THE ENVIRONMENTAL BENEFITS OF URBAN OPEN GREEN SPACES

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ABSTRACT

Most of the scientific papers on urban planning and sustainable development begin by emphasizing the multiple benefits of urban open green space. When it comes to the benefits of urban green and open space, one should concern on the facilities provided to promote human or societal wellbeing, either directly or indirectly. In this study, a review of identified peer-reviewed literature from the most popular online databases was carried out and its contribution to improve our understanding of urban open green spaces and their environmental benefits to the human being are discussed. These many benefits cover various areas such as natural conservation which increases biodiversity of flora and fauna, affecting urban climate by reduction of air temperature and urban heat islands, improving air quality, decreasing air pollution and carbon sequestration, noise reduction and cleaning up contaminants. As urban open green spaces contribute to human and social wellbeing, they are essential for livable and sustainable cities.

Keywords: *Environmental benefits, Green space, Open space, Sustainable development, Urban space*

1. INTRODUCTION

From the historical time period, human being has appreciated greenery to find the flavor of life, form some physical and psychological dependency on nature. People depend on fresh air, natural attraction and landscape which indicate public natural perception and social behavior. (Wuqiang, Song, & Wei, 2012; Gökyer, Bilgili, & Gökyer, 2012). However, nowadays, due to the population growth and urbanization, ecosystems and natural landscape are changing drastically (Barnosky, 2012). Human activities are driving these changes and threatening many of the ecological services that are essential to society (Chapin III et al., 2011), on the other hand sustainable development is a key idea to solve a series of environmental, economic and social problems (Rakhshandehroo, Yusof, Johari, Arabi, & Jahandarfard, 2016). For instance some of the environmental problems associated with UOGS are: species extinction, losing natural habitat, flood, landsliding, urban heat island, air pollution, contaminant, noise pollution etc. Therefore, it is essential to involve how we manage land use and shape our cities (Steiner, 2014).

There are growing number of scientific papers on urban open green space (UOGS) (Rakhshandehroo, Yusof, et al., 2015) which indicate the presence of natural features such as gardens, urban parks, forests, and green belts with their particular components (trees, shrubs, water etc.) contribute to quality of life in many ways (Najafpour, Bigdeli Rad, Lamit, & Fitry, 2014). They provides vital ecosystem services and public benefits in response to rapid land conversion (Wu, 2014).

Providing residents with a sustainable environment protection of urban open green space (UOGS) is the main opportunity especially when they are

allocated to public use. (Hussain, Tukiman, Zen, & Shahli, 2014). UOGS is not only urban parks; it has a vast meaning and can take on many forms, shapes, purposes, and functions. It can vary greatly from community to community, and no single open green space example typifies what this term is (Panduro & Veie, 2013; Swanwick, Dunnett, & Woolley, 2003). For the purpose of this study UOGS contains all types of open spaces in urban areas which completely or mostly covered with vegetation either public or private.

2. LITERATURE REVIEW

This study attempts to collect all empirical evidence from eligible peer-reviewed literature and answer one specific research question. The main research question was: what are the main environmental benefits of urban open green spaces according current scientific evidence. In order to provide reliable finding, minimize bias and make a conclusion, this study: clearly states research question; applies a clearly stated transparent replicable method which rises the validity; and conducts a systematic search to identify all eligible papers.

2.1 Search strategy

In order to find the trend of research, online web of science (the Tomson Reuters) was investigated on 18 January 2016. Literature reviewed and relevant aspects of "urban open green space" was investigated to find proper keywords which were: "green space*", "greenspace*", "open space*", "green infrastructure" and "public space*". They were applied to search articles from web of science core collection in terms of topic (including four section: title, abstract, author keywords and keyword plus) within the publication year limited from 1980 to 2016, indexes: SCI-EXPANDED, CPCI-SSH, SSCI, A&HCI and CPCI.

There were a grate verity papers about UOGS. This diversity can be arrange in 5 categories: 1. Type of paper (Research paper, Review paper, Short communication and other), 2. Type of green UOGS (Green structure, woodland, park, trees and other), 3. research themes (Physicality of green space, experience of green space, valuation of green space, green space management, green space governance and other), 4. Scientific field (Natural sciences, social sciences, humanities, and multiple disciplines), and 5. Type of method (The self-stated (empirical) methods for articles: surveys, measurements, interviews, experiments, literature review, modelling, GIS, observations, valuation studies, review of policy/planning documents, and other).

2.2 Study selection

Based on this search, 11457 publications met the selection criteria. However, some of these documents contained documents not closely relating to the topic. Hence, the search result was refined by web of science categories: "environmental studies or urban studies or geography". A total of 2737 documents were therefore found out based on this refinement.

By using "Citation report tool" of this web site, the following charts were derived. In 2737 results founded: sum of the times cited: 31152; sum of times cited without self-citations: 24354; citing articles: 18018; citing articles without self-citations: 16416; average citations per item: 11.38 and h-index: 74. This report displays citations to source items, indexed within Web of Science Core Collection.

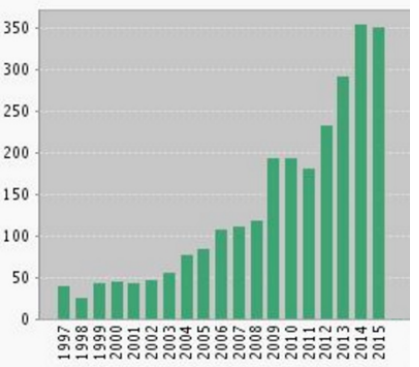

Figure 1: Published Items from 1997 to 2015 (Source: Web of science)

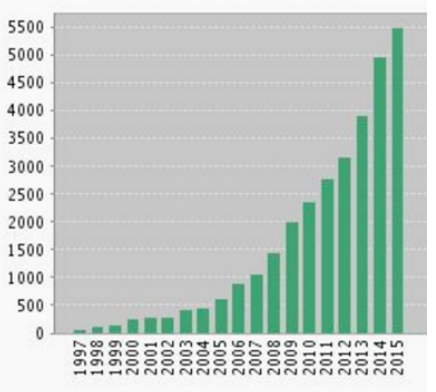

Figure 2: Citations from 1997 to 2015 (Source: Web of science)

Figure 1 and 2 represent a small bibliometic which state how significant topic of UOGS is. Figure 1 indicates from 1997 to 2015 the number of papers increased seriously from less than 50 to more than 530 per year. The increasing number of publication in the last two years is noticeable and figure 2 explains the citation rate has dramatically increased from 1997 to 2015. All in all total linear trend indicates a crucial increasing consideration among researchers on the topic of urban open green space during the last decade.
The 2737 documents that have been found out based on refinement search then article titles and abstracts are screened for relevance and finally 54 article directly applied for this review. Studies of UOGS that supported environmental benefits were included, but social and health benefits were excluded.

2.3 Data extraction

In order to find, categories, and manipulate the finding reported in this review, the relationship between environment, benefit and UOGS should be considered. These data were entered into a matrix that aided analysis based on the research question. Selected papers assessed qualitatively and each outcome is evaluated by the number of studies (weighted analysis) on each environmental benefit. According to content analysis the most common repeated benefits are categorized in six themes: Nature conservation, Biodiversity, Urban climate, Air quality, Noise reduction and cleaning up contaminants. Following sections discuss the many environmental benefits of urban open green spaces based on the documents derived from "web of science" and the other databases.

3. NATURE CONSERVATION

Relationship between cities and nature is a basic challenge for nature conservation in future urban development and also for the future of the wilderness (Kowarik, 2013). The ecological footprint of cities affects ecosystems indirectly from regional to global scales and the ecological functions within open green spaces involve the whole system of plants, animals, soil and human activity (Olsson, 2012).

4. BIODIVERSITY AN WILDLIFE

A higher level of urbanization results in lowered species richness and modifications in the species assemblages (McPhearson, Maddox, Gunther & Bragdon, 2013), particularly of the fauna in urban open green spaces toward more generalist species (urban exploiters and urban adaptors) and exotics, while specialist species and other area sensitive species (urban avoiders) eventually disappear. This applies not only to animals such as birds, bees, ants, beetles, and butterflies but also to vascular plants (Biadun & Zmihorski, 2011' MacGregor-Fors & Ortega-Álvarez, 2011; Oliver et al., 2011). This is because urbanization has an increasing impact on the natural ecosystem, and people can correctly perceive differences in biodiversity (Qiu, Lindberg, & Nielsen, 2013). During the last decade, there has been growing recognition of the importance of implementing urban open green spaces as an innovative way to preserve and enhance biodiversity (Farinha-Marques, Lameiras, Fernandes, Silva & Guilherme, 2011).

Carefully-designed urban open green spaces can protect habitats and preserve biodiversity and therefore constitute particularly significant hot spots for biodiversity. They can be 'wildlife corridors' or function as 'urban forests' and feature good connectivity (Byrne & Sipe, 2010). Green areas in the urban fabric may result in novel habitats which often differ fundamentally from historical patterns but can harbor high numbers of plant and animal species (Werner, 2011; Kowarik, 2013). Some studies have indicated that less isolated, less urbanized, bigger and more diversified parks are often a refuge for a greater number of native species (Lizée, Manel, Mauffrey, Tatoni & Deschamps-Cottin, 2012). Some others have concluded that parks (in comparison with the other types of urban green open spaces) are home to greater species richness than other types of urban green open space (Carbó-Ramírez & Zuria, 2011; Sorace, 2001; Nielsen, van den Bosch, Maruthaveeran,& van den Bosch, 2013).

5. URBAN CLIMATE

Due to the rapid increase in artificial urban pavements such as asphalt and concrete, which are different in thermal, optical and geometric properties (Feyisa, Dons & Meilby, 2014), urban settlements are hotter than rural areas and cities all over the world are experiencing more common urban heat islands (Skoulika, Santamouris, Kolokotsa & Boemi, 2014). Urban heat islands can negatively affect the health and welfare of urban dwellers (Song & Park, 2014), particularly infants, the elderly and poor people who are highly affected by thermal stress (Feyisa et al., 2014).

Furthermore, temperature increase from UHIs worsens the thermal comfort conditions, intensifies the pollutant concentrations (Skoulika et al., 2014), and considerably increases the energy consumption for cooling, (Mirzaei & Haghighat, 2010) and the aggregated effects from UHIs can cause changes in urban ecosystems. This problem is associated with worldwide environmental issues and expected to worsen global warming (Bowler, Buyung-Ali, Knight,& Pullin, 2010).

5.1 Cooling (Reduction of air temperature and urban heat islands)

Complex processes are involved in determining the cooling effect of vegetation on daytime air and surface temperature (Arabi, Shahidan, Kamal, Jaafar, & Rakhshandehroo, 2015). The vegetation cools the environment through evaporative cooling which consumes energy, shading effects which encompass intercepting solar radiation, and its thermal and optical properties (Bowler et al., 2010; Vasilakopoulou, Kolokotsa & Santamouris, 2014; Kleerekoper, van Esch,& Salcedo, 2012; Jim & Peng, 2012).

Cities in the tropics, urban open green spaces are of particular importance as they offer shading and cooling, to mitigate the urban heat island effect and with regard to air pollution (Gago, Roldan, Pacheco-Torres, & Ordóñez, 2013). Trees offer shade on hot days and in sunny climates (Carmona, Freeman, Rose, & Woolley, 2004) and generally, parks are cooler than the urban areas that surround them (Skoulika et al., 2014). According to Bowler et al. (2010), temperature in a park reduces averagely by about 0.94°C in day time and 1.15°C at night. Park size also plays a positive role in estimating the cooling effect, helping to maximize the cooling effects of parks, tree vegetation canopy cover can be increased and the choice of species for greening should be optimized (Feyisa et al., 2014).

6. AIR QUALITY

Many studies have confirmed the beneficial impact of urban area vegetation in urban areas on ambient air quality as it contributes to air pollution removal and carbon sequestration (Konijnendijk et al., 2013; Setälä, Viippola, Rantalainen, Pennanen & Yli-Pelkonen, 2013).

6.1 Reducing air pollution

Air pollution involves many pollutants ranging from PM to SOx and NOx also Cox and may be caused by urban warming, for example, by increasing surface ozone concentration with several negative impacts on human health (Feyisa et al., 2014). It is being associated with indirect health effects (Li, 2014) and abnormal levels of mortality and morbidity among urbanites (Su, Jerrett, de Nazelle & Wolch, 2011). Urban open green spaces play a significant role in decreasing air pollution as they intercept atmospheric particles and absorb different gaseous pollutants, (Yin et al., 2011). They are frequently quoted as a partial solution, as leaves take in gaseous pollutants through their pores and capture particulate matter on their surfaces (Kessler, 2013). They reduce the level of NOx and SOx and remove large amounts of airborne pollution (Pugh, MacKenzie, Whyatt & Hewitt, 2012; Yin et al., 2011) and also contribute substantially to the elimination of particles (Tallis, Taylor, Sinnett,& Freer-Smith, 2011; Tallis et al. 2011). Pollution removal depends on the amount of tree cover, and also the duration of the in-leaf season and a host of meteorological variables that have an effect on trees (Paoletti, Bardelli, Giovannini,& Pecchioli, 2011).

6.2 Carbon sequestration

Cities play an important role in the global carbon cycle. They produce a large proportion of CO2 emissions (Strohbach, Arnold, & Haase, 2012), but urban forests and open green spaces sequester and store carbon within trees and other kinds of vegetation that are very valuable (Davies, Edmondson, Heinemeyer, Leake & Gaston, 2011; Davies et al., 2011). The sequestration of carbon by urban vegetation acts as carbon sinks and plays a significant role in the issue of climate change (Paoletti et al., 2011).

7. NOISE REDUCTION

It has been accepted that soft walls of greenery and trees not only shape spaces and create boundaries, but also have an important impact on noise reduction (Watts et al., 2013; Veisten et al., 2012). The green medians and vegetative buffers lining the express roads, ring roads and airport express routes, produce not only noise buffers but also, sight and air pollution buffers (Yang, Bao, & Zhu, 2011; Veisten et al., 2012).

8. CLEANING UP CONTAMINANTS

In urban areas, harmful contaminants may be released into the atmosphere and then deposited in the soil. Contamination by metals and industrial compounds is a long-term concern especially in industrial cities (Wong, Sharp, Hauwert, Landrum & White, 2012). The use of plants to clean up or remediate contaminated soil, sludge, sediments, and ground water through contaminant removal, degradation, is defined as phytoremediation, which has become popular in recent decades in Europe and North America. Greenery can effectively and economically remove, degrade, or contain contaminants, while bringing the benefits of a green environment to those who reside near the past contaminated sites and provide a sense of redressing environmental injustices (Peng, Ouyang, Wang, Chen & Jiao, 2012).

9. CONCLUSION AND RECOMENDATION

As a summary, there is general agreement that UOGS are essential for a livable and sustainable city. There are a variety of scientific evidences, explain the many different environmental benefits of UOGS which contribute to human and social wellbeing (Rakhshandehroo, Mohdyusof, M., & Tahir, 2015). This can be either directly for example by air cooling, or indirectly for example by their high biodiversity, enhancing opportunities for recreation and nature experience.

Figure 3 illustrates the recommendations for future research and action; as the first step there is a need to uniform definition and classification of open green spaces would allow the city municipalities to preserve adequate amount of open green spaces while enabling continuation of their housing developments and to promote themselves as green cities. Identifying important urban open green spaces and instituting an agenda for its protection prior to development can preserve productive urban farms and gardens, ensure vast recreational land and services for residents, and maintain the region's or community's natural, historic or cultural characters (Ahern, 1991).

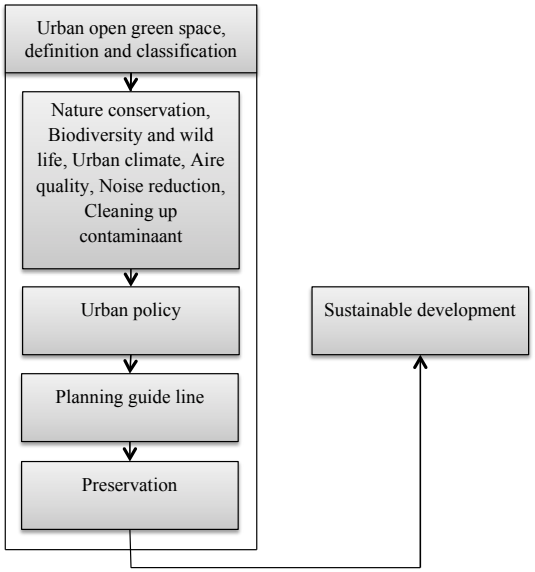

Figure 3: Recommendations for future research and action

However, the application and implementation of urban open green space policies should standardize and the guidelines should focus on all types of development rate undergone by each city. On the other hand, policy should be responsive to pressures of growth and the willingness to change the green areas or vacant land to residential, commercial or etc.

The residents have very clear ideas on how much urban open green space is really important in residential areas in order to provide them with a sustainable residential environment (Hussain, Tukiman, Zen, & Shahli, 2014) so developers should be required to provide greenery in each development under taken. New developments should allocate sufficient UOGS, following the spatial and conservation planning guidelines. Rather than a biased tendency with green acreage and tree counts, geometry of the green network and quality of the greenery also should be emphasized. New spaces should be potential to nurture high quality amenity vegetation, such as over story trees for generous visual and environmental benefits. It is accepted that the value of parkland to human health and quality of life, outdoor recreation and outdoor education, and fulfills our responsibility as stewards of our natural environment and the obligation to preserve and enhance our natural environment through the maintenance, restoration and enrichment of native flora and fauna.

Urban open green space provision provides a balance between development and environment therefore it is the main issue of sustainable development. In order to achieve the objectives of sustainable development, some of these spaces should be allocated to public use. It appears clearly that preservation of open green spaces is one of the right ways to achieve sustainable development and highly important to accomplish a better quality of life.

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