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Study on the Spatio-temporal Characteristics of Soundscape in Famous Historical and Cultural Towns: a Case Study of Labrang Town, Xiahe County, China

ABSTRACT

This study based on field measurements of the acoustic objective data of Labrang town, draws a sound level map and depicts the soundscape characteristics from the perspective of space-time. The distribution of sound levels is imbalanced in the old urban area of Labrang town. The spatial characteristics show that the eastern region has higher sound levels than does the western region; the core area, higher than the edge area; and the nodular area, higher than the homogeneous area. In the typical "Tawa" community and temple area, the sound level is low, and there is a high level of sound in the area along the traffic line and the "nodule area". The spatial distribution of the soundscapes is closely related to the urban functional area and crowd behaviour activities. The time characteristic has an obvious fluctuation and particularity. The changes in sound levels and the characteristic of soundscapes are related to the life rhythms of monks and residents. From the point of view of sound protection in historic and cultural cities, it is necessary to pay attention to the construction of soundscapes in order to optimize the urban functional structure and strengthen the management of the sound environment.

Keywords: *soundscape; temporal and spatial characteristics; famous historical and cultural towns; Labrang Town*

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INTRODUCTION

As part of the trend of rapid globalization and urbanization, the identifiable characteristics of regional culture are gradually erased as economic values, cultural activities and construction become similar, and the original historical scenes are surrounded and dispelled by new cultures. The problems of "homophony", "isomorphism" and "homogeneity" in the world are serious. Soundscape, as a landscape element on a three-dimensional level, has far-reaching significance for the cultivation of urban personality and the construction of urban vitality. In traditional urban planning and environmental protection planning, noise control is often emphasized, and the establishment of the soundscapes is neglected. Soundscape research abandons noise-centred research thought and regards sound as an idiosyncratic source similar to other sources (*Brown 2010; Dumyahn and Pijanowski 2011; Mou and Hong 2016; Kang et al.2016*). Its goal is to manage, utilize, and protect sound. Soundscape research aims to focus on the balance between sounds and their harmonious development with their spatial environment and listeners rather than purely to reduce sound pressure levels to control noise (*Song et al. 2012*). What creates a good soundscape and maintains a wonderful sound environment for inhabitants has important practical significance for demonstrating a city's individuality, creating urban vitality and shaping urban characteristics.

In 1929, the concept of the soundscape was first put forward by Finnish geographer, Granoe (*Kang and Yang 2002*). In addition, it was defined as a phenomenon with perceptible content composed of different sound elements. Canadian musician, Schafer, regarded soundscape as music in the environment from the perspective of music philosophy and scientifically classified and interpreted the soundscape into keynote sounds, signals and sound marks in 1960s (*Schafer 1977*). However, nobody in academia noticed this. Academia and its practitioners did not take the concept seriously until the European Union promulgated the END in 2002 (*Kang 2007*). The bill required every city to delimit and protect "quiet areas". In Soundscape: Definition and conceptual framework, promulgated by ISO, soundscape is defined as the sound environment as perceived, experienced or understood by individuals, groups or communities in a given scenario (*International*

Organization for Standardization 2014). Therefore, the keys to understanding a soundscape are sound, people and environment (*Liu et al. 2013*). In the study of urban soundscape, this study mainly focus on the characteristics of the three elements of sound, people and environment at the overall level of the city and in different functional zones and their differences.

Regarding the research on the spatial characteristics of soundscape, spatiality and dynamics are the key characteristics of the soundscape (*Kang and Zhang 2009*). In the 1990s, French scholars came up about the spatial of the soundscape for the first time, believing that soundscapes have spatial patterns and spatial boundaries similar to vision (*Augoyard 1990*), and their characteristics change with the main function of the space (*Hong and Jeon 2017*) and exploring spatial relationships among soundscape variables in urban areas (*Sun 2008*). Therefore, the function of an urban space should be taken into account as an important background of soundscape analysis (*Hong and Jeon 2015*). Conversely, the plan of redevelopment of an urban space must emphasize soundscape (*Rehan 2016*) and soundscape space planning (*Tian et al. 2014; Xiao et al. 2017; Cerwén et al. 2016*). Spatial and temporal factors play critical roles in urban soundscapes (*Hong and Jeon 2017*) Relationship between spatio-temporal variability of soundscape and urban morphology in a multifunctional urban area.

Regarding the time characteristic of soundscape, sound is not only a spatial phenomenon but also a time phenomenon (*Kitchin and Thrift 2009*), and sound always occurs in a particular spatial environment at a specific time (*Lin 2017*). A soundscape constitutes a finite and unbounded space and is always on the move. Research on spatial and temporal characteristics of soundscapes from a geographical perspective, there is a need to consider that a soundscape in a particular area changes and develops at different point in time, periods and historical eras, and there are differences in spatial and regional performance (*Liu, et al.2014*). The soundscape spatial pattern of a multifunctional city is affected by the landscape characteristics of the bottom layer. However, time change is mainly driven by urban activities (*Liu et al. 2013*). In different parts of a city, dynamic changes in the core elements of a soundscape persist. At different time scales (hour, day, season), the model of a soundscape undergoes very distinct differences (*Torija et al. 2011*). The time-varying sound types and intensity of urban parks (*Qin and Sun 2009;Szeremeta and Zannin 2009; Liu et al. 2013; Hu et al. 2016*), Han Buddhist temples (*Zhang et al. 2018*), botanical gardens (*Cheng 2016*), squares (*Liu et al. 2017*), residential areas (*Berglund and Nilsson 2006; Schulte-Fortkamp and André 2006; He 2014*) and historic blocks (*Kaymaz et al. 2016; Huang and Kang 2014;Deng et al. 2014; Yu and Zhang 2013; Xie and Kang 2014*) are closely related to the urban residents' rhythm of life and the number of tourists. Therefore, the evolution of sound space through sound events can be recreated (*Ji 2012*).

The research scale of soundscape includes cities, historical and cultural blocks, urban public spaces, villages and public buildings, in the field of research involving tourism, geography, landscape, architecture, planning, landscape and music and other disciplines, the research methods mainly include fixed-point measurement, Sound Walk, questionnaire survey, SD semantic analysis and so on. With the development of the subject, the concept of soundscape has been deeply accepted by people. The research of soundscape involves urban environment improvement, soundscape perception, GIS soundscape mapping, Soundscape protection and so on. However, the introduction of soundscape into urban planning, planning control and guidance level has less research. Therefore, this study introduced soundscape into the research of historic and cultural towns, systematically analyzed the spatio-temporal characteristics of soundscape from the spatio-temporal dimension, and provided scientific basis for urban noise control to maintain a good living environment.

MATERIALS AND METHODS

Study Area

The research area covered 260.71 km^2 (**Figure 1**), located in the Xiahe county, Gansu Province, China,where the county government is stationed. The area from west to east shows the Labrang monastery, commercial, traditional residential (Tawa community), administrative office district and other types of residential districts (Government low-rent housing, rural community and commercial community). Among them, the monastery district and the "Tawa" community are the core elements of this famous, historical and cultural city. These are protected as priority sites.

Labrang town is under the influence of Tibetan Buddhist culture. It is a representative inheritance of Anduo culture. It is typically a characteristic of urban patterns, functional zoning, religious sentiment and cultural context, including deep Tibetan religious, nomadic and folk culture. As early as 1996, it was identified as a famous, historical and cultural city at the provincial level. The Labrang temple in Labrang Town

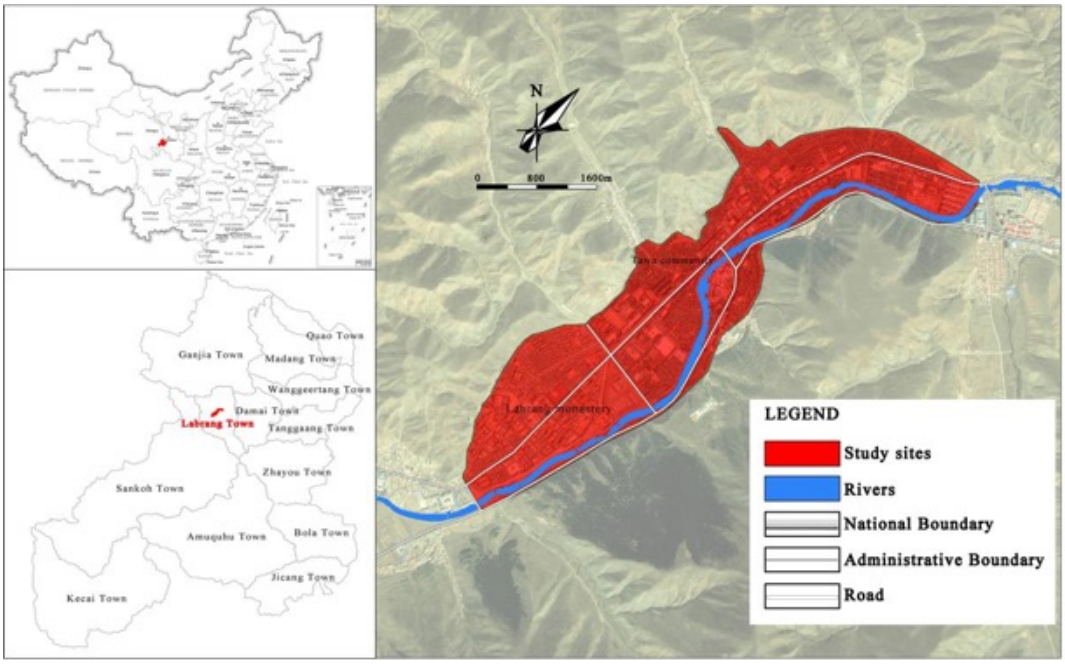

Figure 1. Study sites in Xiahe county, Gansu Province, China

was listed as an historical site under state protection. Labrang town has a long history with deep cultural connotation and cultural relics of high value. Urban spatial patterns of mountains, rivers, temples and cities are very obvious. However, because of the rapid development of urbanization and strong stimuli from the tourism economy, urban life interferes with religious beliefs, and traditional and modern sounds mingle. As a famous religious, historical and cultural city, its quiet and solemn soundscape is interrupted by noisy urban scenes, and signs are drowned out by soundscapes. Its present situation and the solemnity of its imagery form a strong contrast, which influences the image and function of the city. Hence, how to develop deep culture and history, highlight the national characteristics and construct the sound space which corresponds to the famous historical and cultural cities is particularly important.

Data Source and Processing

To deconstruct a soundscape, it is significant to be sure to distinguish between the various sounds. According to the nature and function of sound and physical truth in Labrang town, the sound source can fall into these categories: keynote sound (environmental background sound), signals (warning tone) and sound marks (**Table 1**). Research on traditional soundscapes pays more attention to the objective measurement of sounds and the subjective evaluation of sound by people, but it pays less attention to researching the relationship between sound and spatial environment.

In order to objectively and accurately obtain the soundscape characteristics of Labrang Town, and to make the measurement results more accurate and universal, it is necessary to first conduct scientific and standardized point selection measurements. According to the monitoring method for acoustic environment functional areas in the Acoustic Environment Quality Standard (*GB3096 2008*), a certain acoustic environment functional area to be surveyed and monitored is divided into multiple equal sized squares. The grid should fully cover the surveyed area, and the measurement points should be located at the center of each grid, with general outdoor conditions. This study is based on the plan of Labrang Town and divides the research area into 200 m × 200 m Based on the current land use status (religious land, commercial land, residential land, administrative office land, road traffic land) and the complex situation of the site, considering the principle of selecting fewer points and selecting more measurement points along the road in a homogeneous urban area, 51 measurement points were ultimately determined for the measurement of sound and physical data (**Figure 2**).

This study also measured that the tourism off-season decrease the influence on the soundscape of any external population as far as possible. This study measured a total of two days, at five different time periods. The specific times are 6:00-7:30, 9:00-10:30, 12:00-13:30, 15:00-16:30, and 18:00-19:30. Fifty-one measuring points were measured in the five time periods. The measuring time was three minutes in a row. The environmental characteristics, crowd behaviour and sound source

Table 1. Composition of the soundscape of Labrang Town, China.

Keynote sound	**Birdcall, Dog barking, Water flow, Wind sound, Car sound, Construction noise**	
signals	Folk instrumental sound, Alarm whistle	
sound marks	Labrang monastery	Prayer Wheels sound, Reciting Sutras, The sound of Tibetan Buddhist instruments, White tower bell
	traditional residential (Tawa community)	Mosque bell, The sound of iron beating and silver beating
	Commercial district	Shop music, Sound of business activity
	administrative office district	Publicity Broadcast

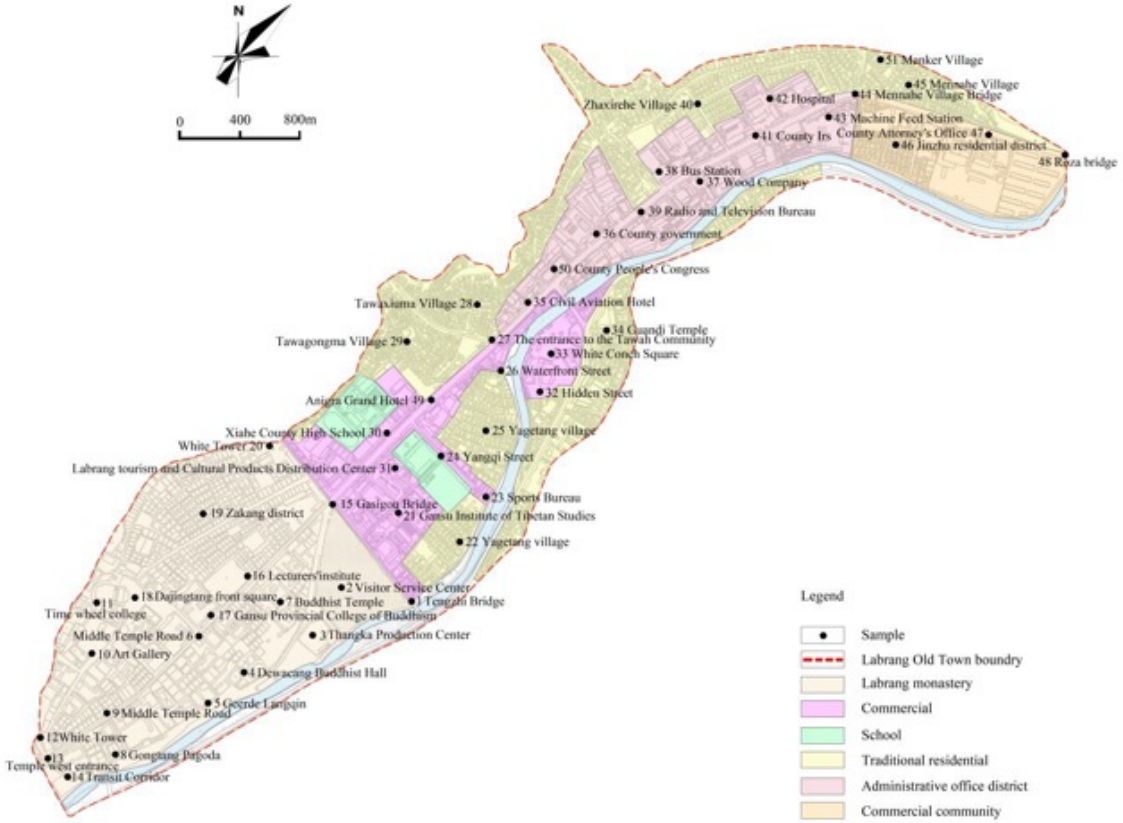

Figure 2. Distribution of sampling points (contain samples, function area)

types around the measuring points were recorded synchronously with a recording pen and a camera. The measuring instrument was Hangzhou Aihua AWA6228, a multifunctional sound level meter. The main measurement was the weighted equivalent sound level LAeq, the maximum sound pressure level L_{max} and the minimum sound pressure level L_{min}.

The sound level data of 51 points in 5 time periods were obtained by field measurement. Data were scattered in dots.

Methods

In order to study the overall soundscape characteristics of the old urban area, this study used the ArcGIS software inverse distance weighted interpolation method to transform 51 points of data into surface data and drew sound level maps.

The inverse distance weighted interpolation method assumes that each input point has a local influence, which weakens with the increase of distance. The inverse distance weighted interpolation method considers that the properties of the estimated block are related to the properties of the known points in a certain distance around it, and the relationship is inversely proportional to the n-power of the distance between the known points and the center of the estimated block. The equation is as follows:

$$Z_0 = \sum_{i=1}^{n} \frac{1}{(D_i)^p} Z_i \left[\sum_{i=1}^{n} \frac{1}{(D_i)^p} \right]^{-1}$$

$$D_i = \sqrt{(x_0 - x_i)^2 + (y_0 - y_i)^2}$$

Where: Z_0 represents an estimate; Z_i represents an

attribute value for the i (i = 1,2,3... N) sample; P is the power of distance, which significantly affects the result of interpolation, and its selection criterion is the minimum mean absolute error, D_i is the distance, the higher the power P, the smoother the result of interpolation, P = 2.

RESULTS AND DISCUSSION

Spatial Characteristics of Soundscape

Spatial differences. The sound level values have an unbalanced distribution in Labrang town. Its sound level values are situated between 43.6 and 68 dB. In general, these values are higher in the eastern core and nodule regions compared to the western, marginal and homogeneous regions (**Figure 3**). Labrang town is a typical representative of a strip city. Its urban form, functional structure and soundscape environment are all fundamentally influenced by its landscape pattern of two mountains with one basin. Its main street, Zhaxiqi Street, runs through city from east to west. Both sides of Zhaxiqi include mainly various types of urban service facilities, and maxed functions make up the main nodal areas of the city. Intense land development is due to high demand of rent. Land development along streets produces many mixed sounds and increases sound level values. The tall buildings on both sides of the street and urban road form a remarkable "pipeline effect", which makes the sound level in this area further amplified. At the same time, the "pipeline effect" also plays a certain role in isolating and weakening traffic sounds and other signal sounds so that the sound level value gradually attenuates to both sides of the street. Some nodule points: the crossings of main traffic streets (Gasigou bridge head, Tengzhi Bridge, etc.) have been in the maximum range of sound levels, which leads to concentric circle structures in the soundscape spaces of local nodule regions. Relatively speaking, homogeneous urban areas, such as the temple in the west and the traditional "Tawa" community in the north and south, belong to low-level areas.

The Coupling Relation Between Soundscape Space and Urban Functional Space. Labrang old town can be divided into a tourist area (The Labrang monastery), a commercial area, an administrative office district and a residential area. The Labrang monastery is the core and soul of the old town and is also an area which is protected vigorously. Under the profound influence of traditional construction thought, a free space order was gradually formed, which was built according to mountains and

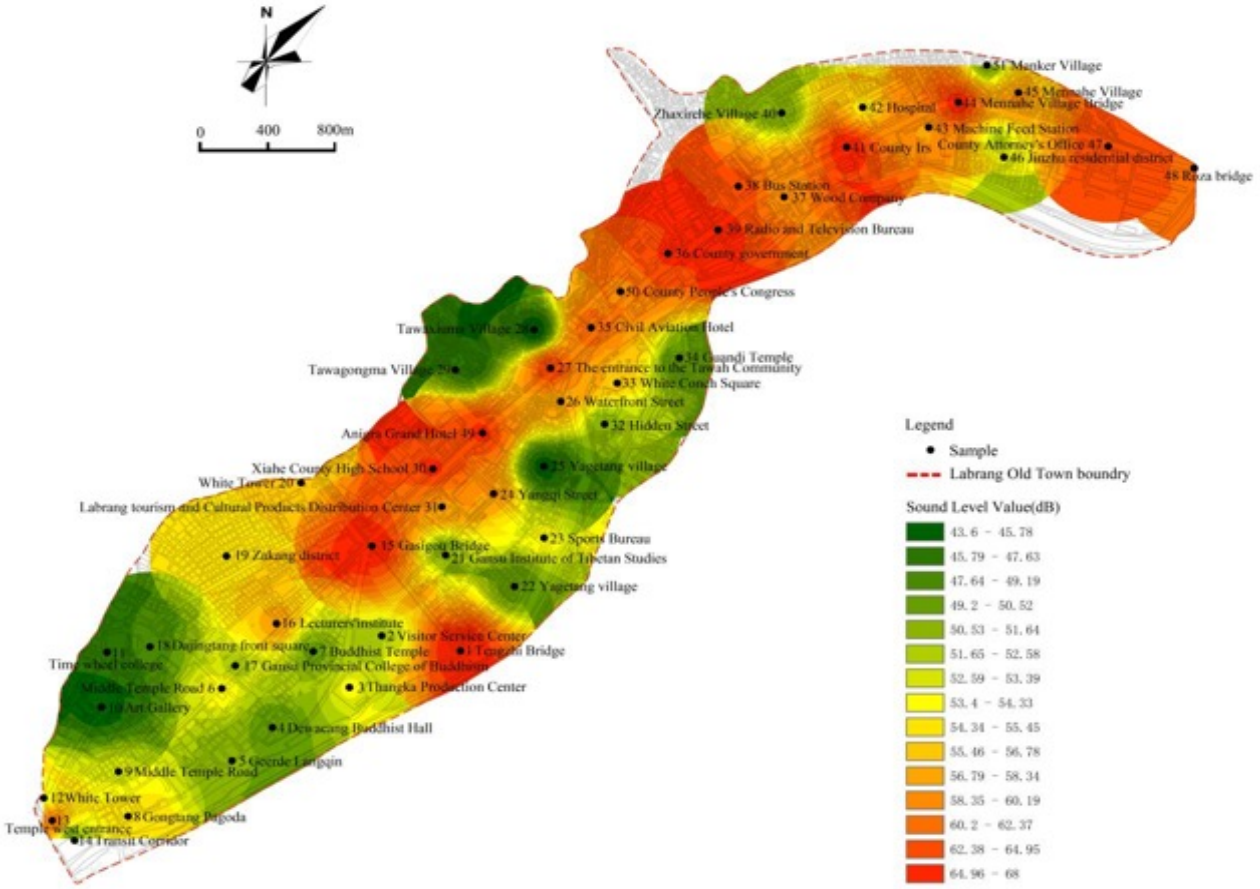

Figure 3. The sound level map of Labrang town

circumstances (*Ren and Gao 2016*). A solemn atmosphere is the most typical soundscape requirement. Under the deep influence of a religious environment and atmosphere, the unique signals and keynote sounds formed. The monasteries were built on along the water and on the side of the mountain. Their site selection conforms to the geomorphological pattern that has a basin. The sound of the Daxia River, the birds' sounds from the north and south mountains and the sounds of wind and horses all show a tone which is consistent with environmental function. However, the sounds that Buddhists produced, including the sound of prayer wheel, chanting and the sound of wind bell, all show a tone which is consistent with religious signals. A tourist that will be visiting will be influenced by this special soundscape and will form an identity and belonging. Compared with some famous historical cultural cities that are over-commercialized and noisy, this is the most significant soundscape.

Although this study tried to avoid the impact of tourism on the sound bas, tourism (especially the instruction of tourism) had a negative influence on soundscape space because the monastery is the main scenic spot in Gannan prefecture. Labrang temple is surrounded by the mountains to the north and rivers to the south. The whole monastery relies on this terrain and the transition from the valley to the mountains, forming a magnificent spatial pattern of mountains, rivers and temples, which is restricted by the terrain and assumes a leaf-like plane shape.

According to its usage function, a collection of buildings can be divided into religious palace buildings and monasteries. The palace buildings are evenly distributed in the temple space, but the monasteries are concentrated in a series. Such a spatial organization affects tourism space organization, which makes soundscape space change. The sound level value gradually decreases from the middle road of the monastery to the south side of the Daxia River and the north side of the mountain. The high-value nodes of sound levels are formed in areas with fewer tourists, such as Wensi College and Shilun College. The six colleges laid out along the north side of mountain are a place for monks to study, and tourists do not visit them. The middle road of the monastery is a main road, Zhaxiqi Street. Although people have obstructed the east entrance of the temple district, there are some motor vehicles, motorcycles and tricycles passing through, which breaks up the keynote sounds and signals of the temple district, and make the sound level value increase. The sound level value of the middle road of the temple is higher than that of the other areas all day, and its sound level value is steady.

There are sub-high value points at the intersection of the temple's middle road and the secondary road leading to the Great Jingtang. The secondary node is the most concentrated attraction point for the flow of people. Gasigou, the west entrance of the monastery, is the boundary between the monastery area (religious cultural area) and other functional areas of the city, and it is the joint of the two major functions. In the boundary space of the temple, the sound level is high and the second source is mixed, which affects the overall sound atmosphere of the temple (**Figure 4**).

"Tawa community" is a typical tradition ally village around Labrang temple. The Yanker valley is divided into upper Tawa (Tawa Gongma village) and lower Tawa (Tawa Xiuma village). The upper and lower Tawa kept typical Tibetan resident building, which is an original prototype of commerce and residence in Xiahe city and is an important component of embodying the history and culture of Labrang monastery.

Tawa community is also the low value area of soundscapes in the old town because of the single activities of residents and the minimal invasion of external factors. Its sound value is between 40.1 and 52.6 dB. The overall feature of the soundscape is that decreases gradually from the edge of the community to the interior. Keynote sounds are mainly dogs barking, conversations, bird sounds and footsteps. Signals are mainly Mosque bells, forge iron and silver beating. The sound level value of upper Tawa is slightly higher than that of lower Tawa, especially between 06:00 to 07:30, which is connected to the inner structure, functional factor and traffic net. During the late Qing dynasty and early Republic of China, the Labrang temple opened Tawa and allowed businessmen of all nationalities to stay and do business. In 1928, many Hui and Han people entered the Tawa community with the establishment of the county government and especially the eruption of the river state incident. This phenomenon led to the complexity of the community structure. In upper Tawa (*Liu 2008*), due to the entry of Hui people, a large number of businesses and a mosque appeared. Compared with lower Tawa, upper Tawa has a more diversified ethnic structure. The Labrang mosque of inner upper Tawa is the only mosque in county, and it is responsible or the worship function of Muslims. Because there is a north-south road in the inner part of upper Tawa, which can be accessed by motor vehicles, there are obvious differences between the types of soundscape and the activities of people in upper Tawa and lower Tawa, and the sound level value is also higher than that in lower Tawa. The commercial district is based on the main road of the city, and it is distributed into zones.

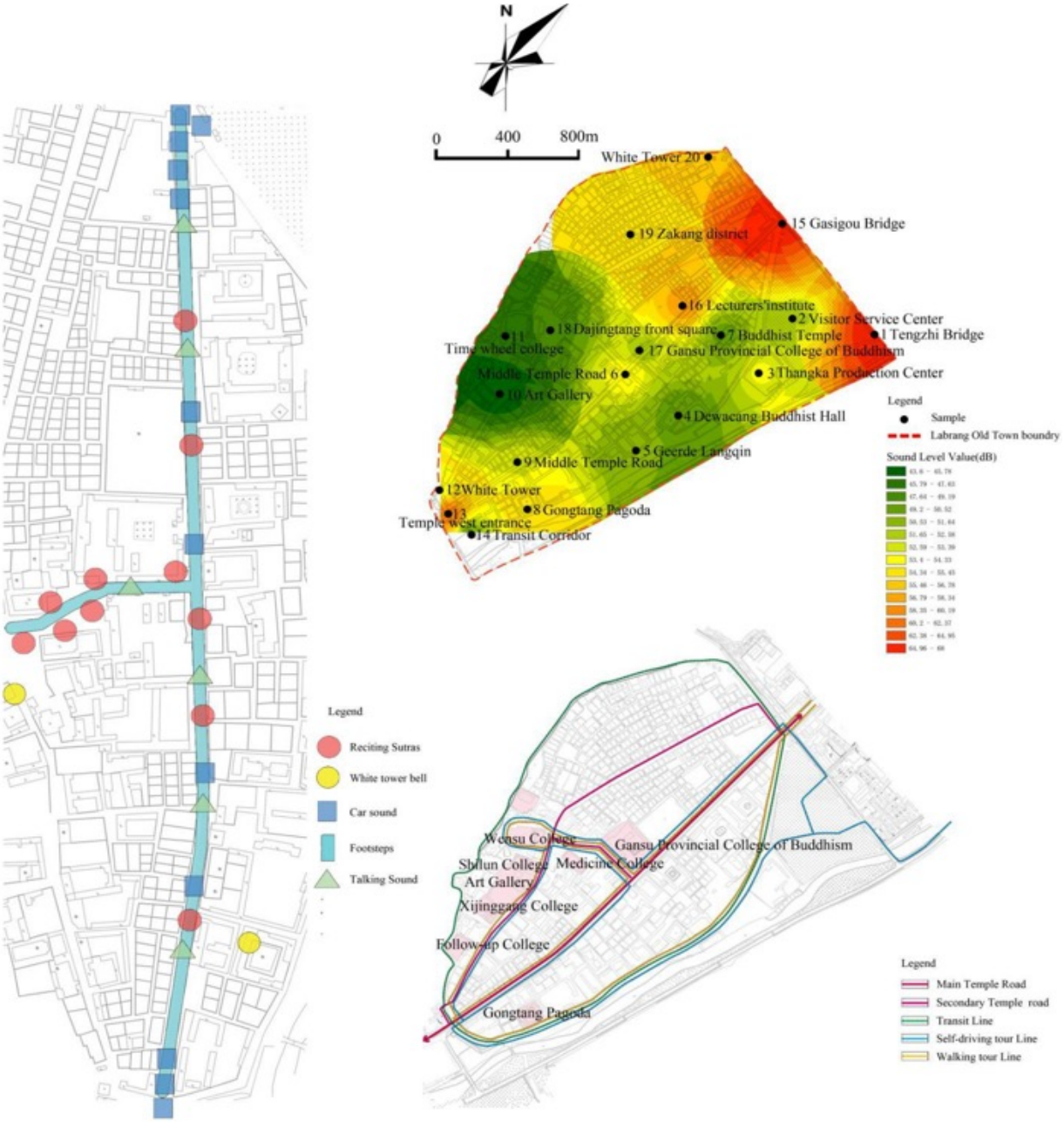

Figure 4. The features of the soundscape of Labrang Lamasery (Left is the soundscape sketch of the middle road of Labrang Lamasery, Right top is the sound level of Labrang Lamasery, Right bottom is tourist route of Labrang Lamasery)

Zhaxiqi Street (east-west direction), Tengzhi road (north-south direction) and Yangqi Street (north-south direction) are the most concentrated districts of commerce. The commercial district is an area of transition from the monastery district to urban area, which resulted in temple space. The commercial district shows many kinds of businesses (retail, wholesale, entertainment, hotel service, etc.) and forms a basically stable soundscape environment. Its sound level value decreases from the west to the east and south. Its sound level is between 65 and 68 dB and the highest value is 67.52 dB at Gasigoubridge (No. 15 measuring point), which fits Clark's rent theory. Keynote sounds are mainly car sounds and conversation. Signals are mainly instrumental sounds and musical singing and dancing. Sound marks are mainly musical sounds and business activity voices. However, many shops play modern pop music, which has a certain impact on traditional Tibetan music and other special soundscapes in commercial districts. Urban passenger vehicles, freight vehicles and motorcycle are all grouped together here. The leading sound is car noise. Noise forms uncomfortable sound environments and has a negative impact on the sound scene of monasteries (**Figure 5**).

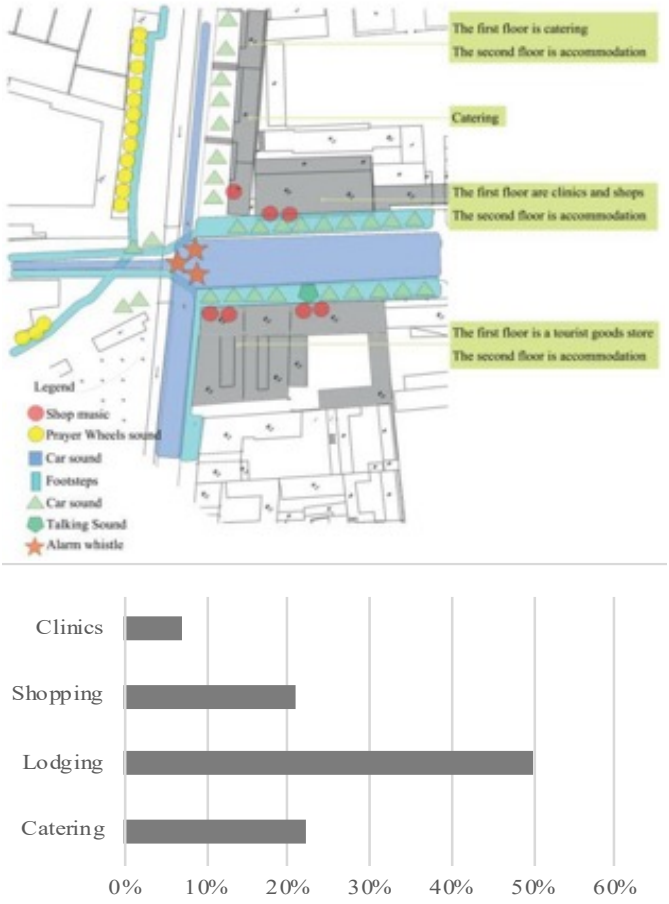

Figure 5. The features of the soundscape of the Gasigou Bridge. (top is the soundscape sketch of the Gasigou Bridge, bottom is the business form of Gasigou Bridge), China.

The administrative office district is located in the middle of Zhaxiqi Street. Compared with other functional areas, there are no special sound marks. The keynote sound is mainly automobile noise, and the signals are mainly whistle sounds. All-day sound levels fluctuate greatly, which is highly in line with official commuting. There is only one main road in the Labrang town. People often choose to drive to work by themselves. Work hours lead to an increase in sound levels and reach a peak at the county government gate.

Time Characteristics of Soundscape

The rhythm change of sound level value is obvious. To depict the changing rules of sound level values in the whole day and explore the relationship between soundscape and urban life rhythm, this paper chooses five discontinuous time periods related to urban residents' life rhythm- 06:00-07:30, 09:00-10:30, 12:00-13:30, 15:00-16:30, 18:00-19:30, respectively, to measure the sound levels at 51 measuring points and calculate the average sound levels so as to depict the temporal change rules of urban soundscapes. On the full-day scale (**Figure 6 and Figure 7**), the sound level values in five periods show obvious rhythmic changes. The sound level value begins to rise rapidly at 06:00-07:30, reach their peak at 12:00-13:30 and begin to decline slowly after 16:30. This is greatly in line with the rhythm of life in the city, and it has the same soundscape features of cities in general. The sound level value changes with on and off duty and forms the highest value. After 18:00, the sound level value declines slowly because of a lack of night life. The reason is that Xiahe County is a typical alpine Tibetan area, and the rhythm of life is slower than that of the mainland. In addition, we measured during winter, when the city's night life is not rich (**Figure 6**).

High Coupling of Soundscape Change and Life Rhythm. In contrast to general cities, the Labrang town is special in soundscape. There is a certain correlation between the time change of a soundscape and the rhythm of life of monks and residents. The sound level value of the same node is different at the different time period, and the sound level value of every node exist difference at the same time period because of the influence coming from different urban functions, people's activities and the rules of urban life.

From 06:00-07:30, from the perspective of spatiotemporal coupling of soundscape, the sound level values of 51 measuring points is between 36 and 66 dB. The average value is 53.32 dB, which is the lowest all day. The city becomes active from dead silence. In the eastern section of Zhaxiqi Street and along the road traffic, high-level areas are formed, and low-level areas are formed in religious and residential spaces. At this time, the peak of work is in the eastern government organizations and their family homes. People often choose to drive by themselves, resulting in a higher level of sound. The monastery is dominated by early classes and transition activities, and the active crowd is monks and ordinary residents, and tourists have not yet entered, thus forming a low-level area. The highest sound level value is at the bus station. The bus station is the main node with which the county city is connected with foreign areas. There are 133 buses in the whole day, and there are 50 buses travelling in this time period, which is the reason that sound level values are highest at bus stations (**Figure 7**).

During the 09:00-10:30 time period, the value of 51 measuring points is between 42.5-78 dB. The average value is 56.73 dB, and the sound level of the whole area generally increases when people begin to work. They gradually concentrate in the monastery (transition

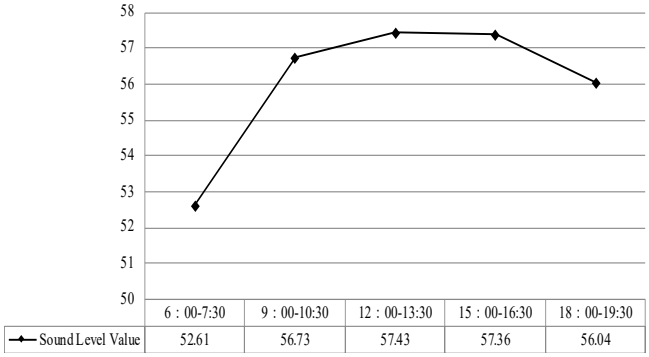

Figure 6. Distribution Chart of full-day mean value of sound level

activities and tourism) and commercial districts. The high value area slowly extends to the monastery. Compared with the previous period, the south side of the Temple road increased significantly, while the sound level of residential areas decreased. Peak areas are formed along Zhaxiqi Street. The east of Zhaxiqi Street is mainly administrative office family homes. Because many people were working in a work unit and there were not many cars, the sound level value decreased compared with the previous period (**Figure 8**).

During 12:00-13:30, the sound level of 51measuring points ranged from 41.1 to 69.2 dB, with the average value of 57.43 dB and the sound level increased again. The high-value areas are further expanded (especially in the eastern part of the old urban area). Such as commercial districts, stations and intersections all formed peak centres, and the sound level of the residential districts also increase to a certain extent. During this timeis at the peak of off-duty, thus the sound level in the eastern part of the city increased. At the same time, due to lunch time, the sound level of each residential area has also increased to a certain extent. In addition, the sound level of the temple area has decreased, which implies traditional travel behaviour. Generally, tourists spend about two hours in Labrang temple. In addition, then, they take a bus to the nearby Sangke grassland to experience Tibetan food and grassland customs (**Figure 9**).

From 15:00 to 16:30, the sound levels of 51 measuring points ranged from 42.2 to 75.6 dB, with an average of 57.36 dB. An active crowd mainly concentrates in the city square and the shops along the street. The residents often choose the nearby street (square) for entertainment (mainly playing cards, sunshine, chatting). Therefore, there are obvious high-value areas around the squares on both sides of the street and in front of civil aviation hotels (**Figure 10**).

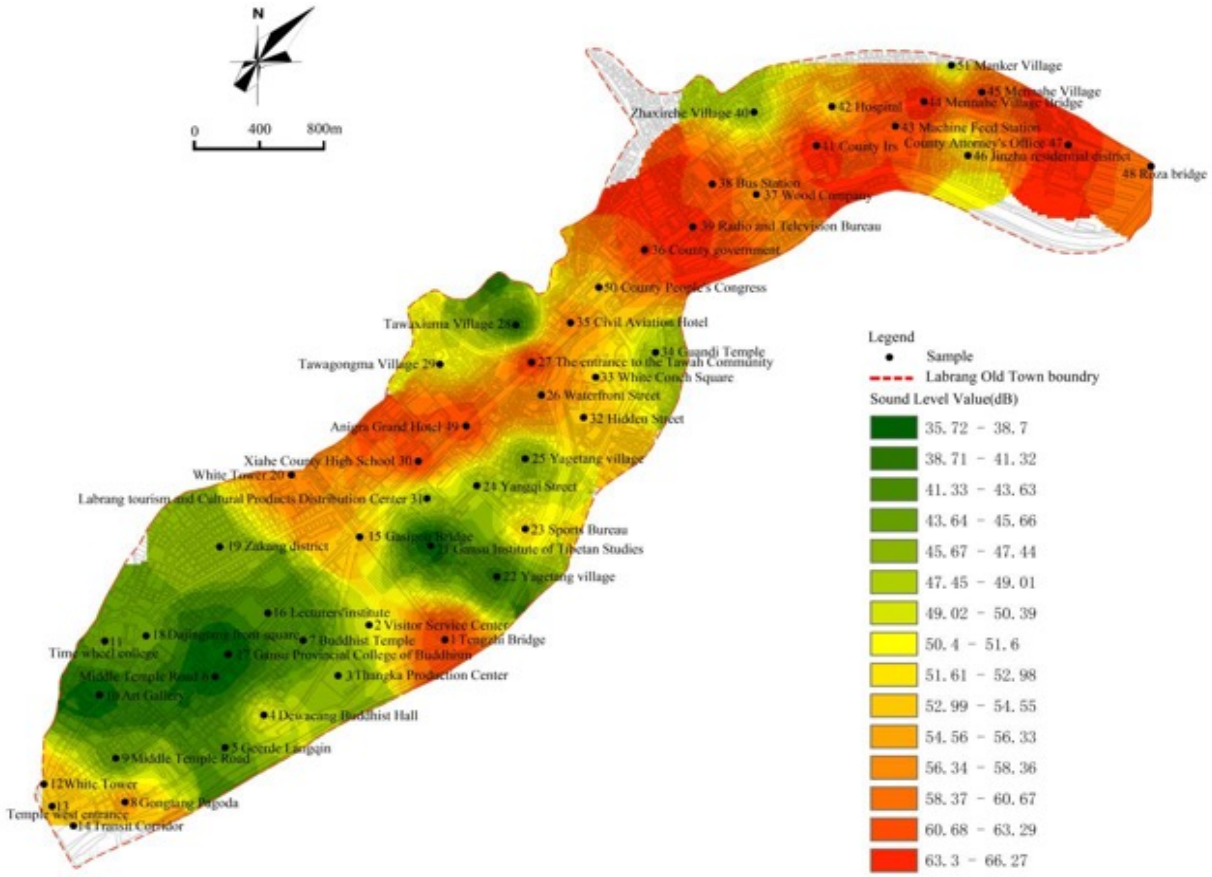

Figure 7. The sound level map of 6:00-7:30, Labrang Town, China

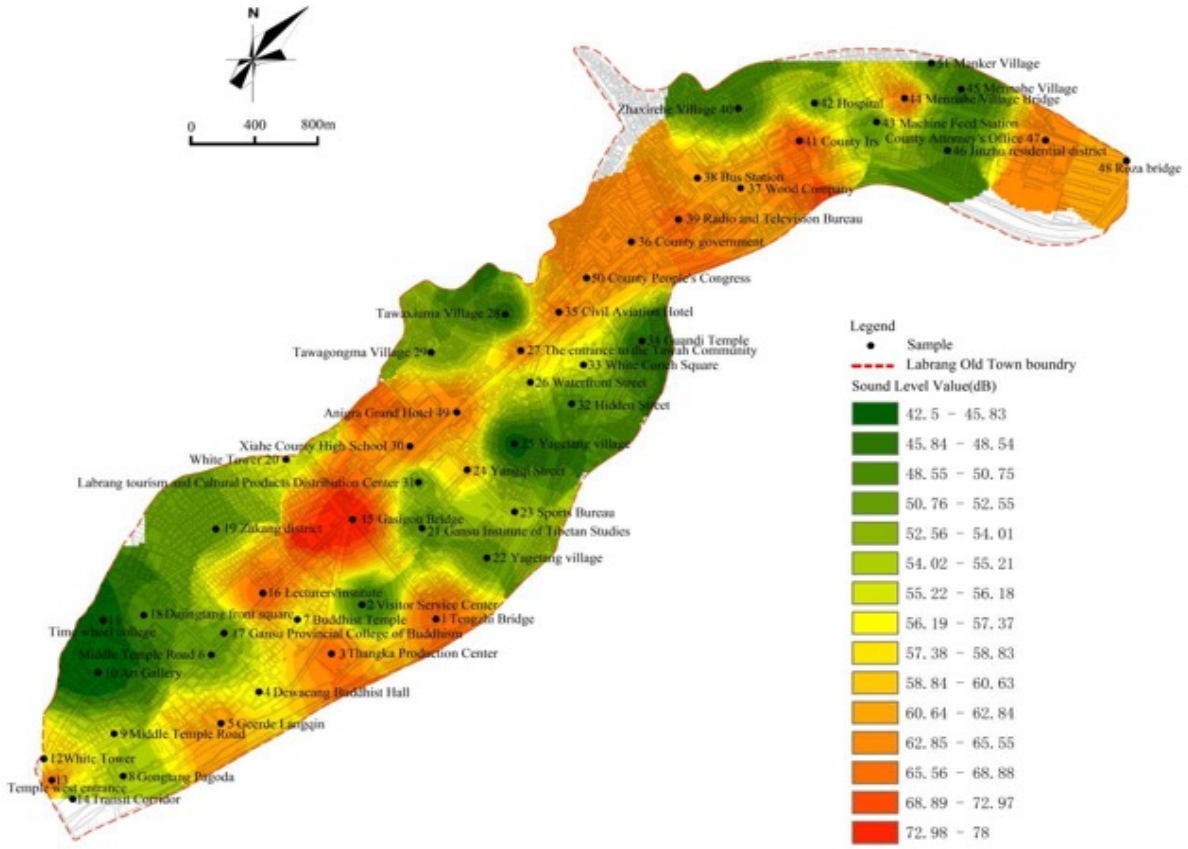

Figure 8. The sound level map of 9:00-10:30 Labrang Town, China

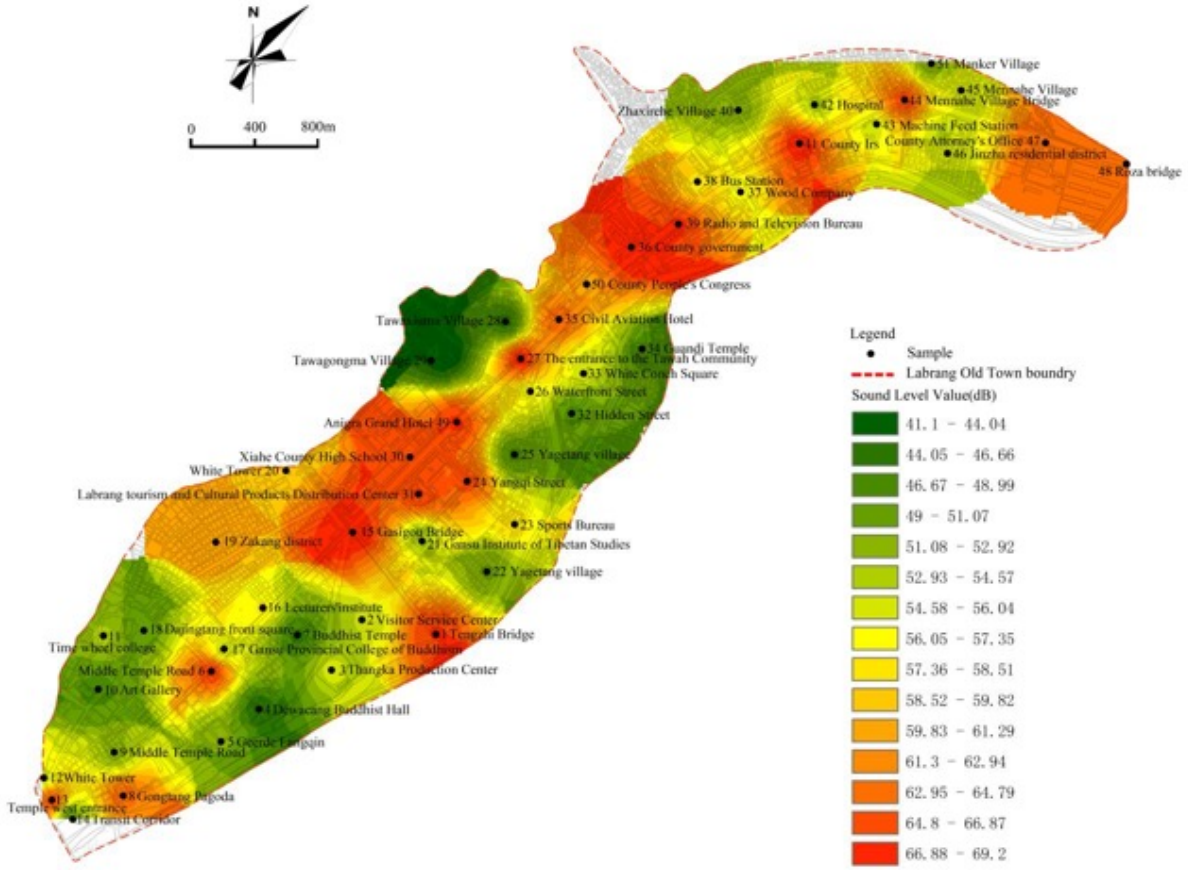

Figure 9. The sound level map of 12:00-13:30 Labrang Town, China

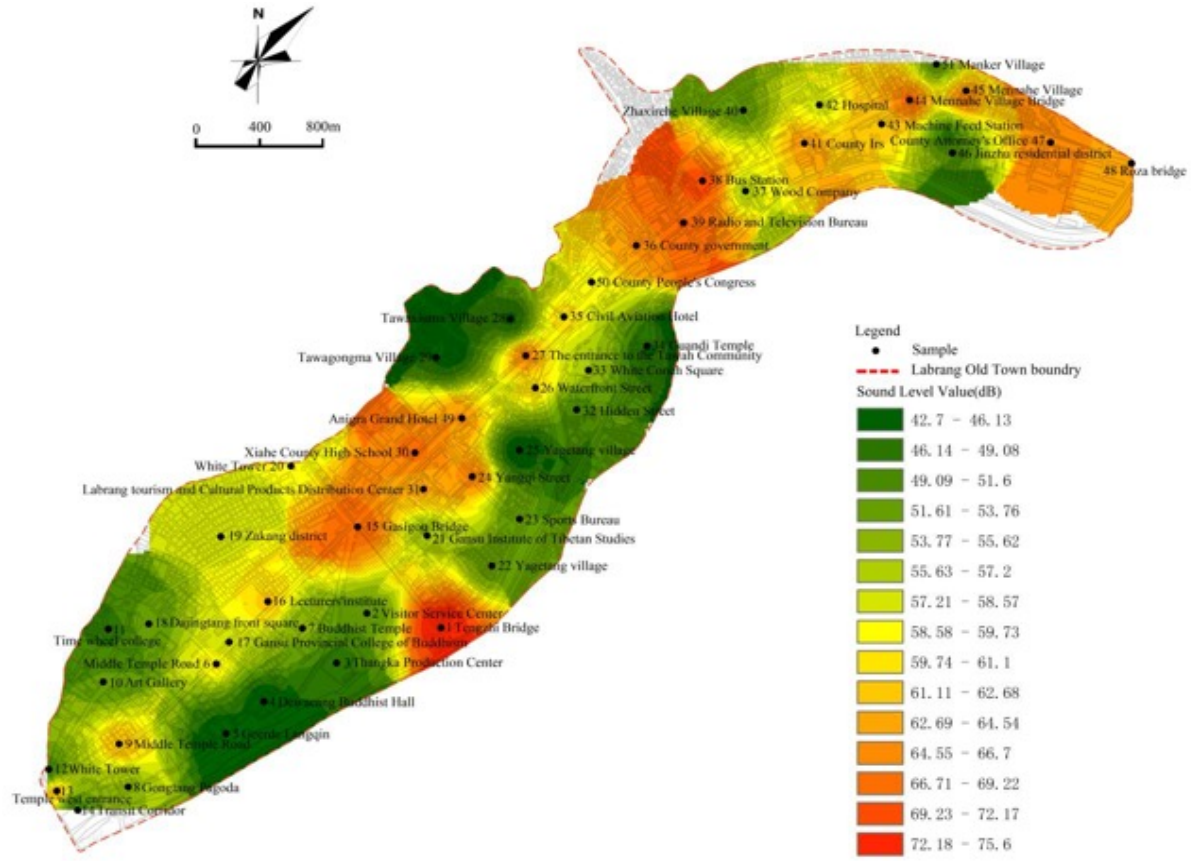

Figure 10. The sound level map of 15:00-16:30 Labrang Town, China

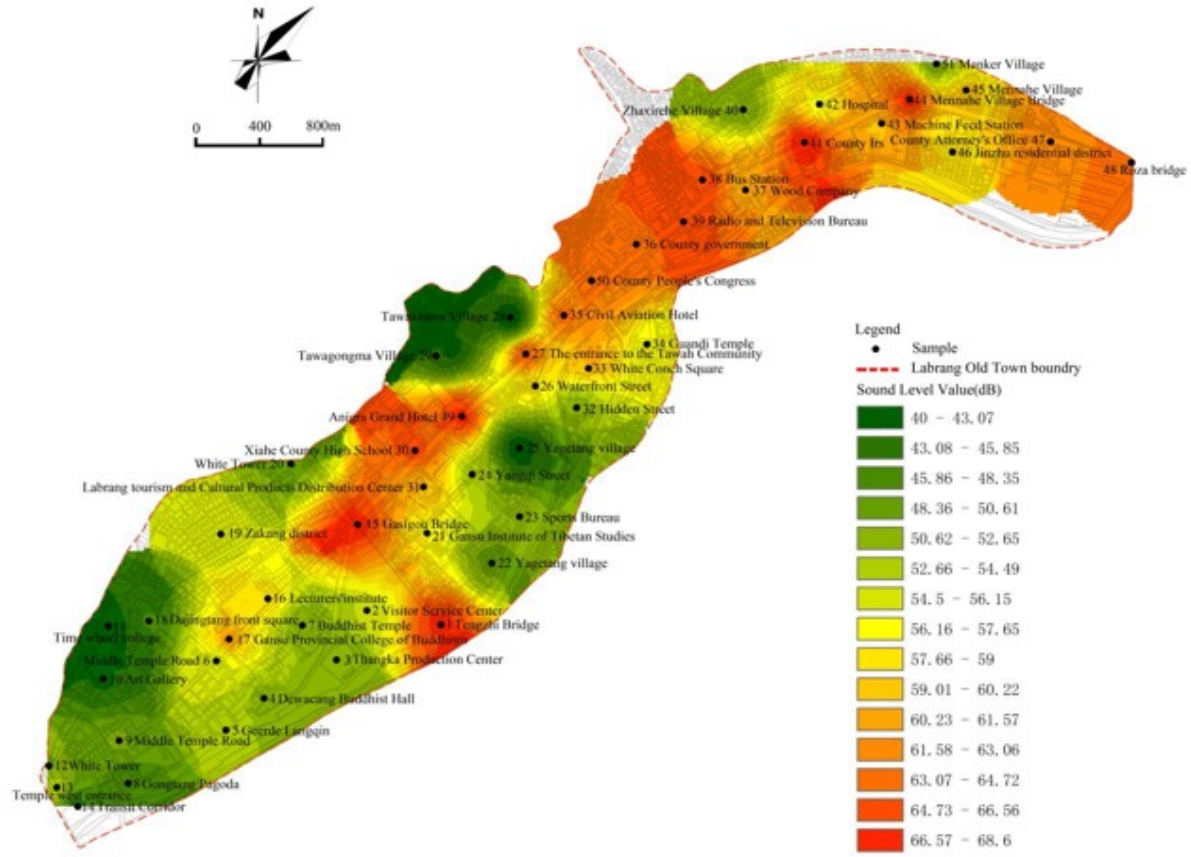

Figure 11. The sound level map of 18:00-19:30 Labrang Town, China

From 18:00 to 19:30, the sound level of the 51 measuring points ranged from 40 to 68.6 dB, with an average value of 56.01 dB. At this time, the high-value areas gradually spread to the administrative office areas, so the sound level value gradually increased in the eastern section of Zhaxiqi Street, while the temple area tended to be quiet. Similarly, it was consistent with the commuting patterns of residents.

After 19:00, the colleges and Buddhist temples in the monastery area began to close their temples and rest, and the temple area returned to a state of quiet, while the sound level of the monk's housing area (Zhakang District) rose, which was consistent with the daily lives of monks (**Figure 11**).

CONCLUSION AND RECOMMENDATIONS

Based on the measurement of 51 points of soundscape in the Labrang Town, China over five periods, this study uses ArcGIS to provide the inverse distance weighted interpolation method which was used to draw sound level maps. The spatial and temporal characteristics of soundscape were analysed by using sound level maps combined with urban functional zoning and crowd behaviour. The results showed that the distribution of sound level values in Labrang Town was unbalanced, showing the spatial characteristics that the eastern part was higher than the western part, the core area was higher than the marginal area, and the nodule area was higher than the homogeneous area. In the typical "Tawa" community and monastery areas, the sound level is low, and there are high sound level areas along the traffic lines and "nodule areas". The spatial distribution of the soundscape is closely related to the urban functional areas and crowd behaviour activities. In terms of time characteristics, there is obvious fluctuation and particularity. There is a certain correlation between the change in sound levels and the characteristic soundscape and the rhythm of life of monks and residents.

This study is about the soundscape of daily life in Labrang Town, so tourism noise is not the main content of this study. In the future, the authors intend to study the sound scene during the peak tourism season and compare it with the sound scene of daily life. As a typical historical and cultural city and religious tourism city, the development of tourism brings good opportunities for the city, but at the same time, tourism also brings the problems of the dissolution of traditional culture, image transformation, functional disorder, and sound and landscape erosion. From the perspective of sound protection in historic and cultural cities, attention should also be paid to the construction of the soundscape, the optimization of urban functional structure and the strengthening of sound environment management.

Paying Attention to the Construction of Soundscape

Zhuying (*Zhang 2015*) believes that the construction of a soundscape can be realized through four aspects: the division of space function, the determination of sound theme, the creation of sound atmosphere and the auditory signs. As the soul and core of a famous historical and cultural city, Labrang Monastery should be solemn and quiet. The sound level of the temple area is controlled between 40 and 50 dB. Sounds of meridian turning, chanting, wind bells and the Fa instrument are the most symbolic signals. This soundscape should be strengthened and constructed, and its sound field environment should be protected by avoiding "noise" intrusion, guiding and restraining tourists' behaviour, and removing tourism service facilities (such as parking lots) from the monastery area. The Tawa community should create a quiet, comfortable and pleasant atmosphere with sound levels between 45 and 55 dB. Maintaining the function of an historic district, which mainly includes religion and residence, and the overall spatial structure pattern of streets, roads and green spaces, as well as the tranquil sound environment atmosphere, protecting the mosque bells, striking iron and silver sounds can arouse people's collective memory and the voice type representing the Tawa community. Combined with the renovation and transformation of the community, the Daxia River water should be introduced into Yankel Valley to increase the sound of water flow and the landscape of water scenery and improve the environmental quality of Tawa community sounds. Business districts should create a lively business atmosphere while reducing the impact of traffic noise and controlling the sound levels of business districts between 50 and 60. It is recommended to restrict the sounds of commercial activities, store music and other symbols, and pop music should be strictly regulated in the soundscape design of commercial districts. They can instead play national music to provide people with a clear and moving sound source and create a good soundscape and travel environment. A quiet and comfortable atmosphere should be created in the administrative office area, and the sound levels of the administrative office area should be kept at 45 to 55 dB. Through the design of green belts and small parks, the influence of surrounding noises can be limited, and parking lots can be centralized. Green plants can be used to isolate parking lots from office buildings to create a peaceful and comfortable office environment.

Strengthen Sound Environment Management

According to the requirements of the Chinese Acoustic Environment Quality Standard, the temple area belongs to the category 0 acoustic environment functional area. Its sound level ranges from 40 to 50 dB, and the actual sound level ranges from 44.62 to 68 dB, and many measuring points are more than 50 dB. The soundscape management within the temple is particularly important. The Tawa community belongs to the category 1 acoustic environment functional area, whose sound level ranges from 45 to 55 dB, and the actual sound level of the Tawa community is smaller than the typical quiet space. The business district belongs to two types of sound environment functional areas, whose sound levels are 50 to 60 dB. The business district's actual sound level is between 65 and 68 dB, which is much higher than the upper limit. The administrative office area belongs to the category 1 sound environment function area, and its actual sound level is between 58.62 and 65.12 dB. It urgently needs to be regulated by strong urban noise management in order to create a good urban sound environment. Therefore, it is necessary to restrict the whistling of motor vehicles and other noises around the monasteries and Tawa communities, which need a relatively quiet environment. It can also reduce road noise from a technical point of view through, for example, the gradual construction of porous greens, which can reduce noise by 3-6 dB compared to traditional pavement. In addition, it can even reduce noise by 8 dB in rainy days (*Li and Lin 2014*)[45]. The strategies for noise reduction are to build green belts on both sides of the road or to plant trees and shrubs to achieve the effect of shielding and reducing traffic noise.

Adjusting the Functional Structure of Cities

Both commercial and administrative office districts have the problem of excessive noise, and the low sound levels of homogeneous areas relative to nodular areas can reduce the proportion of external traffic land and administrative office land in old urban areas and can achieve the purpose of reducing noise by adjusting and optimizing the urban functional structure. The old urban area along the Daxia River is a narrow zone, with high mountains on both sides of the north and south. It is difficult to provide further development space for the Xiahe tourism industry, and it is imperative that we carry out functional relief and spatial replacement for the old urban areas. First, the tourist service facilities in the monastery area will be stripped out with functions incompatible with cultural tourism (especially the parking lot) to avoid the interference of the frequent entry of vehicles to the unique soundscape. Combined with the construction of the connecting bridge between Hailuo Bay characteristic town and Yangqi Street and Baihailing Square, the visitor service centre of Labrang Temple will be relocated to Baihailing Square. On the one hand, the traffic noise of the temple is reduced; on the other hand, Baihailing Square can be integrated into the tourism system of Xiahe County through the tourist service centre. Bai Hailuo Square will be integrated into the tourism system of Xiahe County, changing the tourists' direct route to the Labrang Temple scenic area and establishing Bai Hailuo Square (tourist service centre, Hailuo Bay characteristic town) in the future. Yangqi Street, Zahiqi Street Commerce Zone (or Daxia River Waterfront) will serve as a Labrang Monastery tour route to extend the stay time of tourists. Second, with the urban ecological restoration, a certain width of the isolation zone along the Gasi Ditch should be set up to avoid the spread of urban noise to the monastery area. Third, the Tawa community should undergo cultural restoration. Moving the administrative office area to Chengdong New Area as the administrative centre of the whole urban area will, on the one hand, improve office efficiency, promote the development of new areas, and reduce the pressure of the development of old urban areas; on the other hand, this will guide the flow of vehicles and people to Chengdong New Area through the replacement of certain functions and will reduce noise in the main urban area. The scattered residential areas and other fragmentary land in the commercial area will be transformed into homogeneous commercial lands by land replacement, and the commercial area along the street will be transformed into indoor commercial areas or commercial inner streets to reduce the impact of traffic noise on the commercial area.

Optimizing the Urban Road Network

At present, there are only two cross-linked roads in the old urban area, namely, Zhaxiqi Street and Provincial Highway 312. According to the actual investigation, some transit vehicles enter Zhaxiqi Street by Rouza Bridge from the east to the west and to Gasi Gou Bridge and Tengzhi Bridge from the south to Provincial Highway 312, which has a great impact on the overall sound environment of the city. The traffic noise of Zhaxiqi Street has also become the main source of noise in the old urban area. By optimizing the urban road network to reduce noise, the transit traffic should be reduced in the urban central area, and the transit vehicles should be forbidden from entering the city at the Rouzai logo. At the same time, the current riverside pedestrian road will be opened to break up the traffic pressure on Zhaxiqi Street.

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