



Research article

Cultural relationship between rural soundscape and space in Hmong villages in Guizhou



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ABSTRACT

The Hmong is one of the oldest ethnic groups in south-western China, and sound plays an important role in their culture. According to the general classification of landscape science, the rural soundscape of Hmong villages is divided into three types: a point soundscape dominated by a single sound source, a line soundscape with a typical Hmong rural village alley space as the sound field interface, and an area soundscape with the Bronze-drum Square, the only open public space of Hmong nationality, as the field. Combined with a sound collection and field test during field investigation, we obtained the characteristics of various rural soundscapes and evaluated the acoustic environment. The results showed that the “point” soundscape of medium- and low-frequency powder shotgun and wooden drum sounds in the unclosed Hmong villages exceed the transmission distance and sound durability. The “line” soundscape utilizes the turning point and envelope of different spaces to increase the acoustic reflection surface and create reverberation, increasing the propagation time and distance of the sound, and emphasizing the directivity of the sound through a long and narrow space. The “surface” soundscape includes the richest medium- and high-frequency-based human voice and music sounds and medium- and low-frequency musical instrument sounds, among others. The values of T_{30} , EDT, and C80 in the sound field, all changed significantly because of the lack of acoustic reflection from the ceiling, through the top opening. Finally, the study reveals the cultural association between rural soundscape and space, which is reflected in the Hmong’s “defensive” function and “group” culture. Thus, the Bronze-drum Square sound field does not meet the requirements of the current specification of cultural interpretation, and it is in the participatory Hmong performance mode, centered on drum club group structure.

1. Introduction

The word “soundscape” is derived from “landscape,” and involves the governance and improvement of the urban sound environment. It covers several subjects, including architecture, music, sociology, psychology, medicine, and transportation science [1], and emphasizes the relationship between people, the voice, and the environment [2]. Therefore, soundscape can also be regarded as an abstract form of landscape where the sound and its environmental space are formed together with a complex value system (with humans as the evaluation body). Here, space is the carrier of culture, which can directly reflect a region’s geographical environment, social history, architectural art, and other elements [3]. Voice can convey thoughts and exchange emotions [4, 5]; sound can distinguish things and define space [6] (such as in the medieval city of London, defined as the area within the sound of the bells of the church of St Mary-le-Bow [7]). It is the material carrier of behavior and activities in

human heritage, such as the language recording role [8], and can express special emotions and meaning, and arouse recall [9]. In other words, the voice is responsible for social and cultural functions such as recording history, distinguishing ethnic groups, delimiting spatial scope, and for the warning and defense of a community.

Therefore, the protection of soundscape is one of the priorities of contemporary soundscape research [2]. The primary reason for this is that the soundscape plays a significant role in ecological protection, which is an important factor in ensuring the stability of natural communities and the diversity of species [4, 10, 11]. More importantly, the cultural, historical, spiritual and artistic values of soundscape are the embodiment of its social attributes [4], and also affect the quality of human life from many angles [12]. Sounds with regional characteristics have become one of the most popular soundscapes [13], where any changes in the soundscape will also affect the heritage characteristics of historical and cultural areas [14], emphasizing the historical memory

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role played by soundscapes. Thus, UNESCO (1992) initiated the “Memory of the World Project” [15], while Japan (1996) organized “100 Kinds of Japanese Soundscape: Protecting our Heritage” and proposed taking cultural voices, including the bells in the temple, as part of the heritage, advocating the protection of the historical voice remaining among all the peoples [16]. Some historical heritages that have disappeared can also be partially restored through modern technology [17]. Intangible cultural heritages, which can be difficult to spread can also be publicized, protected and inherited in combination with the communication effect of digital media [18, 19]. For example, in China, there are 7,000 h of recordings in the historical sound archives, including traditional ethnic folk music, literati music, and religious and temple music, collected by the Music Institute of the Chinese Institute of (1997) as part of the “Memory of the World List” [20]. In addition, museum and archives dedicated to preserving and displaying sound heritage have been established [2]. Some examples are the “looking for sound” Sichuan intangible cultural heritage sound archives large music program (2015), the second Sound Asia activity “sound culture recording action” (2019), the theme of “Canal Sound” of the “Zhihua Temple Music and Culture Festival” in Beijing [21] (2019) and other musical and cultural activities, for folk instruments and folk sound heritage, and rescue and restoration protection work.

Contemporary urban Chinese residents have a strong sense of protecting the soundscape [22]: the “Original Sound: Local Sound View of Taiyuan” project (2021), and other urban soundscape protection projects discuss urban history, geography, culture, customs, and contemporary reality from the perspective of the soundscape, and explore the possibility of using sound to condense local identity and build local culture. In recent years, with interdisciplinary development, archaeoacoustics has explored the cultural significance of sound over time through experimental tests, analytical models and other tools [23]. However, in rural China, which is a transitional zone between the city and nature mostly located in inaccessible areas, the main sounds include birds, insects, water and any other natural sounds with a low noise value absolutely different from urban China [24]. These zones thus retain a large number of high fidelity (hi-fi) soundscape systems, where many sounds can be heard clearly [6], and the collocation of wind, rain, and plants creates a soundscape that brings the highest satisfaction [25], with rural and natural sounds [26]. In addition, when we usually analyze and describe sound sources, we analyze the physical characteristics of the sound itself, from different frequency bands. The description of soundscape is completely different, often comprising an understanding of the culture of sound source itself, and its space-related cultural role. This is also one of the main differences between sound source and soundscape. With the countryside as the foundation of Chinese culture, the rural soundscape is often related to residents’ production, life, spiritual and safety needs. Ethnic differentiation [27], is also often based on the soundscape produced under different cultural backgrounds. To date, 6,819 ancient villages have been selected in five batches, and the common characteristics of these villages are the rich historical and cultural traditions, including their overall style and features, rural characteristics, intangible cultural heritage, among others. Sound is one of the most important signs of the vivid existence of these rural cultures, and rural soundscape in some villages with a long history and distinctive cultural characteristics has become a part of them because of its intangible cultural heritage attributes and value [28].

The Hmong people are the oldest and largest ethnic minorities in China. According to historical records, the Hmong originated in the Yellow River area, and after repeatedly being defeated by other ethnic groups, gradually moved to the southwest. Therefore, they are often called “mountain migrants,” and—alongside the Jewish people—are regarded as one of “the world’s most suffering and indomitable nationals” [29]. The particularities of their ethnic culture are reflected in different ways: when building the rural space, it is vertically constructed under the influence of terrain and land carrying capacity [30], which is highly defensive. The rural soundscape has special cultural significance and a

social role. It uses oral teaching to make up for the lack of national characters, such as spreading national ethics, customs, spiritual beliefs and laws and regulations through singing Jia Shi and singing “Jia Li”, one of thirty Chinese intangible cultural heritages of the Hmong. Many reference works in Hmong architecture, music, history, and other disciplines report research on space and sound. However, reflections on the correlation of rural sound and culture, and methods of expressing the cultural characteristics of space, are questions that have not been discussed. This study is a necessity for acoustics and sociology, history, ethnology, and other related disciplines of cultural research. Sound, people, and environment constitute the three elements of soundscape, which mainly refers to the combination of Hmong people in their unique defensive and group cultural form since ancient times. The sound itself represents this cultural feature in different environmental fields (including alleys and Bronze-drum Square). This paper analyzes the physical and spatial cultural properties of the Hmong rural soundscape, aiming to grasp its cultural value and function of rural sound. The goal is to apply the cultural elements of sound, to better protect the heritage of rural villages. Different rural sound frequencies and environmental spatial scales produce different auditory stimuli. For example, medium- and high-frequency sound has higher definition, while low-frequency sound produces a better sense of reverberation. In addition, people’s evaluation and perception of sound are related to their cultural backgrounds [31]. We seek to find the common characteristics of rural sound and villages in the value of cultural heritage to guide protection. Ancient Chinese villages face various threats, such as overexploitation, population loss, and questions of heritage division and historical dating. Therefore, this study is of great significance.

2. Materials and methods

In this study, several typical Hmong villages with well-preserved spatial construction structures and cultural forms—including the Basha Hmong Village in the hinterland of Moon Mountain and the Langde Shangzhai Village, and Songtao Hmong King Village in the Wuling mountain area—were selected as typical cases. Acoustic testing and soundwalk recording methods were adopted, and the impulse response of a typical sound field was calculated using a balloon blasting sound, which has less interference from ambient sound. By analyzing the soundscape elements at different levels, the sound field characteristics of the main rural sound source and its space were obtained.

This research uses the typology method to classify the soundscape. In previous studies, the urban soundscape is divided into four main perceptual dimensions through the semantic differential—relaxation, communication, spatial and dynamics [32], and the two main emotional dimensions of people’s assessment of a local soundscape are calmness and vibration [6]. In sound ecology, according to the natural, cultural, and social attributes of soundscape, it is divided into keynote, signal and sign soundscapes [7]. Soundscape studies the relationship between people, hearing, sound environment and society [33]. The historical and cultural causes of Hmong people’s sounds and the cultural value system of villages can be obtained through literature review. Sound research can be obtained through the classification of points, lines and areas in acoustics, and sound environment can be divided according to the structure of Hmong traditional villages in landscape research. In other words, their plane landscape composition mode can be converted into a circular structure of “building—terraces—forest” or “building—terraces—water system—forest” from the inside to the outside (Figure 1). This will help us determine the different rural landscape elements as follows: points—Bronze-drum Square, village protection trees, wells, ponds. Line—road system. Area—landscape spatial level and elements of architectural complex [34]. The study is based on the classification of Hmong culture, the point and line soundscapes produced under the external defensive culture, and the areal soundscape produced under the internal group culture. Therefore, this paper divides Hmong rural soundscape into three structural levels: point, line and area.

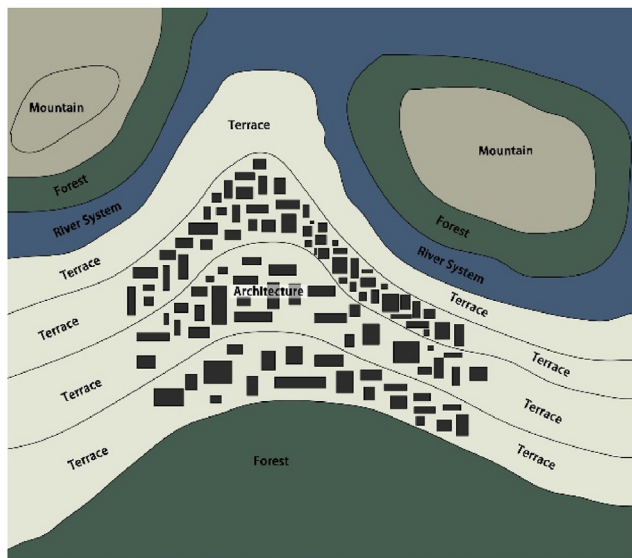


Figure 1. Landscape level of Hmong villages.

2.1. Point soundscape: inspired by a typical sound

The point sound source is generally a single vibrating object without specific directivity [35]. The point soundscape is a soundscape composed of a point sound source with specific cultural information. In Hmong villages, the point soundscape refers to the important signal soundscape composed by the sound of guns and drums Hmong have had the technology of homemade powder shotguns since ancient times. Basha Hmong Village in Congjiang County is the only “shooter tribe” village remaining in China. It still follows the custom that only men aged 14 and above can legally hold powder shotguns (Figure 2). In the Hmong language, wooden drum is called “fighting,” also known as bamboo dragon. The drum’s body is made of hollowed-out nanmu or maple, built as a straight tube. The body is 1–2 m long and about 50 cm in diameter, with both ends of the drum covered in brown skinstightened with bamboo sticks (Figure 3).

2.2. Line soundscape: a typical line sound field

A line sound source is generally a line sound source composed of a line or countless unrelated point sources, with clear directivity [35]. Line



Figure 2. A Hmong with a powder shotgun.



Figure 3. Wooden drum.

soundscape refers to the continuous propagation of a sound source along a line space. The alley is the main space for constructing the behavior and activities of Hmong, it is the skeleton connecting the whole village and one of the spaces for communication among Hmong (Figure 4). In its natural environment without the point sound system, the spatial form of the alley determines the directionality of its sound propagation, and the unique spatial interface material properties of Hmong rural villages determine the physical properties of the sound field. Usually, the point soundscape is one of the sound elements that constitute the line soundscape.

2.3. Areal soundscape: a typical mixed sound field

The areal sound source is a vibrating body that radiates plane sound waves [35]. It refers to the soundscape formed by the mixing of multiple sound sources in a certain field. Bronze-drum Square, also known as the Lusheng Field, is called “Adho” in the Hmong language. Its plane shape is like the large face of a bronze drum. A horn “bronze drum column” is usually erected in the center of a site in the village to hang the bronze drum (Figure 5). This is a necessary public space and activity area in every Hmong village. It is a field with an organic combination of people, things, time, and space, including stylish places, musical instruments, totems, and other decorative objects [36]. At important festivals, Hmong families sing and dance around the bronze drum and “step on the bronze drum,” which is the “areal soundscape” that best expresses the Hmong drum club culture (see Figure 6).

3. Results

The results consist of three parts. Section 3.1 is about the characteristics of the two points sound sources, the powder shotgun and wooden drum. Section 3.2 is about the spatial properties of the alley line sound field, and 3.3 is about the structural characteristics of the sound field on the Bronze-drum Square surface.



Figure 4. Alley.



Figure 5. Bronze-drum square.

3.1. Point: sound source characteristics of powder shotguns and wooden drums

The Hmong nationality has inherited the production technology of the powder shotgun. Because of the wooden gunstock and copper barrels, the pitch of their low-frequency sounds is slightly high and that of the high frequency sounds slightly low. The instantaneous maximum sound pressure level is $LA_{max} = 94.6$ dB(A), which easily forms echoes in mountainous areas. The drum surface of the wooden drum is made of cow leather, and the body is made of wood. Hitting the drum causes a vibration, and the air in the drum body vibrates accordingly. In addition, the natural frequency of the wooden drum body is similar to that of the cow-leather drum surface, and the porosity of the wood itself plays a role in the transmission of sound, so the sound tends to be of low-medium frequency [37] (Figure 7).

3.2. Line: spatial attribute of alley

Most of the alleys in Hmong villages are paved with stone, and the buildings are entirely wooden structures. The material properties of the interface determine the characteristics of the sound field in the space. This article selected a typical alley system with twists and turns and stone masonry, about 0.75 m wide and about 1.5 m high on both sides of a stone courtyard wall, forming a “concave” type space (Figure 8). The results show that the attenuation of sound intensity from the sound-producing to the sound-receiving point is not obvious, which is determined by a small amount of sound absorption and mostly sound reflection by the wall and ground stones (Table 1). Therefore, the sound reverberates through multiple reflections, extending the duration of the sound propagation, throughout the alley space (Table 2).

3.3. Area: sound field structure of bronze-drum square

The tone of modern Mandarin is divided into “Yin Ping, Yang Ping, Shang Sheng, and Qu Sheng.” For the sound “a,” for example, the tones are marked in each of them as: Yin Ping & Yang Ping á, Shang Sheng à, Qu Sheng ǎ.

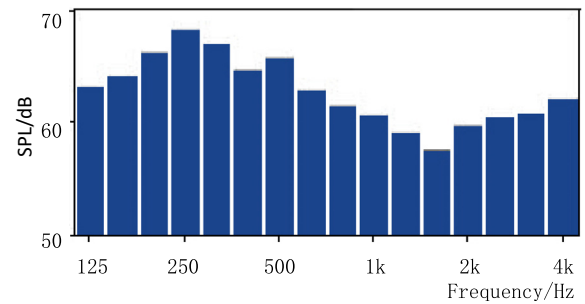


Figure 7. Powder shotgun's frequency analysis.



Figure 8. Concave space.

Table 1. Sound absorption coefficient of stone.

Frequency	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz
Stone	0.03	0.03	0.03	0.04	0.01	0.07

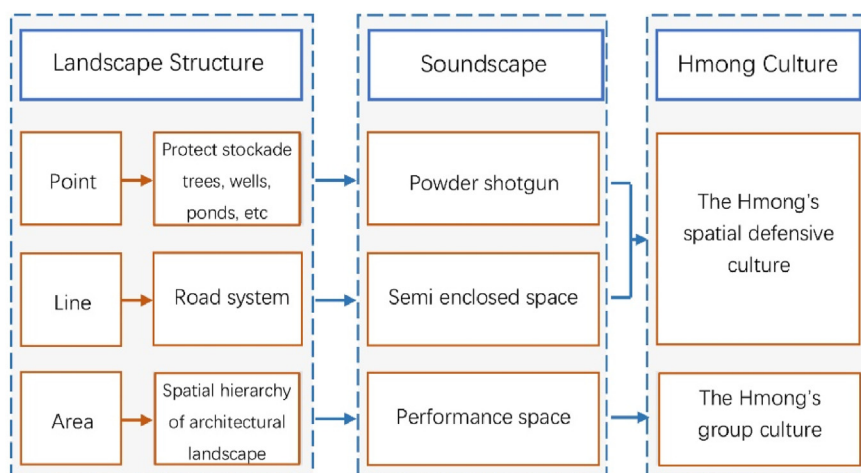


Figure 6. The relationship among the landscape structure, soundscape and culture of Hmong villages.

Table 2. Numerical simulation of reverberation time in Hmong settlement alley (s).

	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz
T10	0.671	0.059	0.135	0.104	0.068	0.031	0.024
T20	0.608	0.462	0.093	0.076	0.268	0.045	0.034
T30	0.562	0.354	0.177	0.071	0.226	0.052	0.039

and Qu Sheng à. The function of tone division is to distinguish semantics, reduce the number of syllables, and increase the beauty of melody.

3.3.1. Sound source property

The Bronze-drum Square is the only open space in Hmong villages and is meant for important activities related to Chinese intangible cultural heritages, such as the Guzang Festival, Sister Festival, etc. The human voice is the most important sound source in the rural soundscape, it is the voice most closely related to human activities, and contains a large amount of cultural information related to production and life. The characteristics of the human voice, and linguistic voice quality, are closely related to the natural and cultural space. For example, dialects in the central plains are considered high-pitched and unrestrained, the Wunong language in the Jiangnan Plain is gentle and soft, and the dialects of the plateau are broad and powerful [38]. The soundscape composed of language is the “context.” Although languages and dialects vary greatly, the average spectrum is not very different [37]. Therefore, tone has become the most direct factor affecting “context.” Hmong is known as one of the most tone-rich nations in the world, with a total of 6–8 different tones (Figure 9.). The Hmong also use onomatopoeic words to imitate the sounds of birds, insects, and the natural environment to create the context, such as *tax tax* (imitating the sound of powder shot-guns), *diul-liuldiul-liul* (for the sound of thunder), *hongl-hail hongl hail, gab-lab, gab-lab*, etc. [39], creating a rich linguistic soundscape.

Music is related to the cultural communication of the Hmong, and is an indispensable voice in the Bronze-drum Square. The flying song, one of thirty Chinese intangible cultural heritages of Hmong, singing sound pressure level is at 73.2–85.1 dB(A), high and passionate, with a strong appeal. Most of the sung phrases are in the 500Hz–2 kHz frequency band of medium-and high-frequency sound, and some singing sentences are at 4 kHz. There are few low-frequency sounds, and most of them come from the wind in the environment and the noise of the audience (Figure 10a), indicating the characteristics of the middle and high pitches of Hmong music. In addition, Hmong music and language are similar, with rich tonal values and high tones. By comparing female and male Hmong speech, and Hmong song, we can find a commonality among the three sounds (Figure 10b). This indicates that the richness of the Hmong language tone value may be related to its national music culture, and has typical musical characteristics, that is, the Hmong speech is a musicalized

language or sung language, and its sentence structure has a strong sense of rhythm, with flat and tonal rhyming [40].

Musical instruments are commonly used to increase the richness of the performance and sound fields. Hmong people are good at making percussion and reed instruments with beautiful sounds using natural materials such as bamboo branches and leaves. Lusheng, another piece of Chinese intangible cultural heritage of Hmong, is the most important reed instrument, mainly in the medium and low frequencies, and can be divided into five categories according to the height of the *sheng* tube (Table 3). The greater the height, the lower the treble color, because the sound wave formed by blowing air in the tube to impact the reed, forcing the air column in the Sheng tube to vibrate [41]. Most of the performances are based on the high-pitched Lusheng, while the middle-pitched Lusheng simplifies the melody. The low-pitched Lusheng is the least used because of its high volume, and is mainly used for strong beats or long duration sounds [42].

3.3.2. Testing and analysis of the sound field

The test field of Basha Hmong Village is a typical non-physical Hmong performance space located at the top of the mountain. The site is surrounded by tall and dense fir and other vegetation from the pine family. The plane is almost elliptical, the entrance is located on the long axis with four layers of wooden stands, each level is about 50 cm high, the floor is paved with wood (Figure 11), which is completely different from other Bronze-drum Squares—which are paved with sun patterns and other pebbles, which is the restoration of the ancient Bronze-drum Square/Lusheng field shape system. During the test, the sound source was always located at the center of the site, with eight sound-receiving points, as shown in the figure (Figure 12).

3.3.2.1. Reverb time T30. The test results show that there are T30 data at each sound-receiving point, the range of other points is 0.2–0.7 s, and increases slowly from 125 Hz to 4 kHz, except at point 1. Point 6 low-frequency band T30 has the highest value, which is due to the lack of any occlusion between the sound point and the sound source, indicating only a small part of the sound absorption from the ground, and sound attenuation from the air. Points 2, 3, and 4 are the main audience spaces, which produce reverberation, and the T30 is the highest in the medium-and high-frequency stages, which is determined by the good sound absorption effect of wood, on low-frequency sound (Figure 13).

3.3.2.2. Early decay time EDT. The test results showed that the EDT of each acoustic point varied in a more complex manner between 125 Hz and 4 kHz. The EDT of points 1 and 5 is minimal, which tends to be almost 0, indicating that there is only direct sound, and no reverberation between the sound source and the receiving point. The changes in the four sound-receiving points —2, 3, 4, and 7 tend to be the same, and the sudden drop is close to 0 at 1 kHz, indicating that the environmental materials have the most obvious absorption of this frequency band. The value at point 8 rises slowly in each frequency range, because this point is the most closed space in the venue, and the mountain gate, the surrounding trees, and the rising ground all reflect the sound to varying degrees. At point 6 it rises steadily as it is a relatively open space, except for the significant EDT changes at 2 kHz. In other words, except points 1 and 5, all points have a rich sound field composition, especially points 2, 3, and 4, which form the main auditorium. The change in the EDT value indicates the richness of the sound field space (Figure 14).

3.3.2.3. Clarity C80. The test results show that the C80 of each sound-receiving point changes significantly. The C80 values of points 2 and 6 close to the sound source were higher in the 125 Hz and 4 kHz frequency bands. The C80 value from point 2 to point 3 shows an obvious downward trend, but increases significantly from point 3 to point 6. Compared with the identification diagram of the test points on the original site, it can be inferred that the main reason for this significant change is the substantial

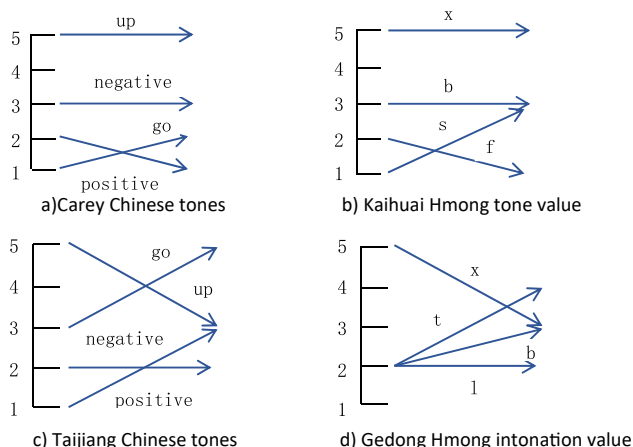


Figure 9. Comparison analysis between Hmong and Han tones [39].

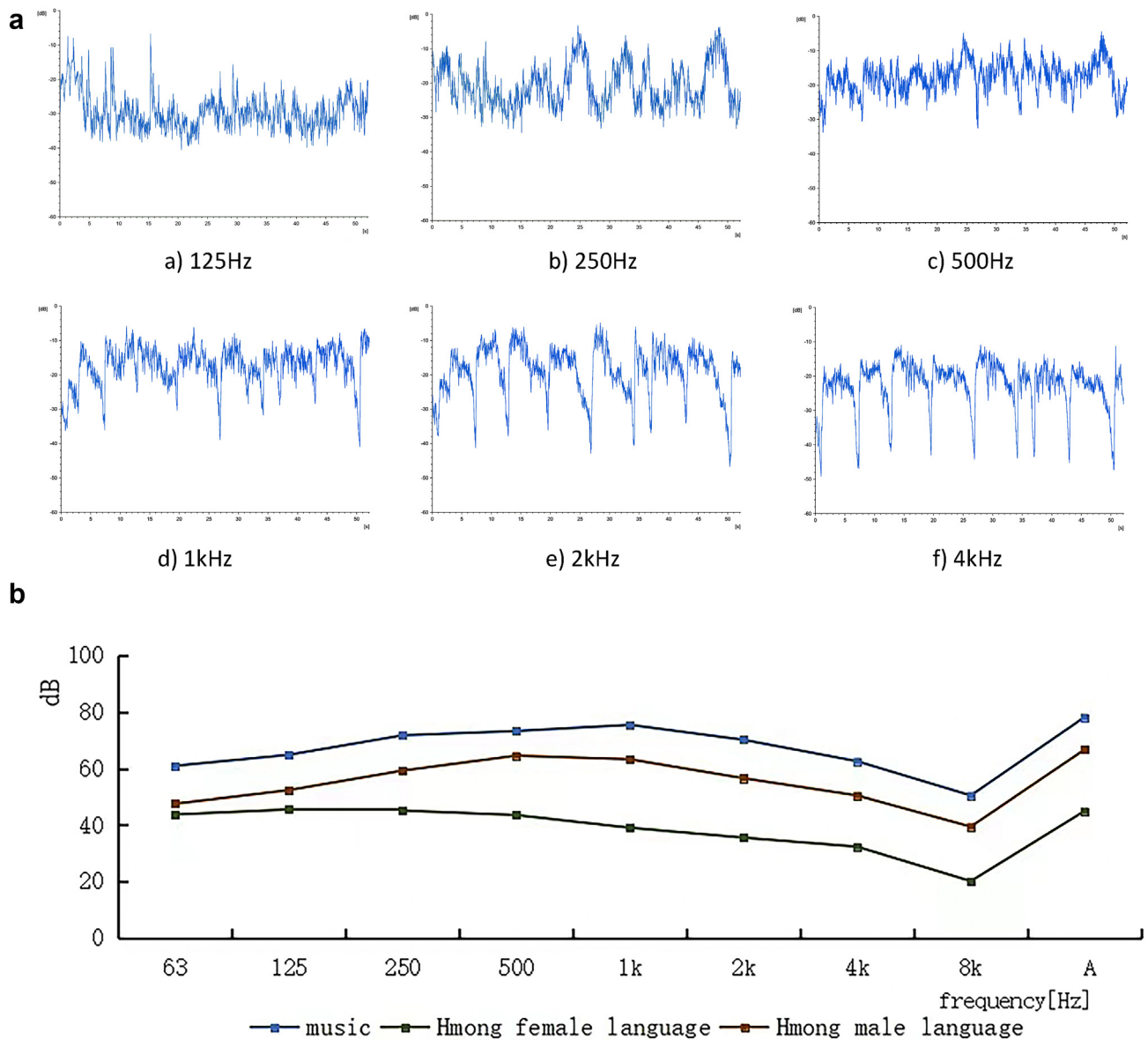


Figure 10. a. Feature map of Hmong nationality singing voiceprint. b. Comparison curve of A-weighted sound pressure levels of Hmong women's and men's language and Hmong music.

Table 3. Classification of Lusheng [43].

	Highest sheng	High-pitched sheng	Accent sheng	Bass sheng	Double bass sheng
Height (cm)	7.2–14.5	14.5–30	30–58	58–105	105–210
Folk appellation	Five drops of water	Four drops of water	Three drops of water	Two drops of water	One drop of water

change in the distance of the sound-receiving points. The distances between points 2 and 6 and the sound source point are equal, so the C80 values of the two sound receiving points are almost equal. Points 1 and 4 are closer to the sound source point than points 5, 7, and 8. The C80 value is relatively smaller due to the relatively higher terrain (Figure 15).

4. Discussion

The rural soundscape in a specific space reflects its unique cultural attributes and value. The spatial structure of Hmong villages clearly



Figure 11. Basha Hmong village Bronze-drum Square.

reflects the essence of Hmong culture, that is, the main line of its social structure—the defensive culture and internal village structure, as well as the life mode formed under the control of drum society culture. Its physical, and acoustic characteristics reflect its group culture and village group spatial layout. Thus, the cultural connection between rural soundscape and space is highly developed.

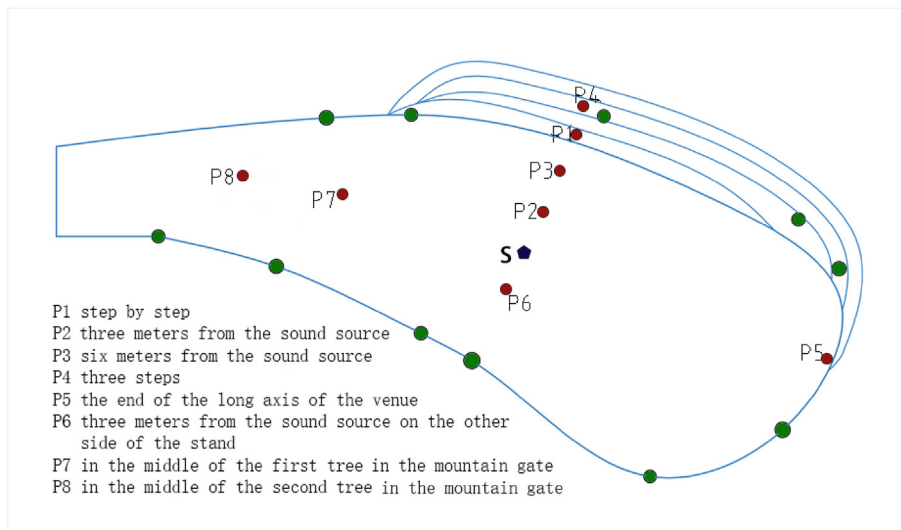


Figure 12. Location map of the sound measurement point at Bronze-drum Square in Basha Hmong Village.

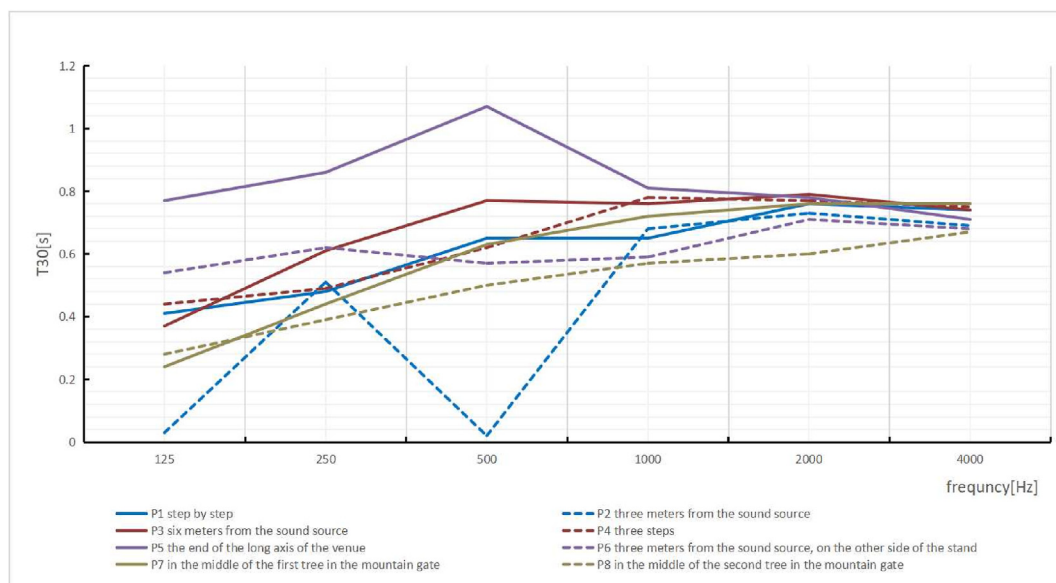


Figure 13. Values of each measuring point of reverberation time T_{30} .

4.1. Point soundscape, line soundscape and Hmong “defensive culture”

Defense is the most direct embodiment of ethnic consciousness in the Hmong culture, which is inseparable from its ethnic history. A location at a high terrain and complicated landform, is central to Hmong construction, indicating an emphasis on concealment and height, to enable a long-distance view that makes it difficult for intruders to invade. The village was also built near water and originated from the river, which offered a route for the Hmong to escape from the plain into the mountains after a defeat in battle. In addition, the twists and dangers of the road inside the rural village, the complex spatial connectivity of each household, a few places dedicated to trading, to reduce the risk factors, achieve the purpose of “benefiting oneself and not others.” This excessive emphasis on spatial defense is also reflected in the characteristics of the point and line soundscapes.

The most basic function of the powder shotgun is for hunting and defense, which is a direct embodiment of their defensive culture. As a form of voice of the Hmong, rooted in common cultural cognition, it contains the signal information that the people can understand, in the

early formation of the rural village—warning of the emergence of prey, for example—giving people the expectation of obtaining food. During a turbulent period, it indicates the approach of danger, and during a period of stability, it indicates the arrival of guests. The signal meaning of the wooden drum is expressed by the “drum language” of different drum rhythms, and the fast, slow, relaxed, and urgent meanings of the drum are used to express different defensive cultural contents for Hmong. The Hmong “sacrifice drum words,” says: “...knock the stone pass not far away, hit the wood bang-bang. Everyone gathered to discuss moving westward blow Lusheng here and wood leaves there. You knock on the wood and shout, I knock on the wood and answer.” [45]. These two kinds of sounds are mainly of medium and low frequency. In terms of human ear sensitivity, although high-frequency sounds can attract the listener’s attention over time (e.g., shrill high frequencies can make people nervous), it attenuates quickly over distance (In the free field, the distance between the receiving point and the sound source is doubled, and the sound pressure level is attenuated by 6dB [35]) and encounters great interference by obstacles. The Bronze-drum Square is surrounded by a large number of spruce trees. The moisture content of the plant itself is

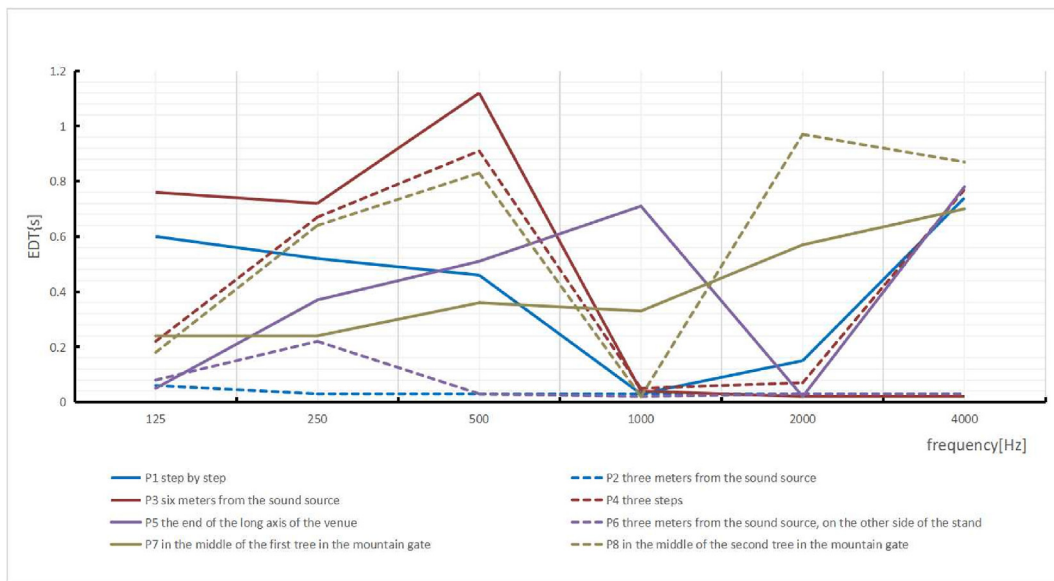


Figure 14. Values of each measuring point of EDT for early decay time.

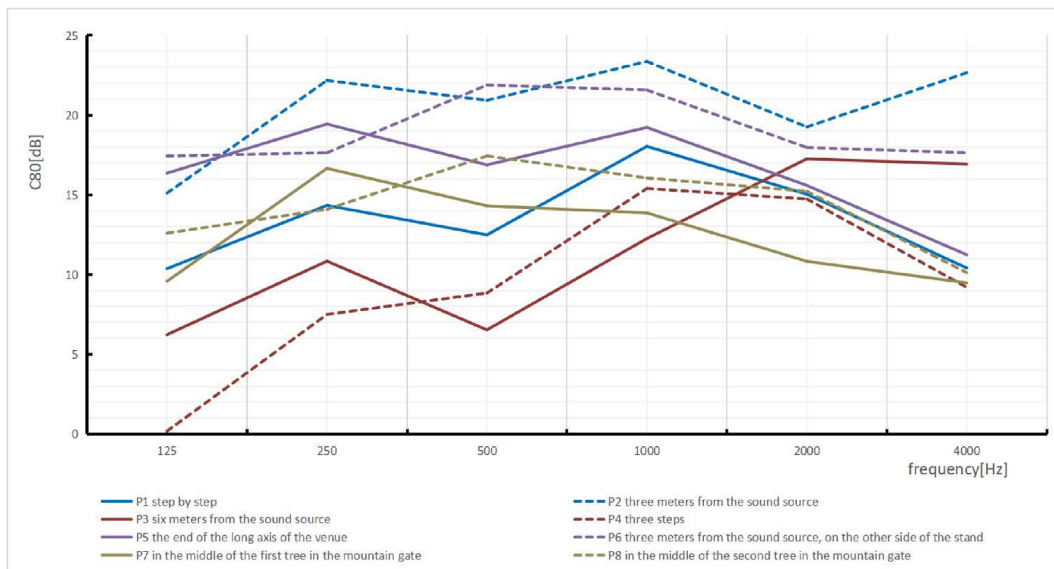


Figure 15. Values of each measuring point of clarity C80.

higher than that of wood, that is, the higher the humidity, the worse the sound absorption effect, and the plant itself has better absorption of high frequency [46]. Therefore, medium - and low-frequency sounds have better propagation distances and durability in Hmong villages. Among them, the instantaneous low-frequency blasting sound of a powder shotgun can achieve the long-distance transmission effect of sound, and the medium- and low-frequency sound, continuously emitted by the wooden drum, can achieve the long-time transmission effect of sound, due to long, slow attenuation and penetration of obstacles.

The “line” soundscape uses the turning points and enclosures of different spaces, to increase the reflection surfaces and improve the sound intensity, or the characteristics of poor sealing of wooden pole and fence buildings and large material pores, to increase the transmission of sound to the interior, and improve the defense of the village [28]. The Hmong village alleys measured skillfully combines sound with terrain, spatial change, and environmental materials, and uses them effectively. For example, using stone for courtyard walls and road laying increases the sound reflection of the interface, and the tortuous alley increases the

number of sound reflections, thus forming reverberation in the alley, and the narrow spatial shape improves the directivity of sound. These are embodiments of the Hmong’s spatial defensive culture.

4.2. Areal soundscape and Hmong “group culture”

Witches and ghosts dominate the spiritual world and behavior patterns of Hmong people, affecting all aspects of life, and these ghosts also appear in the face of groups [47]. Therefore, the “ghost group culture” has developed into a group cultural characteristic shared by the Hmong. In terms of the spatial structure of the village, the group is expressed as follows: the group village structure is of large mixed residences and small settlements. It can be traced back to the mass escape and migration of the ancestors of Hmong to the west and southwest, when the three Hmong countries were defeated [48]. The inward structure of group spatial layout, taking the ethnic vein system as the core, is one of living in groups around the residence of *Zhailao*. During sacrifice, Hmong danced counterclockwise around the bronze drum, which symbolized the expansion

of the ethnic structure with the drum society as the blood unit in the spatial field [49]. It also reflected that the Hmong nationality, like the Dong nationality, maintained the primitive group social system, with the drum, to distinguish the clan and sacrifice as the basic structure. They built a clan public space for group activities expressing group culture. In fact, in ancient China, except for official buildings such as palaces and altar temples, there were no public buildings or special spaces for public gatherings. Like Hmong, the ancient Chinese built special public spaces for ethnic groups' collective activities. Most of them take collectivism as the basic social organizational structure, such as the Dong nationality, with their joint payment systems, as their ethnic organizational structure. This strong sense of group consciousness is reflected in the sound field composition, and traditional performance mode of Bronze-drum Square.

First, the composition of the Bronze-drum Square sound field is an important embodiment of its drum group organization structure. The Hmong nationality takes the drum as the totem of its culture and the symbol of its ancestors. It usually takes the drum society as the clan unit. Groups with the same sacrifice and the same ethnic origin is called a clan, that is, a clan is a big drum society, and a large clan is divided into many ethnic branches [50]. Therefore, the drum society is an important embodiment of the group ethnic organizational structure of the Hmong nationality, and the Bronze-drum Square is a direct product of the drum society culture. Group consciousness endows the spirit of the public activity space in Hmong villages, and forms a multidimensional social organization model. Bronze-drum Square is the most important activity space for the Hmong nationality, its public attributes and the activity characteristics of Hmong people on it, reflect their group characteristics. Thus, through a variety of activities, the common group behavior mode of Hmong is formed, and their ethnic emotional identity is established with the Bronze-drum Square as its core. Because drums are often placed at a higher place in the center of the site, continuous heavy blows and wooden drums dominated by medium- and low-frequency sounds. This makes the drum sound particularly obvious among other such sounds, due to their long wavelength and slow attenuation, highlighting the group-cultural characteristics of the Hmong nationality with drum society as the core.

Second, the characteristics of the Bronze-drum Square sound field are also the embodiment of its traditional group performance mode. As the main activity place in the village, the Bronze-drum Square culture often exists based on people's behavior modes. The rural performance mode of the Hmong nationality, which has become the most significant embodiment of its group culture, is as a unique non-entity performance space of the Hmong nationality. It consists of no fixed actor and audience, and emphasizes the frequent interaction and group participation between viewers and performers. Therefore, although its sound field does not meet the requirements of the modern hall, owing to space enclosure, irregular morphology, and short reverberation time, among others, it conforms to the Hmong performance culture with group participation as the main mode. Meanwhile, blowing the Lusheng and singing are considered the second language of the Hmong nationality. This performance-watching activity is not purposeful appreciation or learning, but is generally a part of their daily life, such as eating and dressing. Therefore, modern sound evaluation standards cannot be applied to this context. However, although the background noise is large, it is easily covered by the sound of Lusheng and other musical instruments, and it is mainly natural sound that has become the main element of enriching the environmental sound field. Therefore, it reflects the characteristics of the public space field, with "group culture" as the core. In evaluating the Bronze-drum Square sound field, it is necessary to integrate the Hmong traditional performance culture and cultural consciousness, which is related to the specific auditory customs of the nation.

5. Conclusion

- (1) The "point" soundscape is a definition given by a single sound source, based on a fixed sound field and specific signal warning

function. The results show that the powder shotgun sound is dominated by low frequency and its signal has had different meanings during different historical periods. The wooden drum sound dominated by medium and low frequency and the wooden drum signal expresses different meanings based on the speed and urgency of the drum. Because they are mainly medium and low frequency, they carry for a longer distance and time in open space, which is the most direct embodiment of the Hmong defensive culture.

- (2) The "line" soundscape is defined based on the complexity of alley spatial structure, and its spatial scale in Hmong villages and the point soundscape is one of its sound elements. The results show that the sound constitutes reverberation, through multiple acoustic reflections at the stone interface. Combined with the role of the alley in Hmong defensive culture and its directivity, it reflects the defensive logic of village space construction and the "unconscious" application of the defensive function of the soundscape.
- (3) The "areal" soundscape is the only open space in the village under the inherent defensive cultural system of the Miao nationality. The results show that too small T30 and EDT values in Bronze-drum Square space will lead to insufficient plumpness of music [44], and there are great differences between EDT and T30 at each measuring point, which theoretically should be generally consistent. This is because the top of the rural sound field is open, and the sound reflection from the ceiling is missing, which is the essential difference in the outdoor sound field. Therefore, the reverberation time formula is not applicable, and the early attenuation time EDT should be used as the main sound quality index of the space [51]. The results also reflect the unique "group" performance culture of Hmong people.

Declarations

Author contribution statement

Linqing Mao: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Xin Zhang and Jianjun Ma: Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Yihong Jia: Conceived and designed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data.

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Data availability statement

The data that has been used is confidential.

Declaration of interest's statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

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