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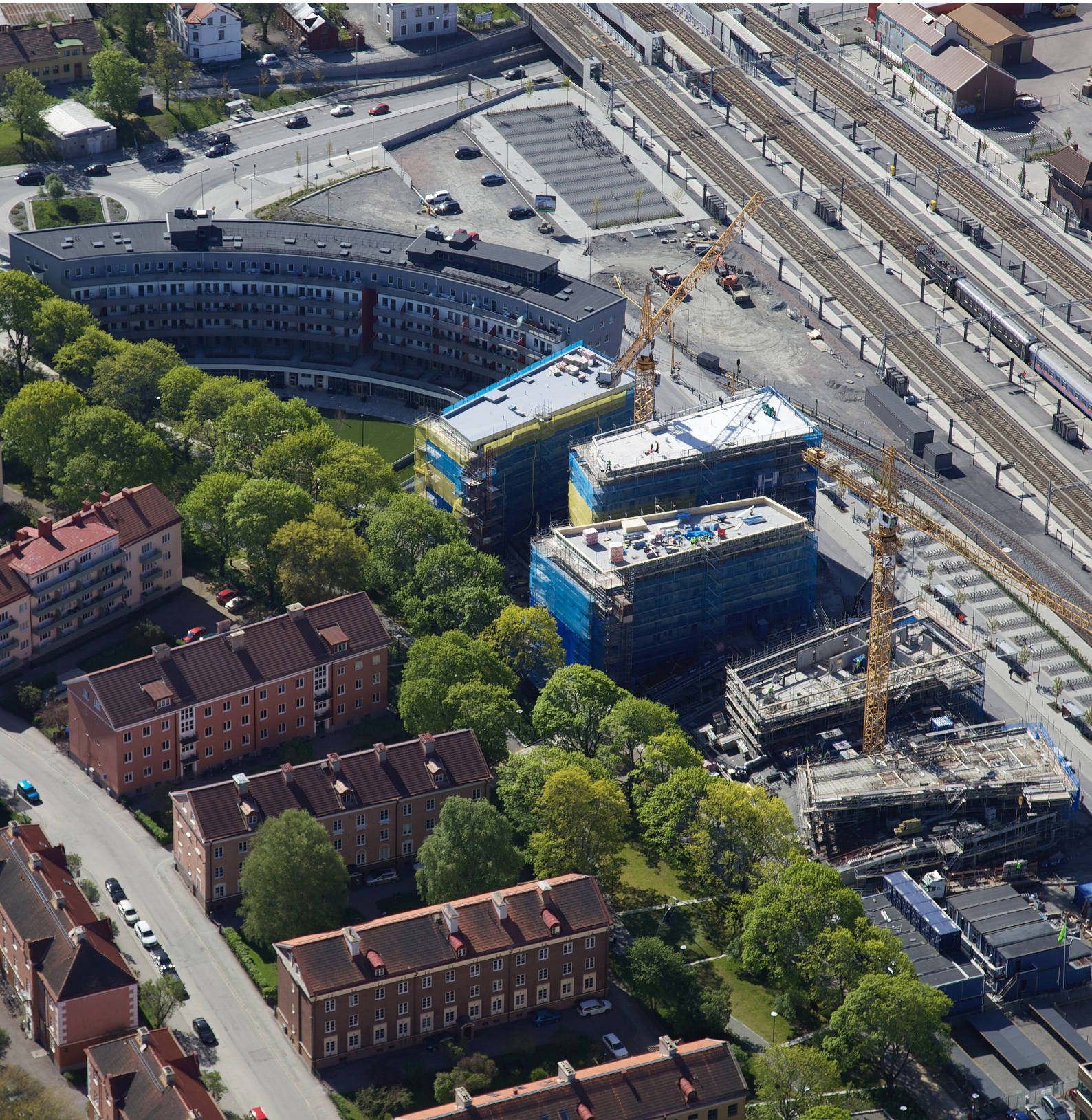

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# THEME ISSUE
# DENSIFICATION AS A PLANNING STRATEGY

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Picture on the front cover: «Frodeparken», Uppsala, Sweden. Photo: Gunnar Britse

NORDISK ARKITEKTURFORSKNING
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# GREEN SPACE IN COMPACT CITIES: THE BENEFITS AND VALUES OF URBAN ECOSYSTEM SERVICES IN PLANNING

MÄRIT JANSSON

## Abstract

This paper presents a literature review on urban green space benefits and values and discusses green space qualities that are important in providing ecosystem services for sustainability of compact cities. Green spaces and elements provide many functions, services and benefits which are needed for the sustainable development of urban areas, as shown in numerous research studies. However, there is often a gap between the research findings on urban ecosystem services and urban planning processes, with green spaces risking being undervalued in compact cities. Two possible reasons for this gap are discussed in this paper: lack of compiled knowledge of the number and extent of ecosystem services provided by urban green space and the need for descriptions of valuable green space qualities including properties and potentials. Previous studies on urban green spaces and their contribution to economic, health, quality of life and ecological benefits in compact cities are reviewed and described. Analysis of the literature indicates that sustainable compact cities can be expected to need green spaces which are close to people, coherent and of sufficient size, varied and well-maintained and where people can engage in development. Such aspects can be increasingly considered in planning practice.

Keywords:
compact city; densification;
ecosystem services; green values;
planning; urban green space

## Introduction

Urban sprawl is often seen as a problem in urbanising areas globally, although land-use is particularly dispersed in US cities (Schneider and Woodcock, 2008). Densification of urban areas is by many actors in planning seen as a way of achieving sustainability, but it has also been questioned as a planning ideal (Neuman, 2005). Studies indicate that high-density neighbourhoods can provide better local services but also have more limited and low-quality green spaces, which may lead to a stronger feeling of insecurity and less social interaction than neighbourhoods with lower density (Dempsey, Brown and Bramley, 2012). Similar policies to control urban growth and realise compact city ideals can be successful in different parts of the world such as the US and Western Europe (Dieleman and Wegener, 2004). However, densification can be realised through different approaches and need to be adapted to each context, which might include a need for green-structure densification (Berg, Granvik and Hedfors, 2012).

The provision of urban green space and its associated benefits are important for sustainable urban development from ecological, economic and social aspects (Baycan-Levent, Vreeker and Nijkamp, 2009; James, et al., 2009) and are considered «*a key ingredient for city sustainability*» (Chiesura, 2004, p. 137), especially in compact cities (Jim, 2004). Despite this, green spaces are often undervalued for example in planning processes (James, et al., 2009; Pauleit, 2003), partly because the many different benefits of green spaces are seldom adequately recognised (Lundgren Alm, 2003). This indicates a need for descriptions and classifications of urban green space benefits in ways that lead to their increasingly being taken into consideration in planning and other landscape practices.

The *ecosystem services* provided by green spaces are depending on the physical *qualities* and *functions* of those spaces, and they give *benefits* and *values* for people (Haines-Young and Potschin, 2008). Ecosystem services are commonly classified into provisioning services (food, water, fibre etc.), regulating services (climate and water regulation, pollination etc.), cultural services (recreation, education etc.) and supporting services (nutrient cycling etc.) (Millennium Ecosystem Assessment, 2005). This classification is valuable but not well connected to the three categories of sustainability (economic, ecological, social) (Bastian, Haase and Grunewald, 2012) and does not focus specifically on green space in urban landscapes – *urban* ecosystem services – where the benefits perceived by residents can be expected to be of major importance (Chiesura, 2004). In order for knowledge on urban ecosystem services to be more fully implemented in urban planning processes, a holistic view of the extent of those services and the particular beneficial green space qualities is needed. It is important to recognise that urban green spaces (landscapes or ecosystems) of different types (parks, gardens, urban forests, cemeteries, wetlands etc.) cannot be highly valued only in general terms, as their

services depend on their qualities including properties (structures and processes) and how well their potentials are carried out (Bastian, Haase and Grunewald, 2012) as related to the rest of the city. The significance of landscape qualities is exemplified by the particular importance of natural, free-growing and multi-layered vegetation characters for specific benefits such as stress relief (Grahn and Stigsdotter, 2010). Landscape qualities including properties such as size, placement and content of green spaces and potentials through e.g. maintenance level thereby affect the actual ecosystem services (Bastian, Haase and Grunewald, 2012) and thereby the benefits and values (Haines-Young and Potschin, 2008).

Several attempts have been made to summarise the benefits of green space (Swanwick, Dunnett and Woolley, 2003; Chiesura, 2004) and even calculate its value in monetary terms (Miller, 1997; Bolund and Hunhammar, 1999; Boyd, 2007; Choumert and Salanié, 2008; TEEB, 2010). The important use and non-use values for people (Chiesura, 2004) are commonly more difficult to calculate than the ecological values (Boyd, 2007). However, they can be measured with direct methods, e.g. how much a person is prepared to pay or give up to access green spaces, or indirect methods, e.g. how much people spend on transport to green areas or on living close to these (Choumert and Salanié, 2008). The many difficulties associated with calculating green space values in monetary terms include the poor connection between input and outcome, resulting in a lack of economic measures such as market-based results and pricing (Boyd, 2007).

This paper presents a wide ranging review of the literature on urban green space and its ecosystem services, benefits and values and discusses green space qualities (properties and potentials) that are important in providing ecosystem services for sustainability of compact cities. Two research questions were examined: Which benefits and values of urban ecosystem services are described in recent literature in the context of sustainable compact cities? Are there green space qualities which are repeatedly mentioned in the literature on urban ecosystem services and their benefits that also could be considered in planning practice for sustainable compact cities?

The narrative review method was based on literature searches and source categorisations in two parallel processes which influenced each other. Scientific publications from the past 15 years on urban green space benefits within the four categories *economic*, *health*, *quality of life* and *ecological benefits* were collected through the Scopus and Google Scholar search engines and the «snowballing» method. These categories and their main content were selected in collaboration with a working group including four planners and landscape professionals in the City of Lund, with the aim of covering the range of economic, social and ecological aspects of sustainability and the categories of ecosys-

tem services (provisioning, regulating, cultural and supporting) from a planning practice perspective. The working group also discussed *attractiveness* as a fifth category, in this paper seen as part of *quality of life*. The literature obtained was then examined for green space qualities repeatedly mentioned as being important for providing benefits of urban ecosystem services.

## Economic benefits

Urban green space can have long-term positive effects on the economy but can also generate more direct economic benefits and values through e.g. increased property value, willingness-to-pay for goods, urban agriculture and city branding.

Increased property values in the proximity of urban green spaces show the attractiveness of such locations. American studies indicate a 20 % increase in property values close to parks (Crompton, 2005). Apartment prices in Finland are higher close to water and forested recreation areas and increase with increasing size of total forested area within a residential district (Tyrväinen, 1997). In Guangzho, China, apartment prices are higher if they have views of green spaces and proximity to water (Jim and Chen, 2006), and in Hong Kong the lack of neighbourhood parks has pushed the value of housing close to them to a 17 % increase (Jim and Chen, 2010). In a study of three Dutch cities, houses in direct proximity to parks were found to be 6–8 % more expensive and those close to water 7–11 % higher in price (Luttik, 2000). Higher property values close to urban green space carry a paradoxical risk that those spaces will be built on as a result of their attractiveness, leading to lack of green spaces and increased socio-economic injustice in housing. Urban forests in the USA are more popular in wealthy areas, where people can afford the property prices (Zhu and Zhang, 2008).

Consumer behaviour is affected by the physical environment outside shops, increasing willingness-to-pay by around 10 % for products in areas where there are trees (Wolf, 2003). In a study of small, local stores in the USA, people were willing to pay more in areas with large trees and other vegetation in combination with trees and where the green elements were well maintained (Wolf, 2009). Joye, et al. (2010) concluded that green elements in commercial districts affect willingness-to-pay, aesthetics and mental health.

Urban agriculture is important for food production, economics and justice in a global context, e.g. for women's rights and equality (Hovorka, 2006) and children's nutrition and health (Maxwell, Levin and Csete, 1998). Members of households participating in community-based urban farming eat fruits and vegetables more often than others (Alaimo, et al., 2008). Although still small-scale in Europe, urban agriculture is becoming

increasingly popular (Campbell, 2009), and its importance will grow with future needs for multifunctional urban green spaces in order to achieve ecological sustainable development (Van Leeuwen, Nijkamp and de Noronha Vaz, 2009). Urban gardening contributes to urban biodiversity, and the products (mainly potatoes, vegetables, fruits and berries) annually grown in Sweden have a high economic value, in 2001 approximately 2.7 billion SEK (Björkman, 2001).

Urban green spaces play a major role in city branding or place branding, whereby cities or regions brand their local identity to attract companies, qualified workers and tourists (Erickson and Roberts, 1997). Using local green elements in city branding can be economically profitable according to a Canadian study (Dodds and Joppe, 2001). Local parks may have large effects on tourism if both parks and the tourist industry are well-managed (Eagels, 2002). The value of local vegetation to the landscape experience and tourism is exemplified by the cypresses by Lake Garda in Italy, which are worth over 100 million Euros per year for tourism (Notaro and De Salvo, 2010).

## Health benefits

Urban green spaces provide a number of benefits for human health, including longevity, physical and mental well-being, brain power and child development, all important for social and economic sustainable development.

Today, physical inactivity is a major global health issue, annually causing disease and around 1.9 million premature deaths (WHO, 2002). In the UK alone, it costs around 1 billion British pounds (Allender, et al., 2007). Positive effects can be expected from health-supporting activities in urban green spaces (Pretty, Peacock and Hine, 2006), as people living close to green spaces with high recreation values spend more time in physical activity than others (Björk, et al., 2008). The amount of park near the home is connected to levels of physical activity, particularly for women and young people (Kaczynski, et al., 2009). Proximity to attractive, public areas with many functions, such as parks, increases physical activity in the form of walking (Jackson, 2003; Giles-Corti, et al., 2005). Where people have access to gardens and other green spaces, the entire urban environment functions better for outdoor activities and healthy transport, reducing stress and overweight (Nielsen and Hansen, 2007). Overall, people are healthier when living in urban areas with access to much green space, even healthier than in rural areas (de Vries, et al., 2003), with less sick-leave (Maas, et al., 2009). People also consider themselves healthier the more green space they can access near the home (Maas, et al., 2006).

The possibility of living a long and healthy life is affected by access to outdoor activities in all facets of life, not least in childhood (Ward Thomp-

son, Aspinall and Montarzino, 2008). For the elderly, longevity in urban environments increases with access to parks and tree-lined streets (Takano, Nakamura and Watanabe, 2002), but green spaces must be well-kept to promote walking by the elderly (Sugiyama and Ward Thompson, 2008). An active lifestyle with regular physical activity, supported by having green spaces accessible from the home, diminishes the risk of dying from severe diseases such as a number of cancer forms (Zoeller, 2009; Orsini, et al., 2009). For example, a study shows that people aged 62 or older live a healthier and more active life if they have allotment gardens (van den Berg, et al., 2010).

Access to green spaces plays a major role for the child-friendliness of cities and children's physical and mental development. Among children in highly urbanised areas, the risk of overweight can be reduced by proximity to much vegetation (Liu, et al., 2007). Accessibility to e.g. parks with shadowing vegetation and playgrounds increases everyday physical activity among children (Timpiero, et al., 2008). Studies show that public playgrounds near vegetation are used more frequently and experienced as better than other playgrounds (Jansson, 2010; Refshauge, Stigsdotter and Cosco, 2012). A park playground within one kilometre from the home is associated with a fivefold reduced risk of a child having an unhealthy weight (Potwarka, Kaczynski and Flack, 2008). Proximity to schools, parks and recreation facilities is important for physical activity among teenagers, but they consider it a problem if parks are too small, badly kept or not welcoming to them (Tucker, et al., 2008). Preschool grounds with slopes, trees and shrubs make children more physically active and better protected from unhealthy amounts of solar radiation than traditional, flat open yards (Boldemann, et al., 2006). Children in preschool with access to natural vegetation show faster development of motor and cognitive abilities than children in more traditional outdoor facilities (Fjørtoft, 2004).

Urban green space has developmental and educational values which can be used in school teaching (Dyment and Reid, 2005). School ground gardening has many positive effects on children and their behaviour, including educational results (Blair, 2009). Schools with large windows facing environments with trees and shrubs have a higher proportion of pupils with good study results and plans for higher education than other schools (Matsuoka, 2010). Viewing vegetation from the home is associated with increased cognitive abilities among children in low-income families (Wells, 2000). Children often use natural vegetation close to housing, since children's mobility is limited unless in organised groups or similar (Florgård and Forsberg, 2006). Access to vegetation makes children more creative (Taylor, et al., 1998) and supports children with difficulties in concentrating (Kuo and Taylor, 2004).

Spending time in green natural environments is of particular value for

the recovery and power of the human brain. Walks in parks with trees, offering shelter from stressful city life, improve concentration and mental control (Berman, Jonides and Kaplan, 2008). Nature-like environments, where human activity is not apparent, have special benefits in this regard (Hartig, et al., 2003), helping the brain recover from mental fatigue or after crises or stress (Ottosson, 2001). Among the elderly, the ability to concentrate is higher after resting in a garden than in a pleasant indoor environment (Ottosson and Grahn, 2005). The natural shrinkage of brain grey matter is slower among elderly people who walk a lot (Erickson, et al., 2010), especially with access to green space (Giles-Corti, et al., 2005).

Mental illness, often connected to stress, is a global problem creating high costs (WHO, 2004). In Europe alone, 33 million people suffer from severe depression (WHO, 2003). Proximity to urban green space is important for reducing mental illness, particularly stress-related forms (Stigsdotter, et al., 2010), as the frequency of use becomes limited at distances above 100–300 metres (Grahn and Stigsdotter, 2003; Nielsen and Hansen, 2006). Living more than one kilometre from the closest large green space is associated with poorer self-reported health and life quality (Stigsdotter, et al., 2010). Viewing natural elements such as trees and water from a window or, even better, walking in such environments reduces blood pressure and stress (Hartig, et al., 2003). Urban green elements are important for individual mental recovery (van den Berg, Hartig and Staats, 2007), for example by offering people the possibility of finding favourite places (Korpela and Ylén, 2007). Restorativeness is mainly found where grass, shrubs and trees form a varied nature-like environment, often in larger parks, but can also be provided in limited spaces (Nordh, et al., 2009). Other qualities of importance for mental health are biodiversity (Fuller, et al., 2007; Grahn and Stigsdotter, 2010), environments providing shelter or «refuge» and nature-like characteristics (Grahn and Stigsdotter, 2010). A small daily «dose» of green experience through e.g. walks, gardening, cycling, fishing or horse-riding can improve mental health and self-confidence, giving a huge potential for individual benefits and economic benefits for society (Barton and Pretty, 2010).

## Quality of life benefits

Green spaces can increase the attractiveness of urban areas for residents and visitors, providing possibilities for increased quality of life in terms of e.g. safety, participation, social interaction and attractive living and working environments.

Green city elements can contribute to a safer society with less negative social behaviour and higher perceived personal safety (Kuo, et al., 1998). People living in multi-family housing with much surrounding greenery such as trees and grass report less mental fatigue, aggressive behaviour and violence and better neighbourliness and safety than others (Kuo,

2003; Kuo and Sullivan, 2001a). Vegetation in urban areas is even associated with lower levels of property and violence crime (Kuo and Sullivan, 2001b; Wolfe and Mennis, 2012). Woodland vegetation, much appreciated for its aesthetics but also associated with e.g. fear of crime, can be designed and managed for better perceived safety (Jorgensen, Hitchmough and Calvert, 2002). Vegetation along streets and roads contributes in general to a safer traffic environment. But, since road trees have been considered a traffic danger, research on safer green road environments has focused on other elements (Mok, Landphair and Naderi, 2006). At the same time, trees have positive effects on driver behaviour (Dumbaugh and Gattis, 2005). Car drivers perceive streets with trees as safer and keep lower speeds there (Rosenblatt, Kweon and Maghelal, 2008), while also feeling less frustrated (Cackowski and Nasar, 2003).

The local development of parks and gardens supports both personal and housing area development (Ferris, Norman and Sempik, 2001). Public involvement in local park development through planning and design increases value in those areas, including better function and stronger personal attachment, according to a Taiwanese study (Huang, 2010). Community gardening can lead to social interactions between people and, by participating in community gardening and creating something beautiful and meaningful, people can strengthen their self-esteem and quality of life (Waliczekz, Mattson and Zajicek, 1996). In community gardens in New York, for example, people with origins in different parts of the world use gardening for production, improvement of common outdoor spaces and activities that promote social inclusion and learning (Saldivar-Tanaka and Krasny, 2004). The organisation created around gardening supports health and local social development (Armstrong, 2000).

Many urban green spaces are freely available to all, regardless of social and economic status. They thereby have a special role as meeting places, counteracting social injustice in society (Swanwick, Dunnett and Woolley, 2003), particularly if well-maintained and with recreation facilities (Kazmierczak, 2013). The social benefits of urban green space include integration within and between different ethnic groups (Peters, Elands and Buijs, 2010), especially when maintenance levels are high (Gobster, 2002). Play by both boys and girls is facilitated by large play spaces (Karsten, 2003) and vegetation (Änggård, 2011), which also increases interaction between children and adults (Taylor, et al., 1998). For older people, green space in housing areas serves to strengthen social ties and the sense of togetherness with others (Kweon, Sullivan and Wiley, 1998). Green space in proximity to the home facilitates social interaction, including both informal contacts and strong ties between people in multi-family housing (Kuo, et al., 1998), particularly if the space contains grass and trees (Sullivan, Frances and Depooter, 2004). Nature-like areas with trees attract different categories of residents, and dense tree plantings close to buildings facilitate meetings by large groups of people (Coley, Kuo and Sullivan, 1997).

Living close to green spaces with recreational values is much favoured (Björk, et al., 2008), while lack of green spaces can result in willingness-to-pay for increased greening (Lo and Jim, 2010). Residents feel more pleased with their housing if they can see natural areas from the window (Kaplan, 2001) and if nearby green spaces are coherent and varied in size and shape rather than fragmented and monotonous (Lee, et al., 2008). Beautiful physical surroundings, with much parkland, playgrounds and walking trails, are an important factor for people choosing a housing area (Florida, Mellander and Stolarick, 2011; Mellander, Florida and Stolarick, 2011). Urban parks express values and trends in the urban space (Thompson, 2004). Besides contact with nature being considered valuable and attractive, also water surfaces have a particular attraction (White, et al., 2010).

Viewing green spaces from the office window increases work satisfaction and quality of life (Dravigne, et al., 2008). The possibility of visiting or seeing a garden or other green space at work also reduces stress levels (Stigsdotter, 2004; Lottrup, Grahn and Stigsdotter, 2013). The attractiveness of working close to beautiful and shading green environments is shown in the rents for offices in such locations, which are around 7 % higher than elsewhere, according to a US study (Laverne and Winson-Geideman, 2003). Crompton, Love and More (1997) found that proximity to green spaces and recreation possibilities is an important location factor, particularly for small companies.

Urban green spaces can play a role in reducing car transport. In areas with much green space, bicycle transport is somewhat more used than elsewhere (Maas, et al., 2008). Besides, children gain larger independent mobility in urban areas with mixed land use and many street trees (Larsen, et al., 2009). Transport in green urban environments, in particular past street trees and flowers, is considered aesthetically attractive and good for mental well-being (Todorova, Asakawa and Aikoh, 2004).

## Ecological benefits

Ecological benefits from urban green spaces include e.g. regulating services, noise and pollution reduction, local climate regulation and reduction of global warming.

High biodiversity of species results in stable ecosystems that can provide many ecosystem services for ecological and other benefits. Urban environments can be important in providing scope for conservation of species in the city (Dearborn and Kark, 2010). Planners therefore have a role in developing the possibilities for biodiversity on different scales (Alvey, 2006) through green spaces of high quality, sufficient size and coherence (Millard, 2008). As a result of diminished biodiversity and loss of habitats, pollinators such as bees are diminishing, risking immense eco-

logical and economic losses (Potts, et al., 2010). Urban vegetation such as green roofs can be the habitats for many insects, spiders and herbs (Brenneisen, 2006). High biodiversity also includes still unknown social and pedagogic services, functions and values (Miller and Hobbs, 2001), such as people's affection and recognition (Martín-López, Montes and Benayas, 2007).

Green infrastructure is economically favourable in cities (Benedict and McMahon, 2006), providing many ecological (regulating) ecosystem services, particularly if it includes wetlands (Bolund and Hunhammar, 1999) and large trees (Gill, et al., 2007). The regulating ecosystem services are generally lower where urban density is high but can be maximised also in such areas (Tratalos, et al., 2007). The ecological value of regulating services can be demonstrated in some sample calculations. A study in Santiago, Chile, concluded that it is economically viable to manage urban forests with trees, shrubs and grass for air cleaning (Escobedo, et al., 2008). The trees in the Chicago area have a net value of 38 million USD, or over 400 USD each, as they annually clean the air of 5 575 tons of polluting particles and store 315 800 tons of carbon (McPherson, et al., 1997). The 2.4 million trees in central Beijing clean the air of 1 261.4 tons of polluting particles every year, while storing carbon dioxide equivalent to 200 000 tons of carbon (Yang, et al., 2005). Stormwater management costs caused by much impermeable surfaces in cities can be lowered by increasing the amount of green spaces (Harnik and Welle, 2009). Vegetation can absorb, store and evapotranspire water at a rate that increases with increasing density of the tree crown layer (Dwyer and Miller, 1999). Green roofs can restore hydrological functions and clean stormwater of pollutants (Palla, Gnecco and Lanza, 2010) and have been found to diminish water runoff from buildings by more than 50 % (Mentens, Raes and Hermy, 2006).

Vegetation has some noise-reducing effects depending on its design (Fang and Ling, 2005), which can serve to reduce the risk of high blood pressure (Bodin, et al., 2009) and cardiovascular diseases caused by traffic noise (Babisch, 2008). Green spaces function as health-supporting quiet zones (Gidlöf-Gunnarsson and Öhrström, 2007), particularly if the ecological quality is high (Irvine, et al., 2009). Green roofs can absorb sound waves before they reach the indoor environment (Dunnett and Kingsbury, 2004).

Small airborne polluting particles from transport and industry cause health problems and premature deaths (Breitner, et al., 2009). Vegetation, mainly the local presence of trees and shrubs, has air purification and filtration capacity (Nowak, Crane and Stevens, 2006). A mixture of trees leads to both high filtration capacity (mainly conifers) and increasing gas absorption (mainly deciduous) (Bolund and Hunhammar, 1999).

In areas with insufficient green spaces, there is a summertime risk of unhealthy local climates with high temperature and dry air, the *urban heat island effect*, leading to ill health and deaths, particularly in poorer areas (Johnson and Wilson, 2009). Green spaces maintain lower temperatures than buildings and paved surfaces, affecting the surroundings (Yu and Hien, 2006). The cooling effect varies with e.g. geography and climate, but parks are generally between 1 °C (Bowler, et al., 2010) and 4 °C cooler than the rest of the city (Wong and Yu, 2005). Cooler air results in a «park breeze» reaching the surrounding city with air circulation, temperature equalising and improved air quality (Upmanis, 2000). The cooling effect increases with large parks with many trees, shrubs and water surfaces (Cao, et al., 2010). Furthermore, green spaces and trees close to buildings shade and reduce wind, which equalises temperatures and reduces energy consumption for heating and air conditioning, leading to ecological and economic benefits (Dwyer and Miller, 1999; Jo and McPherson, 2001). The annual value of each shade tree is approximately 200 USD (Akbari, 2002). Planting 10 % more trees around buildings in Chicago, three more per building, would save 50–90 USD per household and year (McPherson, et al., 1997). Green roofs can keep the temperature down to 30 °C where it would otherwise become 60 °C, reducing the heat reaching indoors (Onmura, Matsumoto and Hokoi, 2001). Temperature equalisation also leads to lower energy consumption, which makes green roofs economically profitable in the long run (Oberndorfer, et al., 2007), but the effect depends on construction, thickness and local geography and climate (Alexandri and Jones, 2008).

Global warming gives rise to immense economic costs and can cause disturbances in ecosystem services, soil quality and water supply and lead to fires (Schröter, et al., 2005). Urban green elements such as trees, parks and green roofs can contribute to reducing global warming (Gill, et al., 2007) by lowering the local temperature (Wong and Yu, 2005) and by storing carbon dioxide (McPherson, et al., 1997; Yang, et al., 2005). Green spaces with city trees can, through evapotranspiration and reduced wind speed, diminish the amount of carbon dioxide emitted to the atmosphere (Jo and McPherson, 2001). One single tree can diminish the amount by 18 kilograms per year or even more if it is standing in a group of trees (Akbari, 2002).

## Analysis and discussion

This review shows that there is much existing evidence of the benefits that can be derived from urban green space and their ecosystem services, benefits needed for sustainability of compact cities. This emphasises the importance of preventing urban green spaces from becoming undervalued and therefore overexploited in planning processes (James, et al., 2009; Pauleit, 2003). Strategic planning, design and management of urban green spaces can increase their potentials and thereby their func-

tions, services and benefits. Densification can be important for saving arable land and creating functional cities but risks resulting in lack of green space qualities (Dempsey, Brown and Bramley, 2012) if implemented without considering urban ecosystem services as a part of the urban matrix.

One way of counteracting the risk of undervaluing urban green space in planning, an undervaluing due to lack of understanding of green space's many different functions, services and benefits (Lundgren Alm, 2003), is to use economic calculations of values (Miller, 1997; Bolund and Hunhammar, 1999; Boyd, 2007; Choumert and Salanié, 2008; TEEB, 2010). Although they are challenging, such calculations serve well as examples demonstrating the immense values put at risk unless green spaces are sufficiently considered in planning. However, it is questionable whether it will ever be possible to identify and calculate all aspects of green space values in monetary terms. Putting nature on an economic scale might result in long-term and irreplaceable urban green space values having to compete unequally with other, more short-term economic values. Thus it is important to develop approaches other than the monetary to demonstrate the values of urban ecosystem services and their benefits. As one alternative, this paper has identified benefits of urban ecosystem services categorised into economic, health, quality of life and ecological benefits.

Concretisation of the qualities (properties and potentials) important for urban green spaces providing ecosystem services in compact cities is important for implementing scientific knowledge from the literature into planning practice. Green space properties and potentials which lead to direct economic benefits include well-kept parks and trees close to homes, work and shopping areas, beautiful parks and water surfaces and possibilities for urban agriculture. Health-promoting green space qualities include green views from windows and proximity to green spaces which are large, coherent, varied, biodiverse, natural, protecting and with possibilities for activities for different ages. Quality of life is connected e.g. to green areas with trees, natural vegetation, well-kept parks, gardens, water or space for gardening close to housing, street trees, green bicycle trails and green elements close to work environments. Ecological benefits are supported by almost all types of green, blue and permeable surfaces, in particular by parks, trees, tree volumes, water, shrubs, green roofs, wetlands, open stormwater ponds, and diversity of species through e.g. coherent habitats and large trees.

In summary, five urban green space qualities which can be considered in planning were found to be repeatedly described in the literature:

– *Proximity to where people live, work, commute and spend time* is a determinant for e.g. use and health (Giles-Corti, et al., 2005; Grahn and

Stigsdotter, 2003; Nielsen and Hansen, 2006), supported by mixed land use with a combination of built structures and green spaces.
- *Coherence and sufficient size* increase several benefits from ecosystem services, for quality of life and ecological benefits, which cannot be provided in small spaces (Karsten, 2003; Lee, et al., 2008; Millard, 2008; Tratalos, et al., 2007). However, some quality of life and ecological benefits can be provided in green spaces of limited size, if well-managed (Nordh, et al., 2009; Tratalos, et al., 2007).
- *Variations in character and type* provide better functions (Lee, et al., 2008; Nordh, et al., 2009), individual choice and a variety of benefits, including green space characters which are e.g. nature-like, biodiverse, recreational and well-kept, in e.g. parks with trees and wetlands. Trees have a particular large range of benefits (Akbari, 2002; Boldemann, et al., 2006; Dwyer and Miller, 1999; Gill, et al., 2007; Matsuoka, 2010; McPherson, et al., 1997; Notaro and De Salvo, 2010; Nowak, Crane and Stevens, 2006; Rosenblatt, Kweon and Maghelal, 2008; Takano, Nakamura and Watanabe, 2002; Wolf, 2009).
- *Maintenance and upkeep to a high quality* support several urban green space benefits associated with a well-kept character, including economic and quality of life benefits (Eagels, 2002; Wolf, 2009).
- *Possibilities for people to be involved in green space development* through e.g. gardening or participatory processes can improve the functions of urban green spaces and their benefits for people (Ferris, Norman and Sempik, 2001; Huang, 2010).

Thus the literature reviewed indicates that planning practices for densification and the creation of compact cities need to permit inclusion of urban green spaces that are close to people, coherent and of sufficient size, varied, well-maintained and where people can engage in development. These rather general and non-quantified quality guidelines may serve to provide various ecosystem services, benefits and values but will need to be adapted to site-specific prerequisites for functional densification (Berg, Granvik and Hedfors, 2012).

More research is needed to further understand which properties and potentials of urban green space that can provide urban ecosystem services and benefits in sustainable compact cities. More in-depth knowledge could shed more light on the effects of urban green space for economic benefits such as trade, city branding, and urban agriculture and for quality of life benefits for social sustainability, such as vegetation for safety, creative gardening processes and educational and cultural benefits and values. The health and ecological benefits of urban green spaces can be increasingly understood through further studies but are today better covered than the economic and quality of life benefits, according to the results from this review. To concretise knowledge on urban ecosystem services and their benefits and implement it into planning practice, it

is also important that the qualities of the green spaces to which this knowledge refers are thoroughly described in literature.

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## Biographical information

Märit Jansson
Senior Lecturer in Landscape Planning
Department of Landscape Architecture, Planning and Management
Swedish University of Agricultural Sciences (SLU)
Address P.O. Box 66, SE-230 53 Alnarp, Sweden
Phone: +46 40 41 51 35
E-mail: marit.jansson@slu.se

Märit Jansson is a Landscape Architect and a Senior Lecturer in Landscape Planning. She studies the management of urban landscapes, particularly concerning adaptation to green space use for children and other users. Her current research concerns the use and management of green space in residential areas and on school grounds.