

# Green Space and Its Effects on Our Lives

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We live in a rapidly urbanizing world. It is estimated that 47% of the world's population lived in urbanized areas in 2005, and this amount is expected to rise to 60% by 2030. As the urban population increases and urban planners are understandably reluctant to allow urban spread into the surrounding areas, cities and towns increase in density. This in turn brings pressure on decision makers to release green spaces within urban areas for development to meet the growing population's needs for housing and services. Wilson's "biophilia" hypothesis proposes that human possess a deep-seated biological need for the connections with the rest of life that are gained contact with nature. The higher density urban living that results in the loss of green spaces to development has potentially significant implications for citizens because of the importance of urban green spaces as nodes of contact with nature.<sup>1</sup>

### What constitutes green space, open space and green open space?

The State University of New York (2010) defines green space as "any piece of land covered with vegetation and usually refers to parks, golf courses, sports fields and other open land within the built-up area, whether publicly accessible or not." The Planning Institute of Australia (2009) describes open space as "land that has been reserved for the purpose of formal and informal sport and recreation, preservation of natural environments, provision of green space and/or urban storm water management" In almost all instances, the space referred to by the term open space is, in fact, green space, so use of the term really is one of semantics. Urban open space comes largely from a land-use planning and conservation position, whereas green space comes from a horticultural planning perspective that focuses on the management of these spaces. With living green plant systems providing considerable benefits in the greening of cities, perhaps a more appropriate term would be "green open space."<sup>2</sup>

### Benefits and functions of green open space in a city

Green open spaces plays multiple roles, functions and benefits in making cities and their stakeholder communities more sustainable. Good quality green open space provides a wide range of social and recreational settings promotes biodiversity, nature conservation, habitat and heritage, as well as enhancing the quality of life of the local community and generally have been categorized into environmental/ecological, social, economic and health benefits. The environmental/ecological benefits can range from acting as the "green lungs" in a city, controlling temperature extremes, and reducing the "heat island effect" often associated with hot and humid summers. Green open spaces have been involved in intercepting, storing and supplying large amounts of fresh rain water, controlling soil erosion,

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<sup>1</sup> HOME, R. HUNZIKER, M. BAUER, N. 2012. Psychosocial Outcomes as Motivations for Visiting Nearby Urban Green Spaces. R. Home et al. Routledge. P350-351.

<sup>2</sup> Aldous, David. 2010. Green Cities in Australia: adopting a national outlook to green open space planning. Australasian Parks and Leisure - Summer2010. P10.

filtering pollutants and other particulate matter, reducing wind speed impact, stabilizing dust and reducing glare, reducing sound and visual pollution, providing security from calamities such as fire and earthquake. Energy savings, improving the rate of carbon sequestration and protecting wildlife, indigenous and threatened species all can eventuate from maintaining effective green open space. The social benefits provide for an active lifestyle, safe play areas for children, closer friendships, as well as reducing crime and disorder, stress, aggressiveness and violence.

Green open spaces have contributed to a region's economic stability by attracting residents, businesses, partnerships, and ecotourism into a region as well as energy savings in terms air conditioning costs, reducing building energy use and cooling costs, provide water savings from electricity generation, pollution and hydrological amelioration, and boost property values. The recent Healthy Parks Healthy People International Congress successfully demonstrated the “connection between the health of our community and the health of our parks, open and green spaces.” Such green open space activities are known to improve individual and community health in the form of reducing morbidity, heart attack and diabetes. Pretty and co-workers demonstrated the link between green space and the health of people in the form of “green exercise,” whilst other researchers see green open space offering some degree of protection against the development of dementia and Alzheimer's disease, Attention Deficit Disorder (ADD) or providing a general improvement in health.<sup>3</sup>

### **Urban green space and mental health**

As many cities experience poor air quality, water pollution, heat island effects and crowding, it is unsurprising that the physical and increasingly, the mental health of urban residents has become of major focus in recent decades. One area of investigation is the relationship between access to urban green space and both physical and mental health benefits. An “integrated area comprising natural, semi natural, or artificial green land”, urban green space provides an aesthetic place for social and recreational opportunities, which encourages physical activity, enhances social ties and promotes mental and physical recuperation. The majority of green space studies evaluate its influence on physical health or general health as the health outcome. Many include a mental health component, but there have been conflicting findings. For example, some studies in New Zealand found no association between green space and a number of health outcomes, including physical health and cause-specific mortality. This suggests that green space and any associations with health outcomes may vary between environments and social contexts, for example the role of green space is likely to be more influential within urban environments in contrast to rural areas.

Much less established is the investigation of the effects of access to and visualization of green space on mental health. General consensus in existing literature finds green space to be negatively associated with poor mental health, however it is met with some contention and the causal pathways remain relatively unexplored. Mental health is important as it is often a precursor for other chronic conditions and physical health outcomes. It is important to evaluate potentially amenable aspects of neighborhood environments which might reduce this burden. Three primary theoretical pathways have been identified

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<sup>3</sup> Aldous, David. 2010. Green Cities in Australia: adopting a national outlook to green open space planning. Australasian Parks and Leisure - Summer2010. P12.

through which green space may influence mental health. First, recreational physical activity, common in green space, promotes positive moods and reduces stress levels. Second, both planned and coincidental social interaction often take place in public green spaces and have been shown to improve mental well-being. Third, green spaces are seen as places for relaxation and recuperation from stressful activities, which influences stress hormone levels.

Due to the difficulty in obtaining population-level mental health data, most studies rely on self-reported mental health scoring, which often under-estimates mental illness. Although some studies have reported no direct relationship between green space and mental health outcomes, others have found that active participation in green space, the proportion of and distance to green space, and perceived greenness were significantly, positively associated with mental health indicators. For example, a Danish study found that individuals living more than 1 km from green space were 1.42 times more likely to experience stress than individuals living less than 300 m from green space. In addition, some studies have evaluated the green space qualities such as size, naturalness, and popularity which may have mental health benefits, yet there are no conclusive findings.<sup>4</sup>

It is hypothesized that green space has positive effects on mental health both through active participation and as a salutogenic environment. Better access to green space is associated with a decrease in anxiety/mood disorder treatment counts. Specifically, higher proportions of surrounding green space in the broader neighborhood and decreased distance to useable green space, are associated with lower levels of anxiety/mood disorder treatment. It is unknown whether green space accessibility through a road network has previously been associated with specific indicators of mental health, however a study using an unidentified access measurement identified that individuals living away from green space were more likely to be stressed.

The results of an ecological study investigating the association between access to urban green space and mental health in New-Zealand showed that we can support two pathways through which green space can have positive effects on mental health. The first identifies the potential salutogenic effect of green space in the broader neighborhood. The authors of the study did not find an association between the proportion of green space within 300 m buffers and mental health, perhaps the greenness of the wider neighborhood may be more influential than the immediate environment and large areas of green space may provide more restorative effects, potentially through visualization of greenness. Cultural and climatic variables are recognized to influence green space perception in urban environments.

The second pathway supported by that study is participation in green space near homes. Results indicated that areas located near to useable green space features, in terms of travel distance through a road network, experience lower anxiety/mood disorder treatment counts. As the relationship was only identified with useable green space, it suggests an active component is involved. This is reinforced by studies conducted in Denmark, England and New Zealand which found use of green spaces to decline with increasing distance, suggesting that residents living nearby useable green space are experiencing mental health benefits through exercise. This finding is not too surprising given that useable green space

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<sup>4</sup> Nutsford, D. Pearson, A.L. Kingham, S. 2013. An ecological study investigating the association between access to urban green space and mental health. Elsevier Ltd. P1006.

is prevalent throughout the city center with non-useable green space more commonly located towards the city boundaries. Nonetheless this area certainly warrants further exploration. Studies suggest that views of natural spaces from home, or workplaces can have a restorative effect and it is most likely that there is an interaction between active involvement in green space and a “background” effect. While results here, and from other studies suggest that active involvement in green space may have stronger associations with mental health, further investigation involving visibility methods such as view-shed analysis would be of value in quantifying this relationship.<sup>5</sup>

So we can see that urban green spaces are an important component of public health because of the positive psychological and physical health effects and the psychosocial outcomes that result from contact with urban nature. Psychosocial outcomes are defined as the responses to a stimulus, in this case urban nature, that involve or relate to both the social and psychological aspects of a person’s life. Psychosocial outcomes are a subset of psychological outcomes that specifically relate to an individual’s psychological development in a social environment and to the results of interactions within that social environment. Such outcomes can be positive, such as family bonding, or negative, such as loneliness.

### **Urban green space and Psychosocial Motivations**

Among the beneficial outcomes that people receive from contact with urban nature is the restorative contrast to the built environment that it provides. Contact with nature can reduce stress, restore attention, and create restorative experiences. Several studies have shown that natural environments are more restorative than urban environments, although most have contrasted stark urban environments with natural scenesor compared the effects of natural views with the effects of windowless rooms. Hernandez and Hidalgo (2005), in examining the restorative effects of nature within cities, found that respondents viewing urban scenes with natural elements returned higher scores on a measure of restorativeness than did those viewing the same scenes without the natural elements. Peron, Berto, and Purcell (2002) found that mixed environments are often perceived as being as restorative as purely natural environments. Common to these studies is that the characteristics of the green spaces provide the vehicle for restoration.

Direct physical health benefits have also been reported from physical activity that results from engaging in contact with nature, including contributing to reductions in obesity, increased life expectancy, and general good health. A substantial body of evidence suggests that contact with urban green spaces is beneficial to urban society as a whole. Coley, Kuo, and Sullivan (1997) found that natural elements, such as trees, in semipublic spaces surrounding urban housing promote increased use by, and interaction among, residents. Urban green spaces that are well used have been shown to encourage bonding among neighbors, to provide a greater sense of safety, and to reduce urban ills such as crime and violence. Furthermore, Ward Thompson (2002) points out the importance of nature to the individual by claiming that access to some form of nature is a fundamental human need. The implication is that individuals gain some positive outcomes from contact with nature. However, few studies have differentiated between active and passive experiences of urban nature and the desire to obtain

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<sup>5</sup> Nutsford, D. Pearson, A.L. Kingham, S. 2013. An ecological study investigating the association between access to urban green space and mental health. Elsevier Ltd. P1008-1009.

beneficial outcomes as a motivation for people to seek urban nature to engage in activities has been considerably less studied. Urban parks tend to be overlooked in discussions and analyses of leisure participation, and urban green spaces outside recognized parks tend to be even more overlooked.

In their study, HOME, HUNZIKER and BAUER concluded that, the study of motivation for engaging in leisure activities has a long tradition in the outdoor recreation literature initiated by Driver and colleagues in the 1970s with the experiential approach that links settings, activities, and outcomes. The topic has attracted less research in recent years, perhaps due to discouragement by the difficulties in finding correspondence between bundles of outcomes and activities. Attention to psychosocial outcomes was given by Shin et al. (2005) in their study of visitors to urban forest parks although there has been little attempt to link expected psychosocial outcomes with specific activities undertaken in the green spaces that could lead to such outcomes.

Their study has shown that people engaging in a particular activity will choose a green space in which to do it with the aim of achieving multiple outcomes simultaneously. While this result supports the findings of Driver and Knopf (1976) in that participants seek bundles of psychological outcomes from their recreation experience as desired from engaging in recreation, it also shows that the relationships are complex and multidimensional. The results of this study show that respondents are motivated to visit urban green spaces by the expectation of achieving psychosocial outcomes that are both varied and specific to their chosen activities.

Similarities were found between this sample study in Swiss and the Korean sample studied by Shin et al. (2005) in both the order of the outcomes that were rated as being most important and in the categories revealed by the principal components analysis. Three categories of outcomes—*stimulation by nature*, *escape*, and *self/other relations*—summarize outcomes that motivate people to visit nearby green spaces and were identified in this study. The most highly rated category of outcomes was to be stimulated by nature, while self/other relations was the lowest rated category in both samples. These similarities possible reflect that both samples stem from highly industrialized countries and application of the scale in other contexts may shed light on whether the similarities are indeed universal or simply common to respondents from industrialized countries.<sup>6</sup>

## **Urban green space and physical health**

Beside mental health, there is also physical health. Can urban green space advance health by encouraging physical activity? There have been studies (e.g. Scjippering 2010; Maas et al. 2006; Ulrich 2006; Aspinall et al. 2013; Korpela et al. 2008) that state urban green space has positive influence on health of people, but the processes through which people gain health from urban green space remain unclear. Because sufficient physical activity has an evident effect on better health (e.g. Lee et al. 2012; e.g. Sallis et al. 2011), urban green areas might support good health through promoting physical activity of people. However, a contradictory relationship between urban green areas and physical activity has been reported in earlier studies. There are studies which state that physical activity of people might be

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<sup>6</sup> HOME, R. HUNZIKER, M. BAUER, N. 2012. Psychosocial Outcomes as Motivations for Visiting Nearby Urban Green Spaces. R. Home et al. Routledge. P351-363.

encouraged through urban green areas (e.g. Nielsen & Hansen 2007), but there are also studies which have arguments opposed to the positive effect of urban green space on increasing physical activity (e.g. Maas et al. 2008; Hillsdon et al. 2006).

The controversy of the earlier studies, exploring the effect of urban green areas on the physical activity of people, suggests a need for further research. Maria Pasanen, in her thesis she tried to explore whether urban green space might affect the total physical activity or the non-recreational physical activity of people (meaning walking or cycling for transportation purposes). It was hypothesized that the respondents living in the neighborhood with more urban green space would have increased likelihood of being physically active when measured by both indicators, total physical activity and non-recreational physical activity.

Firstly, the findings of her study partly run counter to those mentioned hypotheses because the study did not demonstrate a strong positive effect of urban green space on total physical activity of people. This result was consistent with those of Maas et al. (2008), who explored the relation between the percentage of green space and physical activity of Dutch people. In the analysis of the study, there is a weak trend to be seen that urban green space might increase the likelihood of insufficient total physical activity, but when controlled with population density, the effect is reversed and urban green space seems to increase the likelihood of sufficient total physical activity. However, there was no statistical significance to support this identified trend.

Secondly, the results of this study concerning the effect of urban green space on particularly non-recreational physical activity are more encouraging. There is evidence found that urban green space increases the amount of respondents' non-recreational physical activity when certain conditions exist, most importantly sufficient population density of the neighborhood. Before controlling the influence of population density, analyses identified a trend similar to the one found when analyzing the relation between urban green space and total physical activity. There was seen a statistically significant result that urban green space, contrary to expectations, increase the likelihood of insufficient non-recreational physical activity. But when controlling the influence of population density, the described effect of increased likelihood of insufficient physical activity disappears or is reversed. According to this finding, it seems that urban green space might have a notable effect in increasing non-recreational physical activity of people in the neighborhoods with sufficiently dense residential structure.

Hillsdon et al. (2006) have also found a similar effect of less physical activity related to more urban green space. When Hillsdon et al. explored the association between the access to urban green space and the amount of recreational physical activity, they found a result that respondents in the group with the best access to high-quality large green space reported lower levels of physical activity compared to the groups from neighborhoods with less urban green space (OR -0.190  $P < 0.001$ ). Thus, when reflecting on the results of Hillsdon et al. and the findings of this study concerning the increased likelihood of insufficient total and non-recreational physical activity (before controlling the effect of population density), it seems that there might be a surprising association between urban green areas and less physical activity.

However, more research has to be done before the reasons for this relation between urban green space and increased likelihood of less physical activity can be determined. As is suggested in the research of Sealens et al. (2003), the aesthetics of the neighborhood (i.e. attractive natural sights) is one environmental characteristic which supports physical activity. But other activity-supporting neighborhood characteristics are identified as well, such as greater residential density, better land use mix-access (i.e. local shopping possibilities) or better street connectivity (i.e. short distances between neighborhood intersections). (Sealens et al. 2003, 1552-1553.) The neighborhoods which have the largest share of urban green space are located near the border of the downtown area. Although there is more nature, there are probably fewer other activity-supporting environmental factors identified by Sealens et al. (2003). So it might be that these other factors have a stronger effect on the physical activity of people than nature has. The strong effect of population density on physical activity of people gets support from the analyses of this study.

In the results of this study, there are also findings consistent with earlier research (e.g. de Vries et al. 2003; Maas et al. 2006), concerning the population groups which are more affected by the characteristics of our environment. The control variables included in the analyses indicate that urban green space seems to have a particularly strong effect on non-recreational physical activity of people aged from 45 to 60, people with lower level education and women.

As has become clear from Pasanen's study, there are some characteristics in our living environments which are associated to encourage the physical activity of people, and physical activity in turn supports good health of people. By building urban environments which encourage physical activity, there might be a possibility to increase the amount of peoples' daily physical exercises.

Using quantitative data from 2079 Finnish respondents, binary logistic regression analyses were performed to explore the effect of urban green space on total physical activity and non-recreational physical activity of people. The main result of the analyses is that, contrary to expectations, urban green space seems to increase the likelihood of particularly insufficient non-recreational physical activity. But when controlling the influence of population density, the effect is reversed and urban green space seems to increase the likelihood of sufficient non-recreational physical activity. The results of the analyses performed in this study provide support for the argument that urban green space can promote particularly non-recreational physical activity in the neighborhoods with sufficient population density. So it seems that urban green areas can support physically active lifestyle and health by encouraging people to walk and cycle for transportation purposes.

However, because some of the trends identified in this study lack the statistical significance in the formal confidence level of 95%, it is suggested that the found associations should be investigated further in future studies. If there would have been a larger sample to use, and a larger scale measuring the amount of urban green space and population density, the analyses might have gotten more statistically significant evidence to support its findings.

The importance of this study is that its findings give suggestions for indicators that should be evaluated in similar future studies, most importantly the effect of population density on the relation between

urban green areas and physical activity. As the results of this study show, when controlling the influence of population density, the relation between urban green space and physical activity changes substantially. When the analyses are not controlled with population density, urban green space seems to decrease the amount of physical activity. But when controlled with population density, urban green space seems to have an opposed effect, to increase the amount of physical activity. This result is particularly visible when taking into consideration only non-recreational physical activity.

It can be stated that when there is sufficient population density, encouragement of non-recreational physical activity might be one process through which urban green space could support better health of people. But there are definitely other processes working behind this known relation between urban green areas and health, and more research is still needed to determine the processes through which green environment supports better health. The effect of urban green space on health is an important issue for future research because in our time of increasing urbanization there is pressure to build more residences at the cost of urban green areas. If it can be clearly demonstrated that urban green areas support better health, there might be more will to preserve or even build more green areas in our cities.

Nevertheless, even if there is a great and accessible nearby park or excellent cycling lanes connecting home, work and services, many people still make a choice to watch television for their leisure or drive a car to work or services. That is something we just have to accept and develop different motivational factors for different groups of people. As Schneider (2011) points out, to enhance the personal choices of people towards preferable health outcomes, it requires attention to both: to the environments where the lifestyle choices are made and to the other motivation factors which encourage better choices, including education, regulation, market mechanisms, and social marketing (p. 261). So there remains plenty of work to research the effects of our living environments on our health. Thus, urban space is one of the environments through which we construct our behavioral patterns, and urban green space is one important aspect of it.

Furthermore, as important as sufficient physical activity of people is to their personal health and our public health spending, it is also important when taking ecological issues into consideration. The megatrend of urbanization emphasizes the necessity of good urban planning to support the general well-being of people. (Heikkilä & Kirveenummi 2010, 8.) There will be a great increase in the number of new inhabitants in big cities and their surroundings, a fact which will bring more traffic. And traffic in turn will bring more traffic jams, pollution and accidents. Supporting light traffic instead of cars would improve the well-being of citizens in many ways and reduce the harmful influence of traffic on environment. By supporting walking and cycling as a way of transportation, we support the health of people, but the step towards fewer cars could also be the key element in creating enjoyable cities in the time of increasing urbanization. And as the results of this study indicate, it seems that urban green areas might have potential to encourage people to change from driving cars to walking or cycling.<sup>7</sup>

## **Effects of green space spatial pattern on land surface temperature**

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<sup>7</sup> Pasanen, Maria. 2013. Urban Green Space and Physical Activity, Can urban green space advance health by encouraging physical activity? University of Helsinki. P45-50.



The urban heat island (UHI) refers to the phenomenon of higher atmospheric and surface temperatures occurring in urban areas than in the surrounding rural areas. This phenomenon is widely observed in cities regardless of their sizes and locations (Connors et al., 2013). The UHI is mainly caused by the modification of land surfaces by urban development, which uses materials that effectively store short-wave radiation (Solecki et al., 2005). As a result, land surface temperature (LST) increases due to the UHI, which may disrupt species composition and distribution (Niemeł, 1999) by increasing the length of growing seasons, decrease air quality, leading to greater health risks. The UHI may also decrease water quality as warmer waters flow into streams putting additional stress on aquatic ecosystems. Therefore, it has become a major research focus in urban climatology and urban ecology since first reported in 1818 (Howard, 1818).

The intensity and spatial pattern of UHI are largely exacerbated from population dynamics and development of built-up areas. Specifically, urban structure (e.g., height-to-width ratio of buildings and streets), proportion of built-up versus green spaces per unit area, weather conditions (e.g., wind and humidity), and socioeconomic activities determine the development of the UHI. For example, Huang et al. (2011) found statistically significant relationship between the UHI and socioeconomic factors indicating that higher UHI effects were linked to block groups characterized by low income, high poverty, less education, more ethnic minorities, more elderly people and greater risk of crime. As many of these factors, especially land surface characteristics are primarily represented by land-cover and land-use (LCLU), the relationship between the LST and LCLU has been the focus of numerous studies on the UHI (Buyantuyev and Wu, 2010). This is due to the fact that vegetation usually has higher evapotranspiration and lower emissivity than built-up areas, and thus has lower surface temperatures.

Composition and configuration of green spaces are the two major elements of LCLU. The former refers to the abundance and variety of land cover types and the latter is related to the spatial arrangements and layout of land cover types (Connors et al., 2013; Turner, 2005). Remarkable proliferations of studies focusing on the relationship between LST and green space composition has been reported over the last two decades. Though the magnitude of correlations varied among these reports, a negative relationship between the vegetation amount/fraction and LST was consistently observed. However, the spatial characteristics and configurations of vegetation patches within the urban environment have significant impacts on the distribution of the UHI, and that the size and shape of a vegetation patch creates cool island effects, a phenomenon that the temperature of green space is lower than its surrounding areas. Based on a case study of a heavily urbanized Beijing metropolitan area in China, Li et al. (2012) also indicated that increasing patch density results in significantly higher LST when the size of urban green space is unaffected, and that spatial configuration has a significant influence in the variability of derived LST.

Studies show that Percentage of landscape (PLAND) is correlated with LST with statistical significance. It demonstrated negative correlations between LST and the abundance of green space measured by Normalized Difference Vegetation Index, fraction of vegetation, percent cover of LCLU (e.g., Forest, Grass, Cropland, etc.), or PLAND (Li et al., 2012). Trees and other plants help cool the environment, making green space a simple and effective way to mitigate urban heat island effects. Green spaces lower surface and air temperatures by evapotranspiration due to its lower thermal inertia compared to

impervious surfaces and bare soils; by providing shade that prevents land surfaces from direct heating from sunlight. Traditionally, increasing the green space by planting more trees has been emphasized in urban planning, while confirming the fact that the increase in green space can significantly mitigate UHI effects.

Under changing climate, arid regions are likely to become even drier, while wet areas tend to get wetter in response to observed global warming (Durack et al., 2012) as indicated by increasing surface temperature. Expanding the urban green space is a rational approach for adapting to climate change. At the same time, it can contribute to the sustainable development of urban areas. However, it may compete with other socio-economic interests that also require space. Therefore, in order to determine a proper balance between the sustainable development and urban green space increase, urban planners should work on optimizing the configuration of green space patches in selected areas by increasing the size of existing green space patches rather than building new smaller patches.

Water scarcity is the major limiting factor of anthropogenic activities in arid and semi-arid regions. Specifically, the increase of green space cover is restricted by water availability. By increasing patch and edge density of the green space, the thermal environment in the City can be further improved without expanding the percentage of landscape (PLAND). In arid and semi-arid regions, where temperatures are already high and water resources are limited, studies show that we may provide climate change adaptation and mitigation benefits by reducing greenhouse gas emissions and energy demand for the cooling of buildings.<sup>8</sup>

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<sup>8</sup> Maimaitiyiming, M. Ghulam, A. 2014. Effects of green space spatial pattern on land surface temperature: Implications for sustainable urban planning and climate change adaptation. [www.elsevier.com/locate/isprsjprs](http://www.elsevier.com/locate/isprsjprs). P1-8.

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