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THE INFLUENCE OF URBAN PARK ON SHAPING THE PERCEPTION OF SOUNDSCAPE: CASE STUDY OF PUTROE PHANG PARK IN BANDA ACEH, INDONESIA

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Abstract

Urban parks play a vital role in enhancing the quality of life in cities by providing serene, healthy natural environments. Among their numerous benefits, urban parks significantly influence the auditory experience of visitors. This study investigates the impact of landscape elements within urban parks on perceived soundscapes, focusing on Putroe Phang Park, one of the largest urban parks in Banda Aceh, Indonesia. Our methodology combines landscape observations, soundwalk data collection, visitor questionnaires, and sound measurements, including Sound Pressure Level (SPL) and Ambisonic recordings. We used a UNI-T UT sound level meter and a Zoom H1N digital audio recorder for data collection. The SPL distribution within the park was visualized using contour maps generated using Surfer software (version 23.3.202). Our findings reveal that while some landscape elements contribute positively to a pleasant soundscape, others, notably traffic noise, detract from the overall experience. However, the park's Leq remained between 58 and 68dB(A), below the upper threshold of 70 dB(A). Our findings suggest that enhancing the diversity and quality of landscape elements can mitigate undesirable sounds and improve the park's auditory environment.

***Keywords**:* Landscape Elements, Putroe Phang Park, Banda Aceh, Soundscape, Urban Park

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INTRODUCTION

Urban parks are an important element of a city, contributing to the creation of a natural, healthy, and pleasant environment (Ahmad et al., 2024, Zuraidi et al., 2022). They also positively impact psychological restoration (Nordh et al., 2011; Ishak et al., 2018; Zhu et al., 2023), focusing on user preferences (Ersoz et al., 2024). The landscape elements of the parks provide sounds that create a comfortable atmosphere and shape visitors' perceptions. These elements also act as barriers to reducing urban traffic noise. A park in the middle of a city provides thermal, visual, and acoustic comfort to the surroundings (Nursaniah et al., 2023, Hakim, 2012). Environmental acoustics in public spaces support self-soothing activities and health therapy, substituting nature outside the city (Buxtona et al, 2021).

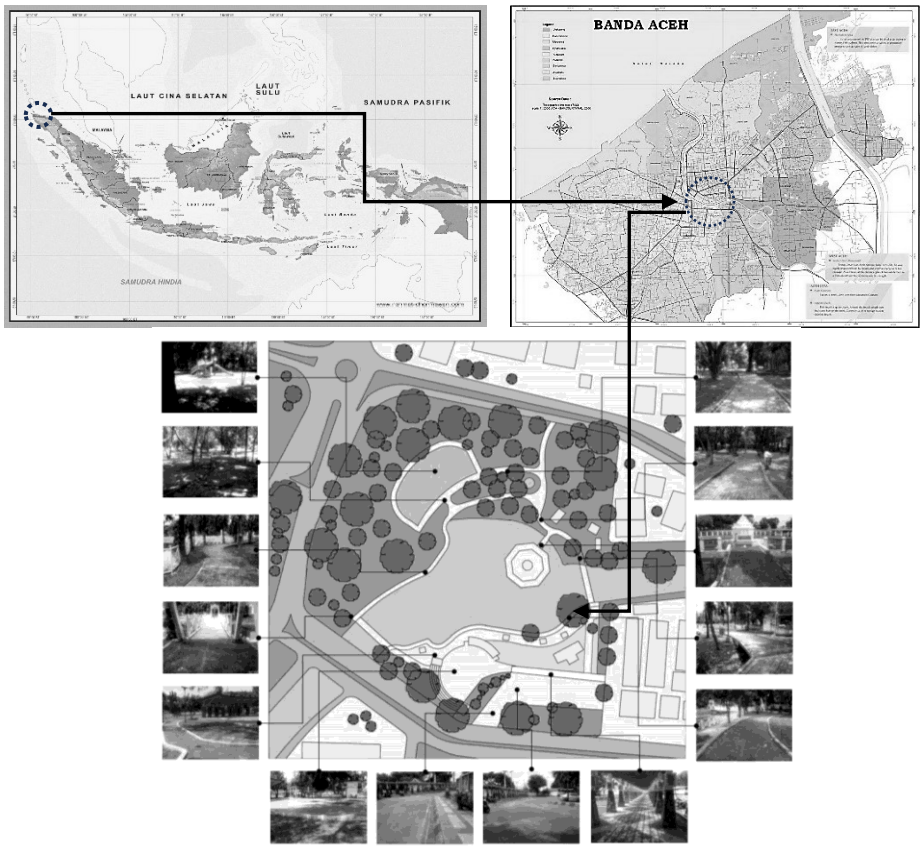


Figure 1: The location of Putroe Phang Park in Banda Aceh positioned at 5°32'49"N, 95°18'59"E and its surroundings

Environmental acoustics and ecology studies have been widely discussed through soundscape or sonic-environment theories (Sugiarto and Ghani, 2019). However, the implementation of landscape elements, an indicator of the quality of 'soundscape' in the built environment, has received less attention. Therefore, this study identifies the influence of landscape elements in urban parks on shaping the perceived soundscape.

Putroe Phang Park, one of the largest urban parks in Banda Aceh, Indonesia (Figure 1), was investigated in this study. Putroe Phang Park features a variety of greenery, including large trees, bird nests, playgrounds, and ponds connected to the city river. The park also features hardscape and softscape elements, allowing for various human activities. As for the sonic environment, human-generated sounds, such as machine noise, tend to dominate over natural sounds like water, birds, and insects. Such noise negatively affects the overall environment (Rehan, 2014).

This study makes a notable contribution to the expanding field of urban park soundscapes and their connection to landscape elements, thus addressing a gap in the research. While much attention has been given to the role of soundscapes in urban environments, less attention has been given to how landscape elements influence the perception of soundscapes. By investigating Putroe Phang Park in Banda Aceh, this research highlights the importance of incorporating natural landscape elements in urban parks to create a more enjoyable and restorative acoustic environment. It demonstrates the ability of these elements to reduce urban noise and improve environmental conditions by enhancing thermal, visual, and acoustic comfort. The study also provides valuable insights for sustainable urban planning, especially regarding how natural sounds can counterbalance the dominance of artificial noise in city parks. Furthermore, it introduces a new perspective on the role of landscape features in shaping soundscapes, which is crucial for improving the well-being of park visitors.

LITERATURE REVIEW

Soundscape

According to Aletta et al. (2019), the concept of 'soundscape,' popularized by R.M. Schafer, refers to the acoustic environment and how it is perceived by individuals or society. It emphasizes the balance of sounds in a living environment and is considered an ecological acoustic discipline (Sugiarto and Ghani, 2019). Soundscape research often focuses on urban areas, where diverse and intense sound sources can invoke different perceptions and emotions. The influence of landscape elements on soundscape perception is not fully understood, highlighting the need for further study (Samsyiah et al., 2019).

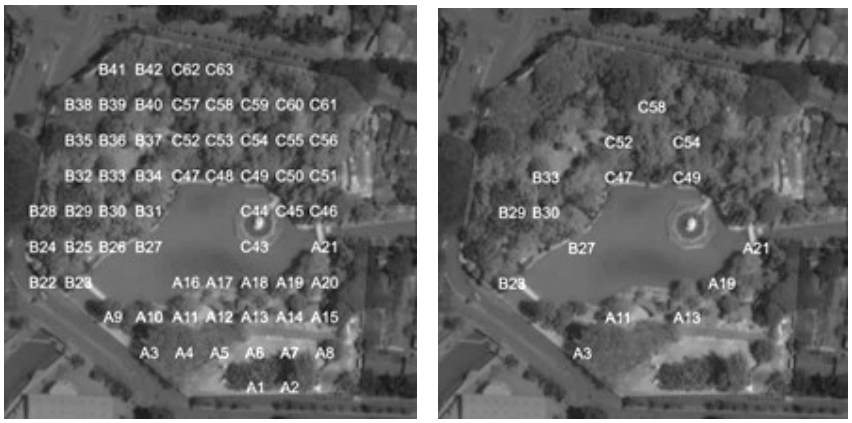
Soundscape research aims not only to control noise but also to facilitate area reconstruction (Wang, 2003). The key landscape elements influencing soundscape perception in city parks include buildings, vegetation, and open-air conditions. (Syamsiyah et al., 2019). Rehan (2014) compared public spaces and concluded that effective soundscape design could incorporate green walls and green roofs, softer materials, water structures such as fountains, and noise barriers to reduce traffic noise. These studies emphasize the importance of urban park design in shaping soundscape perception.

RESEARCH METHODOLOGY

The research employed a mixed-method approach, specifically the triangulation method, to study soundscapes at Putroe Phang Park, Banda Aceh. With its diverse vegetation and urban noise, this park was investigated to build on previous studies by Afif et al. (2023) and Bilqis et al. (2024), which focused on landscape elements and thermal conditions. The study examined several variables: (1) sound and voices, (2) landscape characteristics, and (3) landscape elements. Observational data were collected using the soundwalk/ sound diary method, where the researcher walked through the park, engaging with the space and its acoustics while recording the sounds and experiences encountered (Syamsiah et al., 2015', Mitchel, 2019).

Additionally, a questionnaire was conducted to collect data on user perceptions, using the category and soundscape rating scale listed in ISO/TS 12913-2:2018 (Morillas, 2006). Thirty Architecture students from Universitas Syiah Kuala, aged 18 to 22 years (16 males, 14 females; mean age = 20.3 years, SD = 0.92), participated as respondents. All participants were in good health free from medication that could affect hearing. They were asked to participate in soundwalks in the morning between 09:30 and 11:30 and in the afternoon between 16:30 and 18:30. The Participants were divided into two groups: a morning group (n=15) and an afternoon group (n=15).

To assess the measured Sound Pressure Level (SPL), average Leq (1 minute) noise data were collected from 63 points (Figure 2.a). These measurements, taken with a UNI-T UT353 sound level meter (range: 30 dB - 130 dB(A)), resulted in 1,584 samples—792 from the morning and 792 from the afternoon. Noise measurements were conducted during both periods. Voice recordings were captured at 15 sample points (Figure 2.b) using a Zoom H1N handy recorder, which meets the recommended specifications (20Hz to 20kHz range, 44.1 kHz sample rate, 16-24 bit depth). The recorder was set to WAV 96kHz/24-bit format with a gain of 6-7, and various settings, such as the low cut filter, limiter, and Auto-level, were turned off. A furry windscreen was used to minimize wind noise. The AMB method captures low-frequency sounds, such as bird and cricket calls, at representative points after the initial observations.



(a) **(b)**

Figure 2: SPL measurement point (a) and ambisonic recording point (b)

RESULTS AND DISCUSSION

Putroe Phang Park Overview

Putroe Phang Park is a city park and a green open space that functions as an urban forest in the Baiturrahman sub-district of Banda Aceh City (DISBUDPAR, 2015). It is part of a historical complex, famously known for being built by The Sultan of Aceh (1608-1636) as a refreshing park for his consort, Putri Pahang (Fakhira, 2021). The Park is situated in the heart of downtown Banda Aceh and is surrounded by areas with diverse activities, as shown in Figure 1. To the north, the park faces Sultan Mahmud Syah Street, Simpang Jam, and government office complexes. To the south, it is bordered by Jalan Nyak Adam Kamil 1, which hosts commercial, military, and residential areas. On the west side, the park is bordered by the Krueng Daroy River, the Iskandar Muda Kodam complex, and residential and commercial spaces. The park's eastern side is adjacent to Jalan Teuku Umar, a commercial area of cultural and historical significance.

Landscape character

Field observations of Putroe Phang reveal that it functions as an urban forest and follows a two-way typology, as classified by Irwan (2019). The park's vegetation is primarily dominated by tree species such as Tanjung (Mimusops *elengi*) and Asam Jawa (Tamarinda *indica*) alongside grass. The vegetation grows along the shape of the Krueng Daroy River, which divides the park into two. The park experiences tropical weather conditions with high average humidity.

Landscape elements

Observations at Putroe Phang Park were conducted in three zones: A, B, and C (Figure 3). Zone A includes the amphitheatre, parking lot, and surrounding

spaces. The ground surface comprises cement, gravel, ceramic, paving blocks, and grass mixed with bare soil. The dominant vegetation includes Tamarind, Amboyna wood, Spanish cherry, and Sea Pine trees. Zone B features a landscape dominated by Spanish cherry and Tamarind trees, which provide shade. It includes a rock pool area, designed to resemble a stream that connects to Zone C, and a children's playground covered with grass and shaded by evergreen Reullia angustifolia plants. Zone C is adjacent to Zone B and has footpaths made of paving blocks and cement. The area contains a non-functional cement fountain, and the ground is mostly covered with leaves, grass, and ground-cover plants.

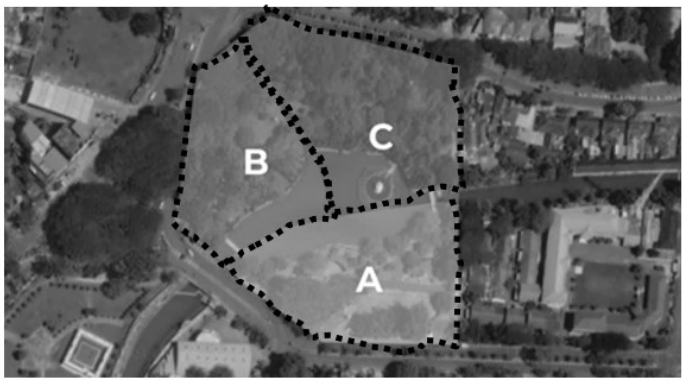


Figure 3: Observation zones conducted in Putroe Phang Park

Distribution of Sound and Sound Sources

Figure 4 illustrates the distribution of sounds and noises that shape the soundscape of Putroe Phang Park, as observed during the initial study. **Anthropogenic** sound sources include traffic noise, car horns, and sirens from the highway adjacent to the park.

Figure 4: Distribution of sound and sound sources in Putroe Phang Park

In contrast, natural sounds, such as geophony and biophony, also contribute. **Geophony** includes sounds from wind, water, and rustling leaves, while **biophony** refers to sounds produced by squirrels, birds, and insects within the park's landscape elements. Additionally, anthropophonic sounds are present due to visitor activities within the park (Figure 4).

Observation Data

Observations were conducted during the morning and evening between late 2021 and early 2022. Over a 45-minute observation period across three days, various sounds and their intensities were documented in Putroe Phang Park. Figure 5 presents a graphic model of soundscape perception following the methodology proposed by Heryanto et al. (2021). In Zone A, traffic noise predominated throughout the day, particularly in the afternoon, with some human activity sounds and occasional natural noises like birds and wind. Zone B, located near a busy intersection, experienced significant traffic noise, with minimal natural or human sounds. Zone C, on the other hand, was quieter in the morning, with more natural sounds, offering the most comfort to visitors.

Overall, Zone B was the noisiest, followed by Zone A, while Zone C was the most tranquil. A significant difference in sound intensity was observed between morning and afternoon across all zones. Zone B caused the most discomfort, followed by Zone A, despite the presence of natural sounds. Zone C, with its quiet ambiance, provide the most comfortable experience.

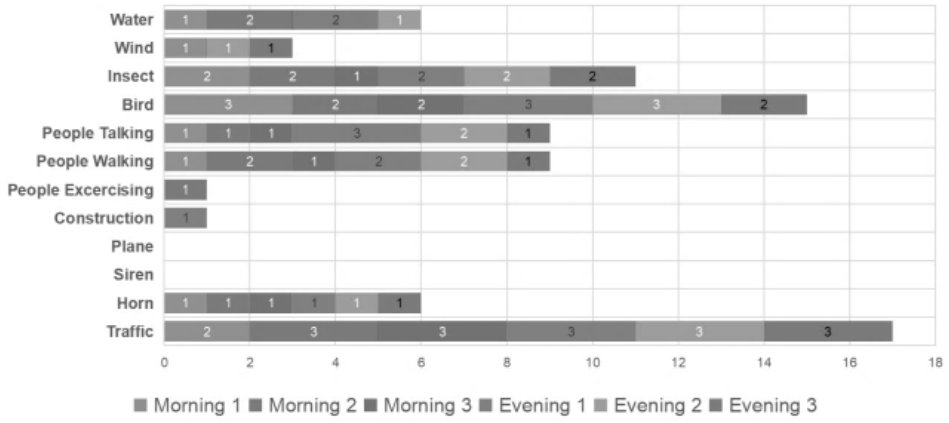


Figure 5: A sample of Sound and voice types observed in Zone A

Soundwalk data and questionnaire

A soundwalk was conducted with thirty participants who walked through Zones A, B, and C, spending approximately 10 minutes listening in each zone under cloudy, rainy conditions. This study revealed that in Zone A, traffic noise was the loudest and significantly more prominent than other sounds. Traffic noise was also dominant in Zone B but more comparable to natural sounds. In Zone C, natural sounds, though slightly quieter than traffic noise, were the most noticeable, while human activity sounds remained minimal due to low visitor numbers (Figure 6).

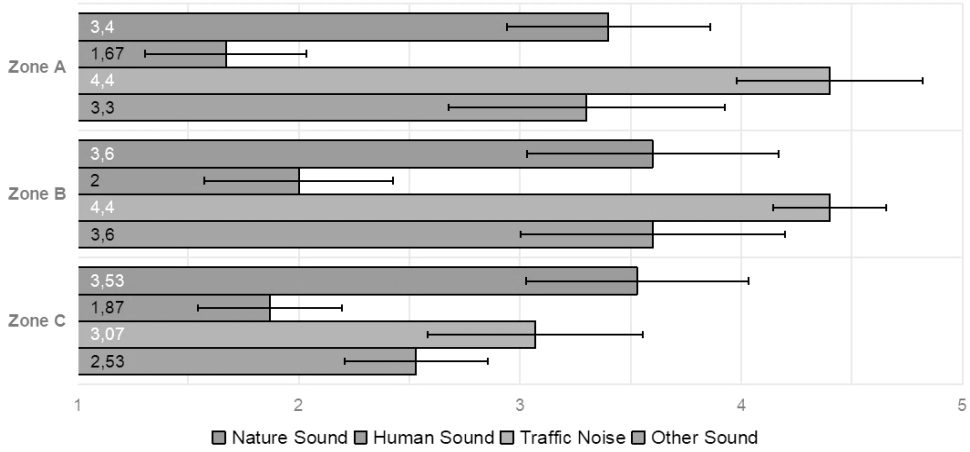
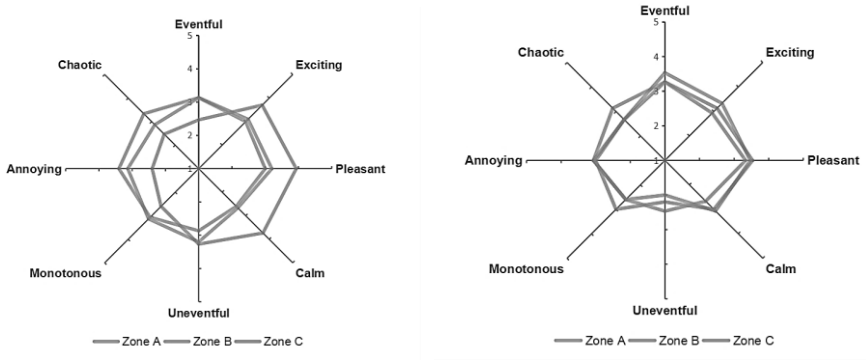


Figure 6: Average values with 95% confidence intervals of the most dominant sound and voices occurring in the morning in Zones A, B and C (first question category)

Figure 7.a illustrates the quality of sound perception in the morning using a radar graph. Zone C was perceived as the most pleasant, comfortable, and calm due to the dominance of natural sounds and minimal traffic noise. In contrast, Zones A and B were perceived as distracting and chaotic, mainly due to higher traffic noise levels. Figure 7.b shows the afternoon perceptions, which were generally more positive across all zones. However, Zone B scored highest for “chaotic” feelings, reflecting the influence of heavy traffic. Zone C scored highest for “pleasant” and “boring” due to a balance of natural sounds and minimal variation. The absence of bird sounds in the afternoon also contributed to more negative perceptions in Zones B and C.



(a) (b)

Figure 7: Average values of the perceived quality of sounds and noises in the morning (a) and in the afternoon (b) in Zones A, B and C (second question category)

Figure 7.a also shows that in the morning, Zone C received the highest scores for soundscape quality and feasibility, favored for its dominance of natural sounds over traffic noise. Zone B received the lowest scores, with participants reporting being most disturbed by road noise. In the afternoon (Figure 7.b), Zone C again received the highest scores, although not significantly different from Zones A and B. Zone B, despite having more greenery, was less favored due to traffic noise. Zone A was seen as more "exciting" and "calm," while Zone C was considered the most "pleasant" due to its natural features.

Leq Measurement

The measurement method collected the average Leq noise data (1 minute) at sixty-three points in Putroe Phang Park in the morning and afternoon. Measurements were also conducted outside the park at three points to compare the average noise levels inside and outside. A total of 1,584 samples were collected, with 792 samples taken in the morning and 792 in the afternoon. Figure 7 shows the average Leq values for both periods.

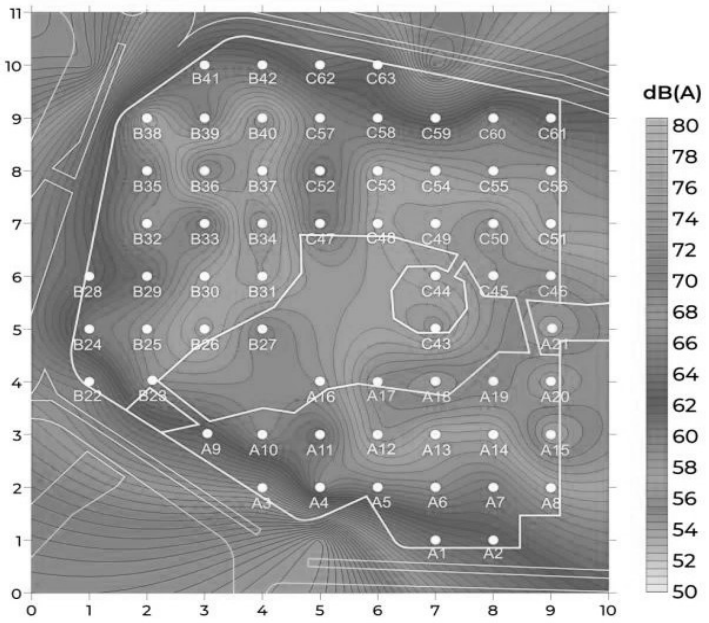


Figure 8: Leq values (1 minute) for measurement points in the morning

The measurements were conducted between 09:30 and 11:30 in the morning and between 16.30 and 18.30 in the afternoon. The weather was sunny, and traffic density was normal. No measuring point was recorded for a sound pressure level (SPL) below 50 dB. As shown in Figure 8, the average Leq value in the three zones (A, B, C) during the morning was relatively similar, around 59 dB(A), which exceeds the Indonesian noise standard (Kep-48/menlh/11/1996). However, it remains below the upper threshold of 70 dB and is classified as quiet (Syamsiyah et al., 2020; Suriandjo, 2021).

Ambisionic Recordings

Figure 9 shows that in Zone A, on a sunny day, traffic noise dominated the morning and afternoon at 20-2500 Hz with an intensity of 50-80 dB. Bird sounds were observed at points A3, A13, and A19 at 2000-8000 Hz with an intensity of 30-65 dB. Water sounds were prominent only at point A21 near the white bridge, ranging from 2000-18,000 Hz. Morning broom sounds were detected at points A3, A11, and A13, while motorcycle noise at point A3 was noted between 2000-9000 Hz.

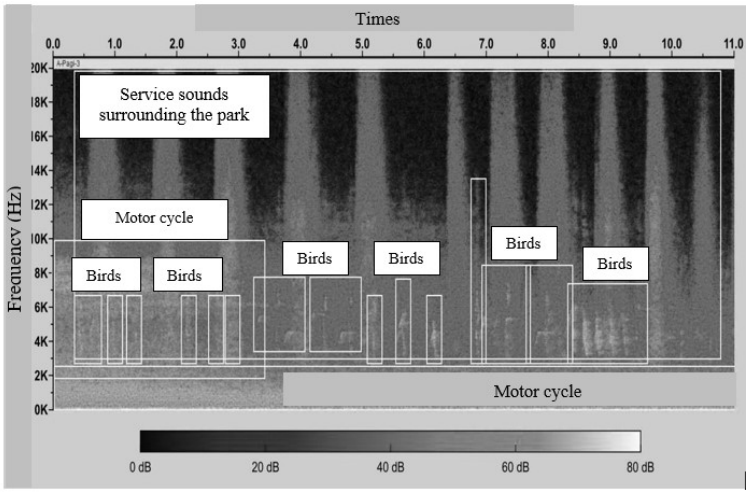


Figure 9: Spectrogram of an 11-second ambisonic recording in Zone A

Figure 10 reveals that in Zone B, traffic noise consistently dominated throughout the day. Bird sounds were prominent at points B30 and B33, between 1800-8000 Hz and 30-65 dB, but less intense at points B23 and B27. Insects were heard at points B29 and B33. By the afternoon, bird sounds had diminished, especially at points B23 and B29, with some activity remaining at points B27, B30, and B33. Wind sounds dominated at point B23, while insect sounds persisted at points B29 and B30. Vehicle and horn noise occurred at multiple points, contributing to the overall noise levels.

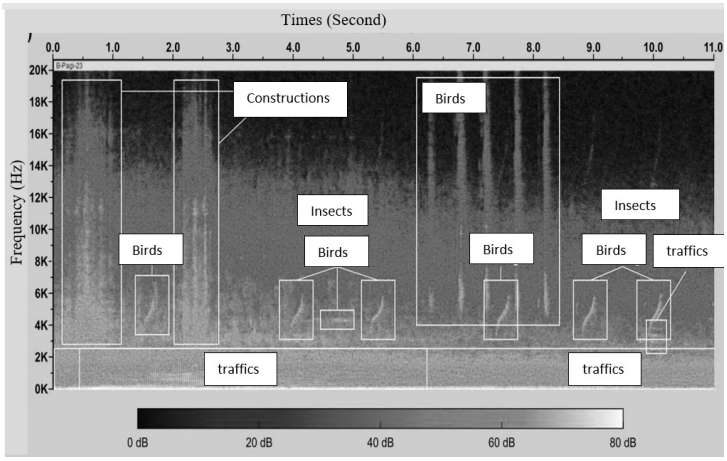


Figure 10: Spectrogram of an 11-second ambisonic recording in Zone B

Figure 11 shows that traffic noise was the primary sound throughout the day in Zone C. Although Bird and insect sounds were present, traffic often overshadowed them. Bird activity was notable at point C58, and insect sounds were strongest at point C49 near the river. Wind rustling through leaves was prominent in tree-covered areas. In the afternoon, bird and insect sounds decreased, while traffic noise remained significant. Additional sounds included vehicle horns, a brief car alarm at point C54, and wind sounds. Key sounds in Zone C included birds, insects, river flow, wind, and traffic. Secondary sounds involved park activities and construction noise. Despite being masked by traffic, insect and water sounds are crucial for preserving the park's natural ambiance.

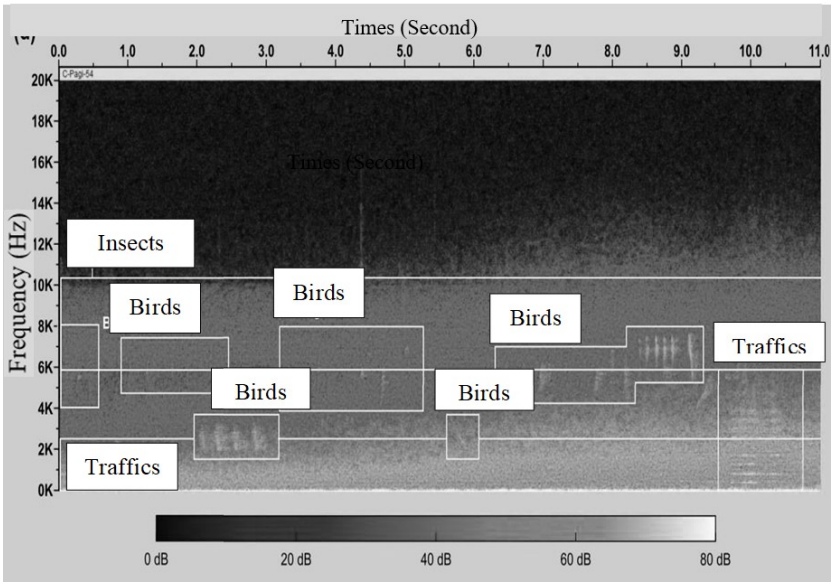


Figure 11: Spectrogram of an 11-second ambisonic recording in Zone C

Comparative Influence:

- **Traffic Noise**: Traffic noise is the most dominant factor across all zones, particularly in Zone C, where it consistently overshadows natural sounds. In Zone A, traffic is less intrusive than in Zone C but remains a significant part of the soundscape.
- **Natural Sounds**: Zone B showcases a stronger presence of natural elements, like birds and insects, especially in the morning, making it feel more balanced between urban and natural soundscapes than Zones A and C.

- **Human Activity**: Zone A presents more varied human sounds, such as broom noises and motorcycles in the morning, while in Zone B, vehicle horns and other traffic-related sounds dominate human activity noise.

This comparison highlights that, while traffic is a constant disruptive factor, areas with stronger natural sound elements (like birds, insects, and water) help balance the perception of the soundscape, making it feel more connected to the park's natural ambiance. Zone B, in particular, seems to strike the best balance, with bird and insect sounds playing a more significant role, especially in the morning.

CONCLUSION

The study at Putroe Phang Park reveals that the perception of the soundscape varies across the three zones. Zones A and B were perceived more negatively than Zone C. Visitors rated Zone C's soundscape quality and feasibility significantly higher in the morning due to the dominance of natural sounds. However, by the afternoon, the zones' differences in soundscape quality were less pronounced. Despite Zone C's better performance, the noise levels in all three zones exceeded the standard limit of 50 dB(A) set by regulation 48/menlh/11/1996. The relationship between the park's soundscape and its architectural elements shows that while some features effectively shape the auditory experience, there is room for improvement to enhance the soundscape in a way that better aligns with the park's regional and historical context.

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DISCLOSURE STATEMENT AND REFERENCES

The authors declare that there are no conflicts of interest related to this study. All data used in this study were collected and analyzed impartially, and the conclusions drawn are solely based on the findings of the research. The authors are committed to academic integrity and transparency throughout the research process.

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