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Heat Mitigation Through Leftover Spaces

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Abstract

Greenspace has a significant cooling effect on urban heat. As urban populations grow, governments tend to increase green spaces. Cities, however, have limited green spaces. Thus, designers and planners need to consider configuring greenspace to reduce urban heat. Because of densification and insufficient green space, small parks could be considered green steppingstones in the urban fabric and complement larger parks. Due to limited urban areas in the future, this study considers leftover spaces as a strategy for Green Urban Development and heat mitigation. In light of the possibility that different management between scales may influence biodiversity and the functioning of the ecosystem, it is crucial to study the characteristics of leftover spaces.

Keywords: Leftover space, Heat island, Air temperature, Green space

Introduction

The heat island (HI) effect is one of the most severe threats to urban development Kaloustian [1]. as well as its associated environmental and social challenges Aflaki et al. [2] Rapid urbanization has grown environmentally negative impacts with the high demand for land-use change, particularly in developing countries. This urbanization affects the urban climate, creating urban heat islands (UHI). In urban areas, green spaces can create cooling buffer zones so that urban areas shaded by green spaces are cooler than other urban areas heated by direct solar radiation Kim & Oliveira et al. [3,4] By implementing effective heat mitigation strategies in urban development today, the effects of UHI can be minimized. According to various studies, increased ambient air temperature in cities due to the UHI phenomenon has enormous negative effects on cities' social, environmental, and economic dimensions Aflaki et al. [5] urban greenspace has significant cooling effects on urban heat Zhou et al. [6]. One of the appropriate measures to reduce thermal islands is to use green cover Ooka [7]. Increasing the percent cover of greenspace can significantly reduce the UHI effect Fan & Wang et al. [8,9]. which affects microclimatic conditions Lee et al. [10]. In addition, the spatial configuration (or arrangement) of green space can also significantly affect land surface temperature Zhou & Wang [9]. Moreover, green space is increasingly recognized as a valuable resource for the environment. In response to the increase in the population of urban areas UN-Habitat [11], governments tend to increase green spaces Nesshöver & Mavoa et al. [12,13]. However, residents may become separated from nature due to limited time and access to green space, especially given that nearly half of the world's population lives in urban areas. Most urban citizens no longer have daily contact with nature Hartig et al. [14].

More important than increasing green space in urban areas would be to increase the availability of these spaces. As cities have limited green spaces, decision-makers need to understand how to configure greenspace efficiently to reduce urban heat Huang & Zhou et al. [9,15]. Increasing the percent of green space leads to a reduction in temperature. However, small greenspace's spatial configuration effects on urban temperatures are less known Zhou et al. [6]. So far, the focus has been mainly on forests and large parks. Because of densification and insufficient green space, however, the interest shifted to smaller city parks. Thus, small parks could be considered green steppingstones in the urban fabric, complement larger parks and fill the need for everyday exposure to nature. However, different management between scales may shape the ecosystem's biodiversity and ecological functioning Tresch et al. [16]. Residual spaces should be considered and better understood in this regard. Due to limited urban areas in the future, leftover spaces, as Trancik termed them, can be viewed as a strategy for 'Green Urban Development' Hwang, & Lee [10]. Dead space and voids are often considered negative parcels without qualities Hudson & Panas [17]. However, Naghibi et al. [18]. note that these areas will likely become critical strategic sites, potentially acting as social, environmental, and aesthetic assets. To find a

design approach that is inclusive and resilient, the characteristics of leftover spaces figure 1 help to understand the relationship between the configuration of physical form, and spatial occupancy, in order to socio-ecological modifications. Cities can modify their climate by using small interventions, which intensify the interaction between the city and the underlying landscape.

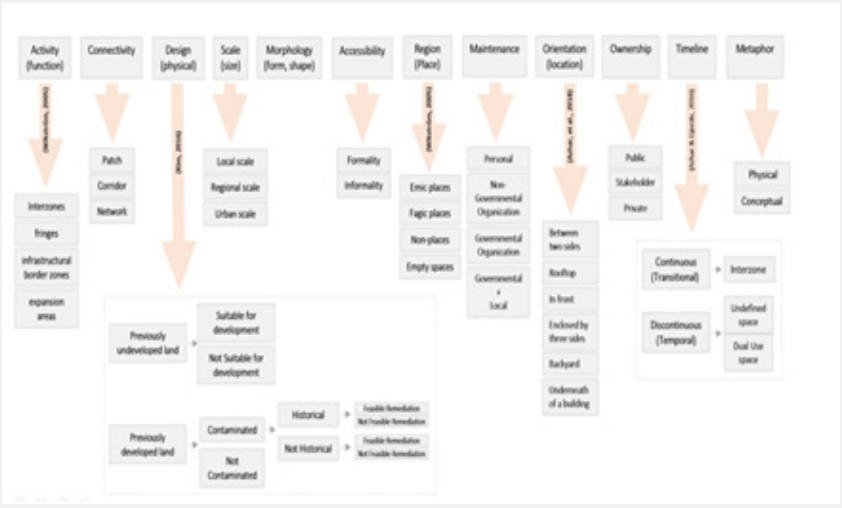

Figure 1: Characteristics of prescriptive leftover space.

In recent studies, the urban characteristics and land use patterns were examined regarding climate change and related environmental issues. According to Nichol et al. [19], the leading cause of UHI in Hong Kong is the urban canopy layer climate, which is influenced mainly by local city structure. Hong Kong faces the same challenges as other high-density cities regarding extreme scarcity of land for urban growth and urgent need. Consequently, the government develops several programs based on using land resources, including Rezoning Land, Land Resumption, Redevelopment, Reclamation, and Reuse of Sites Wang et al. [20]. Notwithstanding these efforts, Hong Kong is considered one of the intensely urbanized areas in the world that suffer from the most serious UHI problems Aflaki et al. [5] Due to the lack of vegetation and public open spaces in urban areas, solar heat is absorbed in the daytime, which leads to an increase in UHI Wong & Lau [21]. In another study, Yusuf et al. [22] considered the effectiveness of measuring UHI impacts and the relationship between UHI and land-use change. Also, as vegetation reduces impervious surfaces, reducing UHI by planting vegetation is considered the best method. As a result, even a small park can mitigate UHI. Lin et al. [23] measured the effect of park size on UHI. Park areas that were less in size than the mentioned studies succeeded in reducing LST, Watkins et al. [24] measured Park Cool Island at 1.7°C–2.5°C in 50ha. According to Srivanit & Hokao [25], the average daily maximum temperature decreased by 2.7°C when the quantity of the trees was increased by 20% in the campus area. In addition, the thermal performance of a small green space (0.24ha) and its influence on the surrounding were showed that the garden was cooler than the surrounding areas by up to 6.9°C of air temperature Oliveira [4]. Spronken-Smith & Oke [26,27] measured higher Park Cool Island with smaller park areas at 0.5°C–12.0°C in an area of 53ha, and Ca & Jauregui et al. [28,29], measured Park Cool Island at 1.5°C–1.9°C in 0.2ha. In addition, green areas look like urban parks with a small or moderate size contributing to reducing LST. For example, Sun & Chen [30] estimated the decreasing Land Surface Temperature in grassland of approximately 9ha at 0.67°C–1.11°C. Thus, in the public space arena, urban interventions in these spaces become more precise and more effective on a large scale.

Conclusion

As a result of climate change, the temperature rise has become a concern in recent years, especially in high-density urban areas, exacerbated by UHI. Due to this concern, practical solutions are needed. As land use/land cover, building configuration, and adjacent heat sources contribute to UHIs Santamouris [31], this study proposes leftover spaces as the basis for heat mitigation and climate modifications in high-density cities. These modifications could include changing wind speeds, solar irradiance, and air temperatures. Studying the effects of vegetation on small parks can be significant. Pocket parks (vestibule parks, vest-pocket, or mini park) are defined as small green spaces embedded in, but not separate from, the urban landscape, which offer small spaces of solace amidst the busy city streets with profound impact Shinew et al. [32]. In the light of limited spaces in high-density areas, the availability of small leftover spaces in urban areas provides scenarios for heat mitigation based on social values and equity. Also, climate mitigation and adaptation efforts are complicated

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and multifaceted, requiring changes in infrastructure systems, social behaviors, and governance systems. Consequently, despite growing interest in environmental issues, it is important to explore the concept of social values and justice in these transforming spaces.

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