorcycles, etc.)?				
	Very weak	Weak	Medium	Strong	Very strong
	ضعيف جدا	ضعيف	متوسط	قوي	قوي جدا
Q4	How do you rate the presence of natural and human sounds (non-mechanical)?				
	Very weak	Weak	Medium	Strong	Very strong
	ضعيف جدا	ضعيف	متوسط	قوي	قوي جدا

questions intended to assess the general impression of the participants on the presented sound samples. In the second section (Q 3, 4), the questions aim to determine the rate of presence of mechanical and non-mechanical sounds (natural and human) in each soundtrack. A 5-point scale was used (*Table 2*). On a scale of 5, the level of perceived sound intensity goes from 1 corresponding to very noisy to 5 corresponding to very quiet.

Results and Discussion

Questionnaire results

Section 1 (Question 1,2)

Figs. 3 and 4 represent the appreciation of the pleasantness as well as the loudness of the participants for the 26 studied sound environments. In *Fig. 3*, a convergence between the values of these two variables was observed, where the mean responses of pleasantness and loudness were 2.86 and 2.70, respectively, with standard deviations of 0.95 and 0.82. In addition, *Fig. 4 (a)* shows that, on a 5-degree scale, the sound environments judged as very pleasant are 4 (18, 19, 25, and 26 located in a street without traffic or with moderate traffic flow rates and urban park) while 3 soundtracks extracted from the gardens and residential districts are judged as pleasant. Based on this evaluation, it is only 15% of all the soundscapes presented in this study that are perceived as very pleasant, while 12% are pleasant and 15% moderately pleasant. However, 23% of the soundscapes studied are evaluated as very unpleasant while 36% are considered unpleasant. Very unpleasant and unpleasant soundscapes are reported in stations located along main traffic routes and two-way streets with high traffic flows and speeds.

As we can see in *Fig. 4 (b)*, from the 26 sound sequences presented in this survey, only four soundtracks are judged as very calm, which corresponds to 15% of the studied soundscapes, while 10% of the soundtracks are judged as calm and 15% as very quiet. On the other hand, 23% of the sound sequences are evaluated as very noisy while 38% are judged as noisy. The environments considered the noisiest among these case studies are those corresponding to points 13 and 5 located near a two-way traffic street with high flow rates.

Fig. 3. *Pleasantness and loudness average ratings of 26 soundtracks*

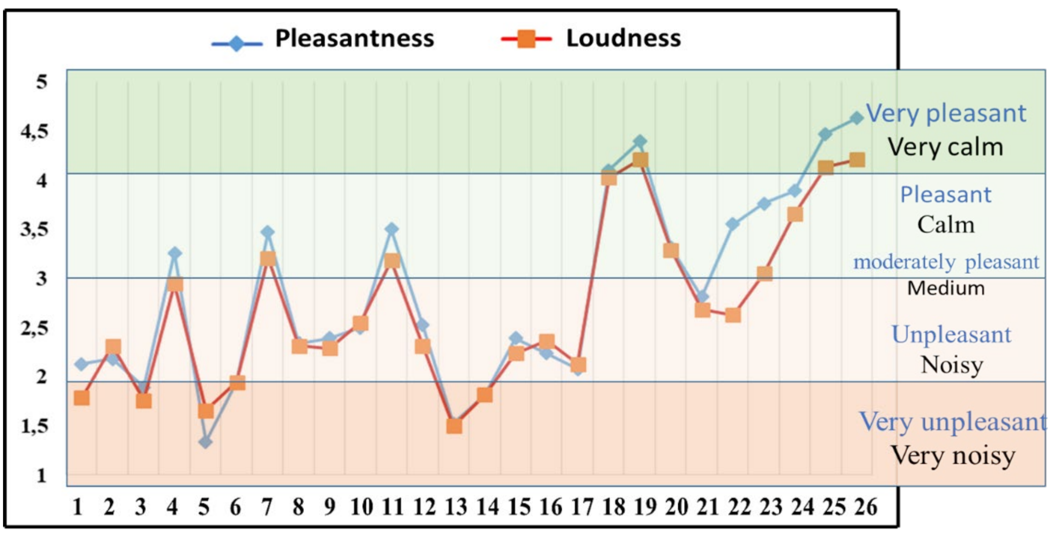
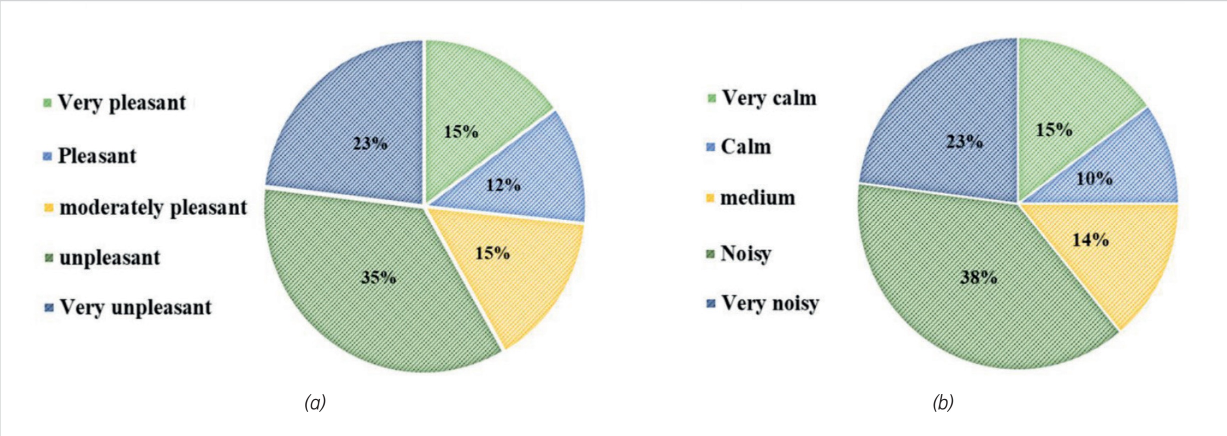


Fig. 4. *Percentages of pleasantness and loudness of the studied soundtracks*



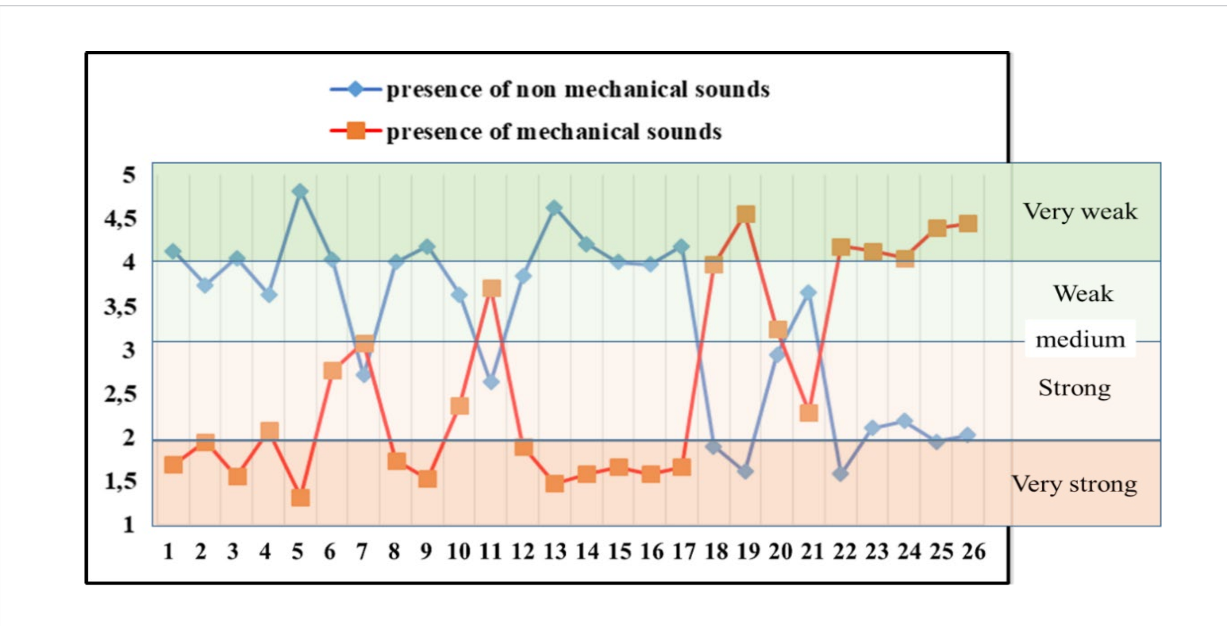
It is clear that the location of the studied region concerning the main mechanical streets, the gardens and the urban squares, the residential areas, etc. directly affects the type and quality of sound passage.

Section 2 (Question 3, 4)

An inverse relationship between the presence of mechanical and non-mechanical sounds can be noticed. It is clear from *Fig. 5* that the stronger the presence of mechanical sounds, the weaker the presence of other non-mechanical sounds, as it can be seen in the sound sequences 9, 3, 13 and in particular 5 which is marked by the strongest presence of mechanical sounds, which masked completely other non-mechanical sounds like sounds of urban biodiversity.

A weak presence of road noise is generally compensated by a strong presence of other non-mechanical sounds deemed pleasant by the respondents, which makes these soundscapes more pleasant and calm as the case of sound environments, i.e., 18, 25 and 26.

Fig. 5. *Relationship between the presence of mechanical and non-mechanical sounds*



Statistical analysis

Correlation between questionnaire variables and sound exposure level

To define the possible correlations between the different questionnaire variables and the sound exposure level obtained by the in-situ measurements of $L_{Aeq,1min}$, two correlation tests were performed. The first is the chi-square test which aims to study the correlation between the different variables of the questionnaire and the $L_{Aeq,1min}$ values which were grouped into three zones of sound exposure: Zone A > 55dB Low exposure (acceptable); Zone B 70_55dB Intermediate; and Zone C > 70dB Overexposed (unacceptable) (see *Table 3*). While the second is the Spearman correlation test that was done to verify the nature of the associations between these different studied variables (see *Table 4*).

Table 3 shows the Chi-square correlation test results between the four variables of the questionnaire (pleasantness, loudness, presence of mechanical sounds, and non-mechanical sounds) and the sound exposure level. It is observed that there are significant correlations between the four variables (p value < 0.001). However, the sound exposure level has a statistically significant correlation only with pleasantness (p value = 0.048), whereas there is no significant correlation with the other variables such as loudness, and the presence of mechanical sounds as well as non-mechanical ones because the p values are higher than 0.05.

The correlation between the different variables is summarized in *Table 4*. A very strong positive correlation was found between the presence of non-mechanical sounds with pleasantness and loudness with a p-value lower than 0.001. A moderately positive association was identified between sound exposure level with loudness and the presence of mechanical sounds. Furthermore, there were strong negative significant correlations between the presence of mechanical sounds with pleasantness, loudness, and the presence of non-mechanical sounds (p value > 0.001). Similarly, there were negative associations between loudness and pleasantness (p value > 0.001), and between sound exposure level with pleasantness and the presence of non-mechanical sounds (p value > 0.005).

Table 3. *Correlation between questionnaire variables and sound exposure level (Pearson chi-squared value [χ2], p value [p])*

Pearson chi-squared test χ2	Pleasantness	Loudness	Presence of mechanical sounds	Presence of non-mechanical sounds	Sound exposure level
Pleasantness	*p* χ2	44.056	37.844	36.111	12.729
Loudness	0.000	*p* χ2	34.450	25.876	11.534
Presence of mechanical sounds	0.000	0.001	*p* χ2	40.510	12.235
Presence of non-mechanical sounds	0.000	0.011	0.001	*p* χ2	13.023
Sound exposure level	0.048	0.073	0.141	0.111	*p* χ2

Table 4. *Spearman correlation between questionnaire variables and sound exposure level (Spearman coefficient [C], p value [p])*

Spearman Correlation N 26	Pleasantness	Loudness	Presence of mechanical sounds	Presence of non-mechanical sounds	Sound exposure level
Pleasantness	*p* C	−0.572**	−0.869**	0.872**	−0.547**
Loudness	0,000	*p* C	−0.731**	0.729**	0.572**
Presence of mechanical sounds	0,000	0,000	*p* C	−0.896**	0.515**
Presence of non-mechanical sounds	0,000	0,000	0,000	*p* C	−0.569**
Sound exposure level	0,004	0,002	0,007	0,002	*p* C
** Correlation is significant at the 0.01 level (2-tailed).					

It is interesting to note that the relationships between the sound exposure level with loudness, and the presence of mechanical and non-mechanical sounds were not significant by the chi-square test, unlike the results obtained by the Spearman test. This can be due to the classification of the measured $L_{Aeq,1min}$ into three zones: Zone A > 55 Low exposure (acceptable); Zone B 70_55 Intermediate; and Zone C > 70 dB Overexposed (unacceptable).

The findings of this study show that as the sound exposure level increases, the perception of pleasantness and the presence of non-mechanical sounds decreases, while mechanical sounds and loudness increase. This shows that the overexposed sound environment is characterized by a strong presence of mechanical (traffic) noise, which causes an unpleasant sensation to the occupants of the space in the studied cases. On the other hand, a low presence of mechanical sounds, a low sound level, and a strong presence of natural and human sounds (non-mechanical) characterize a pleasant and calm soundscape. From all the above, it is important to note that the duality of $L_{Aeq,1min}$, and soundscape components can be considered as a quality measurement tool of the sound environment.

Limitations of the study

One of the potential limitations of this type of research is the translation from English to Arabic (ISO 639: arb) of adjectives used in the questionnaire (reference) for soundscape evaluation such as of Axelsson et al. (2010) and Cain et al. (2013; 2009), which is keeping up with the works of the international Soundscape Attributes Translation (SATP) project (Aletta et al 2020). which aims to provide researchers with a reliable questionnaire to characterize the soundscape in different languages, to use the Arabic version of the questionnaire in our next research. On the other hand, the duration of the recordings of one minute is a short period to judge a soundscape of a city but it remains a representative sound extract (Jeon et al., 2018; Giannakopoulos et al., 2019; Ozcevik and Can, 2012). In addition, the results of the laboratory soundscape evaluation based on reactivated listening may differ from those using the virtual reality technology (VR) or from in situ evaluation because the physical characteristics of the visual landscape and the nature of the smellscape can affect the sound perception (Liu et al., 2014; Liu et al., 2013a; Liu et al., 2013b). The results of other studies are needed to complete this study.

Conclusion

From this study, it is concluded that the noise pollution issue is very serious in the city of Biskra, where more than 45% of the measured noise levels show excessive values that exceed the international safety standards regarding the noise effects on public health and the environment. This condition affects the quality of life, comfort, and health of the inhabitants and can also disturb the fragile natural ecosystems of the cities. This was confirmed by the reactive listening questionnaire results, where more than 56% of the surveyed areas were considered as unpleasant and more than 60% as noisy according to the respondents' evaluation of the soundscape quality. Mechanical noise from road traffic is the main cause of this situation in Biskra, where railway, industrial, construction, and other urban noise are negligible in the studied areas; therefore, they do not have a significant impact on the soundscape of this city, which is characterized by the tertiary and agricultural sectors as main activities.

Furthermore, multiple regressions are used to quantify the relationship between the measured sound levels and the subjective evaluation of the soundscape by the respondents through the subjective descriptors used. From the results of the Pearson correlation tests, it is found that there is a significant relationship between the soundscape components (mechanical and non-mechanical sounds), the soundscape quality evaluation variables proposed in this study (pleasantness, overall loudness) and the $L_{Aeq,1min}$.

From this study, it is also concluded that in addition to air pollution, energy consumption, and the inhabitants' comfort in outdoor and indoor spaces are facing the challenges of the harsh climate of these desert regions, on which researchers have performed much recent research. Saharan cities are also threatened by the problem of noise pollution, which may worsen with time due to the major changes that they are experiencing as a result of rapid urban development and population growth while overlooking the specificity of these regions as well as the traditional architecture and urban planning courses in the region. Additional and thorough research is needed in Saharan cities to determine the status of the sound environment to ensure the well-being of the inhabitants, protect public health and the fragile urban ecosystems of these regions. The findings from this study raise many further research questions, especially regarding the quantification and measurement of soundscape quality, which is always a subjective dimension that is not measurable and difficult to assess because it depends on the feelings of human beings and many other variables. Researchers and authorities will thus be able to unify the methods for assessing soundscape quality, to easily identify "satisfactory urban soundscapes" for protection, and to correct the situation of unsatisfactory soundscapes.

References

Aletta F, Kang J, Axelsson Ö (2016) Soundscape descriptors and a conceptual framework for developing predictive soundscape models. Landscape and Urban Planning 149:65-74, https://doi.org/10.1016/j.landurbplan.2016.02.001

Aletta F, Oberman T, Axelsson Ö, et al (2020) Soundscape assessment: Towards a validated translation of perceptual attributes in different languages

Arnaldi B, Guitton P, Moreau G (2018) Réalité virtuelle et réalité augmentée: Mythes et réalités. ISTE Group

Arras F, Massacci G, Pittaluga P (2003) Soundscape perception in Cagliari, Italy. In: Proc. of Euronoise

Axelsson Ö, Nilsson ME, Berglund B (2010) A principal components model of soundscape perception. The Journal of the Acoustical Society of America 128:2836-2846, https://doi.org/10.1121/1.3493436

Baxter AJ, Scott KM, Vos T, Whiteford HA (2013) Global prevalence of anxiety disorders: a systematic review and meta-regression. Psychological medicine 43:897-910, https://doi.org/10.1017/S003329171200147X

Begou P, Kassomenos P (2021) Exposure to the road traffic noise in an urban complex in Greece: the quantification of healthy life years lost due to noise-induced annoyance and noise-induced sleep disturbances. Environmental Science and Pollution Research 28:12932-12943, https://doi.org/10.1007/s11356-020-11190-4

Berglund B, Lindvall T, Schwela DH, Organization WH (1999) Guidelines for community noise, https://doi.org/10.1260/0957456001497535

Berkouk D, Bouzir TAK, Maffei L, Masullo M (2020) Examining the Associations between Oases Soundscape Components and Walking Speed: Correlation or Causation? Sustainability 12:4619, https://doi.org/10.3390/su12114619

Berkouk D, Bouzir TAK, Mazouz S (2018) Numerical study of the vertical shading devices effect on the thermal performance of promotional apartments in hot dry climate of Algeria. AIP Conference Proceedings 1968:030040. https://doi.org/10.1063/1.5039227

Bild E, Pfeffer K, Coler M, et al (2018) Public space users' soundscape evaluations in relation to their activities. An Amsterdam-based study. Frontiers in psychology 9:1593, https://doi.org/10.3389/fpsyg.2018.01593

Bouzir, T. A. K., Benacer, H., Berkouk, D., Chatterjee, U., and Majumdar, S. (2022). Urban Soundscape and Noise Pollution: An Introduction. Advances in Urbanism, Smart Cities, and Sustainability, 189. https://doi.org/10.1201/9781003126195-14

Bouzir TAK (2018) Morphologie urbaine et pollution sonore: étude de cause à effet. Cas de la ville de Biskra. PhD Thesis, UNIVERSITE MOHAMED KHIDER BISKRA

Bouzir TAK, Berkouk D, Zemmouri N (2019) Evaluation and Analysis of the Algerian Oases Soundscape: Case of El Kantara and Sidi Okba. Acoustics Australia 1-10, https://doi.org/10.1007/s40857-019-00173-2

Bouzir TAK, Zemmouri N (2018) Evaluation of the sound environment of the city of Biskra (Algeria). Journal of Applied Engineering Science and Technology 4:7-11

Bouzir TAK, Zemmouri N, Berkouk D (2017) Assessment of noise pollution in the City of Biskra, Algeria. World Academy of Science, Engineering and Technology International Journal of Environmental and Ecological Engineering 11:1052-1055

Bouzir TAK, Zemmouri N, Berkouk D (2018) Assessment and analysis of noise pollution in Biskra public gardens (Algeria). In: AIP Conference Proceedings. AIP Publishing LLC, p 030069, https://doi.org/10.1063/1.5039256

Boyes W (2009) Instrumentation reference book. Butterworth-Heinemann

Brambilla G, Gallo V, Asdrubali F, D'Alessandro F (2013) The perceived quality of soundscape in three urban parks in Rome. The Journal of the Acoustical Society of America 134:832-839, https://doi.org/10.1121/1.4807811

Brinkmann F, Lindau A, Vrhovnik M, Weinzierl S (2014) Assessing the authenticity of individual dynamic binaural synthesis

Buhaug H, Urdal H (2013) An urbanization bomb? Population growth and social disorder in cities. Global environmental change 23:1-10, https://doi.org/10.1016/j.gloenvcha.2012.10.016

Cain R, Jennings P, Poxon J (2013) The development and application of the emotional dimensions of a soundscape. Applied acoustics 74:232-239, https://doi.org/10.1016/j.apacoust.2011.11.006

Cain R, Jennings P, Poxon J, Scott A (2009) Emotional dimensions of a soundscape. In: INTER-NOISE and NOISE-CON Congress and Conference Proceedings. Institute of Noise Control Engineering, pp 4660-4667

D'Odorico P, Laio F, Ridolfi L, Lerdau MT (2008) Biodiversity enhancement induced by environmental noise. Journal of Theoretical Biology 255:332-337, https://doi.org/10.1016/j.jtbi.2008.09.007

Fairbrass AJ, Rennert P, Williams C, et al (2017) Biases of acoustic indices measuring biodiversity in urban areas. Ecological Indicators 83:169-177, https://doi.org/10.1016/j.ecolind.2017.07.064

Farhi A (2002) Biskra: de l'oasis à la ville saharienne (Note). Méditerranée 99:77-82, https://doi.org/10.3406/medit.2002.3264

Giannakopoulos T, Orfanidi M, Perantonis S (2019) Athens urban soundscape (athus): a dataset for urban soundscape quality recognition. In: International Conference on Multimedia Modeling. Springer, pp 338-348, https://doi.org/10.1007/978-3-030-05710-7_28

Gozalo GR, Carmona JT, Morillas JB, et al (2015) Relationship between objective acoustic indices and subjective assessments for the quality of soundscapes. Applied Acoustics 97:1-10, https://doi.org/10.1016/j.apacoust.2015.03.020

Grant J, Schroeer W, Petersen B, O'Neill M (2000) Our built and natural environments: A technical review of the interactions between land use, transportation, and environmental quality. EPA 231-R-00-005): US Environmental Protection Agency, Tech Rep

Herranz-Pascual K, García I, Diez I, et al (2017) Analysis of field data to describe the effect of context (Acoustic and Non-Acoustic Factors) on urban soundscapes. Applied Sciences 7:173, https://doi.org/10.3390/app7020173

Hong JY, Lam B, Ong Z-T, et al (2019) Quality assessment of acoustic environment reproduction methods for cinematic virtual reality in soundscape applications. Building and Environment 149:1-14. https://doi.org/10.1016/j.buildenv.2018.12.004

Howitt D, Cramer D (2003) First steps in research and statistics: A practical workbook for psychology students. Routledge, https://doi.org/10.4324/9780203457320

Huang Y, Lei C, Liu C-H, et al (2021) A review of strategies for mitigating roadside air pollution in urban street canyons. Environmental Pollution 116971, https://doi.org/10.1016/j.envpol.2021.116971

Jeon JY, Hong J, Lavandier C, et al (2018) A cross-national comparison in assessment of urban park soundscapes in France, Korea, and Sweden through laboratory experiments. Applied Acoustics 133:107-117. https://doi.org/10.1016/j.apacoust.2017.12.016

Lee PJ (2010) Evaluation of Urban Soundscape Using Soundwalking. International Commission for Acoustics 1-6

Lercher P, Widmann U, Kofler W (2000) Transportation noise and blood pressure: the importance of modifying factors. In: Proceedings of the 29th International Congress and Exhibition on Noise Control Engineering (Cassereau D, ed). InterNoise. pp 2071-2075

Liang L, Wang Z, Li J (2019) The effect of urbanization on environmental pollution in rapidly developing urban agglomerations. Journal of cleaner production 237:117649, https://doi.org/10.1016/j.jclepro.2019.117649

Lindau A (2014) Binaural resynthesis of acoustical environments. technology and perceptual evaluation. epubli

Liu J, Kang J, Behm H, Luo T (2014) Effects of landscape on soundscape perception: Soundwalks in city parks. Landscape and Urban Planning 123:30-40. https://doi.org/10.1016/j.landurbplan.2013.12.003

Liu J, Kang J, Luo T, Behm H (2013a) Landscape effects on soundscape experience in city parks. Science of The Total Environment 454-455:474-481. https://doi.org/10.1016/j.scitotenv.2013.03.038

Liu J, Kang J, Luo T, et al (2013b) Spatiotemporal variability of soundscapes in a multiple functional urban area. Landscape and Urban Planning 115:1-9. https://doi.org/10.1016/j.landurbplan.2013.03.008

Lloyd K, Auld C (2003) Leisure, public space and quality of life in the urban environment. Urban policy and research 21:339-356, https://doi.org/10.1080/0811114032000147395

Ma KW, Wong HM, Mak CM (2018) A systematic review of human perceptual dimensions of sound: Meta-analysis of semantic differential method applications to indoor and outdoor sounds. Building and Environment 133:123-150, https://doi.org/10.1016/j.buildenv.2018.02.021

Malchaire J (2001) Sound measuring instruments. Occupational exposure to noise: Evaluation, prevention and control 125-140

Maristany A, Recuero Lopez M (2010) Relationship between objective and subjective indicators in urban soundscape analysis. The case of Cordoba-Argentina. In: INTER-NOISE and

NOISE-CON Congress and Conference Proceedings. Institute of Noise Control Engineering, pp 564-572

Matallah ME, Mahar WA, Bughio M, et al (2021) Prediction of Climate Change Effect on Outdoor Thermal Comfort in Arid Region. Energies 14:4730, https://doi.org/10.3390/en14164730

Montgomery J (1998) Making a city: Urbanity, vitality and urban design. Journal of urban design 3:93-116, https://doi.org/10.1080/13574809808724418

Morillas JB, Escobar VG, Sierra JM, et al (2002) An environmental noise study in the city of Cáceres, Spain. Applied acoustics 63:1061-1070, https://doi.org/10.1016/S0003-682X(02)00030-0

Nilsson ME, Jeon JY, Rådsten-Ekman M, et al (2012) A soundwalk study on the relationship between soundscape and overall quality of urban outdoor places. The Journal of the Acoustical Society of America 131:3474, https://doi.org/10.1121/1.4709105

Ozcevik A, Can ZY (2012) A laboratory study on the evaluation of soundscape. In: Acoustics 2012

Passchier-Vermeer W, Passchier WF (2000) Noise exposure and public health. Environmental health perspectives 108:123-131, https://doi.org/10.1289/ehp.00108s1123

Pérez-Martínez G, Torija AJ, Ruiz DP (2018) Soundscape assessment of a monumental place: A methodology based on the perception of dominant sounds. Landscape and Urban Planning 169:12-21, https://doi.org/10.1016/j.landurbplan.2017.07.022

Raimbault M, Dubois D (2005) Urban soundscapes: Experiences and knowledge. Cities 22:339-350, https://doi.org/10.1016/j.cities.2005.05.003

Schafer RM (1993) The soundscape: Our sonic environment and the tuning of the world. Simon and Schuster

Schafer RM, Gleize S (1979) Le paysage sonore. J.-C. Lattès Paris

Selamat FE, Tagusari J, Matsui T (2021) Mapping of transportation noise-induced health risks as an alternative tool for risk communication with local residents. Applied Acoustics 178:107987, https://doi.org/10.1016/j.apacoust.2021.107987

Śliwińska-Kowalska M, Zaborowski K (2017) WHO environmental noise guidelines for the European region: a systematic review on environmental noise and permanent hearing loss and tinnitus. International journal of environmental research and public health 14:1139, https://doi.org/10.3390/ijerph14101139

Tse MS, Chau CK, Choy YS, et al (2012) Perception of urban park soundscape. The Journal of the Acoustical Society of America 131:2762-2771, https://doi.org/10.1121/1.3693644

Van Kempen E, Casas M, Pershagen G, Foraster M (2018) WHO environmental noise guidelines for the European region: a systematic review on environmental noise and cardiovascular and metabolic effects: a summary. International journal of environmental research and public health 15:379, https://doi.org/10.3390/ijerph15020379

Wokekoro E (2020) Public Awareness of the Impacts of Noise Pollution on Human Health. World Journal of Research and Review (WJRR) 10:27-32

WHO. (1999) Guidelines for Community Noise. Berglund B., Lindvall T., Schwela DH, editors. World Health Organization

Xu C, Kang J (2019) Soundscape evaluation: Binaural or monaural? The Journal of the Acoustical Society of America 145:3208-3217, https://doi.org/10.1121/1.5102164

Yu Z, Guo X, Zeng Y, et al (2018) Variations in land surface temperature and cooling efficiency of green space in rapid urbanization: The case of Fuzhou city, China. Urban forestry and urban greening 29:113-121, https://doi.org/10.1016/j.ufug.2017.11.008

Yu Z, Yao Y, Yang G, et al (2019) Strong contribution of rapid urbanization and urban agglomeration development to regional thermal environment dynamics and evolution. Forest Ecology and Management 446:214-225, https://doi.org/10.1016/j.foreco.2019.05.046

Yuen FK (2014) A vision of the environmental and occupational noise pollution in Malaysia. Noise and Health 16:427, https://doi.org/10.4103/1463-1741.144429

Zannin PHT, Ferreira AMC, Szeremetta B (2006) Evaluation of noise pollution in urban parks. Environmental monitoring and assessment 118:423-433, https://doi.org/10.1007/s10661-006-1506-6