



Research on the Influence Mechanism of Visual and Acoustic Environment of Urban Greening on Residents' Happiness Based on GIS

Yi Cui*

Manchester School of Architecture, Oxford Road, Manchester, M13 9PL, England

*Corresponding author's e-mail: cuiyi9806@163.com

Abstract. With the acceleration of urbanization, the quality of urban environment has gradually become a core factor affecting the quality of life of residents. As shown in Figures 4, land use changes in Hong Kong over the past 20 years reflect this development trend, and urban greening, as an important part of the urban ecosystem, not only has the function of improving the ecological environment, but also plays a positive role in enhancing the psychological well-being and life satisfaction of the residents. However, the synergistic mechanism of visual and acoustic environments as important features of urban greening in enhancing well-being has not been fully explored. In this study, we quantify the visual and acoustic environmental features of urban greening through GIS technology (such as the accessibility analysis shown in Figure 1 and 2), and construct an integrated model to systematically investigate the pathways through which these environmental features affect residents' well-being. It is found that visual greening and acoustic environmental features have important synergistic effects in enhancing residents' well-being, and future urban design and operation should fully integrate these two types of features to optimize the living environment and improve the quality of life.

Keywords: urban greening, visual environment, acoustic environment, GIS, residents' well-being, environmental psychology

1 Introduction

As urbanization continues to accelerate, the quality of the urban environment has become a key factor affecting the living standards of residents. From the development history of Hong Kong in the past two decades, the area of man-made land surface has been expanding while the area of natural land use has been decreasing. This change in land use has not only altered the structure of the physical environment of the city, but has also had a profound impact on the quality of life of the residents. Interestingly, while development has brought us significant economic benefits, the decline in environmental quality has turned out to be a major constraint on the well-being of residents.

In recent years, people's demand for quality of life and happiness has been increasing, and urban environmental design, especially the improvement of green environment, has gradually received widespread attention. Research shows that urban greening not only has ecological effects such as air purification, temperature regulation and noise reduction, but also has a positive effect on residents' mental health through the improvement of visual and acoustic environment. The road transportation sector is a major contributor to urban noise pollution and, according to the sustainability perspective, noise exposure can also have health consequences [1]. However, in existing studies, the effects of visual greening and acoustic features on residents' well-being are often discussed separately, and in-depth analysis of their synergistic effects is lacking. Therefore, this study uses GIS technology to systematically quantify the visual and acoustic environment features of urban greening and explore their overall impact on residents' sense of well-being, hoping to reveal the mechanism of the visual and acoustic environment features in the process of enhancing the sense of well-being.

2 Visual Environment Analysis

In the process of studying the influence of the urban visual environment, from the green space accessibility analysis in Figures 1 and 2, it can be found that there are obvious differences in the degree of green space coverage in different time ranges (1-15 minutes). Especially in the 1-minute walking range (blue area in the figure), the green space coverage is relatively low, indicating that the supply of green resources in the near distance is insufficient. As the time extends to 3-5 minutes (light green and orange areas), the reachable area expands, but the actual frequency of use may decrease due to the increase in distance. Interestingly, studies have shown that residents in areas with higher levels of visual greenery generally have higher levels of well-being and life satisfaction, mainly because visual greenery can provide continuous psychological support to residents on a sensory level, thus helping to reduce anxiety and stress. This phenomenon is particularly evident in densely populated areas, where residents tend to crave more contact with the natural environment.

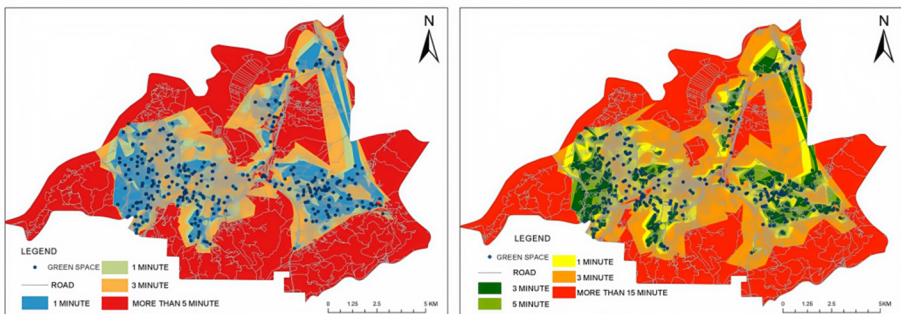


Fig. 1. Green space accessibility within 1–15 minute walking ranges.

In particular, the influence of the visual environment seems to imply a special “green healing” phenomenon. Some research suggests that greenery in the natural environment can inadvertently trigger a subtle visual and psychological experience, subconsciously alleviating negative emotions and perhaps making residents more inclined to maintain a positive mindset. Through this invisible way, these daily contact with greenery may gradually have an impact on the psychological level, sometimes it may just add a trace of peace or satisfaction, and this experience, although difficult to quantify, may quietly add color to the happiness of people's lives, and even strengthen the subtle cohesion within the community.

In the process of urban greening design, the distribution of vegetation levels is also very important to the visual experience. For example, the combination of tall trees, mid-level shrubs and surface flowers not only creates a rich visual hierarchy, but also presents changing landscape effects in different seasons. This diversity of vegetation configuration can not only meet the residents' needs for natural beauty, but also add vitality and vigor to the urban space. Studies have shown that this kind of three-dimensional greening design is often easier to get residents' approval than a single plane of greening, because it can create a richer visual experience in the limited space. Moreover, different heights of vegetation can provide habitats for small animals and increase urban biodiversity, which to a certain extent also enriches residents' daily observation experience.

3 Synergistic Effect Analysis

In urban space, the combination of visual and acoustic environment often brings some unexpected effects. From the heat map analysis of road density in Fig. 3, the high density road network area (red area) is often accompanied by strong environmental noise, in this case, even if equipped with visual greening, its positive effect may be offset by traffic noise. A comprehensive classification scheme for urban sound environments with three categories: natural, human and urban [2]. It was found that the combination of visual greenery and natural soundscape is more likely to provide residents with a positive environmental experience in areas with relatively low road network density (blue areas), but the manifestation of this effect is not fixed, but varies according to specific contexts and individual differences. This phenomenon is particularly noteworthy because it suggests that simply increasing the area of greenery may not be sufficient to improve the quality of the environment, and that synergistic optimization of the acoustic environment needs to be considered.

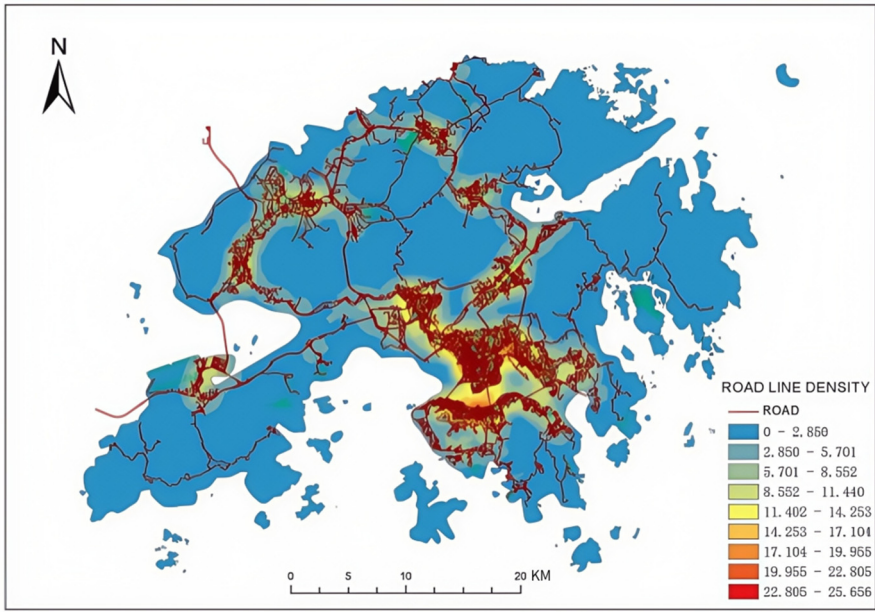


Fig. 2. Comparison of green space reachability by cycling and walking.

While the well-being of residents appears to be higher in areas with high levels of greenery and rich soundscapes, this effect is not uniform across individuals. For example, the presence of water can sometimes bring visual and auditory soothing effects, but the actual impact of this effect varies depending on individual perceptions and cannot be said to be universally significant. This phenomenon is particularly complex in public areas such as parks and squares, where residents' perceptions are influenced by environmental factors as well as personal needs and preferences. Interestingly, even in the same environment, residents of different ages and occupations may have completely different experiences. For example, older people may prefer a quieter environment, while younger people may prefer a more energized atmosphere.

Of particular interest is the fact that the role of the visual and acoustic environment is also closely related to the social interaction and psychological recovery of residents, but the degree of influence often varies from person to person. While the combination of greenery and natural soundscape can in some cases attract residents to socialize and provide a relaxing atmosphere, the actual effect on psychological recovery needs to be analyzed, as there are significant differences in the experiences of individuals. From the data analysis, spaces that provide both a good visual experience and a comfortable acoustic environment are more likely to be the preferred location for residents' daily activities. Such spaces not only meet the needs of individuals for recreation, but also promote natural interactions between neighbors, thus enhancing community cohesion. Although this effect may vary depending on the culture and living habits of the area, the positive impact is obvious.

4 Environment Optimization Strategy

In the process of exploring the potential correlation between urban environment and residents' well-being, the role of different visual elements brings multi-dimensional thinking for future urban design. From the land use changes in Figures 4, it is clear to see the trend of Hong Kong's continuous expansion of man-made land surface (pink area) and the continuous reduction of natural land area in the past two decades. This change makes how the visibility of green space affects the daily psychological experience a topic worthy of in-depth study. We found that natural and living sounds have a positive effect on citizens' moods, while mechanical sounds have a negative effect on citizens' moods[3]. In high-density development areas, even a small area of green space can bring significant environmental improvement to the neighboring residents as long as it is well-designed. Interestingly, compared with large-scale but far away from the residential areas, those small green spaces scattered in the community are rather more popular because they can be integrated into the daily life of the residents.

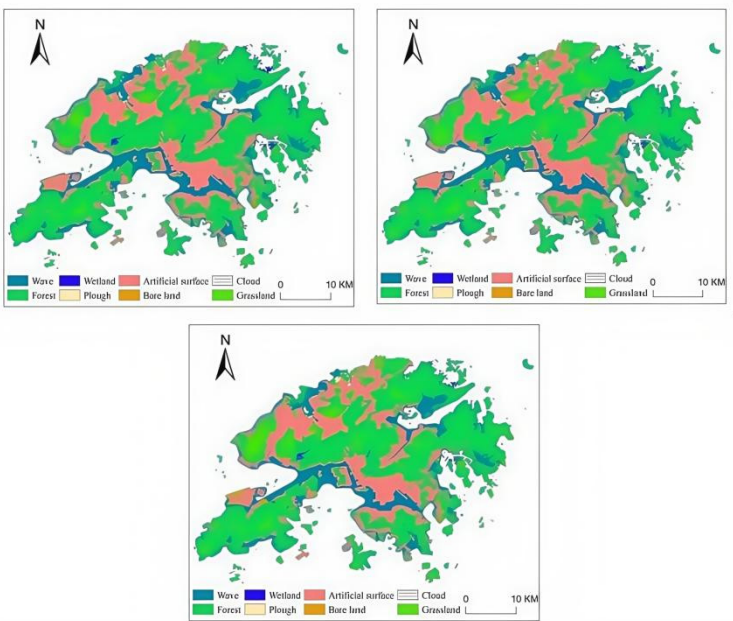


Fig. 3. Road network density heatmap and its environmental noise impact.

It is particularly worth noting that in crowded living places, the way of greening design may not need to be limited to the traditional arrangement pattern. According to the distribution characteristics of roads and green spaces in Figure 3, the existing green spaces are mainly distributed along the roads in the form of ribbons. Although this layout creates a continuous landscape visually, its noise reduction function is not satisfactory. We suggest that in the future planning, we can try to adopt the greening mode of

“point-line-surface” combination, and create a richer environmental experience in the limited space through the diversified forms of street corner garden, rooftop greening, vertical green wall, etc. This three-dimensional greening design is not only the best way to create a green environment, but also the most effective way to reduce noise. This three-dimensional greening design can not only provide more visual interest, but also improve the local microclimate environment to a certain extent.

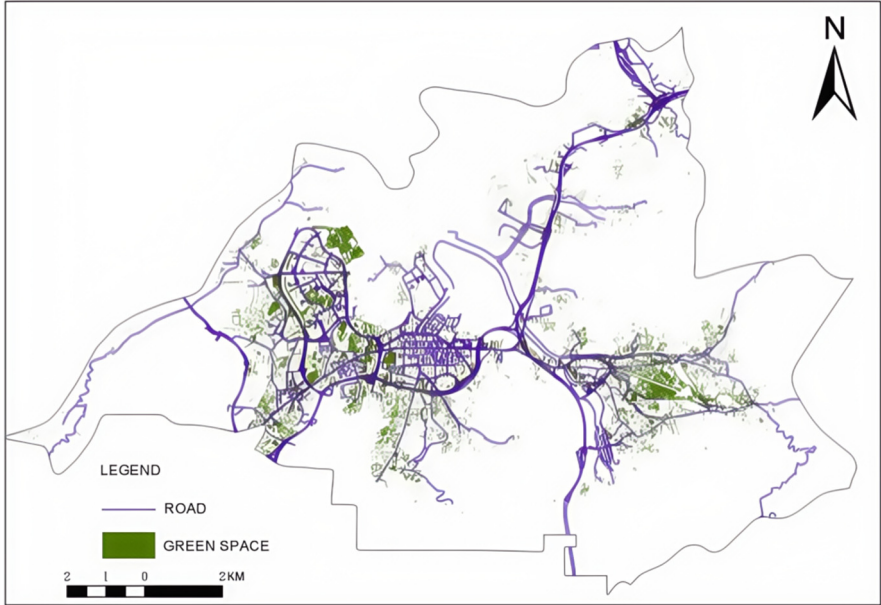


Fig. 4. Distribution of linear green belts in Yuen Long District.

With regard to the optimization of the acoustic environment, we have placed particular emphasis on avoiding a one-size-fits-all approach. From practical experience, there are obvious differences in the demand for acoustic environment in different functional areas. For example, in residential areas and the vicinity of educational facilities, we should pay more attention to creating a quiet and comfortable acoustic environment, and environmental noise can be reduced by adding compound green belts[4]. In commercial areas and leisure venues, on the other hand, appropriately retaining some of the sounds of crowd activities may instead help to create a vibrant atmosphere. Interestingly, studies have found that design solutions that can skillfully utilize natural sounds (such as the sound of running water and the rustling of wind-blown leaves) to mask urban noise tend to achieve better results. This sound environment optimization strategy not only considers the need for noise reduction, but also focuses on creating a pleasant soundscape that enhances the overall environmental experience.

5 Conclusion

Through an in-depth analysis of the characteristics of Hong Kong's urban greening environment, we have found that the visual and acoustic environments have a complex and far-reaching impact on residents' well-being. As can be seen from the land use evolution in Figures 4, the continuous expansion of man-made surfaces over the past two decades has caused significant changes to the urban environment[5]. However, through proper planning and design, we can still improve the quality of life of residents by optimizing the visual and acoustic environments even in urban environments with high density development. Interestingly, the results of this study show that the synergistic effect of improving visual greenery and optimizing the natural acoustic environment has an unexpected effect on the well-being of residents. This effect is not simply superimposed, but creates a more comfortable and pleasant urban space through the organic combination of environmental elements.

Of particular interest is that the accessibility analysis in Figure 1 and 2 reveals a significant difference in the service scope of green spaces at different time scales. This difference suggests that we should pay more attention to the balanced layout of the green space system in the future urban design to ensure that the residents can easily enjoy the high-quality environmental resources. Meanwhile, based on the results of the road density analysis in Figure 3, we believe that more targeted environmental optimization measures should be taken in high-density areas. For example, in areas with dense road networks, we can try to create a good environmental experience in limited space through innovative ways such as three-dimensional greening and small open spaces. Although these measures may seem simple, the actual results often exceed expectations because they respond directly to the actual needs of residents in their daily lives.

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