

Article

# Examining the Associations between Oases Soundscape Components and Walking Speed: Correlation or Causation?

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**Abstract:** The feeling of calm and tranquillity provided by the oases of Algeria can disappear because of the outdated urbanization strategy which is based on the vehicle as a mode of transport. Walkability is one of the most adoptable sustainable strategies to reduce the negative mechanical transportation effects on the quality of life. This paper aimed to examine the correlation and the causation between oases soundscape components and walking speed. The methodology of this field study was based on an empirical approach at the urban settlements in three oases in Algeria. The correlation between walking speed and soundscape components was obtained through the use of the Spearman correlation test. A one-way ANOVA analysis was conducted to assess the effect of the soundscape components on walking speed. A post hoc Tukey test was adopted to explore the sound component that causes increased walking speed. In this study, no significant correlation was explored between the walking speed and the anthropological sounds. In contrast, the statistical analysis of the sound walks experience suggests a moderate and significant negative correlation between geophonical and biophonical sounds, with mean walking speed. The results showed that, the cause of the increase in the mean walking speed of the pedestrians is human sound. The findings suggest that further research is needed to focus on the long-term subjective investigation to explore the correlations and the effects between soundscape, walkability and walking speed.

**Keywords:** soundscape; walking speed; oases; sound walk; walk for leisure

## 1. Introduction

The Saharan Oases are often perceived as a place in contrast with their environment. They are a particular landscape, composed mainly of water and palm trees surrounded by a sandy desert [1]. They are located above the largest underground water supplies in the world [2]. In arid and semi-arid regions, water [3] and palm trees are necessary conditions but are insufficient to explain the creation of oases. The oases are also considered as small agglomerations created by the natives' people. Hence, they are defined as socio-spatial establishments in the middle of the desert, with cultural identities characterizing particular human settlements [4]. In Algeria, rapid, strong and poorly managed urbanization has gradually transformed most oases into Saharan cities, which leads to radical changes in the luminous and thermal atmospheres, in addition to the urban soundscapes [5]. Due to the challenging weather conditions characterizing Saharan cities as well as Saharan Oases, decision makers and urban planners favour a transport planning policy which is principally based on using the vehicle [6], instead of relying on walking which is considered a sustainable transport mode [7]. This strategy can gradually

decrease walking as a mode of transport in urban settlements around oases and create a car-dependent society. Indeed, this problem of transport through the vehicle is not limited to the Saharan cities, it is considered as a larger problem affecting city lifestyle in modern environments.

Sustainability is receiving the attention of the scientific community in many fields [8]. In urban study, walkability is considered a key concept toward sustainable urban development [9]. It is also the underlying characteristic of healthy and sustainable cities [10]. Governments following walkable city development policies and projects demonstrate the importance of walkability [11], where people living in high walkable areas often spend long periods of time walking, compared to those living in low walkable areas [12]. They are also more likely to be physically active, regardless of their income level in their neighbourhood [13], since walkable neighbourhood environments have the potential to raise utilitarian walking [14]. As a result of this policy, people are becoming increasingly interested in walking [15]. The relationship between walking and health is frequently emphasized [11] and thus, walking has turned out to be one of the most favoured and widespread types of physical activity [16–18]. Furthermore, neighbourhood walkability promotes walking, regardless of the inhabitants' age group (adult or small) [19]. In addition, walkable and sustainable neighbourhoods can minimize the crime rate [20], moreover, walking brings life to the streets and lively streets contribute to safer urban environments [21].

Through the crucial combination of information that derives from different sensory channels, people can perceive and orient themselves in the surrounding environment [22]. A growing body of literature can be found on the study of the association of particular variables with walkability in urban spaces, such as connectivity, land-use, density, traffic safety, surveillance, community, green space, parking [23], convenience, conviviality, conspicuousness, coexistence, commitment [21], comfort, legibility, way-finding, feasibility [24], pleasantness and practicability [25]. Along with built environments, social conditions and individual reactions are related to walkability. The thermal, luminous, olfactory and acoustic environments may also have a relationship with the walkability level. In this viewpoint, Calleri et al. [26] found that the soundscape affects the perceived security and perceived social presence. Considering the above, this research mainly focuses on the study of a practical problem that remains unanswered: understanding the association between soundscape and walking speed.

Several recent studies in the literature have highlighted the walking impact on soundscapes, for instance evaluating the impact of the sounds of human footsteps on soundscapes [27,28]. In addition, many researches have examined the sound quality through sound walk [29–32]. From this perspective, the soundscape paradigm considers individuals integrated with their environment [33]. In the same vein, but in a different way, this research is interested in studying walking speed, by testing the soundscape effect on this variable. It is important to recognise that the walking concept is dissimilar from that of walkability. Walking is generally understood as a movement that is one type of human transportation, where it is defined in the urban context as a short distance moving from a point to another [24]. While walkability is a concept known as a measure of how amenable an area is to walking [11] that is, the built environment is friendly to people who walk [34], promotes walking and address issues such as comfort, connectivity, safety, aesthetic values [35], the sound environment affects this perception.

Indeed, there are different motivations for walking, such as walking for transportation and walking for leisure [36]. Despite that there is a substantial interest in walking for leisure and recreation [35], considerable research has been focused on walking for transportation [37–39], while less attention has been paid to the association between walkability and walking for recreation [23]. There is also a lack of studies examining the behavioural responses to soundscapes in a specific environment, such as the urban oasis complexes of the Saharan desert in northern Africa and Algeria. According to this viewpoint, walking speed is one of the behavioural variables [40] that can be examined. This study focuses on the following research questions:

- Is there a correlation between walking speed and soundscape components?

- Do soundscape components affect the mean walking speed of the pedestrians of the Algerian oases? What is the nature of the sounds that can make a difference?

The soundscape concept is broad; accommodating the complete sound environment in a place and the human response to it [41]. The creation of soundscapes is mainly based on a mixture of different sounds (biophony, geophony and anthrophony) [42–45]. In urban areas, it is considered a significant part of the phonic identity of spaces, because sounds are essential to create a sense of place [46]. In this subject area, there is a great deal of research illustrating the positive effects of green spaces on the satisfaction of occupants in urban areas [47–52]. The main objective of this paper is to explore one of the ambiguous scientific tracks, which are the study of the correlation between oases soundscape components and walking speed, as well as exploring the effects of these sound components on the behaviour of pedestrians toward leisure.

## 2. Case Study

The context of this study is limited to the Biskra region (Ziban), considered to be one of the most famous oases in Algeria [53]. It is located northeast of the Sahara Desert, where it is considered as a transition between the mountainous region of the north (Aurès) and the large pre-Saharan plateaus of the south. The Ziban region is characterized by the extent of its oases, with five million palm trees. Its name refers to a group of oases since in Berber, the word “Zab”, in plural “Ziban” means “oasis”.

In fact, the Biskra region consists of three major zones: Zab- Ghebli (Zab of the North), Zab- Dahari (Zab of the South) and Zab-Cherki (Zab of the East). This study focuses on three villages Branis, Chetma and M’chouneche; considering among the most important agglomerations which represent the northern oases, Figure 1. These three oases have common characteristics, where the main activity of the inhabitants is agriculture, and each village contains two main types of urban fabric: the old fabric (old town) and the contemporary fabric (standardization).



Figure 1. Location of the studied oases.

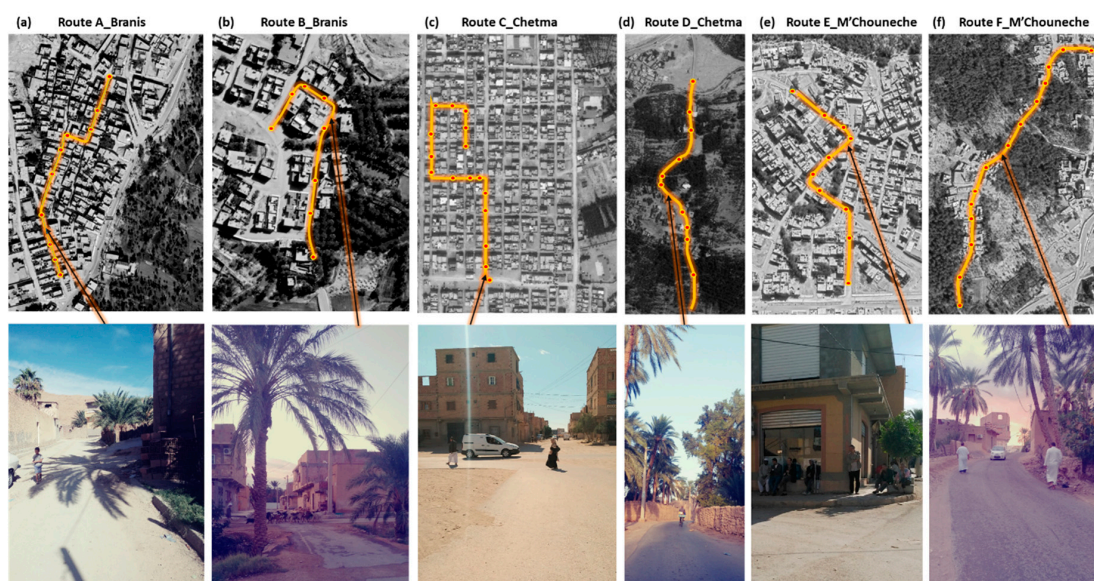
## 3. Methodology

In the present paper, two field studies were carried out in two stages to understand the association between the oasis soundscapes components and walking speed. At stage one, the spatial analysis of the soundscape was performed to identify the soundscape components of the oases. At stage two, individual sound walks were conducted by twenty-seven visitor participants (non-resident). An analysis of the behaviour of pedestrians according to the perception of soundscapes was conducted to verify whether there was a correlation between the mean walking speed and the soundscapes dominant sounds; to determine whether the components of soundscapes affect the mean walking speed.

### 3.1. Data Collection

In order to evaluate and identify soundscapes, binaural recordings [54–56] were used in both study stages as a spatial audio recording technique, although there are others such as the monaural,

stereo, array and ambisonic techniques. It is considered to be the more useful than the other [57], due to the possibility of recreating the spatial characteristics of the sound environment [58]. At stage one, sound recordings were performed in 738 measurement stations distributed in the streets and alleys of the studied areas. Stage two was started by using the sound walk method based on binaural recordings [57,59,60] in six preselected routes, Figure 2. To record the sound experience as perceived by a pedestrian, sound recordings were made along the selected routes using a binaural microphone placed in the ears of the participant. To keep a visual track of the studied routes, the recordings were associated with photos along these paths. At stage two, the soundscapes were identified after performing an analysis of the spectrogram data which were extracted from the recorded soundtracks; this is consistent with previous research [61,62]. The sampling of spectrograms that are representative of real soundscapes was based on the results of stage one.



**Figure 2.** The trajectory of the sound walks in (a,b) Branis, (c,d) Chetma and (e,f) M'Chouneche oases.

The calculation of the mean walking speed of pedestrians was carried out in (m/s) [40], in several sections for each sound walk to explore the cause of the increase in the walkers' speed. The participants' speed was calculated by dividing the distance travelled by the duration of the route. The route duration was measured using a professional stopwatch.

The experiment (individual sound walk) and data acquisition (sound recording and mean walking speed calculation) were realized under similar climatic conditions (see Table 1), because unstable climatic conditions can influence the sound propagation [63], walkability, and mean walking speed.

**Table 1.** Climatic conditions during data acquisition.

Air Temperature (C°)	Relative Humidity (%)	Wind Speed (m/s)
18–26	27–50	0.4–3.2

### 3.1.1. Morphological Characteristics of the Studied Routes

The sampling of routes sections was mainly based on the reason for having a variation in the morphological characteristics, with diverging routes in terms of the soundscape. From this, the sky view factor (SVF) and the height/width ratio (H/W) were calculated at 70 measuring stations. Table 2 shows the codes used to present the routes, stations and sections. The SVF was calculated using the modified method of Steyn [64–66], based on fisheye photography (see Equation (1)). Each fisheye was divided into  $n$  annular rings (by default  $n = 36$ ) to calculate the SVF by adding the contribution of each

ring [67]. Figures 3 and 4 respectively show that the urban geometries of these routes are characterized by divergent values of SVF and the H/W ratio, with a value of  $0.29 \pm 0.18$  concerning the mean SVF of the different measurement stations, and a mean value of  $0.51 \pm 0.41$  for the H/W ratio. Figure 5 represents the variations of the morphological characteristics SVF and H/W, concerning the different sections of each route:

$$SVF = \frac{\pi}{2n} \sum_{i=1}^n \sin\left(\frac{\pi(2i-1)}{2n}\right) \left(\frac{p_i}{t_i}\right) \tag{1}$$

where  $(P_i/t_i)$  is the ratio between the number of pixels in the sky and the total number of pixels in the ring  $i$ .

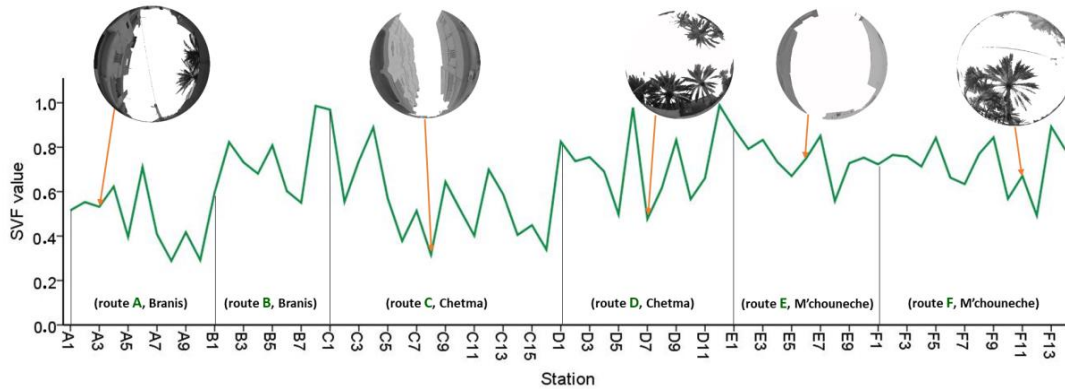


Figure 3. Sky view factor (SVF) values for the studied routes stations with examples of fish-eye images.

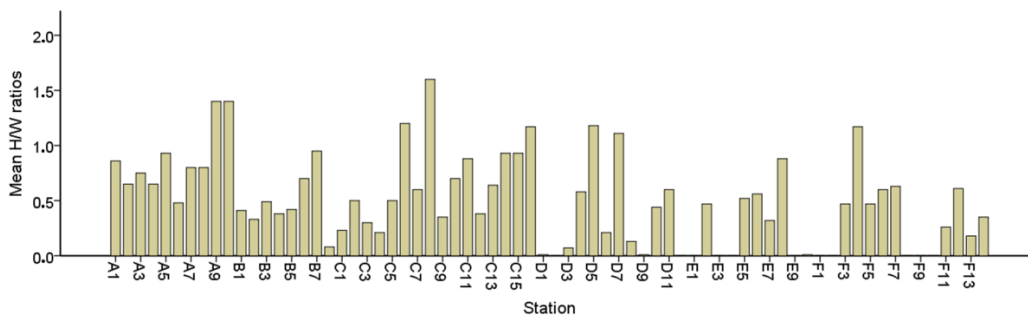


Figure 4. Height/width ratio (H/W) values for the studied routes stations.

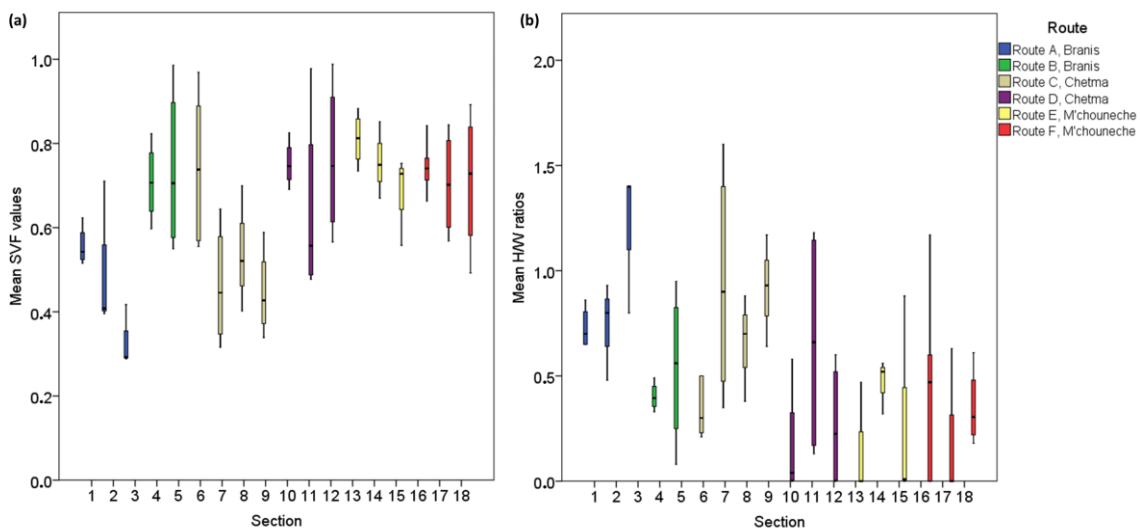


Figure 5. (a) Sky view factor and (b) H/W ratio values for the studied routes sections.

**Table 2.** The codes of routes, stations and sections.

Routes	Stations	Sections
Route A_Branis	A1–A4	S1
	A4–A7	S2
	A7–A10	S3
Route B_Branis	B1–B4	S4
	B4–B8	S5
	C1–C5	S6
Route C_Chetma	C5–C9	S7
	C9–C12	S8
	C12–C16	S9
	D1–D4	S10
Route D_Chetma	D4–D8	S11
	D8–D12	S12
	E1–E4	S13
Route E_M'Chouneche	E4–E7	S14
	E7–E10	S15
	F1–F6	S16
Route F_M'Chouneche	F6–F10	S17
	F10–F14	S18

### 3.1.2. Selection Criteria of the Participants

The individual sound walks were conducted by twenty-seven participants, belonging to the same age category (see Table 3). The participants were architecture students. They were considered as visitor walkers because they were not residents of the studied areas. In order to respect the strong traditions of the studied areas, where young women do not walk alone in the streets; the choice of participants was based only on males. As the body mass index (BMI) may affect the walking level [68], the choice of non-athlete participants was mainly based on their body homogeneity in order to overlook the impact of this variable on the results of this study. Table 3 illustrates the bodily uniformity of the participants by a BMI of  $23.34 \pm 1.54 \text{ kg/m}^2$ . This indicates that all participants have a normal BMI. The BMI [69] was calculated according to Equation (2):

$$\text{BMI} = \text{Weight}/\text{Height}^2 \quad (2)$$

**Table 3.** Body characteristics of the participants.

Participant (no.)	Gender	Age (year)	Weight (kg)	Height (m)	BMI (kg/m <sup>2</sup> )
27	Male	24.81 ± 2.42	73.75 ± 3.49	1.78 ± 0.04	23.34 ± 1.54

The values are presented as follows: average ± standard deviation.

### 3.2. Data Analysis

Soundtrack processing for this study was conducted using the Sound Tools Extended software (STx 5.0), developed by the Acoustics Research Institute of Vienna. This software was used to analyse and extract spectrograms from the sound recordings. In this study, a spectrogram is considered as an acoustic image that gives a visual translation of the recorded soundscapes [70]. The data analysis was carried out using the Statistical Package for the Social Sciences (IBM-SPSS).

Biophony, geophony and anthrophony are the three components that make up the soundscape [42,71,72]. In this study, the identification and analysis of soundscapes was mainly based on these three components. Biophony is the set of sounds emitted by living organisms such as birds, mammals and insects. Geophony is the collection of sounds from natural elements such as wind, rain, tree rustling and water sound, whereas anthrophony consists mainly of human sounds, traffic sounds and mechanical sounds like the sound of El-Adhan and the grass mowing.

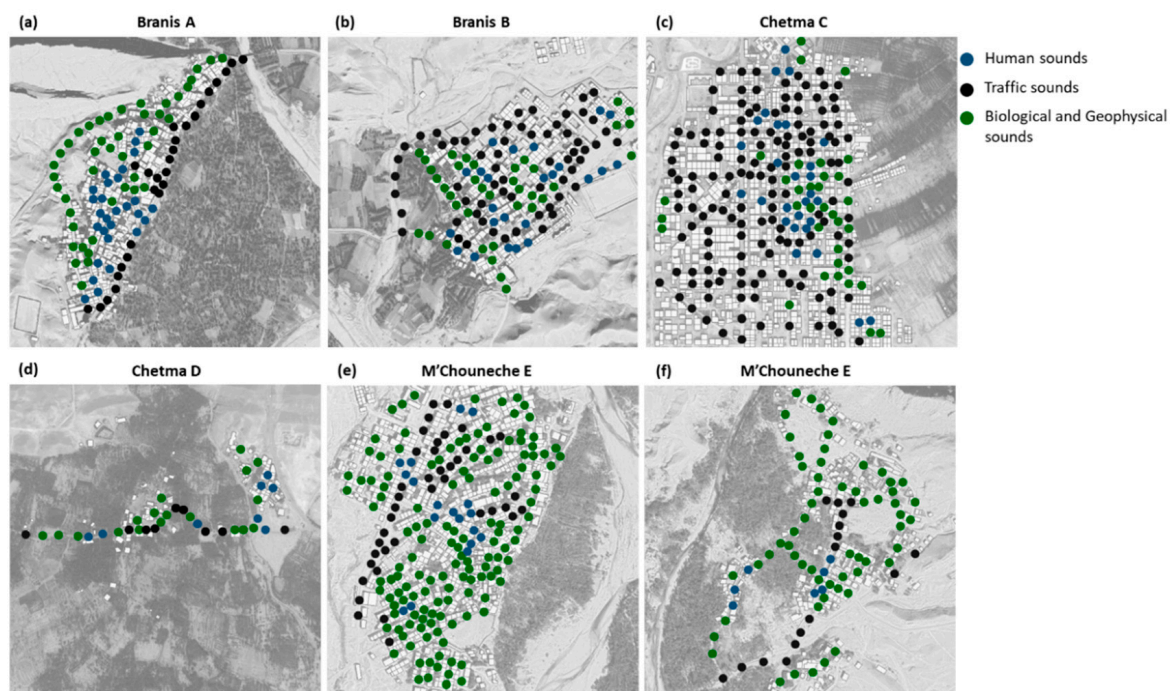
Binaural sound recordings were made using a professional sound recorder (Zoom H4), coupled with a Soundman OKM II Classic binaural in-ear microphone. The soundscapes were identified after an analysis of the soundtracks recorded in Waveform Audio File Format (WAV). The analysis of the soundtracks was carried out in the laboratory using sound reproduction. The sound reproduction was done using “Sony MDR-ZX660AP” headsets, and the same sound output level was applied for all the soundtracks. As the overall judgment of the sound environment is strongly related to sound the events of the last moments, concerning soundtracks which last more than 10 s [73] and extreme sound events characterizing the last seconds of the recorded soundtracks were avoided as much as possible to make the subjective assessment.

A descriptive analysis was conducted in this research to assess the walking speed and the soundscapes of the studied oases. The correlation between the walking speed and the soundscape components was obtained through the use of the Spearman correlation test. On the other hand, a homogeneity test was conducted before verifying the effect of the sound components on the walking speed which was achieved by the use of the one-way ANOVA test. Finally, a post hoc Tukey test was carried out to explore the sound component that causes increased walking speed.

## 4. Results

### 4.1. Soundscape Identification

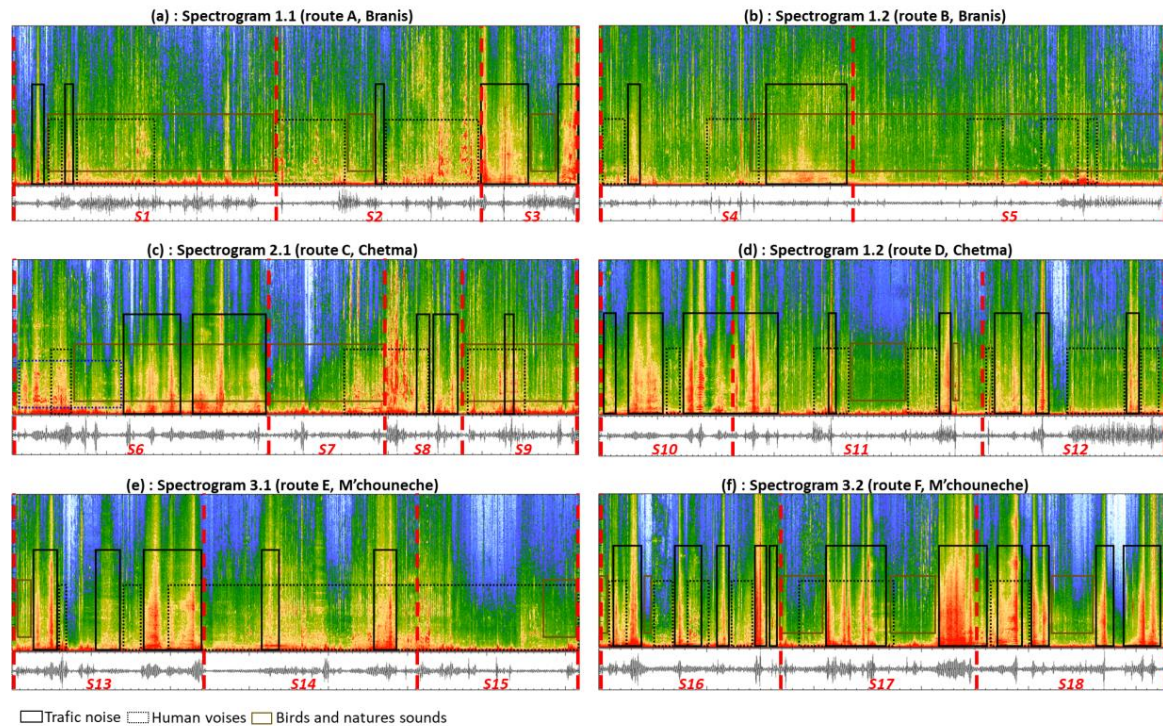
Figure 6 presents the spatial identification of the soundscapes of the studied areas. As seen in Figure 6, biological and geophysical sounds generally predominate over the studied areas' soundscapes. Branis A, Chetma D and the two areas of M'chouneche E and F are characterized by soundscapes predominated by the sounds of geophony and biophony, with 45.45%, 51.43%, 70.26% and 71.95%, respectively. On the other hand, Branis B and Chetma C are characterized by a predominance of traffic sounds on their soundscapes, with 50.4% and 69.8%, respectively.



**Figure 6.** Spatial identification of the oases soundscapes: (a,b) Branis, (c,d) Chetma and (e,f) M'Chouneche.

#### 4.2. Analysis of Recorded Sound Tracks (Sound Walk)

Figure 7 presents the spectrograms of the sound recordings of the studied routes, divided by sections. Where each section has its own morphological characteristic, (see Figure 5), three main sound elements were selected to analyse the studied soundscapes. Two sound elements representing the anthrophony (traffic noise and human voices), and a sound composition of (birds and nature sounds) to represent the geophony and biophony components.



**Figure 7.** Spectrograms of the soundscapes for the six studied zones: (a,b) Branis, (c,d) Chetma and (e,f) M'Chouneche.

Route A contained three main sections S1, S2 and S3, (See Figure 7a). Analysing the spectrogram of the sound recording of route A (Branis) showed that section S1 begins with intense sounds of mechanical origin emitted by the traffic noise of the national road. The pedestrian in this area can frequently hear the sound of the biophony like bird sounds, in addition to the sounds of the geophony with a certain presence of the sounds of anthrophony, in particular the sounds of playing children. In section S2, a remarkable change in the soundscape was marked by the predominance of human voices, as well as the appearance of new sounds, which is a woman's speech emitted from inside houses. In section S3, and with the closest proximity of the pedestrians to the national road, they can strongly feel the predominance of traffic noise over the soundscape.

Figure 7b shows the spectrogram of route B (Branis), which consists of two main sections, S4 and S5. In section S4, the pedestrian can often hear human sounds, especially the sounds caused by surrounding speech and by footsteps. In this section, there was a notable presence of traffic sounds, which hide the sounds of biophony and geophony. In contrast, section S5 was characterized by a predominance of biophonical sounds which was due to the strong presence of birds singing and dogs barking, as well as the geophony marked by trees rustling. The walker in this section can hear from time to time some human sounds due to child speech and footsteps.

The spectrogram of route C (Chetma) is illustrated in Figure 7c. This route consists of four sections S6, S7, S8 and S9. At the beginning of section S6, the pedestrian can frequently hear a mechanical sound, which is due to the sound of the Quran emitted by the speakers fixed in the minaret of the mosque. This sound component is generally connected with the presence of human sounds, in particular the sounds



of footsteps of people who walk towards the mosque to pray. On the other hand, the soundscape of this section is distinguished by a predominance of traffic noise, which hides the sounds of geophony and biophony. Section S7 is characterized by the appearance and predominance of biophonical sounds due to birds singing and house dogs barking. The soundscapes of sections 8 and 9 perceived a strong presence of human sounds, namely the sounds of playing children, and a woman's speech emitted from inside the houses.

Route D (Chetma) contains three sections S10, S11 and S12, Figure 7d. Section S10 is characterized by a predominance of traffic sound which is mainly due to vehicle and motorcycle noises, with a weak presence of human sounds caused by playing children. The soundscape of section S11 begins with a continuity of the traffic sound observed in the previous section. Afterwards, the pedestrian experience revealed a soundscape predominated by the sounds of geophony and biophony. This soundscape is also defined by the presence of human sounds, caused by surrounding speech. While section S12 is determined by a soundscape predominated by the sounds of anthrophony like the human sounds given by speech surroundings, and footsteps, traffic sounds can also be heard in some moments of the sound experience.

The spectrogram of the sound recording of route E (M'Chouneche) is presented in Figure 7e. This route mainly consists of three sections, S13, S14 and S15. The sounds of anthrophony characterize the soundscapes of all the sections of this route. The soundscape of section S13 is defined by a predominance of traffic sound, while those of section S14 and S15 are predominated by the human sounds caused by speech surroundings and footsteps in the popular market area (Souk).

Route F (M'Chouneche) consists of three sections, S16, S17 and S18, shown in Figure 7f. The soundscapes of these three sections are very similar, characterized by a sound composition of anthrophony in which the pedestrian can feel the human sounds generated by speech surroundings and footsteps. These sound components are hidden by the traffic sound caused by street traffic, bicycle riding and motorcycles.

#### 4.3. Analysis of Participants' Mean Walking Speeds

The mean of the participants' mean walking speed for each section of the studied routes are presented in Figure 8 and Table 4. The participants' mean walking speed was  $(0.85 \pm 0.069 \text{ m/s})$  for the eighteen studied sections in the different routes. A maximum value was recorded in Section 2, route A (Branis), with a mean speed of 1.09 m/s. This increase in the mean speed of walking for leisure may be due to the frequent hearing of pedestrians to surrounding speech, such as that caused by women from inside their homes (See the analysis of Figure 7a)—while the minimum mean walking speed was marked in Section S14, route E (M'Chouneche) with 0.78 m/s. This decrease in mean speed in this section may be due to the sound experience from the popular market (Souk), where the visitor walker can hear the sounds of speech and footsteps from the surrounding people, which generates the confidence and curiosity to live this sound experience (See the analysis of Figure 7e).

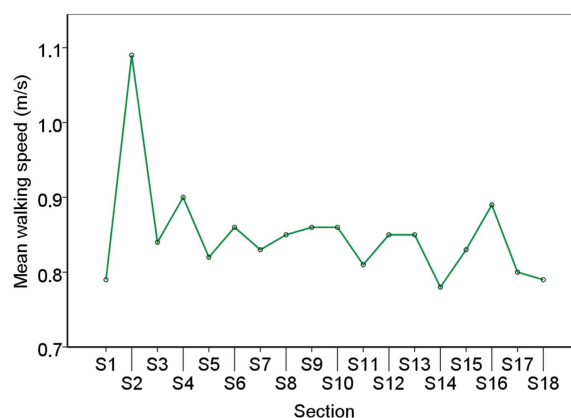


Figure 8. Mean walking speed for the studied route sections.

**Table 4.** Mean walking speed for the studied route sections.

Sections	Mean Walking Speed (m/s)	Standard Deviation
S1	0.79	0.083
S2	1.09	0.278
S3	0.84	0.128
S4	0.90	0.177
S5	0.82	0.159
S6	0.86	0.160
S7	0.83	0.163
S8	0.85	0.093
S9	0.86	0.079
S10	0.86	0.080
S11	0.81	0.106
S12	0.85	0.087
S13	0.85	0.084
S14	0.78	0.094
S15	0.83	0.138
S16	0.89	0.184
S17	0.80	0.106
S18	0.79	0.100

#### 4.4. Association between Walking Speed and Soundscape Components

The results of the Spearman correlation coefficients between the mean walking speed and the soundscapes components are illustrated in Table 5. As shown in Table 5, traffic noise and human voices have no significant correlation with the mean walking speed ( $p$ -values  $> 0.05$ ), whereas birds and nature sounds had a moderate and significant negative correlation with the mean walking speed ( $p$  value  $< 0.05$ ). This suggests that the more the sounds of geophony and biophony increase their predominance on the soundscape, the more the mean walking speed will be reduced.

**Table 5.** Spearman rank correlation coefficients of the mean walking speed with the soundscape components.

Dominant sound	Mean Walking Speed (m/s)	
	Correlation coefficients	Sig.
Traffic noise	0.122	0.629
Human voices	0.380	0.120
Bird and nature sounds	−0.486 *	0.041

\* Correlation significant at the 0.05 level (two tailed).

#### 4.5. Effect of the Soundscape on Pedestrian Walking Speed

To verify that the speed of walking is affected by the soundscape components, the one-way ANOVA test was carried out to infer that the soundscape components are indeed the cause of the increase or decrease in the walking speed of pedestrians. Before starting the analysis, a test of the homogeneity of variances was conducted, where it has a significant value of 0.053, greater than 0.05.

Table 6 illustrates the values obtained by the descriptive statistical analysis and the one-way ANOVA. As seen in Table 6, there is a statistically significant difference between groups as determined by one-way ANOVA ( $F = 7.558$ .  $Df = 485$ .  $p = 0.001$ ), because the  $p$ -value is less than 0.05. This means that there is a statistically significant difference between the pedestrian walking speed and the dominant sounds in the soundscape. Consequently, the soundscape components can affect the mean walking speed.

**Table 6.** Comparisons between the mean walking speed and the dominant sounds in the soundscape.

Indicators	Groups	No.	Mean	F	Sig.
Walking speed	Traffic noise	108	0.8119	7.558	0.001 *
	Human voices	189	0.8786		
	Bird and nature sounds	189	0.8384		

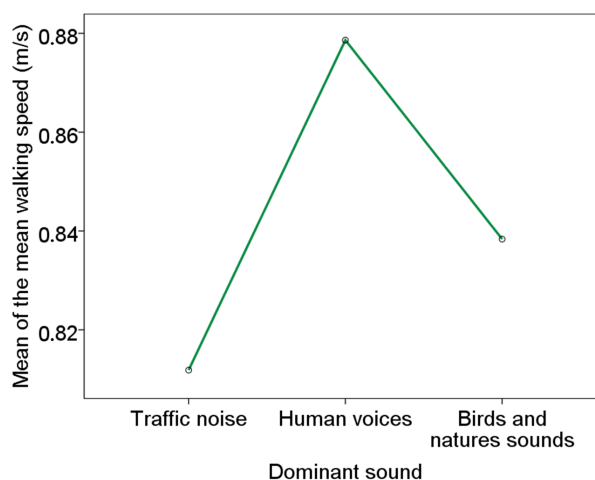
\* if the  $p$ -value of the test is less than 0.05 (5%).

In order to determine which group pair is different, a post hoc Tukey test was carried out. The results of the multiple comparisons are presented in Table 7, while the means are presented in Table 6. The visual representation for comparing the means is illustrated in Figure 9. As shown in Table 7 and Figure 9, the post hoc Tukey test indicates that the mean walking speed was statistically significantly lower after the dominance of traffic noise ( $0.81 \pm 0.13$  m/s,  $p = 0.001$ ), and bird and nature sounds ( $0.84 \pm 0.13$  m/s,  $p = 0.024$ ) compared to human voices ( $0.88 \pm 0.176$  m/s). There is no statistically significant difference between the groups (traffic noise) and (bird and nature sounds) with  $p = 0.303$ . These results indicate that human sounds are the soundscape components affecting the mean speed of pedestrians for leisure.

**Table 7.** Multiple comparisons of the post hoc Tukey test.

(I) Dominant Sound	(J) Dominant Sound	Mean Difference (I-J)	Sig.
Traffic noise	Human voices	−0.06677 <sup>a</sup>	0.001
Human voices	Bird and nature sounds	0.04026 <sup>a</sup>	0.024
Bird and nature sounds	Traffic noise	0.02651	0.304

<sup>a</sup> The mean difference is significant at the 0.05 level. Dependent Variable: Mean walking speed [m/s].

**Figure 9.** Comparisons of the mean walking speed as a function of each dominant sound group of Table 6.

## 5. Results

### 5.1. Findings

The findings from this study suggest that traffic noise and human voices (anthrophony) have no significant correlation with the mean walking speed. In contrast, bird and nature sounds had a moderate significant negative correlation with the mean walking speed, which confirms the results of Franěk et al. (2019) [40], and explains that the more the soundscape is dominated by the geophony and biophony sounds, the more the mean speed of walking decreases.

In addition, the results explored that the soundscape components can affect the mean walking speed of the pedestrian. Somewhat surprisingly, human sounds are the cause of the increase in the mean speed of walkers. This increase in the mean speed of walkers is perhaps due to their frequent hearing of surrounding speech sounds made by women from the inside of their houses. As it is shown in the second section (S2), where we noticed that the highest mean walking speed (see Figure 8) is corresponding to a strong presence of human voices (particularly the women sounds) as is shown in Figure 7, this is due to a respect for the specific social intimacy of these oases.

### 5.2. Strength and Limitations

The strength of this research is mainly due to its empirical approach to examine the correlation between walking speed and the soundscape components of oases and to verify the effect of these sound components on pedestrians' walking speed. None of the previously published articles have investigated the correlation or causation between the soundscape and walking speed in the oases of North Africa.

The findings of this research are limited to the study of the association between a single variable on walking speed, which is the soundscape. Although this study was based on the quantitative statistical analysis of one behavioural variable of the walkability, walking speed, it is considered as a complementary step of the works of Zuniga-Teran et al. [23,74,75] who studied the experience of walkers in relation to aesthetics, slope, way finding and thermal comfort. It is also considered as a subsequent step in the study of Bouzir et al. (2019) [5], who evaluated the soundscapes in oases of hot and arid climates.

### 5.3. Implication on Practice and Future Research

The results of this research help to explore the effects of soundscape components on walking speed. Based on our findings, the authors counsel urban planners to give more importance to the original soundscapes of the oases, in order to preserve and improve them, and to urge inhabitants, visitors and tourists to walk in the outdoor spaces of our oases. Supporting walking should be a strategic policy to encourage sustainable and healthier urban living [76]. As the oasis often refers to a feeling of peace, calm and tranquillity [77]. Other parameters must be taken into account to improve the walking level in our oases, especially that of safety, where the design and maintenance of the house can contribute to the creation of safe and inviting streets for pedestrians [78].

Another interesting implication of this study is that it calls for the creation of sound and soundscape maps for each oasis in Algeria, especially since the soundscape is considered as a part of cultural heritage [79,80]. Unfortunately, this research confirms that the current urban strategy of Algeria is outdated with regard to maintaining the soundscape cultural heritage. Consequently, the authors have confidence in that the engagement with decision makers to adopt and apply the findings and recommendations of this study can anchor their influence on the professional practice of creating oasis settlements that encourage walking through their soundscapes, and which preserve the health of the inhabitant—especially since natural soundscapes have positive effects on human health [81], along with walking or walkability which become promising for increasing overall physical activity and improving health [82,83].

Future research should focus on the subjective investigation of soundscapes and walkability in each oasis in Algeria. The authors are aware that subjective measures of walkability are particularly important in understanding the perceptions of walkability and walking behaviour [10]. This subjective approach is also very important in soundscape evaluation [84].

## 6. Conclusions

In this paper, a field study was carried out to examine the correlation and the causation between soundscape components and walking speed in six oasis settlements. Overall, this study suggests that there is no significant correlation between traffic noise and human sounds with mean walking speed.

On the other hand, the sounds of geophony and biophony have a moderate and significant negative correlation with mean walking speed. This research also highlights that human sound is the cause of the increase in the mean walking speed in the oasis outdoor spaces. Further research is needed, which focuses on a subjective investigation to determine the correlations and long-term effects between the soundscape and the walkability in each oasis in Algeria.

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