

Chapter 12

Urban Green Spaces and the Potential for Health Improvement and Environmental Justice in a Changing Climate

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Abstract Urbanisation and climate change affect people's health and well-being in various ways. Nature-based solutions implemented as natural, sustainable solutions in cities can attenuate negative health impacts of these processes. In this chapter, urban green spaces are considered as one type of nature-based solutions that use urban ecosystem services to provide mitigation and adaptation actions and solutions to climate change and urbanisation related challenges. An overview over the relationships to urban health is presented. The city of Berlin is used as a case, to show how an unequal distribution of urban green area may be linked to an insufficient provision of ecosystem services and the related positive health outcome effect. This is discussed through the presentation of the distribution of different vulnerable population groups such as children and elderly people throughout the city area. The link to environmental justice is made and discussed in this context.

Keywords Urbanisation • Health • Well-being • Children • Elderly • Urban green space • Berlin

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12.1 Introduction

Urbanisation and climate change are increasingly-affecting the global earth surface and urban health today and create a number of challenges to urban planning. World's urban population is expected to increase by more than two-thirds by 2050, from 3.9 billion in 2014 to 6.3 billion in 2050 (United Nations, Department of Economic and Social Affairs 2014). Interlinked pressures from land conversion, soil sealing and densification of built-up areas, decrease in quantity and access to urban green and blue spaces and increase of traffic and related effects of air and noise pollution pose significant threats to human health and well-being. In addition, climate change will have a significant impact on city environments (The World Bank 2010). Main climate change effects in cities include a rise in air temperature (e.g. during heat waves), poor air quality and higher ozone concentration, as well as extreme precipitation events (European Environment Agency 2016). Urban planners and decision-makers have to deal with the challenges of urbanisation and climate change to equitably secure access to clean air and drinking water, recreational green and blue spaces and an overall healthy living environment and, with this, the provision of ecosystem services (McHale et al. 2015). Ecosystem services are various goods and benefits that biodiverse natural environments provide to people, such as nutrients, livelihoods and cultural and recreational experiences (Millenium Ecosystem Assessment 2005). They provide specific health benefits to city residents. New approaches are needed in order to efficiently adapt to and mitigate negative effects from climate change and urbanisation and to maximise opportunities for improving the health of all urban residents, independent of socioeconomic status, gender, cultural background or age. Nature-based solutions (NBS) in urban areas are one approach, which have the potential to counteract these challenges across populations. NBS to societal challenges are defined by the European Commission 2016 as “[...]Nature-based solutions to societal challenges as solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource-efficient and systemic interventions”. By referring to “solutions that are inspired and supported by nature”, urban green space can be implemented as components of NBS in cities. Such solutions contain natural or semi-natural areas like urban parks, vegetated roofs and facades, street trees, gardens and blue systems such as rivers, canals, lakes, wetlands or ponds as well as other types of interventions that use at least partial ecosystem functions and services to provide adaptation and mitigation actions to climate change and challenges from urbanisation (Kabisch et al. 2016a). This chapter discusses how urban green spaces can provide ecosystem services and thus act as NBS particularly to health challenges resulting from climate change and urbanisation. In this regard, the present chapter builds on the previous chapter on “Effects of Urban Green Space on Environmental Health, Equity and Resilience” by Braubach et al. (Chap. 11, this volume). Using the city of Berlin as a case, a special focus is on environmental justice with distribution of urban green spaces linked to different vulnerable population groups such as children and elderly people.

12.1.1 The Potential of Urban Green Spaces for Ecosystem Service Provision and Health Improvement

Many of the climate regulation ecosystem services counteract particularly the environmental health threats connected to urbanisation and climate change (Haase et al. 2014). Extreme weather events such as heat waves, exacerbated by the urban heat island (UHI) effect, cause premature death and illnesses (Basagaña et al. 2011; Xu et al. 2016). The UHI effect is most significant in areas of high impermeable built-up density and low share of green space (Oke 1973; Rizwan et al. 2008). Urban trees and vegetation provide climate regulation services as they reduce the UHI effect through evapotranspiration and shading and can thus help preventing heat-related morbidity and mortality (Chen et al. 2014). Also urban blue spaces can decrease heat levels and mitigate heat-related morbidity (Burkart et al. 2015). In this context, green and blue spaces may therefore be considered as examples of NBS.

There is also an interaction effect between heat and air pollution, with higher levels of pollution in hotter environments (Harlan and Ruddell 2011). Air pollution from traffic and industrial sources has increased with rising urbanisation resulting in a severe impact on human health with an estimated 600,000 premature deaths annually in Europe alone (Lelieveld et al. 2015; WHO 2016; Brauer et al. 2016). Increased exposure to poor air quality conditions can have severe health effects in the life course of individuals. (King et al. 2011; Lindström et al. 2014). The issue is particular problematic in poor areas of cities, often situated close to traffic or industry with sparse vegetation and high-quality green spaces. There is some evidence around the regulation potential of urban green space as an NBS to reduce air pollution levels in cities. However, evidence is inconsistent (for a detailed discussion and evidence on the potential of air pollution improvement of NBS, see Baró et al. Chap. 9, this volume). Some studies show significant effects (Nowak et al. 2013; Vailshery et al. 2013; Baró et al. 2014), while others show no effect (Setälä et al. 2013) or even worsened pollution levels under street tree canopies (Jin et al. 2014). However, by careful management and planning, it is likely that reduced air pollution levels can be achieved through an optimised relation between plant genotype, tree canopy density and leaf area index as an NBS (Derkzen et al. 2015; Cameron and Blanuša 2016).

Flooding is another risk factor, which is associated with climate change-related impacts and is exacerbated in dense cities with high sealing rates and less inflow. Floods can induce high economic losses because of the risk for intense infrastructure damage. Climate change projections show an increase in the risk of river floods, superficial floods as well as coastal floods due to sea level rise (European Environment Agency 2012). Next to economic effects, floods have severe effects to human health. Flooding not only poses severe direct risks to health of residents but also affects health infrastructure. The local characteristics of a city, including sealing rates and green space cover, determine the amount of damages and impacts on infrastructure and human life through flooding. Particularly, in high density districts, extreme precipitation events can cause flooding and lead to economic and

infrastructural damages with risks to health of local residents. In summer 2016, an extreme precipitation event occurred in the city of Berlin, Germany. This extreme precipitation event has not been existing in the last 50 years and has led to flooding of the particular high-dense districts of Neukölln and Wedding in Berlin with damages to the transport infrastructure (Berliner Morgenpost 27.07.2016). The strategic implementation of green spaces to mitigate extreme precipitation and potential resulting floods can be accounted as an NBS based on regulating urban ecosystem services (Haase et al. 2014).

12.1.2 Unequal Distribution of Exposure to Health Threats in Urban Areas – An Issue of Environmental Justice

Many of the mentioned environmentally related health threats are unequally distributed in a city with a higher exposure to vulnerable populations in deprived areas, often living in very dense areas with high share of imperviousness, living closer to traffic, industrial sites, contaminated soil and poor accessibility to high-quality green spaces (Su et al. 2011). Health inequalities are expected to grow with ongoing urbanisation and with impacts from climate change, thus affecting people's equal chances to create healthy and prosperous lives (McMichael 2000). Apart from socioeconomically deprived populations, children and elderly populations belong to vulnerable groups with increased sensitivity to urban health risks related to climate change, such as heat stress and air pollution (Vanos 2015; Benmarhnia et al. 2015). Children are in a developing state, thus more sensitive to environmental extremes and harmful exposures. Elderly can be more vulnerable due to co-morbidity, medications and inefficient thermoregulation. Both children and elderly are restrained in their capacity to behavioural adaptation (e.g. mobility constraints). The disproportionate allocation of environmental burdens to different population groups raises concerns about environmental justice (Davis et al. 2012). Environmental justice is traditionally related to the health of low-income residents and minority groups who live in neighbourhoods with low environmental quality (for a literature review, see Downey and Hawkins 2009). For definitions of the concept of environmental justice, see Box 12.1.

Box 12.1: Definition of Environmental Justice in a European and US Context

In a European context, environmental justice has been defined as "... equal access to a clean environment and equal protection from possible environmental harm irrespective of race, income, class or any other differentiating feature of socio-economic status" (Schwarte and Adebawale 2007). The US Environmental Protection Agency defined environmental justice as "... the fair treatment and meaningful involvement of all people regardless of race, colour, national origin, or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies" (United States Environment Protection Agency 2017).

12.2 Links Between Urban Green Spaces, Health and Environmental Justice

12.2.1 *Health Effects as Co-benefits of Nature-Based Solutions to Climate Change Mitigation and Adaptation from Urban Green Spaces*

Several pathways have been proposed for explaining the link between urban natural (green and blue) areas and improved public health. Such pathways relate to, for example, the opportunities for stress recovery, physical activity and social contacts (Hartig et al. 2014). As the same factors – stress, physical inactivity and social isolation – are major risk factors for many chronic diseases (e.g. diabetes, cardiovascular and mental disorders, obesity and cancer), actors in public health urgently seek to identify strategies to reduce these risks. City living may worsen the exposure and consequences of these risk factors. For example, the higher prevalence of mental disorders in urban as compared to rural areas has, among other factors, been attributed to the relatively hectic and stressful life in cities (Peen et al. 2010). Similarly, environmental factors also contribute to physical inactivity in cities, such as high-density traffic and lack of parks and sidewalks. In this context, NBS implemented as urban natural spaces have emerged as health-promoting environments to reduce stress, encourage physical activity and provide a sense of community for increased social interactions.

Recent epidemiological studies seem to confirm the beneficial health impact of natural spaces. Demonstrated health effects in a general population are, for example, reduced mortality (Gascon et al. 2016), reduced cardiovascular morbidity (Tamosiunas et al. 2014; Donovan et al. 2015), lower blood pressure (Grazuleviciene et al. 2014) and decreased depressive symptoms (Reklaitiene et al. 2014). At the same time, improved conditions are found for pregnancy outcomes (Dadvand et al. 2012), and general physical and mental health (Annerstedt et al. 2012; Triguero-Mas et al. 2015).

12.2.2 *Health, Justice and the Link to Urban Green Spaces*

Urban green spaces and the benefits they provide can be disproportionately available to a subset of urban population (Ernstson 2013). Scientific literature suggests that immigrant communities in European cities often have limited access to parks and urban green spaces in their vicinity compared to nonimmigrant groups (Germann-Chiari and Seeland 2004; Comber et al. 2008; Dai 2011). Many studies have also demonstrated that health inequalities tend to decrease in greener areas (Mitchell and Popham 2008; Mitchell et al. 2015) and that deprived groups seem to

benefit the most from the positive health effects of nature (Ward Thompson et al. 2012; Roe et al. 2013; Ward Thompson et al. 2016).

Children is one group with particular needs and particular health risks related to urban living. There is a risk that in today's society, with increased screen time, computerisation and less outdoor play, children will become disconnected from nature and thereby miss out on related health benefits (Louv and Hogan 2005). Research indeed demonstrates that children in areas with more green show a better cognitive and behavioural development (Amoly et al. 2014; Dadvand et al. 2015) and symptoms of various behavioural disorders are relieved in nature (Faber Taylor and Kuo 2009). In addition, street tree density and other urban greenery have been associated with less childhood obesity (Kim et al. 2014) as well as lower asthma prevalence (Lovasi et al. 2008).

The elderly population is particularly vulnerable to environmental exposures with negative impact on health. Older people's health can benefit from quality and quantity of urban green spaces (Takano et al. 2002; Barbosa et al. 2007). Proximity to green space (near home of residents) improves longevity of senior citizens (Takano et al. 2002). A study by Kawachi and Berkman (2001) showed that even the potential to be outside in a green space could increase older people's health. Sugiyama and Ward Thompson (2007) identified that neighbourhood environments are likely to contribute to older people's health by providing places as opportunity spaces to be active. They found that older people who live in a supportive environment including green spaces are likely to walk more and are equally likely to be in better health. Those studies have shown that the pure existence of urban parks motivates older people to walk and go outside, which in turn improves their health and well-being and decreases potential health costs.

12.3 Unequal Distribution of Urban Green Spaces as a Concern for Environmental Justice

Establishment and management of green spaces are examples of societal actions that cost-efficiently can improve public health and counteract health inequalities. Being a free and public asset providing benefit independent of individual resources, green spaces can positively influence health in various population groups. However, within cities, green spaces are often unequally distributed between groups of different socio-economic status, age and ethno-racial characteristics, making specific population groups more vulnerable to climate change- and urbanisation-related health impacts (Gobster 1998; Byrne and Wolch 2009). Unequal access to urban green space has, thus, become an issue of environmental justice (Kabisch and Haase 2014), and awareness of this problem has increased in order to prevent avoidable negative health impacts across the life course (Dai 2011). This means that NBS provided by green spaces may be withheld from those who need it most.

Uneven distribution of and access to urban green and blue spaces may be related to a number of interlinked factors including historic land use development, park management and design. Also in historical times, green spaces and parks were created where the rich lived. Even today, the installation and development of urban green spaces – such as parks – increases attractiveness of a neighbourhood, making it desirable for investments. In turn, raising house and rent prices can potentially lead to a displacement of those residents the green space was actually meant to be beneficial for. Such effects are called “green paradox” (Wolch et al. 2014), “eco gentrification” (Patrick and Kowalski 2011; Haffner 2015), “ecological gentrification” (Dooling 2009) or “environmental gentrification” (Checker 2011) (for an intensive discussion on the concepts, see A. Haase, this volume).

To ensure that all residents in a city have a minimum amount of urban green spaces in their vicinity and therefor benefit from the ecosystem services provided by them, city planning departments use threshold values to coordinate their urban green space planning and development and to safeguard current green space quantity. Some city agencies try to focus on concrete per capita threshold values (e.g. 6 m² per inhabitant for Berlin, 10 m² per inhabitant for Leipzig) or certain park or green area sizes which should be reached by a certain distance (e.g. 2 ha in 300 m or in 500 m, Handley et al. 2003). These values are still planning objectives, as they are not met in all parts of the city, at least in the case of Berlin (Kabisch and Haase 2014). Calculation of accessibility and availability of green spaces using different threshold values has already been applied and analysed in geographical information system (GIS) analyses (Kabisch et al. 2016b, c; Dai 2011; Comber et al. 2008; Barbosa et al. 2007). Kabisch et al. (2016c) assessed urban green space availability using a sample of EU cities. They identified a diverse picture across the countries. Southern European cities show below-average availability values, which may be explained by their low forest and tree cover and reflect the history of cities in Southern Europe. Comparatively, above-average availability values in Northern European cities were identified and discussed to may be a result of biophysical conditions, the presence of rich forestland in general but also of Northern European attitudes towards urban living that naturally value having forests close to home. Comber et al. (2008) showed that Hindu and Sikh groups have limited access to UGS in the city of Leicester. For Sheffield, Barbosa et al. (2007) found that 64% of Sheffield households fail to meet the recommendation of the regulatory agency English Nature (EN) that people should live no further than 300 m from their nearest green space.

However, there are also critical notes arguing that threshold values simply underestimate the actual provision of urban green spaces. Threshold values and a certain size or distance measure may say nothing about the actual accessibility for different population groups, nor do they provide real information about the quality and the safety and the use of the space. Thresholds do not consider how many people actually live within the recommended distance and therefore do not take into account the pressure on the area and the risk for crowding and overuse. For example, in cities where green spaces and waters are distributed throughout the whole city, this can result in good overall green space provision values despite low per capita values in

certain dense areas. Thresholds used for defining availability or accessibility such as maximum 300 m linear distance to a green space of minimum 2 ha may also not be the most appropriate for identifying differences on a sub-district level for certain vulnerable groups. A 300 m linear distance is often longer in reality, as the linear measure, which is mostly applied in accessibility studies does not consider the actual walking route, including larger roads and other potential physical barriers. The 300 m threshold may therefore be less relevant for children and the elderly.

12.3.1 Threshold Values for Urban Green Space Provision in Berlin

Berlin is applying a 6 m² urban green space per capita value on a local scale to have some orientation for further green space development projects throughout the city. The threshold is met in most of Berlin's sub-districts (see Fig. 12.1). However, values are below the threshold in the very central districts with population densities of more than 14,000 inhabitants per km².

With regard to the percentage of specific age group distribution in the city the maps show that relatively high proportions of older individuals (more than 65 years of age) are located in the peripheral parts of the city where share of green space is particularly high (with more than 50% in some districts). In some inner city sub-districts, older individuals represent less than 10% of the sub-district population, whereas in most of the districts, the percentage of children is between 8 and 13%. There are some inner city districts such as Neukölln in the south east of the city and Mitte in the central and northern inner city parts where percentage of children is more than 17%. Here, population density is comparatively high with high sealing rates and less green spaces (see also a paper on children's health and distribution of urban green and blue spaces by Kabisch et al. 2016b).

12.4 Discussion and Conclusion

Urban green space development and maintenance as NBS for climate change adaptation and mitigation will almost certainly become increasingly important as urbanisation and climate change increase (European Environment Agency 2012). Various scenario studies and existing cases show that climate change most strongly affects those who are the most vulnerable, such as people of low income and education, children and elderly people. For those population groups, NBS implemented through, for instance, parks, street green, urban forests, pocket parks or even roof greenery could potentially function as a complementary health resource, counter-acting some of the socially determined health inequalities present today in our cities (Hartig et al. 2014; Mitchell et al. 2015). In this chapter, we discussed how urban green spaces may act as an NBS to climate change and urbanisation-induced

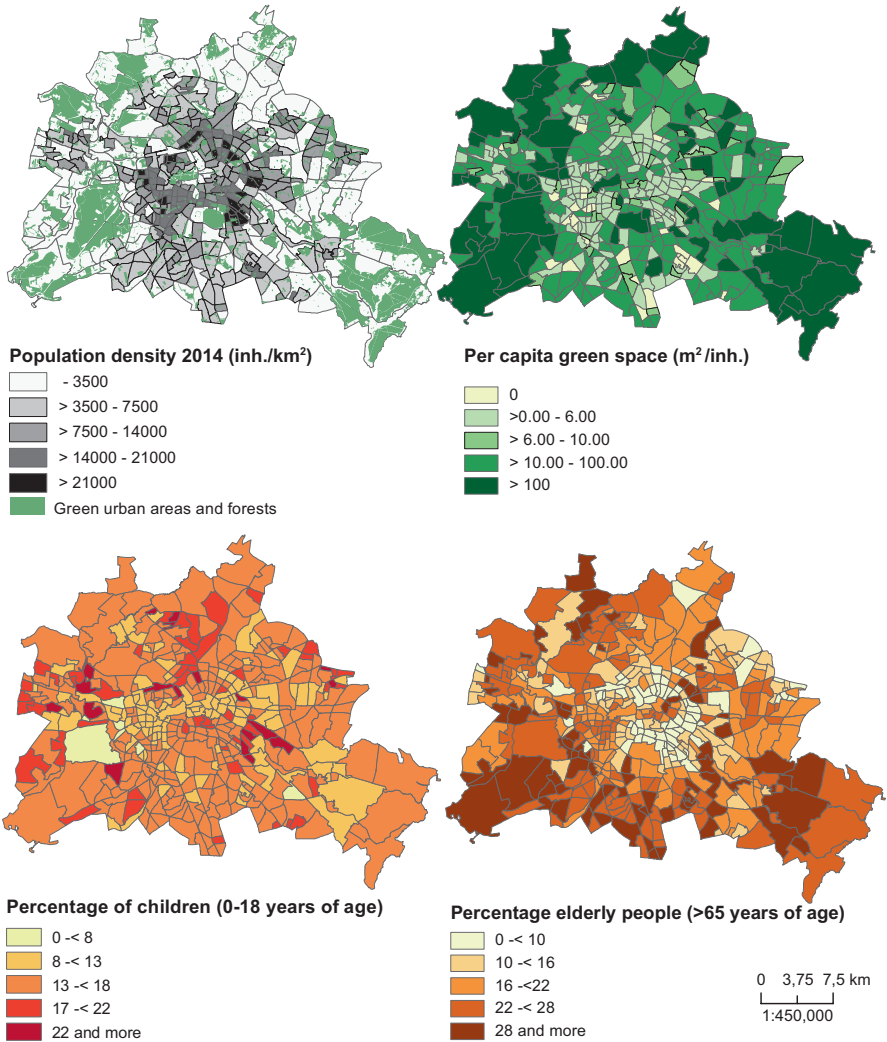


Fig. 12.1 Population density and per capita green space in the sub-districts of Berlin 2012 (Land use data are based on the Urban Atlas 2012 (Source: <http://www.eea.europa.eu/legal/copyright>). Copyright holder: Directorate-General Enterprise and Industry (DG-ENTR), (Directorate-General for Regional Policy). Population data are provided by the Department of Statistics Berlin-Brandenburg, (www.statistik-berlin-brandenburg.de) and refer to 2014)

challenges and at the same time counteract health inequalities across socio-economic status and age scales. This could potentially have a substantial bearing as health inequalities is a major target for improved public health. There are no biological fundaments for differences in health between groups of different education or income, nevertheless the health gap is wide between poor and rich and continues to widen (Dai 2011; Vaughan et al. 2013).

This means that there is a need to act on social and environmental health determinants to achieve good health for all people (Martuzzi et al. 2010; Marmot et al. 2012). In order to achieve positive health outcomes it is important that urban natural spaces are available in a sufficient quantity and easily accessible to all population groups. Children, especially from less wealthy families with fewer opportunities to travel, are bound to spend much of their time in the close neighbourhood and are as such specifically vulnerable to effects of the residential environment (Koller and Mielck 2009). Therefore, an equal distribution of high-quality and safe urban natural spaces, adequate for physical activity and play, is of utmost importance in healthy urban planning. This was highlighted already in the Parma Declaration (WHO 2010) where the European member countries committed themselves “to provide each child by 2020 with access to healthy and safe environments and settings of daily life in which they can walk and cycle to kindergartens and schools, and to green spaces in which to play and undertake physical activity”. Green space implementation projects as NBS should be considered as an appropriate tool for city planning and administrations to reach this commitment.

Left for future research and intensive discussions is the question of how much ecosystem service can an urban green space provide when it starts to get very frequently used, get crowded or even overused in very dense urban districts. This is sometimes the case in some of Berlin’s inner city parks such as the Mauerpark or the Görlitzer Park particularly at the weekend or during holidays. Although studies showed that in general residents tend to use their nearest park most often (Neuvonen et al. 2007; Schipperijn et al. 2010), this may not hold true in cases where the quality does not meet certain standards because of the overuse and the resulting low-quality aspects such as trash, dirty toilets, vandalism and criminality. Local residents may start avoiding these parks and even use other places farther away causing negative outcomes such as traffic (Arnberger 2012). Good quality park management that adapts to local conditions and integrates the needs of local residents may improve such situations at place.

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