URBACT Health&Greenspace network
Health-responsive planning and management of urban green infrastructure
July 2022

Guide for Cities on Health-Oriented Planning and Use of Urban Green Spaces

Lead authors:
Tamás **Kállay** (Lead Expert of the URBACT Health&Greenspace network)
Zsófia **Hamza** (Project Coordinator, URBACT Health&Greenspace network)

EUROPEAN UNION
European Regional Development Fund

URBACT

Lead authors

Tamás **Kállay** (Lead Expert of the URBACT Health&Greenspace network)
Zsófia **Hamza** (Project Coordinator, URBACT Health&Greenspace network, Hegyvidék Municipaliyt, Budapest 12. district)
Viktória **Soós** (Communication Officer, URBACT Health&Greenspace network)
Katalin **Bunyevácz** (HBH Strategic and Development Kft.)

Contributors

Eduarda **Marques da Costa** (Centro de Estudos Geográficos, Universidade de Lisboa, URBACT Ad-Hoc Expert)
Franca **Beccaria** (Eclectica, Institute for Research and Training, Torino, URBACT Ad-Hoc Expert)
Birgit **Georgi** (Strong cities in a changing climate, URBACT Ad-Hoc Expert)
Lucia **Vecchi** (GMLV arquitectura del paisaje, URBACT Ad-Hoc Expert)
Gábor **Kapócs** (Department of Psychiatry and Psychiatric Rehabilitation, New Szent János Hospital and Clinic)
Marc **Sansom** (SALUS Global Knowledge Exchange and Healthy City Design)
Attila **Varga** (Institute of People–Environment Transaction, Eötvös Loránd University)
Anastasia **Steinbrunner** (Peace Corps, TIER Mobility)
Sanda **Lenzholzer** (Wageningen University, Landscape Architecture and Spatial Planning)
Maria **Sitzoglou** (UIA Expert, OASIS)
Kateřina **Bonito** (Project Manager, CLAIRO)
Elżbieta **Raszeja** (University of the Arts Poznań, Faculty of Architecture and Design)
Anna **Gałecka-Drozda** (Poznań University of Life Sciences)
Lucy **Saunders** (Healthy Streets Ltd.)
Juhan **Teppart** (KINO landscape architects)
Karin **Bachmann** (KINO landscape architects)
Karien **van Bijsterveldt** (Municipality of Breda)
Inge **van den Broek** (GGD West-Brabant)
Söderman **Tarja** (City of Espoo)
Laura **Lundgren** (City of Espoo)
Anna **Hakala** (City of Espoo)
Sarah **O'Malley** (Limerick City and County Council)
Sharon **Lynch** (Limerick City and County Council)
Dino **Alessi** (Municipality of Messina)
Josephine **Di Pino** (Municipality of Messina)
Agnieszka **Osipiuk** (City of Poznan)
Katarzyna **Bogdańska-Głuchowska** (City of Poznan)
Sonia **Fluxá Juan** (Municipality of Santa Pola)
Marie Carmen **González Vives** (Municipality of Santa Pola)
María José **Mójica Marhuenda** (Municipality of Santa Pola)
Gabriela **Lazar** (Municipality of Suceava)
Irina-Elena **Nicolescu** (Municipality of Suceava)
Anna-Liisa **Unt** (City of Tartu)
Indrek **Ranniku** (City of Tartu)
Jaanus **Tamm** (City of Tartu)

Table of Contents


BRYANT PARK
BRYANT PARK

1 Introduction

A growing body of empirical evidence indicates that exposure to urban green spaces has positive impacts on both our physical and mental health. Spending only two hours a week in nature can do a lot for our health[1]. There is evidence that positive health benefits peak around 4 hours of exposure to nature. The positive impacts are evident for both young and old, men and women, and for people with different health status. Furthermore, it is not necessary to do physical exercise for health benefits, it is sufficient to simply sit on a bench.

Every 10% increase in green space is associated with a reduction in diseases equivalent to an increase of five years of life expectancy according to the European Environment Agency[2].

Increased greenspace exposure was found to be associated with reduced blood pressure, better pulmonary and immune function, reduced risk of stroke, cardiovascular disease, and asthma[3]. Access to natural environments can also improve overall mental health. The impact of green spaces to mental health include stress levels, improved general mood, reduced depressive symptoms, better cognitive functioning, improved mindfulness and creativity.

Parks have notable cooling effects in the vegetated areas and also in the surrounding built environment.
The oasis effect of park will become ever more relevant for urban residents as climate change related heat waves presents a range of health risks, including potentially fatal heat stroke[4]. Vegetation has an important role also in improving urban air quality by reducing exposure to pollutants through dispersion, deposition, decomposition and assimilation. Green urban areas also facilitate physical activity and relaxation and form a refuge from noise. Furthermore, parks and green spaces are places to connect with other people in the community and improve social well-being.

As artificial urban environment is rapidly expanding, and more and more people are forced to live in cities, urban green spaces are becoming particularly valuable. But as cities expand and densify, precious urban vegetation in cities is increasingly coming under threat. Despite their significant potential, the use of urban green spaces remains marginal, fragmented, and highly uneven within cities.

Local authorities can significantly influence how people use urban greenery, as well as how to improve their potential to deliver health and wellbeing benefits. Well planned and properly managed urban green spaces can contribute to healthy urban living, climate change adaptation and improved urban air quality.

There is a great variety of pathways to health and wellbeing that can be taken by cities. Examples for potential actions include among other the organization of community programs and cultural activities in green spaces, the development of health-nature trails and healing hospital gardens, temporary greening interventions, the transformation of streets into green cooling corridors, planting hedges along busy roads to capture air pollutants, the creation of outdoor educational routes and sites or natural play spaces, or the identification and protection of tranquil green areas.

Even small-scale greening interventions were found to deliver health, social and environmental benefits[5]. Experience also shows that successful small-scale actions can trigger long-term, larger-scale investments in urban neighbourhoods.

2 The URBACT Health&Greenspace Network

The **URBACT Health&Greenspace Network** is a transnational network of 9 cities working together to link green infrastructure design and management to urban health policies and practices. The project focuses on physical and mental health benefits of urban greenspaces, and their role in improving social health and air quality and reducing heat stress in cities. Actions targeted by the network are linked to both physical changes to the urban environment and the promotion of social activities in green areas.

The Health&Greenspace URBACT Action Planning Network is a partnership of nine cities:
Budapest 12th District (HU), Breda (NL), Espoo (FI), Limerick (IE), Messina (IT), Poznan (PL), Santa Pola (ES), Suceava (RO), and Tartu (EE).

3 About this Guide

This guide developed under the URBACT Health&Greenspace Network aims to support cities that are making efforts to adopt policies targeting at health-oriented planning and use of urban green spaces.
The guide was prepared based on five thematic reports published under Health&Greenspace:

- Impacts of Green Spaces on Physical and Mental Health (Thematic report No. 1)
- Impacts of Urban Green Spaces on Social and Individual Wellbeing (Thematic report No. 2)
- Urban Heat Stress and Cooling with Green Infrastructure (Thematic report No. 3)
- Using Urban Greenery to Improve Air Quality (Thematic report No. 4)
- Street Greening for Health and Wellbeing Outcomes (Thematic report No. 5)

The potential **pathways linking green space to health and wellbeing** are presented in the guide in **five domains:** Health Promotion, Wellbeing outcomes, Heat Stress, Air quality, and Noise. In addition, the guide covers also Street Greening separately as a priority area.

The guide is action-focused, supporting cities in the identification of specific measures most suitable for their situations. The document displays the rich diversity of actions that cities can take to link urban green space to improved health and well-being.

In Section 4, a **Matrix of Policy Interventions** is presented, that provides an overview of specific measures that can be adopted by cities to improve health and wellbeing outcomes with the use of urban green spaces.

In the subsequent sections, potential actions are described in detail together with specific aspects that need to be considered during implementation. The various types of actions are illustrated in the **Annex** of this document with a number of **showcases** from Europe and beyond.

4 Matrix of Policy Interventions

This section includes a matrix of potential policy interventions promoting improved health and wellbeing outcomes through the design and use of urban green spaces. The actions in the matrix are clustered by five domains: Health Promotion, Wellbeing outcomes, Heat Stress, Air quality, and Noise. Under each cluster the actions are differentiated further on the basis of urban situations (urban density, potential for greening actions) and the availability of budget for interventions linked to urban green spaces.

	LOW BUDGET	MEDIUM BUDGET	HIGH BUDGET
HEALTH PROMOTION			
densely built-in neighbourhood	• green prescription scheme • organized outdoors physiotherapy sessions • outdoor 'Friendship bench' scheme: mental health treatment by lay health workers	• development of healing hospital gardens • development of therapeutic gardens • designing green spaces into health-promoting environments	• running a green prescription program combined with free outdoor training sessions in neighbourhood parks • converting parts of existing parks into dementia parks • converting parts of existing parks into parks for people with disabilities
high share of green spaces / large areas suitable for green spaces	• green prescription scheme • organized outdoor physiotherapy sessions • guided therapeutic walks • Friendship bench' scheme in parks: mental health treatment by lay health workers	• development of health walk routes in large green spaces • development of dementia paths in parks • designing green spaces into health-promoting environments	• running a green prescription program combined with free outdoor training sessions in larger parks • development of dementia parks • developing parks for people with disabilities • development of linear or irregularly shaped parks
WELLBEING OUTCOMES			
STRENGTHENING COMMUNITIES			
densely built-in neighbourhood	• supporting the use of green spaces • tactical urbanism interventions to support social interactions • development parklets supporting social interactions • organization of social events /leisure programs / family days / community gatherings • farmers' market in green squares • organizing social programs in community gardens / allotment gardens	• placemaking supporting social interactions • establishment of community gardens / allotment gardens • development of roof gardens to foster social interactions • development parklets supporting social interactions	• large-scale program of community gardens / allotment gardens • large-scale program of roof gardens supporting social interactions

	LOW BUDGET	MEDIUM BUDGET	HIGH BUDGET
STRENGTHENING COMMUNITIES			
high share of green spaces / large areas suitable for green spaces	• supporting the use of green spaces • tactical urbanism interventions to support social interactions • organization of social events /leisure programs / family days / community gatherings • farmers' market in parks • organizing social programs in community gardens / allotment gardens	• placemaking supporting social interactions • establishment of community gardens / allotment gardens	• development of parks with large open spaces suitable for social activities • large-scale program of community gardens / allotment gardens
CULTURAL ACTIVITIES			
densely built-in neighbourhood	• organizing outdoor movie series • organizing music performances in green spaces • creative workshops / painting, public reading, drama and dance classes in parks and gardens	• developing stages for performances in green spaces	• development of an outdoor auditorium for performances • financing the organization of cultural activities in green spaces
high share of green spaces / large areas suitable for green spaces	• organizing outdoor movie series • organizing music performances in green spaces • creative workshops / painting, public reading, drama and dance classes in parks and gardens	• developing stages for performances in green spaces	• development of an outdoor auditorium for performances • financing the organization of cultural activities in green spaces
AREAS FOR CONTEMPLATION			
densely built-in neighbourhood	• development of green peaceful corners for contemplation • promoting contemplation in tranquil zones of existing green spaces	• development of peaceful zones in parks dedicated to reflections	• development of linear parks with long-distance views
high share of green spaces / large areas suitable for green spaces	• development of green peaceful corners for contemplation • promoting contemplation in tranquil zones of existing parks	• development of peaceful zones in large green spaces dedicated to reflections	• development of large green spaces or linear parks with long-distance views • development of tranquil reflection parks

	LOW BUDGET	MEDIUM BUDGET	HIGH BUDGET
OUTDOOR EDUCATION & PLAY SPACES			
densely built-in neighbourhood	• green classrooms and winter gardens in schools • development of outdoor educational corners in schoolyards • organization of field studies for schoolchildren	• development of educational paths • development of educational sites • greening schoolyards • development of natural play spaces • development of educational organic gardens	• program for greening schoolyards • program for the development of natural play spaces
high share of green spaces / large areas suitable for green spaces	• organization of field studies for schoolchildren • organization of environmental education programs • development of outdoor educational corners in schoolyards • green classrooms and winter gardens in schools	• organization of environmental education programs • development of educational paths • development of educational sites • development of outdoor classrooms • greening schoolyards • development of natural play spaces • development of educational organic gardens	• neighbourhood program for field studies • program for greening schoolyards • program for the development of natural play spaces
PHYSICAL ACTIVITY IN GREEN SPACE			
densely built-in neighbourhood	• organization of outdoor gyms • organization of guided walks in green spaces • appointment of physical activity managers	• program of outdoor physical activity sessions • development of running tracks, bike paths, walking routes in green spaces	• large-scale program of facilitated physical activity sessions • program of guided walks
high share of green spaces / large areas suitable for green spaces	• organization of outdoor gyms • organization of guided walks in green spaces • appointment of physical activity managers	• program of physical activities sessions in parks • development of running tracks, bike paths, walking routes in green spaces	• large-scale program of facilitated physical activity sessions • development of entertainment parks • program of guided walks
SAFETY IN GREEN SPACE			
densely built-in neighbourhood	• animating green spaces with a range of activities • involve the community in the design and maintenance of the green space • involving 'problem' groups or various under-represented groups in the revitalisation of green spaces • establishment of 'parks' friends' groups'	• ensuring passive surveillance within or nearby parks (cafés, apartments, stores and offices) • developing visible exits in parks • locating washrooms beside major activity areas • ocating night-time activity nodes nearby lighting	• developing positive features (play spaces, flower and herb beds, water features and boardwalks) • installing lighting in green spaces

	LOW BUDGET	MEDIUM BUDGET	HIGH BUDGET
SAFETY IN GREEN SPACE			
high share of green spaces / large areas suitable for green spaces	• animating green spaces with a range of activities • involve the community in the design and maintenance of the green space • involving 'problem' groups or various under-represented groups in the revitalisation of green spaces • establishment of 'parks' friends' groups'	• ensuring passive surveillance within or nearby parks (cafés, apartments, stores and offices) • developing visible exits in parks • locating washrooms beside major activity areas • locating night-time activity nodes nearby lighting	• introducing a park warden service (park staff patrolling larger parks) • developing parks with open views ensuring visibility • installing lighting in green spaces
HEAT STRESS			
densely built-in neighbourhood	• making public green space (gardens of public institutions, child care facilities) accessible as climate shelters • extending park hours during heat waves	• development of cooling corridors and pocket parks for cooling • installation of green roofs and green walls for cooling	• increasing the share of green spaces in the city / neighbourhood • developing a network of cooling corridors or pocket parks for cooling
high share of green spaces / large areas suitable for green spaces	• promoting large parks with water features as climate shelters • making public green space (gardens of public institutions, child care facilities) accessible as climate shelters • adopting construction bans to protect green ventilation corridors • development of plant-covered shade structures (pergolas) • extending park hours during heat waves	• converting parks into cooling islands • alignment of parks to take advantage of airflows • installation of green roofs and green walls for cooling	• increasing the share of green spaces in the city / neighbourhood • development of network of cooling islands • establishment of a large-scale program for green roofs/walls
AIR QUALITY			
densely built-in neighbourhood	• planting hedges along child care facilities • using greenery to invite people to less polluted areas • route planner for finding green walking routes with good air quality	• greening to improve air quality along roads • installing green roofs / green walls for pollutant capture	• program for green roofs / green walls to support pollutant capture • program for hedges along child care facilities • program to improve air quality along roads
high share of green spaces / large areas suitable for green spaces	• planting hedges along child care facilities • adopting construction bans to protect green ventilation corridors • using greenery to invite people to less polluted areas • route planner for finding green walking routes with good air quality	• greening to improve air quality along roads • installing green roofs / green walls for pollutant capture	• development of urban forests for deposition of air pollutants • development of green spaces to support ventilation • program for hedges along child care facilities • program to improve air quality along roads

NOISE	LOW BUDGET	MEDIUM BUDGET	HIGH BUDGET
densely built-in neighbourhood	• identification of tranquil areas • increasing the accessibility of tranquil areas • using dense vegetation structures as noise buffers	• creation of green tranquil spots • developing green walls functioning as sound buffers • program for protection of tranquil areas	• large-scale program on natural noise buffers
high share of green spaces / large areas suitable for green spaces	• identification of tranquil areas • increasing the accessibility of tranquil areas • using dense vegetation structures as noise buffers	• creation of green tranquil spots • developing green walls functioning as sound buffers • program for protection of tranquil areas	• creation of tranquil green areas • large-scale program on natural noise buffers

5 Health Promotion with the Help of Urban Green Spaces

5.1 Green space use integrated in health care practice

5.1.1 *The impacts of urban green spaces on health and well-being*

Academic literature, the World Health Organization (WHO) and other institutional sources highlighted the importance of green spaces to improve health and well-being. WHO presented a causal model of the impacts of urban green spaces on health and well-being (Figure 1)[6]. Through improved air and water quality, reducing noise levels and contributing to temperature regulation, urban green spaces can effectively reduce environmental health risks associated with urban living. In addition, they deliver health and well-being by enabling stress reduction and relaxation, physical activity, improved social interaction and community cohesion. Access to natural environments can improve overall mental health, physical fitness level, cognitive and immune function, and can lower mortality rates in general.

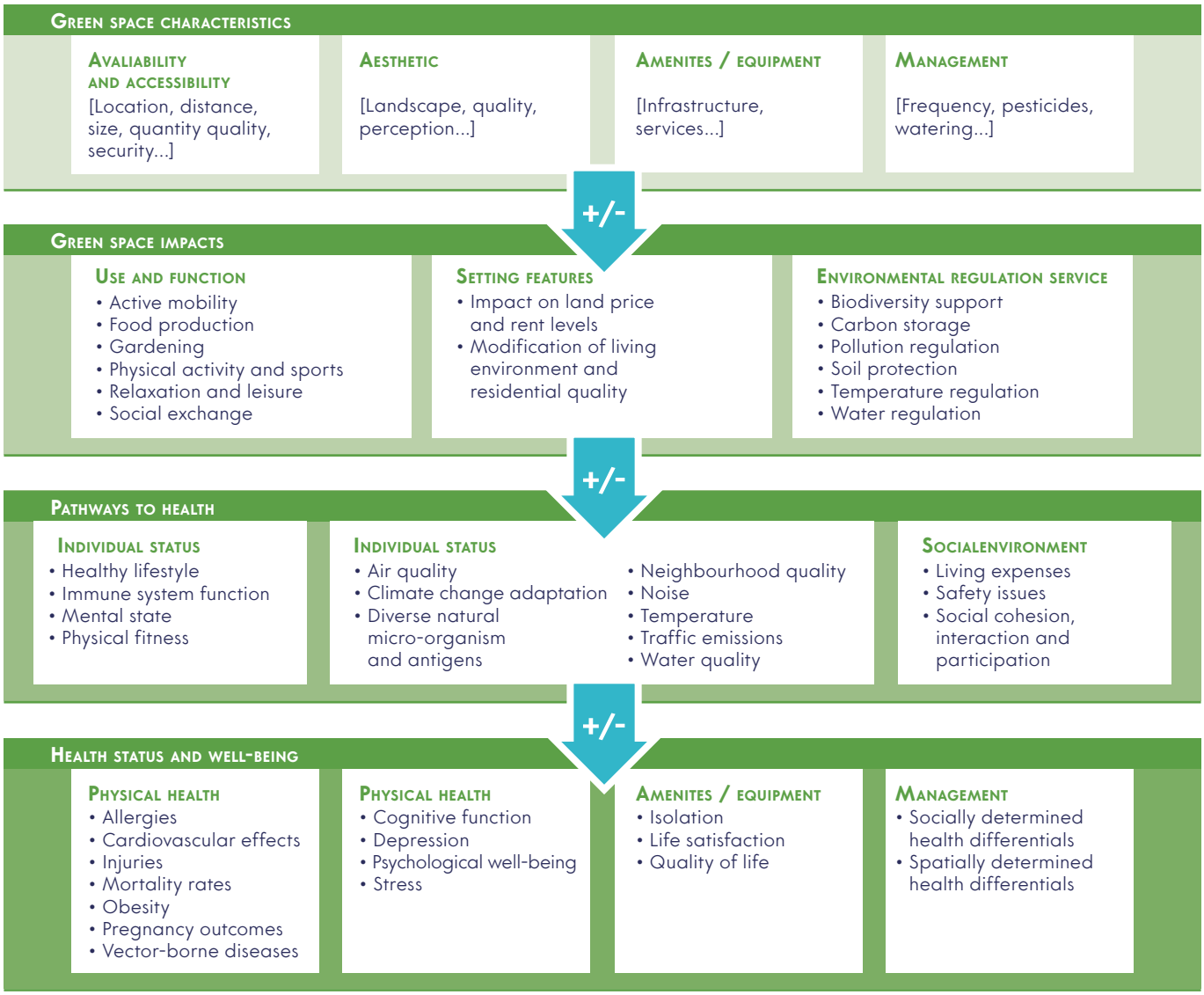


Figure 1. *A causal model of the impacts of urban green spaces on health and well-being*
Source: developed from A. Roué-Le Gall in Milvoy & Roué-Le Gall (2015), in WHO (2017). Urban green spaces: a brief for action, Copenhagen: WHO - Regional Office for Europe, p.8

5.1.2 *Impacts on physical health*

There is evidence that the provision of open and green spaces is associated with improved general physical health outcomes. According to the European Environment Agency every 10% increase in green space is associated with a reduction in diseases equivalent to an increase of five years of life expectancy[7].

A systematic review of five online databases and over 100 studies undertaken by the University of East Anglia found that people who spend more time in green spaces have significantly reduced risks for a number of chronic illnesses. According to the research, exposure to green spaces was linked to lower heart rate, lower blood pressure, lower cholesterol, and reduced incidence of stroke, asthma, diabetes and coronary heart disease[8].

Some studies[9,10] have indicated that there is a positive correlation between higher levels of green space and lower levels of obesity.

Evidence from a systematic review of studies shows that living in areas with higher residential greenness reduces the risk of cardiovascular mortality[11]. In Florida, higher level of exposure to green space has been associated with a reduced risk of stroke mortality[12].

A study undertaken in Australia[13] was highlighting the relevant role of the diversity of landscape features, such as trees and open spaces in improving physical health outcomes. The study has indicated that a greater variability of neighbourhood greenness was associated with reduced risk of cardiovascular disease and stroke. The likelihood of hospitalization and of self-reported heart disease or stroke was lower among people who lived in urban areas with highly variable greenness. It is suggested that heterogeneity in the distribution of greenness might contribute to better health outcomes through promoting physical activity.

Direct exposure to green space improves the functioning of the immune system[14]. According to a Finnish study[15], the immune systems of children can strengthen in a short time if their day-care centre yards are made more natural using forest undergrowth and grass. The findings suggest that exposure to natural environment can change the microbiome of children that result in better functioning of their immune systems.

Residential access to green space was also found to be linked to improved pregnancy outcomes[16].

In the 1980s, the study of Roger Ulrich showed that merely having a view of nature can provide physical benefits. Patients with a view of trees from their hospital bed recovered more quickly, required less pain medication, and had fewer post-surgical complications than patients in rooms with urban views.[17]

5.1.3 *Impacts on mental health*

Access to natural environments can also improve overall mental health. There is an indication that experiencing the natural environment reduces stress levels.[18] The impact of green spaces to mental health also include improved general mood, reduced depressive symptoms, enhanced cognitive functioning, improved mindfulness, short-term memory performance and enhanced creativity.[19,20,21]

At individual level, the lack of contact with natural spaces is linked to an increase in the incidence of mental illnesses[22]. Based on a growing body of evidence suggesting that living without nature is unhealthy, Richard Louv has coined the term 'nature deficit disorder'[23].

There are several theories that attempt to explain the beneficial effects of nature exposure:

- **Ulrich`s Stress Reduction Theory (SRT)** proposes that contact with unthreatening natural environments or viewing natural elements, having a restorative effect, can be effective in reducing stress, creating positive emotions and feelings[24].
- **Kaplan's Attention Restoration Theory (ART)** suggests that continued attention and fatigue can degrade our ability to solve problems and cause various negative emotions, and that mental fatigue and concentration can be improved by time spent in, or looking at nature, showing that natural environment can resolve health problems of modern people's daily lives caused by stress and fatigue. Nature exposure allows individuals to be away from daily stressors, as natural environment attracts their attention through 'soft fascination' providing the opportunity for recovery from mental fatigue.[25]
- **Wilson's biophilia hypothesis** claims that, as a consequence of evolution, humans have an innate tendency to interact positively with nature. When individuals engage in a non-threatening natural environment, the setting will naturally draw out strong positive responses, observed as research evidence of benefits from nature exposure. When individuals are exposed to natural environment, the setting will naturally trigger their strong positive responses.[26]

The biophilia concept is closely linked with the 'biophilic cities movement' Biophilic cities are cities that integrate natural features into their designs, providing close and daily contact with nature. A biophilic city is a biodiverse city, allowing people to integrate their daily lives with nature across different scales.[27]

5.2 Approaches and practices to improve health outcomes linked to green space use

Urban green spaces can have a significant role in supporting or complementing various **medical treatment programs**. Examples for using urban green infrastructure for therapeutic purposes include nature-based rehabilitation for people with stress-related illnesses or mild depression; nature-based addiction treatment, designed to help patients cope with drug and alcohol addiction; or postsurgical medical treatment, such as outdoor activities in green spaces as part of rehabilitation services for cardiac patients. A pilot study undertaken in Scotland has found that using a woodland-based cardiac rehabilitation programme that is combined with regular cardiac rehabilitation activity, can boost recovery[28]. To complement conventional therapies a health professional can prescribe activities in green spaces to patients.

Long-term exposure to green areas through reducing stress, increasing physical activity, and stimulating social cohesion can support **preventative care,** contributing to the prevention of many chronic disorders, such as cardiovascular diseases, and asthma.[29] Various prevention measures for cardiovascular diseases can be easily linked to green space use. These include regular outdoor exercise, or stress management techniques applied in natural environment, such as stress-releasing walks or mindfulness practices.

Above all, the use of urban green spaces can contribute to **health promotion.** As defined by the Ottawa Charter signed in 1986 at the First International Conference on Health Promotion organized by the World Health Organization, health promotion is „the process of enabling people to increase control over, and to improve, their health". it is not only the responsibility of the health care sector, but it goes beyond healthy life-styles to overall well-being.[30] It is also more than disease prevention that calls for action in advance, in order to make it improbable that the disease will progress subsequently.[31]

A similar concept, **'health creation'** has also been embraced recently. The concept is about changing the focus to the role of people and communities that create health instead of just mitigating illness. In his book, Lord Crisp explores the importance of creating health in the home, the workplace, the school, the community and wider society[32], or in other words, the role of employers, teachers, community leaders, architects, and families in helping to build a healthy and health-creating society. Health creation represents a power shift from health care practitioners to people and communities.[33] It can be actively promoted by supporting various engaging activities, and the provision of communal spaces.[34]

In line with the Ottawa Charter, health promotion relies on creating supportive environments[35]. Urban green spaces can function as such supporting environments. Parks and urban forests, apart from functioning as spaces enabling therapies and prevention, also have a particularly high potential for contributing to health promotion and health creation through making possible the contact with nature, social connections, and exercise.

5.2.1 *Health-responsive planning of urban green spaces*

When designing greens spaces with an overall aim to bring about health benefits, a number of factors or aspects need to be considered.

In line with the biophilia hypothesis introduced by Wilson humans have an innate tendency to seek connections with nature and other forms of life[36]. At the same time people are attracted to built environments (urbanophilia) because civilization offers protection from the dangers of nature[37]. People prefer the combination of natural and built environments, although in terms of relaxation potential the more greenery versus hard surfaces, the better.

A study of Hunter, Cleary and Cleland[38] provides a number of general recommendations for designing urban green space interventions that can potentially deliver health benefits:

- urban green space interventions should be a combination of a physical change to the green space and promotion programmes that aims at increasing park use,
- small-scale physical interventions, such as urban greenways/trails and pocket parks can be effective in bringing about health and well-being benefits,
- when designing green spaces, components that specifically focus on long-term health, social and environmental effects, as well as long-term management and maintenance need to be considered,
- the local community should be engaged in the design process to ensure that their needs are met by the intervention and to mobilise local knowledge into local solutions,
- the type and the context of green space should be considered when designing urban green space interventions.

See Showcases 5.1, 5.2, and 5.3.

Action:
Designing green spaces into health-promoting environments

Design can help in turning green spaces into health-promoting environments. In this regard, a report of the United States Environmental Protection Agency (US EPA)[39] includes a number of recommendations:

- *green spaces need to be accessible with good links (pedestrian and cycleways) to nearby neighbourhoods*
- *greens spaces should be designed with multifunctional uses; they should include spaces that encourage active mobility, physical activity and sports, relaxation and tranquillity, and opportunities for social interactions;*
- *the development of green spaces should be framed as a public health investment;*
- *when designing green space interventions, the needs of different age, social and cultural groups need to be considered;*
- *the creation of multisensory restorative environments can help mitigate the psychological stresses.*

Action:
Development of irregularly shaped or linear-shaped parks

A study by the research team of the Texas A&M University has found that the shape or form of green space has an impact on human health. The study revealed that irregularly shaped parks reduce the mortality risk of residents who live near them. The complexity of the park shape was found to be positively associated with a lower risk of mortality, that might be attributable to the higher number of available access points to the green space. In addition, as compared to compact-shaped green spaces, linear parks can also increase accessibility contributing to positive health outcomes.[40]

5.2.2 *Taking a life-course approach for green space planning*

Different subgroups (different age, social and cultural groups) use green spaces in a variety of ways. Although children and the elderly might have different needs, it is still possible to create a park or a garden that is attractive for all. While keeping the overall cohesion of the green space, it is possible to design it with 'rooms', which are distinct spaces responding to varying needs.[41]

A research led by the Institute of Future Cities at the Chinese University of Hong Kong explored how to plan and design urban green spaces to **facilitate the needs of older adults and to promote active aging** in an urban environment[42]. Their findings included the following:

- as mobility decreases with increasing age, accessibility is an essential factor to consider in planning the spatial distribution of urban green spaces; in line with the findings of the study a green space within 400 m can be considered as accessible by walking for older adults;
- there is an indication that in case of older adults, visiting of parks and other green spaces is closely related to their everyday activities, so it is worth locating urban green spaces close everyday places, such as stores, markets, service providers and public buildings;
- those with better self-reported health status preferred more stimulating, sunny and lively areas in urban green spaces, while people who perceive themselves to be in poorer health preferred less stimulating, shaded and quiet spots;
- attractive urban green spaces are considered safer and the maintenance condition of the urban green spaces as well as the colour of the plant affects perceptions of safety (in case of older adults there is an overall preference for greater number of flowers in green areas);
- Locations with design features (seating) that can encourage social interactions are typically the most popular spots in urban green spaces.

Douglas, Lennon and Scott in a study published in 2017 taking a life-course approach have provided guidance on improving green space benefits for health and well-being for different age groups[43]. Some of the recommended interventions included in the study are listed below by age group:

- *children:* engagement with nature and physical activity should be encouraged with certain designed-in elements, such as paved walkways, play equipment, fields and courts;
- *adolescents:* provision of sports facilities and other facilities supporting movement and physical activity; provision urban wilderness areas, untended vegetated areas, wildflower meadows for exploring and creative play; and zones of sheltered areas for relaxation and social interaction;
- *adulthood:* ensuring proximity of green spaces; provision of opportunities to engage with nature, spaces for walking, cycling for stress relief; development of communal seating areas in parks to encourage social interactions;
- *pregnant women:* provision of safe and accessible walkways, regular seating areas and clean public toilets;
- *elderly:* provision of accessible green spaces in close proximity to residential areas, sheltered seating areas with interesting views that encourage social interaction, spaces for games suitable for elderly abilities, such as chess and boules-type games; increasing exposure to green space through targeted greening of the streetscape.

Action:
Green prescribing

*A **green prescription** is an emerging nature-based health intervention, that is designed to improve physical and mental health and wellbeing of patients through exposure to natural environments.[44] It is a written advice of a health professional to a patient to be physically active.[45] Under the scheme the doctor can recommend the patient to go for regular jogs or walks in the park, or to participate in some other nature-based activity. Green prescriptions are typically complementing conventional therapies, and can be regarded as one part of a holistic health-promotion strategy.[46] It is a smart and cost-effective option to promote health creation.[47]*

(See Showcase 5.4)

Potential examples of green prescription activities include: participation in regular group walks; gardening as part of a horticultural therapy; undertaking of biodiversity conservation activities, such as habitat creation and restoration; green exercise (e.g., nature walks, biking, climbing); or wilderness arts and crafts.[48]
The 'green prescription' term was first introduced in New Zealand in 1998.[49] In the original initiative the general practitioner provides patients with plans for strategic physical activities and healthy diet. The term has since been broadened to include nature-based activities aimed at addressing chronic diseases, mental health issues and social isolation.[50]

Green prescriptions are mostly used to support prevention and the complementary treatment of chronic diseases such as cardiovascular disease and diabetes.[51] Such schemes were shown to result in increased levels of physical activity, quality of life, a decrease of blood pressure and a change in coronary risk.[52]

In the UK green prescriptions is a rapidly spreading practice. Liverpool City Council and Liverpool Clinical Commissioning has launched referral schemes that encourage activities in parks to tackle obesity and diabetes. In Devon and Somerset a three-year scheme is under way where general practitioners are encouraging patients to visit the national parks as part of their treatment. Walks, conservation work, gardening and sailing are promoted by an initiative in Dorset.[53]

As a response to the COVID-19 pandemic the UK government has announced in July 2020 a £4 million investment in a two-year pilot to bring green prescribing to four urban and rural areas that have been hit the hardest by coronavirus.[54] Green prescribing became an important lever of the recently adopted Tackling Obesity strategy of the UK government.

Action:
Developing health walk routes

The development of health walk routes can help in supporting communities to connect with urban green spaces such as parks, gardens and forests to experience the various health benefits of nature. The aim of the creation of a green health route is to enable people to use their local green spaces and at the same time to improve their health condition or maintain a healthy lifestyle.[55] Healthcare practitioners can recommend their use through green prescribing[56].

(See Showcase 5.5)

Green health routes can be used as part of rehabilitation services for cardiac patients through the organization of regular guided therapeutic walks.

Action:
Developing healing gardens and therapeutic gardens

Hospital gardens can be used as a part of a therapy program. Patients' access to natural landscape or a garden can potentially improve well-being and health outcomes.

Healing gardens in line with the definition of the American Horticultural Therapy Association are seen as plant dominated environments including green plants, flowers, water, and other aspects of nature that are designed as a retreat for patients and visitors. They are generally associated with hospitals and other healthcare settings. A therapeutic garden is a specific type of a healing garden, that is designed for use as a component of a treatment program. This can be a physical therapy, an occupational therapy or a horticultural therapy program. Therapeutic gardens are created to meet the needs of a specific user or population.[57]

A healing garden can function as a space for relaxation and restoration from mental and emotional fatigue[58]*, it can potentially reduce recovery time for surgery patients, reduce stress, lower blood pressure*[59]*.*

Providing patients with access to a gardening space can have additional therapeutic benefits. Letting the patients actively participate in gardening, rather than only passively enjoy the garden can have significant healing effects.[60] *In horticultural therapy patients are engaged in horticultural activities led by a therapist with an aim to achieve specific treatment goals.*[61]

(See Showcase 5.6)

The effects of a healing garden can be enhanced by careful design. Greenery should take up roughly 70% of the space, while hard artificial surfaces about 30%. The following features are particularly effective: tree-bordered views of water features, lush, multi-layered greenery, mature trees and flowering plants that attract birds and wildlife, private conservation areas, chairs that can be easily moved, features that engage multiple senses and easy entry.[62]

There are differences in what features are sought by various age groups in the gardens. With children, natural elements that enable interactive activities, such as plants, rocks, water features are particularly popular[63]*. Middle-aged adults tend to look for peace and quiet in the garden, while older adults are mostly seeking stimulation, and opportunities for social interaction*[64]*.*


CAROLINE GARDN
Design
CAROLINE GARDNER
Stringer

6 Improving Wellbeing Outcomes with the Use of Green Spaces

6.1 Social wellbeing impacts of urban green spaces

The urban green spaces have a relevant impact on residents' wellbeing. The World Health Organisation (WHO) defines health as 'a state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity'[65]. According to the definition social wellbeing is regarded as a key component of health. It is generally accepted that the social world affects physical, functional, psychological, and cognitive health and that each of these other dimensions of health influences social well-being[66].

According to the European Environment Agency every 10% increase in green spaces has been associated with an increase of five years of life expectancy[67]. However, the positive impact is not only on the length of life but also on its quality. Evidence shows that to have access to natural environments improve individual and community wellbeing.

Jennings and Bamkole[68] summarize the main factors that relate urban green spaces to social interactions and consequently to social dimension of health: open parks design to encourage active recreational activities, the availability of sidewalks, improved access to parks through quality transportation options, shaded areas that support relaxing environments, functional playgrounds, and the extent of organized activities.

These authors developed a conceptual framework (Figure 2) to illustrate the relationship between cultural ecosystem services from urban green spaces and social cohesion (as a social determinant of health) with social and health outcomes, where social determinants of health are an overarching domain that includes the conditions for living, working, learning and playing. The presence and/or access to urban green spaces stimulate activities that contribute to enhance various health benefits.

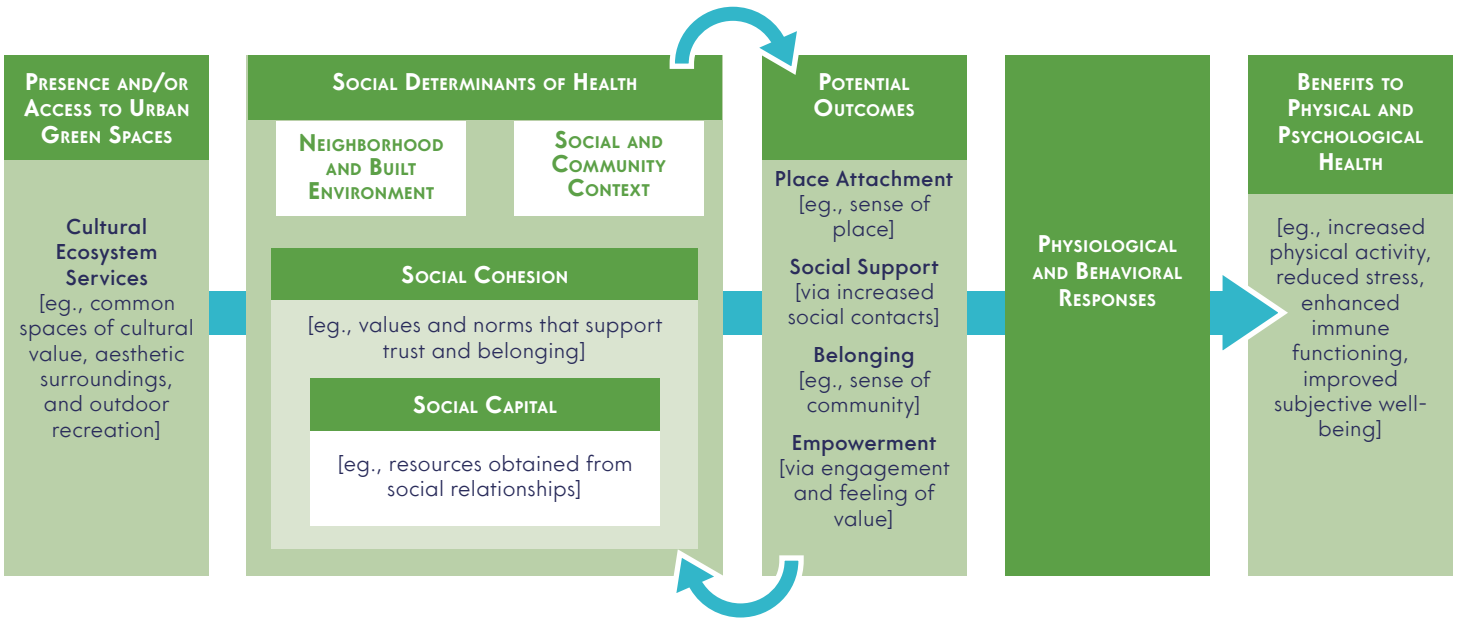


Figure 2. *Jennings and Bamkole's conceptual framework illustrating the relationship between cultural ecosystem services from urban green spaces and social cohesion*
Source: Jennings, V., & Bamkole, O. (2019). The relationship between social cohesion and urban green space: An avenue for health promotion. International journal of environmental research and public health, 16(3), 452.

6.2 Pathways to improve wellbeing with the help of urban green spaces

6.2.1 *The role of green spaces in strengthening communities and social groups*

Urban green spaces have a high value for communities, being the focal points for groups meetings. Urban green spaces contribute to build a sense of community among residents, promote social interaction, develop social ties and community cohesion. They provide places for social and cultural interaction in informal contacts (place to meet and celebrate with others) and more formal participation in social events (like music performances, concerts, dance up), social inclusion, recreation, individual and group sport activities, aesthetic pleasure and wildlife. As natural meeting points, urban green spaces increase the sense of identity and belonging, support civic society, increase individual social capital, and play a relevant role in any community development. All kind of people, without cultural, religious, ethnic distinctions, can access to these opportunities[69].

(See Showcase 6.1, and 6.2)

Urban green spaces are central spaces for community volunteer groups that provide facilities and activities, and often they are in charge of the conservation and maintenance of the greenery.

Action:
Designing green spaces to support social activities

A research team of the University of Illinois has found that there is a positive link between the level of tree and grass cover in an outdoor space and the amount of social activity that takes place there. Almost twice as many individuals are engaged in social activities in green compared to sparsely vegetated areas[70]. Another research by the Eindhoven University of Technology revealed that the level of social contact among neighbours is proportional with the availability of trees and grass[71]. Dedicated green space design can further increase social activity and improve community cohesion.

A number of aspects need to be considered when green spaces are designed for promoting social interactions:

- *Levels of green space usage are influenced by proximity and accessibility. Good public transport links, and good entry points away from busy roads increase the accessibility of green spaces.[72]*
- *Urban green spaces should not be over-designed supporting only very specific functions. They should instead facilitate activities for various population groups, encouraging undedicated use through making these public spaces suitable for multiple uses.[73]*
- *Higher levels of use can be stimulated by attractive natural attributes, such as landscaped features, ponds, trees and lakes.[74]*
- *Welcoming meeting spaces should be created, e.g., by opening cafés or installing food kiosks in parks.[75]*
- *Infrastructural features, such as benches, waste bins, toilets should be provided.[76]*

Action:
Promoting the use of urban green spaces

The user-friendliness of green spaces can be effectively increased through the creation of social activities[77]. As a park can be regarded as much as a social space as a physical infrastructure, local authorities should promote activities that animate green spaces. Facilitated activities, such as family days, cultural events, guided walks, sports events, and markets should be funded, organized and endorsed by cities to increase community engagement[78].

In line with the brief of WHO on 'Urban green spaces'[79], building on a 'dual approach', cities should always combine physical green infrastructure interventions with social promotion activities. Robust outreach and promotion activities are vital for effectively increasing park use by a diversity of population groups.

To develop community programs in urban green spaces local authorities should engage and actively involve individuals and social groups through discussion groups and consultations in order to organize with the users' involvement artistic events, sport activities, ethnic minority background activities, leisure programs, community gardens, etc. Through participatory approaches active community groups can share with local authorities the responsibility of tasks, and at the same time partnerships are promoted among different groups.[80,81,82]

Civil society involvement enhances the quality of experiences in urban green spaces and can support long-term sustainability through contributing to creative and innovative approaches for funding. International policies[83] have encouraged users' participation in the diverse phases of public green spaces development, but for achieving this goal citizens should be informed and motivated to become active in designing, planning and maintaining public green spaces and to promote community programs in these spaces[84].

Action:
Promoting cultural activities in green spaces

Green spaces can provide an appropriate setting for performing various cultural activities, such as public readings, exhibitions, dance and music, plays, drama, and to paint.

(See Showcases 6.3 and 6.4)

Arts and cultural programs are ideal tools for effectively attracting people to parks and thereby improve wellbeing of visitors. The arts can play an essential role in the revitalization of a park and in intensifying social life in entire neighbourhoods.

Since the 19th century parks have been commonly used for sculpture or hosting musical events. Later on, as a widespread practice, outdoor theatre and film screening events, as well as dance performances have become activities to be included in park programming. Parks can also be appropriate venues for temporary photo exhibitions.

A dedicated briefing paper published under the City Parks Forum Program of the American Planning Association[85] summarizes various options for promoting arts and cultural programs in parks:

- *Public film screenings are among inexpensive activities that can attract large numbers of visitors to a park at night, when such areas otherwise might be perceived by many as unsafe spaces.*
- *The concentration of museums and other cultural institutions in a park can make the area an important artistic destination in a city and can help build a large circle of supporters for the park.*
- *Outdoor classes offered in music, painting, drama, and dance in after-school setting can be particularly effective in attracting children to parks.*
- *Abandoned, poorly maintained, deteriorating parks can be effectively improved through cultural activity.*

6.2.2 *Community gardening*

Researches show a range of wellbeing and health benefits of community gardens especially for vulnerable populations, groups of people who are likely to fall or remain below a certain welfare threshold due to factors outside of their control, like age, ethnicity, illness, lower socioeconomic status. Malberg Dyg and her colleagues' review shows that being involved in community gardening has positive effects on relationships and social connections, and on local communities, with consistent results among studies involving refugee and ethnic minority populations, disadvantaged youth and elderly[86]. Gardeners reported greater social support than non-gardeners, having more opportunities to develop new relationships[87]. Growing vegetables in community gardens with youth programs was found to improve interpersonal skills, informal social control, cognitive and behavioural competencies and nutrition[88]. Garden participation strengthens social involvement and connections, improves mutual trust, and civic engagement and contributes to community building, indirectly leading to better health outcomes[89,90]. Furthermore, collective gardens function as an interface between city, nature, and agriculture, that could work toward a sustainable city[91]. A study from Australia has revealed that refugees were able to connect to the new country through community garden participation[92].

In dense urban areas allotment gardens can also be turned into places of social life, by making them accessible for the local community, apart from the renters, and by organizing smaller activities in their shared areas.

6.2.3 *Seclusion and areas for reflections in green spaces and individual wellbeing*

Although urban green spaces have a relevant role in reinforcing social relationship and community bonds, but sometimes for their wellbeing people need to enjoy the state of being private and away from other people, to find a relief from the pressure of urban living. Urban green spaces are also those places outside home where people can experience and enjoy nature, plants, trees, birdsongs, and the sound of water in a state of seclusion. In public green spaces one can be in touch with the natural cycle of the seasons. Surroundings are perceived with all sensory modalities, including visual (sight), auditory (hearing), olfactory (smells) and tactile (touch), with a synergistic effect. Sight is relevant as a visual sense of beauty and colour, hearing allows one to sense the sounds of water, birds and other animals, the sense of smell helps one to be aware of the scents from flowers in bloom, and touch to feel the soil while working with it or the breeze upon the skin[93]. Design targeting individual use can support activities like observation of nature (sensory perceptions) and mindfulness journeys (pathways, labyrinths and sites for reflection).

Walking alone, reading a book, lying with closed eyes on the lawn, having an immersive walk in the woods, sleeping away from the bustle or simply from others are some of the experiences that sometimes people need to do alone in order to get out of stress, to relax, to find their own wellbeing. In urban green spaces men and women can take a rest from the frenetic activities of the city life, or simply from their chaotic life. In case of appropriate dimensions and design it is possible in many public parks to have an immersive, tranquil experience, being surrounded by the sounds of nature. See Section 9 on Reducing Noise Pollution with Urban Vegetation.

Action:
Designing green areas for contemplation

Landscape design can help develop contemplative settings. Olszewska[94] provides some guidance on how to maximize the serenity of urban green space:

- *Settings with long-distance views (over 400 meters), open spaces or sparsely wooded areas that stimulate to look at the sky are found to be more contemplative.*
- *A linear structure of green spaces with very far views, which are rare in urban areas, can have a particularly strong calming effect.*
- *Green spaces should provide serenity at least in some of their zones, which should be designed in a way so one can feel the distance from other people and from built-up areas.*
- *More stimulating and enjoyable landscapes with brightly coloured flowers, attractive elements and geometrical design and very organized parks are found to be less relaxing to spend time in.*
- *Similarly to excessive design, wild landscapes are also perceived as less contemplative.*
- *The least contemplative settings in green spaces include dense, complex, enclosed and canopied environments.*

6.2.4 *Education in green space*

A study by the University College London revealed that living in areas with more green spaces does not just enhance health and wellbeing outcomes, but could also improve specific cognitive functions in children. The findings suggest that exposure to greenspace may help develop a better spatial working memory, which in turn can improve children's academic achievement and particularly their mathematics performance.[95]
A study from Taiwan showed similar results, suggesting that higher surrounding greenness contributes to a better English and Mathematics academic performance in students from elementary school, secondary school and higher education regardless of sociodemographic characteristics[96]. The type of vegetation influences the impact green space has on academic performance. Evidence indicates that children studying in schools with more trees had higher test scores advanced in Mathematics and Reading. On the other hand, such relationship was not found in case of grass and shrubs.[97]

If a school is not just simply surrounded by green spaces, but outdoor learning activities are also organized in these areas as part of the curriculum, that can bring a range of additional benefits to the students. Outdoor learning can be undertaken as part of fieldwork in various natural sites and forest schools, or outdoor visits to parks, forests, nature centres and gardens.

In 1994 in California an assessment of schools incorporating outdoor learning into their curriculum showed that secondary students from schools undertaking outdoor learning activities scored higher in a number of fields, such as reading, science and maths than students from traditional schools.[98]

(See Showcase 6.5)

The findings of a study conducted in Amsterdam show that the proximity of green spaces strongly stimulate environmental education fieldwork. Visits to neighbouring green spaces were found to encourage teachers to organize more excursions that are further away from the school. The teachers involved in the study reported that lessons become more vivid helping pupils to stay focussed more easily.[99]

Environmental field studies in ecology organized for school children were also found to improve social skills of the students.[100]

(See Showcases 6.6, 6.7, 6.8 and 6.9)

Outdoor learning can take place not just outside the school's premises, but also in green schoolyards, which are used as 'outdoor classrooms'[101]. Sealed school grounds can be transformed into educational spaces, natural play spaces, educational organic gardens with raised beds, larger well-treed areas, or wildflower meadows. Numerous subjects can be taught in green schoolyards that are turned into outdoor classrooms, such as reading, writing, mathematics, sciences, environmental education, social studies, art and drama.[102,103]

In a study undertaken in Boston, 60% of the interviewed educators involved in school grounds programmes reported that their school garden schemes improved academic achievements in the fields of mathematics, sciences, language, art and reading.[104] Schoolyards that are specifically designed to support learning can have a calming effect on students[105], can reduce anti-social behaviour and build a stronger sense of community[106]. Children attending outdoor day-care facilities in schoolyards in any weather conditions were found to take fewer sick days than those attending conventional day-care facilities[107].

Action:
Development of outdoor learning spaces

The team of Out Teach Landscape Architecture, a non-profit organization based in the United States, has provided a guidance on creating quickly and inexpensively outdoor learning spaces.[108] Their most important recommendations include the following:

- *a spot with natural shade should be identified for an outdoor learning space;*
- *the site should be located near school doors so that it can be accessed and left quickly,*
- *proximity to playgrounds and sport fields should be avoided, to prevent distraction during the class,*
- *a whiteboard should be installed at the site, as teachers are less likely to use the outdoor classroom regularly if they need to bring along the equipment,*
- *tree stumps can be used as inexpensive seating,*
- *it is essential to provide a waterproof storage option near the whiteboard, where markers, wipes, cleaners, pencil and paper can be kept.*

6.2.5 Natural play spaces

A growing trend in urban design in Europe and North America is the creation of natural play spaces for children instead of over-programmed playgrounds. A natural playground or a natural play space is a play environment that consists of natural elements, such as trees, stumps, rocks, sand and water, instead of traditional playground equipment that include slides, swings and climbers. Natural playgrounds typically feature more open space[109], and less structured play equipment[110] as compared to conventional playgrounds.

(See Showcases 6.10 and 6.11)

Natural play spaces provide a vast array of benefits linked to health and wellbeing for children[111,112,113].

- They support an increased level of activity. Natural play areas, full of plants, logs, trees stumps and boulders create a particularly stimulating environment. Research by the University of Tennessee indicate that the time spent playing more than doubles when natural elements are incorporated into the playground.[114]
- They encourage creative and imaginative play. Natural play features through supporting various types of sensory stimulation encourage imaginative play creativity. Children, instead of being dictated on how to play by the equipment, are motivated by natural play structures to engage in open-ended play and to develop new ways to challenge themselves.
- They improve the development of motor skills. In natural playgrounds children are engaged in more aerobic and bone- and muscle-strengthening activities, as well as various sensory activities involving touching, feeling and playing with natural objects, that improve their fine motor skills.
- They strengthen social skills. Natural plays spaces through encouraging free play as well as group play, help the development of various social skills, such as communication, cooperation, and collaboration.
- They are safer, as they are lacking the mechanical moving parts of traditional play equipment.
- They are more accessible, since unlike traditional playgrounds, less structured natural play areas are more welcoming to children with differing abilities and fitness levels.
- They help children learn about nature, as natural lay spaces bring children into direct contact with the environment.

Action:
Development of natural play spaces

Experience shows that natural play spaces are easier to create, less costly, and more durable than conventional playgrounds, and at the same time children use them more often and for longer.[115]

Play structures in natural play spaces can range from logs, tree climbs, tree stumps, hillsides, long grass, sand, dirt, raised garden beds to water features. The Government of South Australia has described some basic principles linked to the planning of natural play spaces[116]*:*

- *Stimulative spaces should be created that give children an opportunity to use all their senses, by using various colours, playing with forms and the intensity of light, providing different textures, using plants with scented leaves and flowers and creating an environment rich in natural sounds.*
- *Natural elements should be used as they strongly support creative and imaginative play:*
  - *Water can be used to create small streams, ponds and other water features supporting interactive and multisensory play*
  - *Sand and mud urges children to dig and create particularly if mixed with water.*
  - *Wood and stone can be used to construct different structures, such as bridges or pathways.*
- *A diversity of different play spaces should be developed to provide an inclusive place for children with various needs. Separate zones should be created for group play, for adventures and physical activities, and for tranquil small hidden places for seclusion.*
- *Children should be offered the opportunity to play with loose parts with different size and form, such as stones, leaves, pinecones, sticks, log rounds, or shells.*

6.2.6 Physical activity in green space

According to World Health Organization (WHO) physical inactivity is the fourth leading risk factor for global mortality.[117] A study by the University of Cambridge indicated that almost 4 million premature deaths are being averted worldwide every year by people maintaining physical activity.[118]

Availability of green space and greater levels of physical activity are strongly linked, as well as the associated health benefits. A study by the University of Oxford revealed that people who live in the greenest areas of England were more likely to undertake increased amounts of physical activity[119]. Parks provide places for people to engage in physical activity. Large and attractive parks were found to promote walking for health benefits[120].

Several studies pointed to the role of natural factors of urban green open space in promoting physical activity suggesting that grass, trees, or flowers, cleanliness, maintenance, and aesthetics of the urban green open space were positively were associated with physical activity.[121]

Action:
Promoting physical activity in green space

Evidence suggests that out of all the relevant factors, close access to the site is the most relevant one that contributes to increased physical activity in green space. People who are within walking distance of a park are more likely to use it and the recreation services provided at the site, than those who are not.[122]

In a study, Kostrzewska from the Gdansk University of Technology, apart from highlighting the relevance of proximity to the place of residence, lists a number of other relevant features that should be considered during green space design that aims at ***increased physical activity***[123]*:*

- *public spaces to be activated should be connected into a cohesive system that allows active mobility among different city areas,*
- *to facilitate active and safe travels, bicycle stands and parking spaces should be provided near the activity areas,*
- *the facilities to be installed should be diverse and multifunctional to encourage all age groups to undertake physical activity,*
- *the design needs to be adapted to the local context and the surrounding landscape,*
- *the green activity and recreation spaces should allow use all year round and in all weather conditions, due to good lighting, and various architectural features protecting from sun, wind, rain, or snow.*

The development of large, open areas can maximize outdoor space appropriate for physical activity[124]. Park activity features (walking paths, play spaces, sport fields) should be complemented by good quality support features such as benches for rest and observation, shading, water fountains, and restrooms to attract higher visitation[125]. A review of studies provided evidence that neighbourhood spaces that encourage social interaction also stimulate physical activity[126]. As green activity spaces also have an important social function providing a meeting place for local communities, urban furniture that supports social interactions such as proper seating are particularly relevant in design[127].

A review of studies provided evidence that neighbourhood spaces that encourage social interaction also stimulate physical activity.

Mixed-use parks, that facilitate a variety of activities and provide numerous reasons for more people to walk, show higher levels of physical activity[128]. Access to activity spaces depends on good connectivity. There is a need to improve travel connections to park and recreation facilities[129]. A greater variety of paths and a higher density of intersections within and next to parks supports more walking and physical activity[130].

Proper design of park space and various facilities alone is not sufficient to physically activate visitors in green spaces, since as evidence shows that the organization of social programs and actions are also essential in bringing active park use to a higher level[131].

Scheduling a wider menu of organized park activities and recreation programs targeting various groups of society can effectively improve the potential of green spaces for supporting physical activity[132,133]. Onsite and offsite promotion of park programs have an important role in increasing awareness of organized park opportunities and in achieving higher levels of active use of green space[134].

(See Showcases 6.12 - 6.18)

6.2.7 *Tactical urbanism and placemaking to enhance social wellbeing and community cohesion*

Tactical urbanism is a city, organizational, or citizen-led approach aiming at neighbourhood building that is based on the use of short-term, low-cost, and scalable interventions, which are meant to catalyse long-term change[135]. Tactical interventions can target at the creation of temporary spaces, performances in the public space, and all forms of community activism, that can trigger processes of change. Through supporting temporary interventions, such as the development of pop-up parks or pop-up parklets, or the promotion of guerrilla gardening, tactical urbanism can be a particularly effective tool supporting urban greening.

Longer-term changes can be made by placemaking in community public spaces such as parks and green streets. Placemaking is a creative, collaborative and place-based process for the design and development of built environment, that helps shaping the public realm to maximize shared value[136,137]. The aim is to create spaces that facilitate social engagement and chance interactions[138]. Placemaking is fundamentally helping people to turn a space into a place that they call home. In essence, placemaking brings together urban planning, mobility, sustainability, arts, ecology, and landscape architecture to build healthier and more liveable neighbourhoods.

Placemaking approaches can provide support in converting temporary spaces into permanent places by introducing green infrastructure, such as city trees, green roofs, green zones, and green walking routes. Pocket parks and parklets can be particularly effective placemaking devices.[139]

(See Showcases 6.19, and 6.20)

6.2.8 *Safety in green spaces*

Parks can function as community spaces as long as they are considered safe by potential users. There is an indication that parks and other urban green spaces can in general prevent violence. In a study undertaken in Chicago in 2001 it was found that residents living in a greener urban area reported lower levels of fear, and less aggressive and violent behaviour[140]. A similar relationship was seen between green space and crime in another study conducted in 2012 in Baltimore that has shown that a 10% increase in tree canopy brings about a roughly 12% decrease in crime[141].

But the type and quality of the green spaces really matters when it comes to perception of safety. In line with a study undertaken by Schroeder and Anderson undeveloped densely forested sites are associated with low security, while open areas with few trees are perceived significantly safer[142]. Another study carried out by Talbot and Kaplan has found similar results indicating that well-maintained areas were preferred over more untouched and densely wooded areas, which were often associated with danger[143]. View distance seems to be a decisive factor in the perception of safety in green spaces. Research suggests that at sites, where vegetation blocks views, fear of crime increases[144].

Action:

Promoting wellbeing through increasing the perception of safety in green spaces

Design and maintenance of green spaces are critical in improving the public's perception of safety. Evidence suggests that investing in a combination of good design, attractive facilities, park staff and maintenance of green spaces can be more effective in avoiding vandalism and anti-social behaviour, than the use of video surveillance[145]. Investing in the quality of the park can result in long-term savings. as a significant proportion of parks' maintenance budgets in cities is spent on replacing vandalised items in parks[146].

Open views and visibility are essential to perceived security[147]. Visibility is as much about being seen as about being able to see around. For people to feel safe and secure in public spaces, other people need to be present in accordance with the concept of "eyes on the street" proposed by Jane Jacobs[148]. Therefore, the animation green spaces with a range of activities is relevant in improving perceived safety. Parks that are heavily programmed on a regular basis tend to attract more visitors. After dark, carefully designed lighting can promote positive activities in parks reducing violence[149]. Maintenance of greenery is another essential factor, as low levels of maintenance in urban green areas were found to result in reduced perceptions of safety[150].

(See Showcase 6.21)

The Commission for Architecture and the Built Environment (CABE), a former non-departmental public body of the UK government responsible for advising on architecture and urban design, which was merged in 2011 into the Design Council, had provided recommendations for preventing anti-social behaviour in green spaces[151,152]:

- *a clarity of the design with open vistas and clear sight lines should be ensured,*
- *exits should be visible and long corridors with no alternative ways out should be avoided,*
- *positive features that attract people to parks, such as play spaces, flower and herb beds, water features and boardwalks should be developed,*
- *in the design passive surveillance from surrounding areas should be exploited; cafés, apartments, stores and offices within parks or nearby have a great potential in this regard,*
- *to be able to create a public space that is attractive for various user groups, it is important to involve early on the community in the design and maintenance of the green space,*
- *there are significant benefits of involving 'problem' groups or various under-represented groups in the revitalisation of green spaces, so that they feel a sense of ownership,*
- *the establishment of 'parks' friends' groups' can lead to significant improvements in levels of anti-social behaviour, since such groups can support informal surveillance,*
- *introducing a park warden service, ensuring that park staff is patrolling larger parks can dramatically increase the perception of safety among visitors.*

A guide produced by Toronto Parks & Recreation also highlights a number of aspects to consider to create safer parks[153]:

- *the layout of the park should be easily understood, entrances and exits should be easy to locate, focal points should be clearly visible,*
- *the edges of the park should be open, allowing the passer-by to see into the park and park users to look out,*
- *the location and clustering of activity areas, such as play spaces and sports fields should allow informal surveillance,*
- *a diversity of physical features, vegetation and activities is likely to result in attractive environments and frequent use,*
- *it is beneficial to locate washrooms beside major activity areas,*
- *lighting should help in directing movement between destinations at night,*
- *night-time activity nodes should be located nearby street lighting.*


PLAZA

7 Reducing Heat Stress with the Help of Green Infrastructure

7.1 The potential of green infrastructure to reduce heat stress

Green infrastructure, such as parks and gardens, trees, green facades and roofs, can reduce the heat load in cities. In general, it reduces the heat storage capacity of urban surfaces, reduces air temperature through shading and evapotranspiration of water from the leaves and supports the chimney effect and ventilation bringing cool air into the city. The EEA has analysed sources on the effectiveness of different types of nature-based solutions to reduce heat and found strong evidence that nature-based solutions are moderately and highly effective (Figure 3).

Trees and green spaces appear to be particularly effective in regulating air and surface temperatures. Dense tree cover has an exceptionally high cooling potential. Air and surface temperature increases can be prevented by green roofs and green walls. In case of green roofs, spatial coverage is less important than leaf density and canopy height in achieving greater temperature reductions.[154]

Cooling by vegetation happens in two ways - by evapotranspiration and shading. When radiation hits the trees' canopy it causes water to evaporate from the surface of leaves. In addition, during transpiration, water moving through a plant is converted from liquid into gas as it passes through small openings on the undersides of leaves[156]. This process of direct evaporation at the ground and on plant surfaces combined with transpiration, called evapotranspiration, cools the plants down – just as sweating cools humans' skin. The leaves release water into the atmosphere which vaporizes and cools the surrounding air. Urban green can thus catch

Figure 3. *Effectiveness of different NBS types to reduce heat.*
Source: EEA, 2020[155]

the radiation before it reaches the ground and use the energy for **evapotranspiration**. However, the extent of this cooling effect depends on the type of vegetation and on how well it is thriving. Evapotranspiration can be greatly reduced if the growing conditions are poor[157].

Trees provide cooling by **shading** and this is not just a physical effect. Peoples' perception may even play a bigger role. While the reduction in air temperature is found to be relatively small, a research team of the University of Applied Sciences Amsterdam[158], that analysed shaded and sunny locations in parks, streets, squares, and near water bodies in Amsterdam, found a reduction in the physiological equivalent temperature (PET) between 12 and 22 °C in spaces shaded by trees compared to sunlit areas. While shaded areas are perceived cooler and more comfortable, open grassy green spaces were not perceived as cooler. These results have been found consistent with other studies and lead to the conclusion that thermal comfort in parks on summer days could be improved by placing more trees and shade provisions.[159,160]

It needs however to be noted that the actual heat reduction potential of green space and elements depends not only on the type of vegetation, but also their distribution and design. Open, vegetation-covered areas at the edges of cities will deliver fresh air during night time, if ventilation corridors are not blocked. Vegetation that shades in surplus of cooling by evapotranspiration, like trees, provide humans more relief in outdoor environments than grasslands. However, if standing densely or as a tunnel in streets, trees may block **ventilation** and hamper cooling.

Cities can generate a country breeze, a local low-level air flow directed towards the centre. Its driving force is temperature difference between the usually warmer urban areas and cooler rural areas. The warmer air over built-up areas rises and cooler air rushes in into its place from non-urban areas.[161]

Similarly to rural areas, parks, acting as small-scale 'non-urban areas', can create a smaller circulation, the 'park breeze'. The daytime cooling that is a result of evapotranspiration of park vegetation and the evening cooling that happens as vegetation does not retain as much heat as artificial surfaces, creates a 'park cool island' (PCI) effect. As a result, the cooler air over parks replaces warmer air in nearby neighbourhoods.[162] Larger parks are able to cool the surrounding urban fabric by creating stronger park-breezes[163].

7.2 Practical approaches to reduce urban heat stress with green infrastructure

Adaptation to the impacts of climate change with warming temperatures in cities requires re-thinking urban design, in particular the design of green urban spaces and green elements. A number of general principles should be born in mind when urban green spaces are developed to reduces heat stress[164,165]:

- Areas with high exposure and vulnerability should be prioritized when designing green infrastructure interventions for cooling. Neighbourhoods with a high proportion of elderly and very young citizens, or with large numbers of aged care facilities can we considered particularly vulnerable.
- Detailed microclimatic analysis (i.e., the assessment of shadow or wind patterns) can help answer design questions, such as whether cooling is prioritized during day or night time, or whether cooling is desired within or outside buildings.
- Deciduous trees should be preferred for cooling as they can provide shade during summer and do not block radiation during winter.
- Species resistant against heat and drought should be used.
- Urban green open spaces with primarily grassed areas and a relatively sparse or absent tree canopy, can provide 'islands' of cool in hot urban areas and can also lower the temperature of the surrounding landscape. Larger urban green open spaces should be located upwind of priority areas as they can effectively cool down areas downwind.
- Adequate water supply is essential for maximizing the cooling services of vegetation. This can be achieved through storm water capture and storage, providing sufficient root space, and increasing the cover of permeable surfaces.

(See Showcase 7.1)

Action:
Increasing the share and accessibility of green spaces

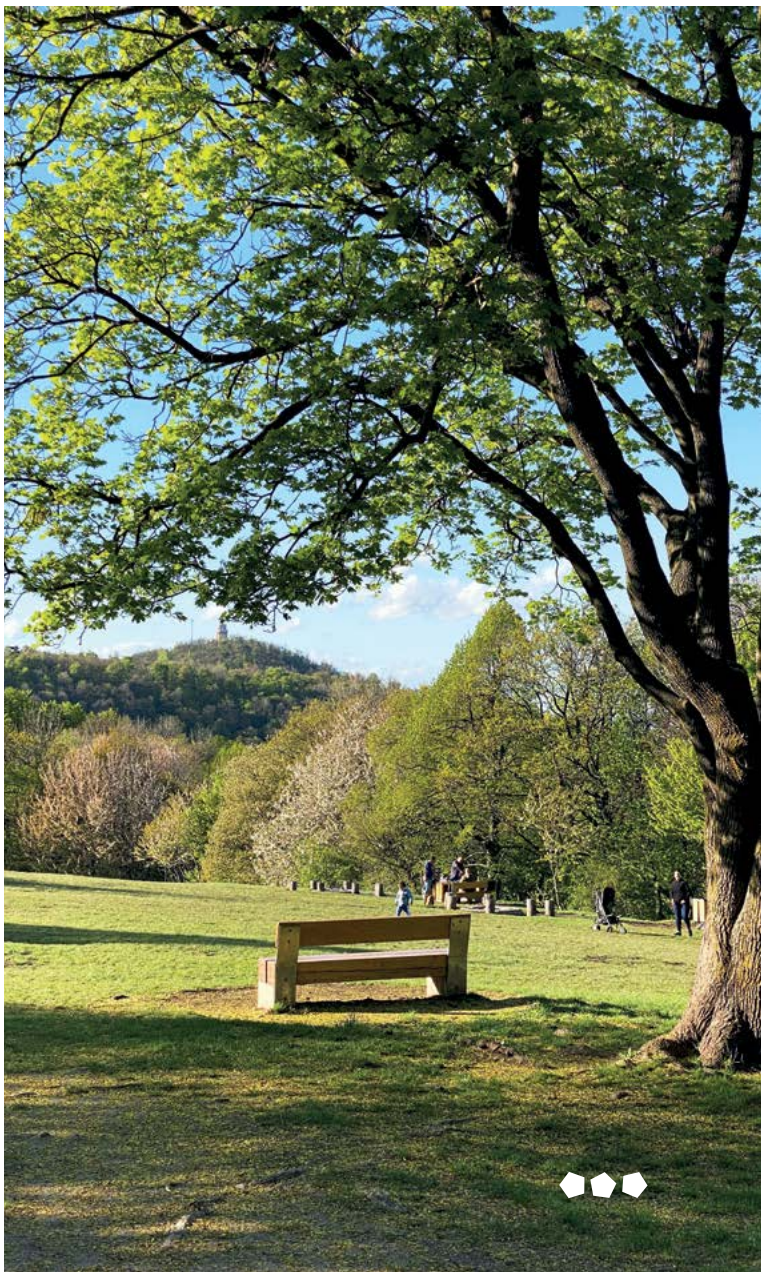
In general, a higher share of urban green spaces will increase the cooling potential of a city. Heat stress risk can be reduced with increased accessibility of green spaces[166]. During planning actions for city-level cooling, the followings should be considered[167,168].

- *A higher percentage of city area devoted to parks has more enhanced cooling benefits.*
- *On a city level a network of **interconnected green spaces and green elements** should be maintained and developed further.*
- *Larger parks have greater cooling potential than smaller ones, although in neighbourhoods, where space is limited, small green areas should still be used for reducing heat stress.*
- *In dense neighbourhoods with minimal private outdoor spaces the presence and accessibility of public green spaces should be ensured.*

Action:
Designing parks for cooling

Green parks can be particularly effective in reducing urban temperatures. The cooling effect of parks extends beyond its boundary into the surrounding neighbourhood. With increasing park size, the area around the park benefiting from the cooling effect also increases[169]. Planners should consider among others the following aspects when parks are designed for cooling[170,171].

- *Apart from park size, vegetation greenness is also an important factor for park cooling efficiency.*
- *Increasing the share of water body can effectively improve the cooling effect of a park.*
- *Flexible and multifunctional spaces should be created in parks to enable individual thermal adaptation.*
- *In a park, **gradients of open areas** and shading elements should be developed, as edges between sun and shade are popular places for visitors in parks providing them opportunities to adapt to diverse thermal conditions. A ratio of 40% sun, 20% half-shade and 40% shade seems to be in line with the preferences of park visitors under various thermal conditions and on various times of the day.*
- *In a park, **green fraction should be preserved or increased on the wind side** of the park (prevailing summer wind direction should be considered) and cold air corridors should be kept open, to improve thermal conditions within the park.*



Action:
Developing cooling corridors and cooling islands

Cooling corridors, such as tree-lined urban streets provide a cooling effect in a largely paved environment[172]. Squares can be transformed into cooling islands if they are designed with more greenery, water and shading. The majority of buildings in a city have flat roofs creating the potential to form a green roof landscape that can reduce temperatures of roof surfaces and the surrounding air. In densely built neighbourhoods green facades can also provide cooling effects.

(See Showcase 7.2)

A study in Shanghai[173] indicated that in most of the cases pocket green spaces have a cooling effect on their surroundings. Some recommendations for planning cooling streets and cooling islands are listed below[174,175,176].

- *In **streets with high solar radiation tree species with large canopies** should be planted.*
- *In streets with heavy traffic, to avoid the 'tunnel effect', space should be created for **wind circulation** between tree canopies.*
- *In street canyons a **diversity of microclimates** should be created with sunny and shaded areas so that pedestrians might select their preferred route for walking.*
- *In street canyons the **thermal perception** of pedestrians can be improved when green elements are installed at various heights.*
- *Wide street canyons and narrow canyons with low buildings can be considered **priority streets** for cooling with greenery. Green cover should be maximised on the west-facing (east) side of the street, that is likely to become the hottest, as it is exposed to the afternoon sun.*
- *In street canyons 'overhead' vegetation canopy cover should be maximized (optimally tree canopies, or vine-covered archways). Broad, wide and short trees are particularly effective at shading sideways.*
- *ITrees can trap heat under their foliage at night, therefore street trees should not form a continuous canopy to allow hot air to escape through the spaces between the plants.*
- *Pocket green space that are dominated by tree-shrub-grass have particularly high cooling efficiency.*

Action:
Making green public spaces accessible as climate shelters

Green spaces, both small and large ones, can improve thermal comfort in extreme heat events. Parks, school grounds, gardens and green patios of public buildings can all function as cooling elements for residents during prolonged hot days and nights.

(See Showcase 7.3)

Larger parks with high presence of urban greenery and water fountains are particularly effective as climate shelters. During heat waves public and private gardens can be made accessible for all, and park hours can be extended.

8 Using Urban Greenery to Improve Air Quality

8.1 The potential of greenery to reduce concentration of air pollutants

Urban green infrastructure can bring about positive health outcomes through reducing the public's exposure to air pollution. The use of greenery can offer options for mitigating air pollution that can effectively complement conventional emission control strategies. Vegetation plays an important part in controlling the flow and distribution of pollutants.

In general, the adverse impacts of air pollution can be reduced through the application of three basic methods:

- **Reducing emissions at source.** Measures linked to this method include using less polluting industrial processes, using less polluting raw materials, improving process efficiency, emission control technologies, traffic calming, emission controls on vehicles, or use of cleaner fuels. This method should be prioritized, since reducing emissions is the most effective way of mitigating exposure to pollutants.
- **Extending the distance between pollution sources and receptors.** The concentration of pollutants decreases with distance from the source as pollutants are mixing with cleaner air.
- **Protecting receptors.** This method has to do with direct interventions targeting reduced concentrations at the receptor site.[177]

Green infrastructure can help to varying degrees in the application of all three methods. By placing vegetation as barriers, the distance between sources and receptors can be extended virtually. Hedges acting in this role can be used as green buffers separating vehicles and pedestrians. Greenery can also protect people from air pollution, through increasing the deposition rates of pollutants with the help of the relatively large surface area of the plants[178]. Urban green spaces can even help in reducing emissions indirectly, through taking the place of emission sources, or through encouraging less polluting active transport[179].

8.1.1 *Processes influencing air quality*

Urban greenery can protect people from air pollution through two key processes, dispersion and deposition.[180]

Dispersion is a process through which air pollution is distributed into the atmosphere. Urban vegetation, with its dispersive effect, changes the speed of pollutants and also the distance pollutants travel before they reach people. This can lead to significant reductions in the concentration of pollutants locally[181].

Trees and hedges by providing obstacles to the airflow, introduce turbulence, increasing the dilution of pollutants. As a result, the distance between the source and receptor will be virtually extended. The introduction of a vegetation barrier displaces the flow of pollutants upwards, extending the effective path-length of air from source to receptor, while dilution is promoted[182].

In an open-road environment a vegetation barrier (i.e., a hedge) can halve the concentrations of pollutants in its immediate vicinity[183]. The introduction of hedges between road and pedestrians are particularly effective in reducing pollutant concentrations through dispersion. A study of the University of Surrey indicated that hedges along roadsides can cut back the concentration of black carbon, a key component of fine particulate matter, by up to 63%. It was also confirmed by the study that hedges or a combination of trees with hedges are the most effective forms of greenery for reducing exposure to pollution emitted by cars[184]. Smaller reductions were shown for gaseous pollutants[185].

Deposition is a process by which pollutants land on solid surfaces and are removed from the air[186]. Green infrastructure can reduce the concentration of air pollutants locally by enhancing their deposition rates, since pollutants deposit more efficiently on vegetation than on smoother artificial surfaces[187]. Trees and shrubs have a relatively high surface area that can function as natural sink for pollutants. The rate of deposition is subject to the available surface area as well as the aerodynamic roughness of the surface[188].

Apart from dispersion and deposition there is a third mechanism, the modification of particulate matter, through which green infrastructure can improve air quality. These modifications include the coagulation of smaller particles that may accelerate deposition, and the changing of pollutant compositions that may reduce the toxicity of particulate matter[189].

Leaf-associated microbes, such as bacteria, yeasts, and fungi have a role in bioremediation (phylloremediation) of air pollutants. Microbial communities colonizing the surface and the interior of plants' leaves were found to be able to adsorb and biodegrade or transform pollutants into less toxic molecules.[190]

8.2 Practical approaches to reduce air pollution with the use of greenery

Some trees are far more effective at trapping air pollutants than others[191]. A number of vegetation traits needs to be considered for the selecting appropriate plant species for pollutant capture.

The filtering activity of trees depends mainly on the canopy size. Not surprisingly, larger canopies can trap more pollutants than smaller ones[192]. The density of the foliage is a key factor as it actually determines the vegetation area available for deposition[193]. The density of a tree is influenced by the branching of the crown and the characteristics of the leaves[194]. Although vegetation density increases deposition, still a green filtration barrier should not be too dense to allow penetration and to ensure that the airflow is not directed above the barrier limiting opportunities for deposition[195]. An optimal vegetation barrier density will permit infiltration without throughflow[196].

Mature trees with large canopies are significantly more efficient in removing pollutants compared to young trees[197]. Research indicates that large, healthy trees with a trunk diameter above 75 cm remove more than 70 times more air pollution than small, healthy trees with a trunk diameter below 25 cm[198].

Apart from the height of a tree and foliage density, the shape of the crown is also relevant. A spherical crown for instance is found to be more effective than one with a pyramid shape .

Foliage longevity is another important aspect. As opposed to deciduous trees, which lose their leaves during winter, evergreen species can act as year-round filters[200,201]. However, evergreen species may be more sensitive to certain environmental stressors, such as draught and heat[202]. Among deciduous species those ones are preferable that exhibit longer in-leaf seasons[203].

There is an indication that species with smaller leaves tend to be more effective than ones with larger leaves. Conifers with their dense canopy of needles seem to support more effectively deposition of particulates than deciduous species.[204]

The features of leaf surface also influence the filtration potential of plants. Rough, hairy and rugged surfaces that include grooves and ridges act as the best biofilters for particulates[205,206]. The stickiness of the leaves was also found to be significant in trapping particulates[207]. Due to their hairy leaves, silver birch, yew and elder are particularly effective at capturing ultrafine particles, which can pose substantial hazards to human health[208].

Stomata that are the small pores found on leaf surfaces controlling gas exchange, have a relevant role in pollutant capture, particularly in case of gaseous pollutants[209]. Air pollutant removal may be enhanced by the selection of species that have stomata with extensive opening periods, such as poplar and some oak species[210].

Not only the structure and other properties of the leaves are relevant for particle capture efficiency, but also the canopy shape and shoot structure. There is an indication that tree species with more complex shoot structure have higher particle capture efficiency.[211]

Despite its ability to capture air pollutants, greenery can also be a source of pollution. Trees and other plants produce volatile organic compounds, which when

exposed to sunlight react with nitrogen oxides emitted mainly from vehicles and industrial sources to form ozone, that can lead to the formation of ground-level smog. In addition, many tree species produce pollen, which can cause allergic reactions.[212] When planning urban greenery in the vicinity of residential areas, it is wise to avoid planting tree species that produce highly allergenic pollen, such as birch, ash, oak, and elm[213], or those ones that emit significant amount of volatile organic compounds, such as black locust, poplar or plane tree[214].

Various beneficial vegetation traits that influence capture efficiency does not automatically make certain plant species fit for any context. Simply selecting tree species that have a high potential for air pollution mitigation will not lead to desirable results. When designing greenery for pollutant capture, plant species should be selected that are adapted to the local environmental conditions. In urban settings, and particularly in roadside environments, vegetation has to cope with multiple stressors, such as dry or poor soil conditions, various diseases, soil compaction, lack of root space, excess water in the root zone accompanied by anaerobic conditions, air pollution, or salt pollution[215]. Considering these extreme conditions in urban systems, when assessing the suitability of various species, it is plants' stress tolerance that should be given priority over all other functionalities[216].

Different foliage density is desirable depending on whether the greenery is used for dispersion or deposition. As the density of the barrier decreases, the effective path-length shortens and with this the dispersive effect of the vegetation decreases, but at the same time the opportunity for pollution removal through deposition increases[217]. The denser the vegetation barrier, the more effective it will be at displacing and diluting the polluted air. Therefore, green barriers used for dispersion should be as dense as possible[218,219]. In contrast, vegetation barriers that aim at the filtration of pollutants should be sufficiently dense to promote deposition with an extensive surface area, while at the same time should not be overly dense, to support penetration, instead deflecting the airflow[220].

Action:
Using greenery to improve air quality along roads

A guide titled, 'Using green Infrastructure to protect people from air pollution' published by the Greater London Authority[221] provides a range of practical recommendations for designing greenery for reductions in exposure to urban air pollution along roads. Depending on the type of urban road the guide provides help in the identification of the appropriate type of green infrastructure intervention. The guide highlights the relevance of careful design, as in certain urban situations wrongly placed vegetation can even increase locally pollution concentrations. Some of the key recommendations of the guide are summarized below:

- *On busy roads surrounded by buildings on each side (street canyons), where the air is more polluted at street level than above, a dense row of trees can have an adverse effect on local air quality, as the trees can trap the pollution emitted from vehicles under their canopies. In such urban situations, vegetation barriers between the vehicles and pedestrians, such as hedgerows, can be effective in reducing pollutant concentration at the receptor side.*
- *On very quiet street canyons where air is more polluted above the buildings than at street level, a dense tree alley with extensive canopies can effectively reduce downward dispersion, protecting people at street level.*
- *On open roads, when the aim is to protect people right next to the road, hedges can function as effective barriers between the road and pedestrians (Figure 4). As the height of the vegetation barrier increases, the protected area increases.*
- *When the goal is to protect people further away from an open road, a taller barrier, such as a dense row of trees with hedges, can be useful to reduce concentration of pollutants in a larger area.*
- *Green open space next to a road, such as a park has an essential role in reducing exposure to pollution from transport, as it allows pollutants to disperse.*
- *A thicker vegetation barrier will be more effective at displacing road transport emissions and at supporting their dilution.*

Figure 4. *Protecting people with hedges at the side of an open road*
Source: Greater London Authority, 2019

Action:
Introducing hedges around child care facilities and play spaces to filter pollutants

Hedges are particularly effective in protecting schoolgrounds, kindergarten yards, and playgrounds from air pollution exposure.

(See Showcase 8.1).

Evergreen species are proposed for vegetation barriers by a study undertaken by the University of Surrey[222], which can effectively reduce exposure to air pollution in all seasons.

Action:
Installing green roofs and green walls for air pollutant removal

Green roofs and green walls can also remove large amounts of pollutants from air. While trees can trap pollution under their canopies in certain urban situations, green roofs and walls let the air circulate freely and at the same time can remove pollutants[223]

(See Showcase 8.2).

A study conducted in Australia indicated that green roofs can contribute to emission reductions ranging from 35% to 83%[224]. Green walls in street canyons were found to reduce PM10 concentrations of by up to 50%, and NO2 concentrations by up to 35%[225].

Action:
Developing larger green spaces for air pollutant deposition

When greenery is designed for deposition, a number of factors need to be considered. One key aspect is the height of the vegetation. Low grasslands have the weakest, while coniferous forests have the strongest filtering potential. In between, filtering effect increases in the following order, high grassland, shrubs and deciduous forests. Research has shown that transitions in the landscape from low vegetation to forest also have a significant effect on the deposition process of air pollutants. Because of an 'edge effect', deposition in the centre of a forest is significantly lower than in the fringe zone. Deposition will increase further and the deposition zone will grow if the transition in the woodland fringe is sharp.[226]

(See Showcase 8.3).

Action:
Using greenery to invite people to areas with better air quality

Urban planners can also use green infrastructure to invite residents to spend more time in public spaces with better air quality.

(See Showcases 8.4 and 8.5)

Such areas can be made more welcoming and comfortable by adding new greenery[227]. Parks can protect people from air pollution indirectly by attracting them away from polluted areas into cleaner ones[228]. When designing streets, people could be encouraged by adding greenery to stay longer in the mid-sections of the streets and away from street corners[229], as intersections are typical pollution hotspots in a city[230].

Action:
Developing green spaces to support ventilation

Green corridors and parks promote ventilation within the urban fabric and through this can help improve air quality. Strategic urban planning can enhance the natural circulation of air in a city. Designed in line with natural wind patterns, green corridors create air pathways that can reduce pollution in stagnant air[231]. Ventilation in a city can be supported by the creation of wide linear parks[232], by the use of construction bans at strategic places (such as valleys, hills, hillsides, and saddle-like topographies)[233,234], and by the development of a grid of parks and small green areas that are connected to one another[235]

(See Showcase 8.6).

The greenery in ventilation corridors should be planted in a less compact arrangement, to make it possible for the wind to pass through them[236].

9 Reducing Noise Pollution with Urban Vegetation

9.1 The role of vegetation in noise reduction

Hedgerows, green roofs and green walls can function as sound barriers. Vegetation reduces noise pollution by accelerating the dissipation of the energy of sound through absorption, deflection, refraction, and masking.[237] Sound is absorbed by plant parts such as leaves, stems, branches, and trunks. Due to their dynamic surface area, rough bark and thick leaves are particularly effective at absorbing sound. During sound deflection, when sound waves hit the flexible material of plants, it will vibrate as audible energy is transformed into physical energy. Refraction of sound waves happens when sound passes through vegetation barriers and bends around plant structures.[238]

Apart from blocking noise, trees and shrubs also have a masking effect, as they produce natural sounds (the rustling of leaves, the movement of branches in the wind, the sounds of birds and insects associated with trees, etc.)[239].The sounds of nature have been associated with a range of perceived restorative experiences such as pleasure, relaxation, and escape from everyday concerns[240].

Compared to bare soil or pavement, low vegetation in open areas has a muffling effect on sound, similarly to the carpeting in a room.[241] There is evidence that a dense belt of trees and shrubs can reduce sound levels by as much as 6 to 8 decibels.[242] In addition, green noise buffers absorb sounds mainly at the highest frequencies that annoy people the most.[243]

Vegetation apart from physically dampening noise, can also contribute to the perception of quietness. Noise bother people less, when they do not see its source. The use of green infrastructure between people and the source of noise impacts the human perception regardless of the thickness of the vegetation.[244]

9.2 Practical approaches to reduce noise exposure through green infrastructure

Action:
Using plants as noise buffers

Green noise barriers can be an alternative means of reducing urban traffic noise[245]. Forest Research, Great Britain's principal organisation for forestry and tree-related research, provided recommendations for planning noise buffers[246]:

- *The noise buffer should be planted closer to the noise source than to the area to be protected.*
- *Trees and shrubs should be planted as close to each other as the species will allow.*
- *Plants with dense foliage should be used.*
- *The foliage of the plant should reach the ground. This effect can be achieved by combining shrubs and trees.*
- *Year-round protection is provided by evergreen plants.*
- *Tall trees should be used as noise buffers, or if that is not possible, then shorter shrubs should be combined with tall grass.*

For effective traffic noise reduction, the ideal depth of vegetation barrier is around 5 meters[247]. In wide open spaces, dense hedges are more appropriate for blocking off noise than a single row of trees[248].

Green roofs have a great potential to substantially abate road traffic noise. Green facade walls seem to be less effective in noise reduction.[249]

Action:
Creation of tranquil areas and increasing their accessibility

Tranquil areas that imply both quiet and natural settings, can be beneficial to human health and wellbeing through contributing to stress reduction. Accordingly, the provision, protection and improvement of tranquil areas should be seen as important goals in urban planning[250]. Tranquil areas are not areas of complete silence, they are rather places that ensure relative quietness, which are dominated by natural sounds.

(See Showcase 9.1)

When cities develop measures supporting tranquil areas, the following should be considered:

- *Policies should be developed for the identification of tranquil areas.*
- *Tranquil green spaces under threat should be protected.*
- *The creation of tranquil amenity spaces can effectively contribute to human health and wellbeing through contributing to stress reduction.*
- *Establishment of buffer zones can increase the perception of silence.*
- *Access to quiet, natural places in urban areas can be enhanced by improving the ecological quality of urban green spaces.*

10 Street Greening for Health and Wellbeing Outcomes

10.1 Benefits of green streets

The benefits of street greening can enhance the ecological, economic and social environment around a city street.

Ecological benefits

Improves water quality
During episodes of heavy rains, green infrastructure is temporarily storing runoff water and filtering it from pollutants, improving the quality of water entering water bodies.

Increases groundwater recharge
In an urban environment the high share of impermeable pavement aggravates the problem of flooding and negatively affects runoff water management. Therefore, increasing the permeability city surfaces is a priority. Green infrastructure, such as rain gardens and bioswales fulfil this function: they catch stormwater, with the help of plants they remove pollutants, and they infiltrate water into the groundwater plate.

Improves air quality
Trees and other vegetation can improve air quality by directly removing air pollution and slowing temperature-dependent reactions that form particulate matter that is hazardous to human health.

Reduces urban heat island effects
Vegetation blocks the short-wave solar radiation, but also absorbs long-wave radiation emitted by surrounding materials, lowering temperatures especially during the day. Permeable pavements and vegetation will evapotranspire water and cool air temperatures.

Enhances wildlife habitat
Green infrastructure can offer a better environment to live, find food and shelter for wildlife living in an urban environment.

Economic benefits

Reduces water treatment costs
Green infrastructure practices that increase infiltration or use water on-site (bioretention systems, permeable surfaces) can reduce the amount of water being conveyed to wastewater treatment facilities and reduce the volume of water discharged to the sewage system.

Reduces infrastructure costs
Green infrastructure can reduce investment costs through reducing the need for infrastructure expansion.

Increases property values
Increased greenery within urban areas enhances the aesthetic value of neighbourhoods. The positive impact of green infrastructure practices on aesthetics can be reflected in the relationship between urban greening and property value.

Social benefits

Increases pedestrian safety and traffic calming
Bump-out curbs, swales and segregated bike lanes offer security to bikers and pedestrians, and stimulate a healthier kind of mobility. By promoting walking and cycling, the risk of obesity and related heart diseases will decrease.

Enhances well-being of individuals
Aesthetically pleasing pathways, trees and other vegetation, enhance well-being and help the mind recover from mental fatigue or stress[251].

Increases the sense of community
Green street projects provide an opportunity to involve the community in the process of designing and proposing ideas for their communal environment. For this reason, it is important to implement green infrastructure practices together with placemaking and the participation of the community.

10.2 Greening streets for improved health and wellbeing outcomes

Positive impacts of green streets on physical and mental health

A greater exposure to green space is linked to improved physical and mental health across all socioeconomic groups[252]. A 2021 study at Harvard T.H. Chan School of Public Health[253] shows that regularly spending time around trees provides a wide range of health benefits, from lowering stress to improving cognition to increasing longevity.

Reducing heat stress with street greening

Vegetation blocks the short-wave solar radiation, but also absorbs long-wave radiation emitted by surrounding materials, lowering temperatures especially during the day. Using reflective and lighter surfaces in pavements and incorporating vegetation can reduce temperature impacts. Permeable pavements and vegetation contribute to increased evapotranspiration of water that help cool air temperatures.[254]

Street greening contributing to improved air quality

Trees and other vegetation can improve air quality by directly capturing air pollutants and slowing temperature-dependent atmospheric reactions that form hazardous particulate matter.[255]

Positive impacts of green streets on social wellbeing and community cohesion

Green spaces can strengthen social ties among neighbours[256]. Neighbourhoods with strong social cohesion have lower rates of anxiety and depression. The contact with greenery enhances well-being and helps the mind recover from mental fatigue or stress[257]. A study has found a link between increased vegetation and the use of outdoor spaces for social activity, concluding that urban greening can foster interactions that build social capital.[258]

Green streets for noise reduction

Vegetation has been considered as a means to reduce outdoor noise pollution, mainly in areas with high volumes of traffic. But also the use of porous pavement in city streets was found to reduce noise level by up to 10 decibels[259]. In some cases, linear tree buffers can even replace conventional noise mitigation strategies, such as concrete noise walls[260].

10.3 Design considerations

10.3.1 *Identification of priority areas for street greening*

In cities there are countless of opportunities for introducing green streets into the townscape. But, when resources available for interventions aiming at the use of nature-based solutions across streets are limited, then urban authorities need to be careful with the prioritization of target areas. A number of aspects need to be considered during the selection of priority areas for street greening[261, 262, 263, 264, 265, 266].

- The current built environment should be carefully mapped to capitalize on inefficient use of space.
- It is essential to distribute greening in streets fairly across various neighbourhoods. The amount of greening and the access to canopy cover across the local government area should be assessed to identify hotspots lacking sufficient greenery.
- Low-cost and simple projects should be ranked as high-priority.
- In case of streets that are wider than necessary, greening interventions combined with street width narrowing actions (such as the elimination of travel lanes on multi-streets or the reduction of the number or the size of on-street parking places) should be considered, contributing thus to traffic calming and a balance and healthy streetscape.
- The space under and above ground should be suitable for increased canopy.
- Heat hotspot and vulnerability hotspot mapping should be used determine the priority zones for greening streets. Neighbourhoods with a high proportion of elderly or children, or with large numbers of aged care facilities can we considered particularly vulnerable to heat stress. Wide street canyons and also narrow canyons with low buildings can be considered priority streets for cooling with greenery.
- Areas/streets should be mapped that can effectively contribute to the establishment of a calm space network through targeted greening actions. In sections where permanent greening is not available, the use of temporary and 'pop-up' green spaces can be considered to offer respite.
- It is worth combining street greening efforts with planned road or footpath upgrades due to occur in the street.
- Capital improvement projects, weather resiliency plans, stormwater management plans or citywide initiatives can help identify potential green infrastructure sites.
- Large-scale development projects can offer opportunities for greening the streetscape in the vicinity of the development site.

10.3.2 *Species selection*

Urban trees and street trees in particular are growing under exceptionally harsh conditions in the presence of multiple stress factors. Soil compaction, caused by heavy traffic, construction work, and dense buildings are some of the major problems affecting street trees. In compacted soil the water and air permeability are poor and the roots grow more slowly.

(See Showcase 10.1).

Increased surface runoff and poor water retention in urban areas result in soil drought. In addition, street trees typically need to cope with contamination, nutrient deficiency, limited light access in densely built-up areas, or excessive illumination due to the use of reflective materials on buildings, or light pollution disrupting plant physiology[267]. Therefore, in an urban environment it is of paramount importance to select species that are tolerant to various stress factors. As urban habitats do not favour tree growth and shortens the lifetime of the plants, more durable species should be selected for a street environment[268].

Here some basic principles are summarized for the selections of species[269, 270, 271, 272].

- When possible, it is preferable to use native species, although many native species do not adapt well to harsh urban conditions, or might not meet desired functions.
- Consideration should be given to watering needs and heat resistance of the species in light of a changing climate.
- Where it is desired to maintain canopy during the winter season (e.g., for pollution reduction), evergreen species should be used, but if the goal is to let through the sunlight during winter, then deciduous trees should be selected.
- Vegetation placed along roads should be tolerant to air pollution as well as salt and other de-icing compounds.
- An increase in tree diversity in the city can reduce the vulnerability of trees to pests and diseases. On the other hand, forced diversity of trees may results in planting unsuitable species of trees.

10.3.3 *Planning for maintenance*

Without designing with maintenance in mind, green streets will not perform as expected over the long-term. There are several maintenance factors to consider before project implementation. During the green streets design process, designers should be in close contact with municipal staff to be able to understand the human resources available for long-term maintenance. If the new greenery will require duties that is different from current practices, the training of staff needs to be undertaken prior to project completion.[273]

Maintenance of green infrastructure needs to take account of a wider landscape context (biodiversity, amenity) together with drainage requirements.[274]

At a minimum, green infrastructure practices should be inspected annually to remove trash, clean inlets and outlets, remove invasive species and prune vegetation. Maintenance should be performed more frequently while vegetation becomes established.

10.3.4 *Accommodating utilities during of green infrastructure*

Utilities in the streetscape above and below ground can often hinder the implementation of green streets projects. Yet, with the right site conditions, careful planning and stakeholder support, green infrastructure can coexist with utility systems. Close cooperation with the local utility companies during the design phase of green infrastructure interventions can ensure that utility needs and concerns are also addressed.[275]

The Green Streets Handbook published by the United States Environmental Protection Agency (EPA)[276] provides a summary of basic principles that should be considered for accommodating utilities during the implementation of green street projects.

During project design among other the following requirements might arise associated with utility systems:

- providing access to utility lines for repair or replacement and sufficient space for accommodating utility vaults and utility valve boxes, and
- providing adequate protection around utility lines.

To avoid any utility conflict, the simplest and most cost-effective option is to locate green infrastructure clear of any utility or to reduce its size to provide sufficient distance from the utility lines. In case sufficient protection and clearance is ensured on the site, then utility companies can be encouraged to coexist with the new greenery. Modifications to the design of both the green elements or the utility system can also be effective in specific urban situations. As a last resort, the utility can be replaced or relocated. Ideally utility lines can be rearranged as a compact system rather than separate infrastructure.

In many cases, a number of solutions are available to address utility challenges and enable the realization of green infrastructure projects in streets. Options provided by the handbook to avoid problems include:

- placing utility vaults outside the wet zones,
- protecting utility trenches with impermeable geotextile or liners or clay or other impermeable plugs to prevent the infiltration of stormwater,
- installing a clay or other impermeable plug within the utility trench to inhibit movement of stormwater within the trench line,
- construction of a deep curb profile to separate the layer of native soil on which the foundation of a road is laid from the green verge.

The Green Streets Guide of Vermont[277] provides some additional considerations in this context:

- in case overhead utilities are present on the site, then during the selection of plants, the mature height of various tree species needs to be carefully considered,
- the minimum required setback distances for maintenance of above and below ground utility systems need to be applied,
- the cost of underground utility access for repairs might be lower in case of greenery systems (and pervious pavers) since they are easier to remove or replace than traditional hardscapes.

10.3.5 *Green infrastructure contributing to healthy street design*

Due to car-centric planning, in most of the modern cities across the globe the air is poor, noise levels are high, there is little space for cycling and walking, the amount of greenery is often negligible, and in certain cases it is particularly dangerous not to drive a car.

A Healthy Streets Approach was developed by Lucy Saunders, according to which streets need to be made much more pleasant, welcoming and safe to promote an active urban life[278]

(See Showcases 10.2 and 10.3).

According to the approach, in a typical healthy street there is a wide sidewalk for pedestrians urging people to take a leisurely walk, conditions for two-way bicycle traffic are provided, car traffic is limited, and there are facilities around, such as cafes, stores, benches or fountains that motivate people to stay longer and socialize.[279]

Action:
Creating healthy streets with the use of greenery

Well designed and maintained green infrastructure can effectively contribute to the creation of a healthy street[280]:

- *good-quality and attractive street greenery feels welcoming, and encourages people to be more physically active on the street,*
- *well maintained green infrastructure by improving the ambience of a street, increases the perception of safety of pedestrians,*
- *vegetation on streets (e.g., parklets, trees with benches around and under them, or planter boxes next to benches) can provide a sheltered resting place,*
- *greenery, such as hedges, can reduce the exposure to air pollutants on the street,*
- *trees and hedges can mitigate heat, providing shade from the sun,*
- *green infrastructure can function as a sound barrier and can reduce the perception of noise,*
- *street greenery has a calming effect on people contributing to stress reduction.*

10.3.6 *Tactical urbanism and placemaking with greenery on street level*

A tactical urbanism approach for street greening, could be to add temporary green elements to a street section, such as planters or parklets, to enhance social wellbeing and community cohesion on neighbourhood level. Following this initial temporary intervention, a process of placemaking can generate a collective design with the participation of the local community, to turn the same temporary space into a more stable green space, with trees and other elements of green infrastructure. One example illustrating this practice is described in

(Showcase 10.4.)

10.3.7 *Planning for walkability and bikeability*

Cities are largely composed through traffic. Modern urban development is car-dominated, leading to an unfortunate distribution of land. The streetscape however should not be designed only for traffic. Streets, and particularly streets in city centres should be places to slow down and stop, rather than places for passing through. If in a typical street in an urban centre a car lane is replaced or narrowed by different services, such as greenery, wider sidewalks, or bike lanes, similar or increased traffic capacity can be achieved that will be accompanied with health and wellbeing and other benefits.

A green street can provide space to stimulate walking, running and biking, not only to enjoy physical activity, but also to use alternative and healthier modes of transport to commute and move around in the city.

One of the proposals of the Mayor of the City of Paris, developed by Carlos Moreno, in this line is the '15-minute city'. It promotes walkability and cycling in big cities based on a concept of urban proximity.

Carlos Moreno's 15-minute city framework is based on four key characteristics[281]:

- Proximity: services, stores need to be close.
- Diversity: a wide variety of urban amenities need to be offered through mixed land uses.
- Density: the neighbourhood needs to be dense so that there is sufficient number of people to support a diversity of businesses in a compact land area.
- Ubiquity: these compact neighbourhoods should be available and affordable to anyone who would move in one of them.

Walkable and bikeable streets and cities start by planning with a human-centred design, that aims to enhance a sense of proximity and ease of access to an ameliorated urban way of living.

(See Showcases 10.5, 10.6 and 10.7)

Annex

Showcases

Showcase 5.1

‘Flower Power’ programme in Breda, improving human health through bacterial biodiversity

Biodiversity is important for our health. A biodiverse vegetation with various wild plants creates favourable living conditions for many bacteria associated with these native wild plants that are very important to human health. Around the roots and stems of plants there are hundreds of thousands of bacteria, the services of which are essential for the human body, e.g., in the production of vitamin K, or in the transportation of nutrients in the intestines. By having contact with microbes through the environment and healthy food, they colonize our skin and intestines. This makes us more resilient by developing a stronger immune system. Adequate access to a biodiverse environment is seen as an important factor in defending ourselves against diseases that have been on the rise since World War II. The City of Breda is working on a programme establishing a green biodiverse belt around the city.

As part of the programme, ecological connection zones or nature roads will be linked to the green belt to bring biodiversity into the city to improve health outcomes. The aim of the programme is to ensure that children and citizens can get in contact as much as possible with bacterial biodiversity. The monotonous vegetation such as lawns, will be replaced by more natural and biodiverse urban meadows. The programme promotes sowing instead of planting and aims to increase exposure to bacteria by making semi-natural green areas experienceable, and locating them in upwind direction of the houses of residents. Priority areas for the greening interventions will be urban areas frequented by many people. Residents will also be encouraged in the programme to turn their private gardens more natural.

Source: City of Breda

Showcase 5.2

Health-enhanced yard of Vallipuisto day care centre in Espoo to increase microbiota biodiversity

In 2019, the yard of Vallipuisto public day care centre in Espoo, Finland was renovated based on a research intervention by the University of Helsinki. In the project, asphalt, gravel, and sand were replaced with natural materials rich in microbiota biodiversity, including sod, shrubs, meadow grasses, and forest floor patches.
The staff, children and their parents in the day care centre took part in the research projects Towards Healthy Adulthood (KOTA) and Autoimmune Defense and Living Environment, which studied, how nature-oriented yard affects children's microbiota and how engaging with the natural environment enhanced the children's well-being in the day care centres.
Two kinds of litter cover were used in Vallipuisto day care centre. One was a mixture of pinecones, conifer needles and sticks. The other was a mixture of sand and mull, and the microbe fauna of the material was enriched beforehand. Also, blocks of peat and decaying wood were placed in the yard. The new yard had a zonal structure, where the immediate vicinity of buildings and passageways were left with asphalt and other artificial materials. The next zone is a mixture of sticks and soil. The outer zone is covered with forest cover and soil, shrubs, trees and undergrowth.
The studies showed that letting urban children play in microbiologically diverse dirt and vegetation alters skin and gut microbiota. These results indicate that even small changes in materials towards a more nature-based environment have a positive effect on children´s health by decreasing the risk of immune-mediated diseases in urban societies. The commensal microbiota of children in the intervention day care centre became similar to that observed in children who visit nearby forests on a daily basis. The forest floor mat, sod, peat blocks, and planters also offered day care children new dynamic and emotional ways of engaging with the natural environment, which had positive impacts on children's mood, energy and motivation. The greener yards enabled the children to become skilful in using the natural environment as a play environment.
In addition, activities related to caring for vegetation and exploring them boost the development of environmental relationships.

Source: City of Espoo

Showcase 5.3

Cardio Trail in Budapest supporting rehabilitation and cardio check-up in an urban forest

In the recent decades, significant progress was made in Hungary in the treatment and prevention of cardiovascular diseases, however, they are still the leading cause of deaths in the country, more than half of the population dying from them. Therefore, rehabilitation and preventive measures and innovative solutions should be top priority in the health-care system. Budapest Szent Ferenc Hospital, a pioneer in cardiac rehabilitation innovation, in partnership with Normafa Park, the green space management organization of one of the most popular green areas of Budapest, designed a Cardio Trail in Budapest 12th District with the aim to enable rehabilitation walks and outdoor cardio check-up in an urban forest that is easily accessible for all interested patients. The trail consists of several check-up points where, following the instructions, patients can measure their heart rate and fill out the check-up forms provided at the start of the trail. At the end of the trail, the forms are collected in a box that is emptied at regular intervals, and delivered to the hospital where doctors examine the results. If they see something irregular, they get in touch with the patient suggesting another check-up in the hospital, this time, conducted by the medical staff. There are also regular guided rehabilitation walks on the Cardio Trail organized by Szent Ferenc Hospital, during which a physiotherapist helps patients master the use of Nordic-walking sticks. The cardio trail does not only support cardiac rehabilitation and the prevention of cardiovascular diseases but can also save lives: several times patients were referred to heart surgery based on their trail check-up forms.

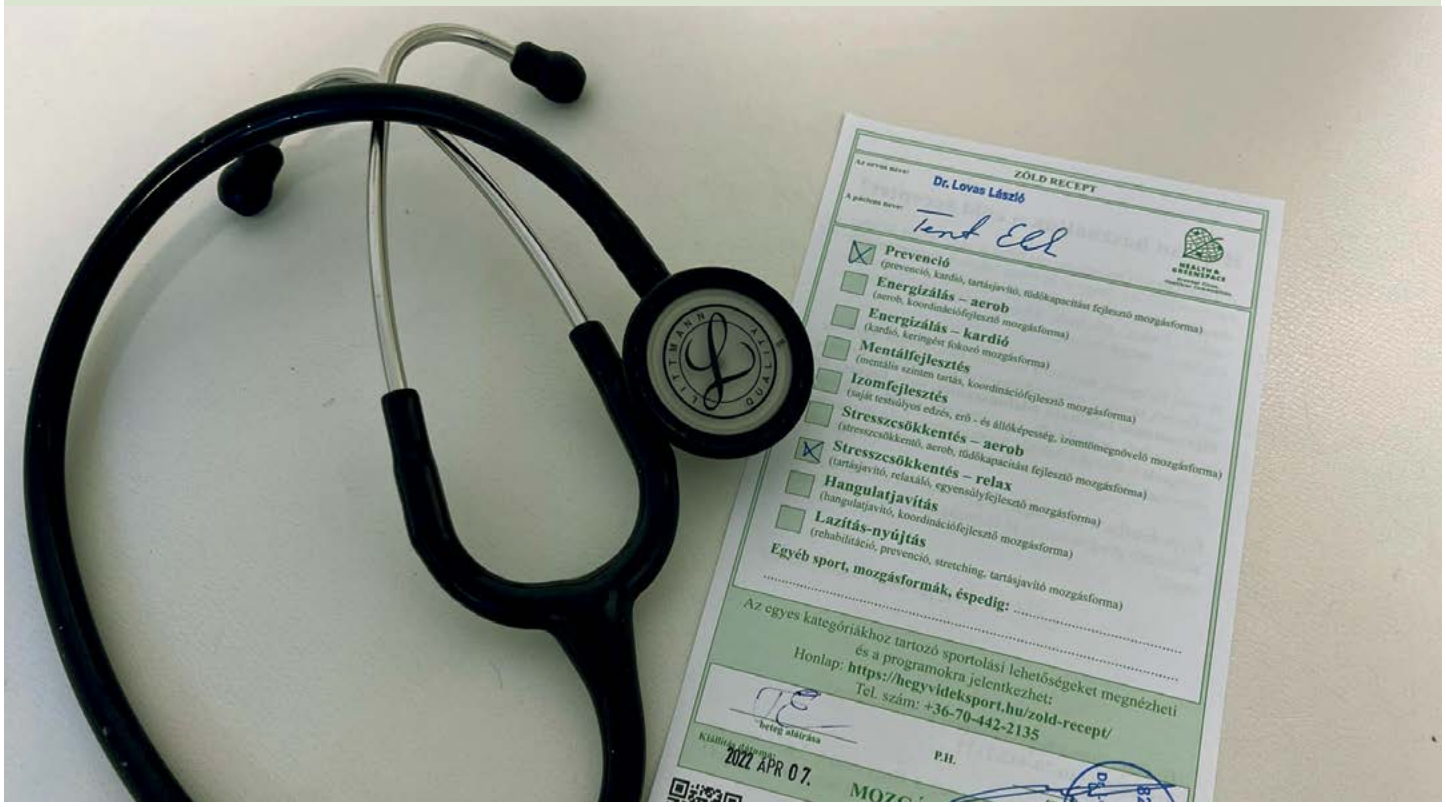
Source: Budapest 12th District

Showcase 5.4

Green Prescription scheme in Budapest 12th District

According to the statistics of a Budapest clinic specialized on cardiovascular diseases, one third of heart surgery patients die within three years after their treatment. The reason for these tragic statistics lies in the fact that these patients are unable to change their lifestyles, lose weight and exercise more, which would be essential for them to keep healthy. Therefore, more emphasis needs to be put on supporting healthy life choices by doctors. So far, outdoor physical activity and the health services were not connected, but now, thanks to the green prescription concept originating from New-Zealand more than 30 years ago, Budapest 12th District (Hegyvidék) linked them together, approaching prevention and health promotion in an interdisciplinary manner. Just like a regular prescription, the green prescription is provided as a written advice by the general practitioner to the patients during a visit. However, green prescription, instead of medication, offers free outdoor exercising opportunities in the district, motivating patients to be physically active in urban green spaces. The green prescription scheme was directly linked to the Active Hegyvidék Programme that offers a number of free physical activity sessions, such as running and hiking, to local residents in larger parks of the district. The health care professional can tick several categories on the green prescription sheet, which include prevention, aerobic or cardio-type energization, mental development, stress reduction, mood improvement, or stretching. Patients are urged to contact the call centre of the Active Hegyvidék Programme, where based on the selected categories on the green prescription sheets various types of outdoor physical activity sessions are offered to them. The scheme is also linked to the Alzheimer Café initiative of the district, to the guided rehabilitation walks on a cardio trail, or to the activities of a local pétanque club or a picnic for the elderly. In the near future, Budapest 12th District plans to support additional activities, such as local heritage walks or bird-watching walks. The municipality hopes that building on the authority of the doctors already existing free outdoor exercising options will become more popular.

Source: Budapest 12th District



Showcase 5.5

Olari health nature trail in Espoo[282]

In the Olari district of the city of Espoo, a new health nature trail was opened in 2019, where visitors can experience the health benefits of nature and take a break from everyday life. The trail is located in Espoo Central Park and enters various landscapes in the Kokinmetsä forest. The path with an approximately 2.4 km length has eight checkpoints with three separate exercises each. The various exercises guide the hikers to observe, learn and experience the multiple health effects of nature. These exercises have been designed with a view to target the three main target groups of the trail, children, visitors unfamiliar with the forest, and those who are seeking the health benefits provided by nature. The trail is marked with easily distinguishable blue hearts. The development of the trail was initiated by a local association, Olari-seura. Several organisations, including scout troops, day care centres, schools, a mental health association, residents' associations worked together in the planning and creation of the trail. A wide range of local stakeholders co-designed the trail and the exercises. The construction of the path was primarily undertaken by volunteers.

Source: City of Espoo

Showcase 5.6

Therapeutic biogarden in Szent János Hospital, Budapest

In 2017 a Mental Health Day Care centre was opened in Szent János Hospital that aimed at the psychosocial reintegration and rehabilitation of chronic psychotic patients. A couple of months later, in early 2018, as a result of a joint initiative of the patients and the therapeutic group, a small strip of soil was planted with vegetables next to the building of the day care centre. Patients and the medical team started gardening together, initially during the breaks and later already as part of the therapies. The aim was to establish a recovery-oriented psychosocial reintegration and rehabilitation practice by actively involving patents in gardening.

Building on the initial positive experiences, a year later in Spring 2019 a therapeutic biogarden was established with the involvement a bio-gardener, a human-ecologist and a sociologist. Raised garden beds were used with differing heights to allow also older patients' activities and to enable deconstruction in case of a potential relocation. The patients were actively involved in the planning of the garden, the assembly of frames of the garden beds, and planting. In the biogarden various vegetables and herbs are cultivated.

During the breaks in between therapeutic occupation the patients together with the therapeutic team undertake smaller tasks, such as watering or weeding. During the socio-therapeutic and skill-developing teamwork the patients are engaged in harvesting, cooking, eating together with the medical team.

As a result of the initiative patients have left the closed therapeutic space and this in itself is a therapeutic factor supporting the improvement of their mental and social health. The shared gardening helps them reintegrate into society. With time, it became common that during breaks patients went out into the garden to socialize while they were routinely weeding the vegetables. The therapeutic garden can also effectively help the medical team in burnout syndrome prevention.

This easily adaptable 'green care' initiative served as a proof of concept study that can provide inspiration for other urban institutes providing health and social care services for psychiatric patients and people living with psychosocial disabilities.

Source: Gábor Kapócs (Department of Psychiatry and Psychiatric Rehabilitation, North and Central Buda Centre, New Szent János Hospital and Clinic)

Showcase 6.1

Open Gardens Program in Poznan, Poland

In Poznan, Poland an 'Open Gardens' programme was initiated in 2017 for unlocking green spaces of public institutions for local communities. Under the programme part of the yards of kindergartens are made accessible for residents.

The idea for Open Gardens came about as a response to the fact that central districts of Poznan lack easily accessible green space and suffer from their uneven distribution. Principally in old, historical neighbourhoods the urban fabric is so dense that there is physically no space to create new green areas. Therefore, the aim of the program is to make better use of existing green spaces in these districts, making them available for as many users as possible. According to the concept a part of the kindergarten yard is made accessible for the local community in a controlled manner.

A pilot project of the program was implemented in a kindergarten in Wilda district of Poznan from March 2017 till June 2018 based on a participative approach. The entire kindergarten community with the children, the preschool teachers, and the parents were engaged in the planning process together with the local community and the district council under the supervision of a landscape architect. A series of three workshops were organized to discuss the needs and concerns of potential users.

As a result of the planning process a place was developed where children can learn about nature, adults can relax, and local residents can grow plants. The local community is allowed to use a designated part of the yard that is separated by a low fence from the rest of the area. The larger preschool part of the yard, accessible only for children, was revitalized through greening and the provision of play facilities. In the 'open garden zone' raised beds, hammocks, a gazebo, seats, an insect hotel, and a composter were installed. All these features aim at fostering social interactions.

In the summer season the garden is open from Monday to Friday from 1 PM to 8 PM, and in winter from 1 PM to 5 PM. Until 1 PM the entire yard is used by pre-schoolers. On weekends the garden is opened on individual requests to host get-togethers or workshops.

Following the pandemic additional kindergartens are planned to be opened in Poznan for local communities under the programme. The scope of the scheme will also be broadened to include also allotment gardens, where common spaces are foreseen to be opened to host various community events.

Source: City of Poznan

Showcase 6.2

Frizon in Umeå: An equal place to meet

Frizon (Free zone) was designed together with young girls in Umeå, Sweden to cater for young girls' needs in public areas. During spring and autumn of 2015, a total of 30 girls between the ages of 15 to 18, have worked together with the municipality to design the Frizon meeting place. One group also participated in the implementation phase of the project, they were present at a press conference about the project and in the opening of an exhibition about Frizon in the Museum of Västerbottens. The exhibition showed a film, along with some postcards, signs and photographs about the planning process.

Based on the dialogues with the girls, the basic requirements for the design of the new meeting place were collected for the designer. Finally, the project has been realized in a central park in Umeå, in line with the control's group vision. Following the girls' feedback, Frizon was designed around an existing tree. It is open all seasons, it has sitting and hanging surfaces for socializing, WiFi connection and the possibility to listen to music together. An important feature for ensuring a sense of safety, is that Frizon is close to other social places and has lightning in the evenings.

Sources:
www.boverket.se/contentassets/e88bfb45d884493080ace98f2460b235/frizon-umea-slutrapport.pdf
www.tyrens.se/en/projects/urban-and-rural-planning/frizon/
www.umea.se/frizon

Showcase 6.3

Programmes in the United States for converting abandoned areas into art parks

Arts organizations usually struggle with finding space in cities for rehearsal and performance. In Los Angeles and Chicago specific initiatives were developed to promote cultural activities in public areas through creative placemaking.

In Los Angeles a community-based programme was launched in 1992 to promote innovative uses of land and foster creativity and community involvement. The goal of programme, managed by ARTScorpsLA, a non-profit organization in association with the University of Southern California, was to turn abandoned lots into art parks that function also as gathering places. The new community art parks were open to all, even to gang members.

The artistic and landscape projects of ARTScorpsLA actively engaged young adults. Workshop spaces were created and educational programs were offered for local youth. Under the programme with the help of a city-wide anti-graffiti initiative 28 murals were created across the neighbourhoods of Los Angeles.

The Arts Partners in Residence, a similar programme in Chicago identified underused parks or parks spaces to turn them into cultural spaces. Under the scheme arts organizations looking for venues were contracted to provide performances or educational services in exchange for free space. As a result, the neglected public spaces became animated with the help of art activity, local communities had been strengthened, and at the same time arts organizations were provided with precious space.

Sources:
www.rudybruneraward.org/winners/artscorps-la-2/
www.rudybruneraward.org/wp-content/uploads/2016/08/06_ARTScorpLA.pdf
www.brec.org/assets/General_Info/Why_R_Parks_Important/Papers/Parks-for-Arts-and-Cultural.pdf

Showcase 6.4

Outdoor theatre play at Tatarasi in Suceava

Due to restrictions imposed by the Covid-19 pandemic, in July 2020 the theatre moved to Tatarasi Park in Suceava, Romania, and the playground was transformed into a performance stage. The actors of the city theater brought to the audience the premiere of the play "Tragicomedy of Don Cristobal and Rosita" by Federico Garcia Lorca for the first time outdoor. The audience eagerly awaited the reunion with the actors from Suceava, while the actors have been preparing for this show for almost a month and a half. More than 300 people watched the staging of the play. The playground with slides and swings in the Tatarasi amusement park was the scene that were adapted to such a show. Real efforts were made to keep the event safe while enjoying nature and culture. The open-air theatre was a real success amid restrictions linked to the pandemic. The initiative was repeated in 2021 and the municipality plans to organize the event again in the summer 2022.

Sources: Municipality of Suceava

Showcase 6.5

Classes on the beach in Murcia

In order to reduce the risk of COVID contagion, the classes of the Felix Rodrigez de la Fuente primary school were moved to the beach for a day alongside the Mar Menor coastal salt water lagoon in Los Nietos, Spain. The special day was implemented in the frame of the "Aire Limpio" (Clean Air) program which aims to improve children's knowledge and understanding of the natural environment in which they live.
Morning classroom areas were drawn into the sand, while one zone was reserved for physical education. On top of learning and in the breaks also playing in a Covid-safe environment, teachers reported also other benefits of the outdoor class: instead of being over-excited pupils behaved in a responsible way and rose to the challenge. Students were reported to be more attentive than in conventional classes held indoors. The mild climate of Spain provides execptional opportunities for outdoor teaching.
Based on the success of the scheme, the exercise is planned to be incorporated into the educational planning documents so that these outings can be repeated at the beach.

Sources:
www.murciatoday.com/classes-on-the-beach-for-children-at-the-primary-school-of-los-nietos_1577378-a.html
www.niusdiario.es/sociedad/educacion/colegio-los-nietos-clases-orilla-mar-menor-playa-murcia-reducir-riesgo-contagio-covid_18_3110895173.html

Showcase 6.6

Forest School in Baggot Estate, Limerick, Ireland

Baggot Estate is a public park west of Limerick city, Ireland. Once a week from September to December 2020 a local primary school for children with a hearing impairment delivered a Forest School in Baggot Estate. Each session lasted three hours with children from 2nd to 6th class (8-12 years old) engaged in outdoor learning. The teacher who is a Forest School Leader, used the outdoor space to engage students in their learning but also helping to maintain social distancing as per government guidance for teaching and learning due to COVID-19.

Before each session the teacher and two students prepared an area in the estate for the Forest School. This included establishing boundaries which were extended each week. Informed by the primary school curriculum activities were linked to subject areas such as, social, environmental and science education, art and craft, English, social personal and health education, mindfulness, imaginative play and physical education, including balance and movement. Under the scheme other schools are encouraged to engage in similar activities in Limerick.

Sources: Forest School Ireland
Limerick City and County Council

Showcase 6.7

Nature Explorers' Day in Breda

On 27 October 2021, during the autumn break in the Netherlands, children from 6 to 12 years old had the opportunity to become a nature explorer. The Municipality of Breda together with nature conservation and experience organization IVN organized a preview of the natural treasures in the vicinity of the future Seelig park in the city centre of Breda.
Children could discover which animals and plant species live in the city. With special tools, they could examine the soil, water and air. Guides from the IVN were there to explain what the children discovered. Aquatic animals were fished out, edible herbs were added to the broth, bird nests were woven, soil animals were examined. "We wanted to make people enthusiastic about what is to come and make them better acquainted with nature in the city," explained Karien van Bijsterveldt, municipal project manager. Nearly 70 people took part in the excursions and the discovery trail, amongst them 35 children. Breda plans to organize this event every year in order to involve young people in the development of the new park Seelig.

Sources: City of Breda

Showcase 6.8

Birdwatching activities in Messina

In Sicily the City of Messina organized during Spring of 2021 a birdwatching activity for schoolchildren.
The aim was to deepen the knowledge of citizens and schoolchildren of the natural context that surrounds the urban territory in Messina.
Messina has always been historically a seaside city and its economy has always been closely linked to the sea. The city has about 70 km of coastline and many citizens have the opportunity to reach the beach on foot. The citizens of Messina love the sea which is much easier to reach.
On the other hand, the Peloritani mountains that are bordering the city from the west tend to be neglected by urban residents.

The City of Messina aims to promote the natural context of the Peloritani mountains, an ecosystem rich in native botanical and fauna species, and to bring citizens closer to the mountains. Birdwatching is an important tool for reaching this goal.
The activity took part in the mountains at a height of 1200 meters. The children, apart from watching birds, participated in various environmental education activities led by the ornithologists of MAN (Mediterranean Association Nature). Building on the popularity of the initiative, later similar activities were organized for adult residents of Messina.

Sources: City of Messina

Showcase 6.9

Use of QR codes to support environmental education in Messina

The Multifunctional Centre of Camaro is a natural area managed by the regional forestry agency and is located on the Peloritani mountains at about a thousand meters high not far from the city centre of Messina. The initiative conceived by a large stakeholder group led by Messina, was born from the need to make the citizens of Messina more familiar with the Peloritani Mountains. The paradox of the Camaro Multifunctional Centre is that it is unknown to the majority of the inhabitants of Messina. The Centre has a considerable variety of native botanical species and a reproduction of the lithographic map of the province of Messina, as well as of all the rock types present in the province. With the help of the University Orthobotanical Institute of Messina, a detailed census was made of all the botanical species present in the Centre. Subsequently, a special website was created where all the recorded data were uploaded. After, wooden panels were created positioned in various points of the centre containing a QR code through which visitors can easily connect to the site and obtain all the information.

Sources: City of Messina

Showcase 6.10

Natural Playgrounds in Kindergardens in Poznan

For the last few years Poznań has been promoting the idea of a "natural playground" in public kindergartens. Each year, the city hall is providing the kindergartens support. The play spaces were designed by a landscape architect. Workshops were organized for teachers on how to use such space with children. Kindergartens were equipped with 'ecological demonstrators' and provided by lesson plans for eco-education.

Natural playground is more like a 'garden to play' than a typical playground. Among traditional playing facilities like a swing or a slide, playing facilities are introduced made of living plants (like willow tipi or a maze made of tall grass), of earth (hills, natural paths) or from natural materials (wood, stone). Artificial safety surface is replaced by natural, water absorbing surfaces (sand or gravel). Vegetation is introduced to provide a pleasant microclimate, shade or natural isolation from the traffic noise and pollution.

Children can observe how the plants grow and sometimes can even consume the fruits. The natural playgrounds support recreation, as well as creative play with natural substances. A mud kitchen encourages play with sand and water, a wooden stage around the tree or tree trunks forming a ring support group play. There are also places designated for eco-education, such as 'wild biodiversity zones', meadows with houses for insects, flower beds, or raised planters with fruit and vegetables.

The advantage of a natural playground in comparison to a traditional one is double, for both the city environment and the children themselves. A natural playground is more ecological, creates a green zone in the city, helps with increasing biodiversity and natural water retention. On the other hand, it provides for children direct contact with nature, improves their creativity and makes them happier.

Sources: City of Poznan

Showcase 6.11

Active School Yards project of the City of Tartu

Tartu City Government in cooperation with The University of Tartu Research Group of Physical Activity for Health has successfully promoted the Active School Yards project. The project redesigns both the programmes and physical spaces inside and outside schools to encourage students to be more active.
The programme resulted in robust outcomes. Three schoolyards have been promoted by the local community and they have been the winners of the participatory budget campaign of the City of Tartu and thus rebuilt to follow the Active School Yards brand. The redesigns consider a daily safe and healthy commute, present simple universal equipment that inspire play and movement rather than suggest certain use, add seating and greenery to promote time spent outdoors. The main aim is not so much to provide places for sports but allow for a variety of outdoor spaces for all types and ages of students, including quiet places for observing and contemplating.
The goal is to get students outdoors.

Source: City of Tartu
Illustration: a redesigned school yard at Reiniku school. The project was one of the winning entries of Tartu 2019 Participatory Budget programme

Showcase 6.12

Physical activity taken outside in the Active Parks programme in Birmingham, UK

The Birmingham Active Parks scheme offers free physical activity sessions at various parks across the city with the aim to encourage people to enjoy being active, to improve their health and wellbeing, and to strengthen local communities. The sessions run throughout the year and include a wide range of activities, such as led walks, running, cycling, frisbee, Tai Chi, Zumba, boules, skipping, rowing, tennis, gardening, orienteering, or nature play.

Active Parks was meant to animate previously underused parks, and aimed to tackle social inequalities. The programme first started as a pilot project in 2013 in six parks, and then over the years it was gradually rolled out to over 80 parks and green spaces across Birmingham. The activities were specifically designed to engage those who would not normally use traditional sports facilities.

The scheme has successfully engaged groups of society that are typically underrepresented in sport activity, such as women and ethnic minorities. In many activities children are involved helping mothers who have difficulties with child care. In 2016 over 80% of participants came from the most deprived areas of the city. The activities successfully engaged young children and the elderly. In case equipment is needed for the sessions a van is used by the Active Parks team to transfer them around various sites.

The evaluation of the scheme shows its effectiveness, particularly among inactive people, as 74% of the users were previously not a member of a sport facility, and 20% of the users were previously totally inactive.

Sources:
www.sportengland-production-files.s3.eu-west-2.amazonaws.com/s3fs-public/active-design-active-parks-case-study-march-2017.pdf?3irXdTM9P-9mG_GjTaaLL8NOC7Aubw6uq
www.isca-web.org/files/MOVE-CONGRESS-2013/Files/presentations/Karin_Creavin.pdf
www.readkong.com/page/improving-the-condition-of-public-spaces-to-promote-active-1249146

Showcase 6.13

‘Outdoor Friends to Elderly’ scheme in Espoo targeting mobility and wellbeing of senior citizens

In the City of Espoo (Finland), the Sports and Exercise and Elderly Services Units uphold together a network of volunteers, who have committed themselves to help senior citizens to spend time outdoors. As part of a scheme coordinated by the national Age Institute, the outdoor friends help the aged citizens to go out for fresh air or to run an errand safely. Some volunteers also help at joint excursions with multiple participants or in outdoor events. In Espoo, most of the volunteers help senior citizens living at sheltered homes.
Many of the aged, also those still living at home, do not dare to go out alone. A trusted company encourages upholding one´s physical activity, which enhances muscular strength, balance, and vitality. The ‘Outdoor friends to elderly’ scheme have also been experienced to have a significant effect on the mental wellbeing of the elderly, as well as on their independence, participation, and social interaction among different age groups. The volunteers, on the other hand, have found to enjoy the company of the aged and get fresh air also themselves. In sheltered homes, volunteers are considered as a valuable resource for the wellbeing of the senior residents.

The scheme is based on a written agreement. The aged and the volunteer agree together on the frequency of the visits and the length and route of the walks.
Many of the volunteers in Espoo have found the scheme through public sports groups, by advertisements in local newspapers or in Espoo liikkuu newspaper, which is published by the Sports and Exercise Unit.
Each new volunteer goes through a training for acting as a voluntary outdoor friend. Senior citizens in need of outdoor friends are charted ahead of time, so the volunteer and the aged are able to get a good start for the walks already during the training.
In Espoo, the scheme was developed as the result of a collaboration among the public sector, non-governmental organizations, and active volunteers.
One of the crucial success factors of the activity was the creation of clear procedures and making the volunteers feel welcome in the sheltered homes and by the aged. The scheme is planned to be further developed, the number of outdoor friends is to be increased, and further training and support is to be given to the volunteers.

Source: City of Espoo

Showcase 6.14

Sonning Common Green Gym, Oxfordshire, UK

The Green Gym is a program put in practice in Sonning Common, Oxfordshire, UK since 1997 on the principle of creating a healthy natural environment and improve people's wellbeing and health. The program is now spread around UK with thousands of volunteers involved. Different work sessions take place in diverse sites in urban spaces (including parks and allotments) or in the countryside. Tasks vary by location so that people with different abilities or difficulties can find the right place. Each session lasts about 3 hours and is led by two team leaders who are responsible for the smooth running of the session. All the sessions follow roughly the following format:

- 'Tool Talk': the safe handling and correct use of tools are discussed as well as the aim of the day.
- 'Warm up': exercises to prepare muscles for activity and reduce the risk of injury.
- 'Work session': always includes light and heavy tasks, there is something for everybody. Most of the activities are made by hand to burn the calories and to get the blood flowing.
- 'Refreshment': time to share food and cakes but also for chatting.
- 'Work session'
- 'Gather up tools': tools are collected and checked if something is missing.
- 'Cool down': exercises to prevent stiffness.

In addition to improving fitness, the participants valued the scheme as a means of enhancing mental wellbeing, being stimulated by nature and enjoying social contact, and as a flexible way in which to attain a valued productive role. Even if the program has adults as main target, children are also welcome. They have to be accompanied by an adult, and children's tools are also provided.

The flexibility and diversity of tasks at the Green Gym suggest that it has the potential to enable occupationally deprived individuals, including those who have experienced social exclusion through mental ill-health, to access a productive occupation in the community[283,284].

Source: www.onningcommon.tcv.org.uk, www.tcv.org.uk/greengym

Showcase 6.15

Scheme on orienteering in Limerick

Orienteering is a competitive sport that combines racing with navigation, using the geographical skills of map reading and the physical activity of running or walking. Limerick City and County Council (LCCC) has several large seminatural green spaces which offer the potential for outdoor recreation but which are currently. The greater use of some of these spaces can be encouraged by introducing new organised activities such as orienteering to the areas.

LCCC developed an orienteering map and orienteering course in a semi-natural woodland called Baggot Estate (13ha), located approx. 1.5 miles outside of Limerick City centre. The orienteering courses provided the opportunity to increase the number of local residents, school and community groups, and visitors walking and socialising in Baggot Estate. A variety of courses were created, of varied technical difficulty, and distance. The primary route is in Baggot Estate and for the longer, more technical courses the surrounding urban streets are included. All orienteering courses and maps are available in both hard copy and through the Maprun6 app.

Orienteering leader training delivered by Irish Orienteering Association was subsequently organised to promote these newly created courses. Teachers, local youth group leaders and residents association members took part in the workshop. Each participant received four hours of training and a resource folder of games cards/equipment to run their own orienteering events. Feedback from the event included requests to organise larger orienteering events in Baggot Estate in the future. Future events will demonstrate how best to use the MapRun6 courses for different levels of orienteering, illustrate the different type of orienteering that can be used, including score and star relay. Introducing participants to the key skills of orienteering in a fun and exciting way.

On the success of this course LCCC will develop similar maps for other areas of the city.

Source: Limerick City and County Council

Showcase 6.16

‘La Milla’: Walk promoted along the coast of Santa Pola

“Let´s do the Mile” or "Anem a fer La Milla” are expressions that are common knowledge among Santa Pola citizens. This Spanish term coming from the past is related to the marine Mile, when most of the men from the town who worked as fishermen came back home every now and then and had to do exercise to be healthy until it was time to leave again over the seas for months. They used to walk from the city centre until the end of the east urban beaches in Varadero, or even beyond them until the protected coastline. Building on this tradition Dr Maria Jose Cencerrado, a municipal doctor incorporated it into the routines of the Maintenance Gymnastics Groups for the Elderly in 1998. At first, the walk started from the Civic Centre door following the gym sessions, but in the 2020, because of the Covid-19 pandemic, as the gymnastics sessions were moved to the beach instead, it sets off from the door of the town hall every Wednesday, where people can join freely an open and dynamic group. The Municipality of Santa Pola, building on its participation in the Health&Greenspace Network created a new brand to encourage people to do physical activity in a healthy and attractive natural environment. The same brand will also promote a network of safe paths and bike lanes in Santa Pola to stimulate healthy lifestyles.

Source: Municipality of Santa Pola

Showcase 6.17

Senior gymnastics on the beach in Santa Pola

In 2004 in Santa Pola, Spain Dr Maria Jose Cencerrado, a municipal doctor has launched indoor gym sessions for fibromyalgia groups. During the Covid-19 pandemic, starting from June 2020, these groups started to do activities on the beach. It became a free activity for elderly people from Monday to Friday, from 9:30 to 10:30. The initiative that only costs 11,240 euros per year to the council and is free for everybody. Up to 80% of the participants are not local residents. The initiative is expanding to other target groups and also to other neighbouring municipalities.

A survey was undertaken on the initiative to learn details about the user profiles to be able to improve the services. According to the results most of the participants were women, aged between 60-80, and the vast majority of them were neither social services users nor under medical prescription. Participants highlighted that after taking part in the program their self-appraisal and physical well-being improved, and that they became more willing to leave their homes and relate to others. Participants also reported to have more stamina. Almost none of them would be happy to go back to do indoor exercising.

Source: Municipality of Santa Pola

Showcase 6.18

Recreational area on Suceava river banks

The rehabilitation of the banks of Suceava River together with the development of a large recreational area on the site is a recent green infrastructure investment of the Municipality of Suceava (Romania). On 22 October 2021 the works of the new leisure area have been completed. The new green space has quickly popular. Suceava residents, young and old, alone or with family and friends, are visiting the area to discover and participate in various team or individual activities. The park has an area of 155,560 m2, on which green spaces (140,050 m2), pedestrian alleys and bike lanes (9,755 m2), a tennis court, two badminton / volleyball courts, a fitness platform and an area for cultural events were created. The whole area is equipped with urban furniture, lighting systems, irrigation systems and will have Wi-Fi coverage.

Source: Municipality of Suceava

Showcase 6.19

‘Street Moves’: a strategic approach to support pop-up parklets across Sweden

Under a Swedish governmental project, called Street Moves, pop-up parklets started to appear in Stockholm and Gothenburg. Street Moves aims to study how parking spaces can be taken away in the city, and how street can be turned into vibrant, healthy and sustainable places in Sweden. Street Moves builds on tactical urbanism but applies a strategic approach with an overall aim to create streets of the future. The system Wooden strips with a width of 9 cm provide the basis for the parklets, which can be laid down rapidly. Through a participatory co-development process, the parklets are customized to the specific need of the site. The wooden strips can cover one, two or more parking, and can feature different amenities or attractions suiting the site. These light structures, working like a Lego system, can change the streetscape immediately. One unit can be installed in five hours. The parklet in Gothenburg installed next to a gourmet shop, having a bench, a picnic table and a bicycle rack became a popular micro space for hanging out. Another parklet in Helsingborg features seating, planters and integrated LED lighting.

Sources:
www.lundbergdesign.se/portfolio/street-moves/
www.aspiremetro.com/swedens-street-moves/

Showcase 6.20

Policy instruments supporting the creation of parklets in San Francisco

The blueprint for the global parklet movement was first developed as temporary interventions in San Francisco in 2005 by the designers of Rebar. In 2009 the San Francisco Planning Department stepped in adopting policies to support the local parklet movement to move away from tactical urbanism. By March 2015, more than 60 parklets have been installed in San Francisco by merchants, neighbourhood groups, and civil society organizations. San Francisco Planning Department recognizing the added value of the small scale temporary interventions, developed targeted policies to support the scheme. First 'Pavements to Parks', an experimental city programme was created to repurpose in a quick and inexpensive way a significant portion of public spaces in San Francisco dedicated to parking. Under the programme Rebar was hired by the city to design a flexible Parklet prototype with its elements, such as seating, tables, bike racks and landscaping. Parklets developed under the programme are removable and do not impede curb side drainage. They are open to the public and cannot be used for commercial purposes. They are raised to curb height so that they can be accessed by wheelchairs. Parklets can contribute to the green infrastructure of the city when they are created with greenery.

A Parklet permit programme was also developed by the City of San Francisco. The programme enables a simplified permit process for businesses or residents who want to convert parking spaces into parklets. By obtaining a parklet permit, one is responsible for maintenance of the parklet.

In September 2021, the Parklet Program was transitioned into San Francisco Shared Spaces Program.

Sources:
www.gehlpeople.com/projects/parklets/
www.globaldesigningcities.org/publication/global-street-design-guide/streets/pedestrian-priority-spaces/parklets/case-study-pavement-to-parks-san-francisco-usa/
www.sfpublicworks.org/services/permits/parklets

Showcase 6.21

Bryant Park, New York, USA: A no-go area converted into a popular social arena

Bryant Park in New York City, which once was a place for criminal activity, was transformed as a result of an extensive renovation lasting four years into one of the most welcoming and influential public spaces in the world.

After decades of deterioration from the 1960s, by the early 1980s the park became an intimidating area that was taken over by drug dealers, prostitutes and homeless people widely avoided by New Yorkers. Poor design was the reason for the bad conditions. The park itself was elevated from the street, surrounded by high walls and covered from view by tall hedges. Sideways were connected to the park by steps at narrow entrances. The site lacked activities and amenities.

As part of the renovation starting in 1988, the park was cleaned up, graffiti were removed, damaged architectural elements were repaired. The park was lowered nearly to street level, entrances were opened up, and iron fences and shrubs were removed to improve visibility. To improve accessibility of the site, new entrances, stairs, ramps and pavements were added. New lighting was installed in the park and also on a nearby rooftop to improve the perception of safety at night.

Furthermore, a number of actions were taken to attract people into the park. More than 2000 moveable folding chair were scattered around allowing visitors to sit wherever they wanted. Two food kiosks were installed and a restaurant and outdoor cafe were built. These services operated by private companies apart from attracting visitors also provide income for the park's maintenance.

The organization of various events, activities and games, such as chess and pétanque in the newly refurbished park also proved to be a magnet for users. An outdoor movie series held at night became particularly popular among visitors. Providing access to outside programmers generates additional income for the park's operation and maintenance.

As a result of increased access and visibility, improved lighting and a range of services, events and activities provided, in seven years following the reopening of Bryant Park, crime had been reported to be reduced by 92 percent.

Sources:
www.pps.org/projects/bryant-park
www.umusama2015.wordpress.com/2015/04/11/case-study-bryant-park-new-york-city/

Showcase 7.1

Cool City concept implemented in Stuttgart: Focus on green ventilation corridors

As Stuttgart is located in a valley basin with low wind speeds, heat is easily trapped in the city. Over time, development on the valley slopes has prevented cooling airflows from moving through the city. As a response, early on, since the 1970s the German city has embarked on a long-term and complex climate planning strategy to become a cool city.

Stuttgart has adopted a wide range of interventions to apply the cool city concept, exploiting natural wind patterns and the positive effects of dense vegetation. To hinder overheating through the preservation of cool air flows in the city, at strategic places, such as valleys and hillsides, construction bans have been used, and green ventilation corridors have been developed and kept wide. In densely built areas and around new developments increased vegetation has been recommended. The prevention of construction projects enhanced the ventilation effect of cold-air flows at night rushing down from the hills surrounding the city. An environmental office with the task to evaluate the effect of planned buildings on the microclimate and to protect key areas was established in the city. In 2008 a Climate Atlas was developed for the Stuttgart region, indicating the distribution of temperature and cold air flows. With the help of these detailed climate plans the city has stopped planned construction over 60 hectares. More than 60% of the city is covered by green area. Starting from the 70s, Stuttgart has integrated green areas into a massive U-shaped public park that has a substantial cooling effect on the city, and besides that the city boasts lots of other parks. Furthermore, Stuttgart is a global frontrunner in green roof infrastructure development. As a result of a combination of economic incentives and regulatory instruments introduced from the mid-'80s, over 300,000 m2 of rooftops have been greened by 2019.

Other adaptation measures implemented include the greening of 63 kilometres of tram tracks, using street trees for shading building facades, developing smaller public spaces into 'cool spots', and installation of water fountains, since dispersed water has a significant cooling effect.

Sources: Rehan, 2016[285], Climate ADAPT[286]

Showcase 7.2

Medellin's network of green corridors

Medellín, the second largest city of Colombia, has created an interconnected 20-km network of greenery that includes 30 Green Corridors ('Corredores Verdes'). This large-scale green infrastructure system connects existing green spaces, reduces the urban heat island effect in the city, improves biodiversity and urban air quality.

In recent decades Medellin was struggling with rising temperatures as the urban heat island effect has increased dramatically in line with the rapid urban development and population growth. To mitigate heat stress in urban areas, the city implemented a three-year programme called 'greener Medellín for you'. Native trees, tropical plants, and palms were planted in big numbers along sidewalks, busy roads, and riverbanks and in squares and parks. Under the programme about 8,800 trees and 90,000 smaller plants were planted along 36 green corridors on 65 hectares. The more than $ 16 million initiative gave 75 disadvantaged residents the opportunity to become gardeners after training in the city's botanical garden.

New green spaces were created functioning as cooling islands along busy roads, new parks were opened, new public spaces were designed with less concrete and more greenery, pillars, bridges and metro stations were turned green, and green roofs and vertical gardens were installed on government buildings to reduce temperatures.

This massive tree planting initiative had an extensive impact on the local environment. The project has managed to reduce average city temperatures by 2 degrees Celsius since 2018.

Sources:
www.c40knowledgehub.org/s/article/Cities100-Medellin-s-interconnected-green-corridors?language=en_US#:~:text=These%20Green%20Corridors%20provide%20Medell%C3%ADn,of%20more%20wildlife%2Dfriendly%20habitats.
www.reuters.com/article/colombia-heatwave-environment-nature-idUSL8N2OY69Q
www.qubit.hu/2021/09/15/igy-lett-medellin-a-kokain-es-az-eroszak-kozpontjabol-az-egesz-vilagnak-peldat-mutato-zold-okosvaros

Showcase 7.3

OASIS: Schoolyards converted into green cooling islands in Paris

By September 2019, nine new schoolyards were transformed in Paris into 'cool islands', by integrating nature-based solutions for shading and for storm-water management.

Over the last decades the frequency of heatwaves has increased in Paris. During a heatwave in June 2017, due to record-high temperatures the schools had to be closed down for 3 days. This event triggered the idea of converting the predominantly asphalt covered schoolyards into shared green spaces.

Under the UIA OASIS project, the city has selected 10 schoolyards out of which nine was converted into 'cool islands'. These revitalized spaces will also be open on a regular basis to the local neighbourhood after school hours and weekends, providing a recreation area to the broader local community. During heatwaves the schoolyards offer a cool and shaded refuge for locals. The OASIS project is implemented under the broader frameworks of the Climate Adaptation Strategy and the Resilient Strategy of the City of Paris.

During the planning stage, the aim was to focus the renovation of schoolyards on the well-being of children, especially through nature, to design more natural spaces at low costs, and to strengthen the social bonds within neighbourhoods.

The new schoolyards offer increased vegetation, permeable grounds, inventive play areas, natural and artificial shaded areas, water points, quiet corners and an inclusive use of space. At least 20-30% of the total area of the schoolyards are dedicated to green spaces. These new shared spaces provide an opportunity for residents to come together and interact. The newly transformed schoolyards are places for physical activity and contact with nature, which offer comfortable microclimates. They support psychomotor learning, sensory learning and the development of imagination.

Building on the experience of the pilot projects, OASIS has produced a set of recommendations and plans for other schoolyards. So far, another 35 schoolyards have been transformed in Paris and the city is planning to have all 760 public schoolyards transformed into neighbourhood oases by 2050. As every Parisian resides within a radius of 250m from a public school, according to the plans eventually each neighbourhood in the city would acquire a cool and shaded green refuge for days of extreme heat.

Sources:
Maria Sitzoglou, UIA Expert, OASIS, 4th Health & Greenspace Academy
www.uia-initiative.eu/fr/uia-cities/paris-call3[287]
ec.europa.eu/regional_policy/en/projects/France/oasis-in-paris-greening-the-city-and-reversing-climate-change-one-schoolyard-at-a-time[288]

Showcase 8.1

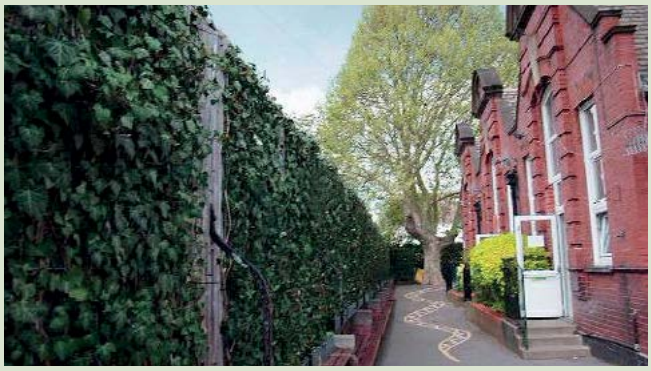
Green screens and hedges protecting schools from air pollution in London

Channel 4's Dispatches programme together with researchers from Kings College and Queen Mary University implemented a set of measures linked to green infrastructure interventions to reduce exposure of schoolchildren to air pollutants at Lordship Lane Primary School in London.

Under the scheme 1.8 meter high and over 1-meter-wide ivy screens were installed around the perimeter of the school playground to absorb pollutants. The plants on the ivy screen are grown on steel frames. In the playground evergreen hedging plants were supplementing the screens.

Before the intervention, NO2 levels were over 50% higher than recommended levels around the school. Laboratory testing indicated the presence of sooty particles in the children's lungs. After the installation of the new greenery, pollution levels were reduced by 53% in the playground, while the concentration of pollutants still remained high around the school. In addition, laboratory tests showed that pupils had benefitted from reduced exposure from pollutants.

Under a targeted program, 29 schools are supported across London to install barriers made of plants and hedges around primary school playgrounds to combat air pollution.



Sources:
www.hedgesdirect.co.uk/acatalog/how-hedging-can-help-reduce-air-pollution.html[289]
www.futureclimateinfo.com/air-pollution-invest-now-to-safeguard-our-children/[290]
www.standard.co.uk/futurelondon/cleanair/air-pollution-london-sadiq-khan-a4054416.html[291]

Showcase 8.2

Installation of moss-covered walls in Stuttgart to combat air pollution

The City of Stuttgart has been experimenting with innovative solutions since 2017 to combat serious air pollution. One of them, is the installation of a moss wall which is over 100 meters long and three meters high. Moss that usually grows in damp places, such as forest floors, tree trunks, moors, cliffs, and artificial surfaces, can store water and nutrients. It also has a capacity to filter air pollutants clinging to its sticky surfaces. The filtered pollutants with the help of a bacteria are converted into the biomass of the plant. Two moss species were used in Stuttgart (Ceratodon purpureus and Racomitrium canescens), which were specifically bred to capture and degrade fine particulate matter. Moss walls were found to be more effective in reducing particulate matter and NOx concentrations than other plants due to a number of reasons. Mosses have a 30 times larger surface area than other plants, that significantly increase the filtration efficiency. As the surfaces of mosses are negatively charged, airborne particles adhere through electrostatic attraction to them. This process is particularly effective for the filtration of fine particulates. The evergreen mosses filter pollutants all year round and in addition they are more active in winter, when the concentrations of air pollutants are typically higher. The organic components of pollutants are biodegraded or transformed into less toxic molecules by bacteria living on the surface of mosses.

Sources:
www.waste.uni-stuttgart.de/download/18.pdf
www.dw.com/en/stuttgart-builds-moss-covered-wall-to-fight-air-pollution/a-37866760

Showcase 8.3

Urban forests planted in Ostrava to improve air quality

The CLAIRO project under the Urban Innovative Actions initiative of the European Union aims at the systematic reduction of air pollution through comprehensive planning and planting of greenery with a positive impact on air quality. Under the project new greenery was planted in Ostrava, Czech Republic in 2021 that is aimed to function as a living lab for cities in the Upper Silesian metropolitan area and beyond, providing long-term information on air quality improvement.

The vegetation was installed in two plots located in the most polluted neighbourhoods of Ostrava, close to a metallurgical plant. The design of the composition and structure of the greenery was supported by measurements of air pollutants and climatic conditions. The long-term goal is to share with other districts and cities the novel experience gained at the urban greenery living lab, and to inspire them with innovative green solutions.

The detailed design of the greenery structure and composition was finalized in summer 2020.

The objective was to establish communities of trees and shrubs that form continuous and dense canopies to allow effective filtration of the air.

Communities of multiple plant species with similar ecological needs were specified that correspond to the habitat conditions of the target sites. Maximizing leaf surface that allows increased pollution deposition was an important consideration in the selection of the species. Preference was given to species with a densely branched crown and a large volume of green matter, as well as to evergreen tree species that can catch pollution all year round. The new vegetation has two tree layers and a shrub layer in order to maximize the canopy density and through this filtration efficiency. In addition, species with increased resistance to air pollution were preferred.

At the two target sites, which are located next to an industrial area, the newly planted trees are exposed to air pollution and other abiotic stressors. To increase their tolerance to air pollutants and contamination, as part of an experiment, the soil and the plants are treated with specific preparations that contain plant hormones. Modelling results indicate that with the designed vegetation the capture of particulates at one of the target sites is expected to almost triple as compared to the initial state.

Sources: www.uia-initiative.eu/en/uia-cities/ostrava[292]

Showcase 8.4

Using street-level air quality data to improve urban design in Copenhagen

In Copenhagen as part of a unique initiative Google's Air View data was combined with Gehl Architects' data on the everyday movement of children and day care workers, and based on this urban design solutions were suggested to reduce exposure to air pollution and to increase access to better air quality.

In 2013 Google started to develop the Air View Project in order to measure street-by-street air quality in cities. For measurements Google Street View Cars were used that were equipped with air quality sensors. Such detailed measurements have shown that air pollution differs street by street sometimes up to 5-8 times within a city block. Under a related research heart diseases were found to be related to street-level variation of air quality. The results have indicated that hyper-local maps of air pollution can be useful for supporting policies to reduce air pollution.

In 2018 in a collaboration with Gehl Architects, Google started measuring air quality in Copenhagen to build an annual average street by street map. Gehl was tasked in the project to operationalize the air quality data by assessing the everyday movement of children and day-care workers. Gehl mapped childcare institutions and playgrounds in the Vesterbro neighbourhood and studied where small children move through the city. The mapping has shown that a lot of children move through streets with really poor air quality.

Under the project, busy areas with poor air quality were identified in Vesterbro, where the aim was to reduce exposure to air pollutants. For such areas Gehl proposed traffic calming measures, the removal of parking, and the installation of green buffers as pollution barriers.

At the same time areas with better air quality were also identified, where small children could be invited to spend more time. A concept was developed for such areas, featuring wider sidewalks and new greenery to make the place more welcoming, as well as narrow roads to lower car speeds.

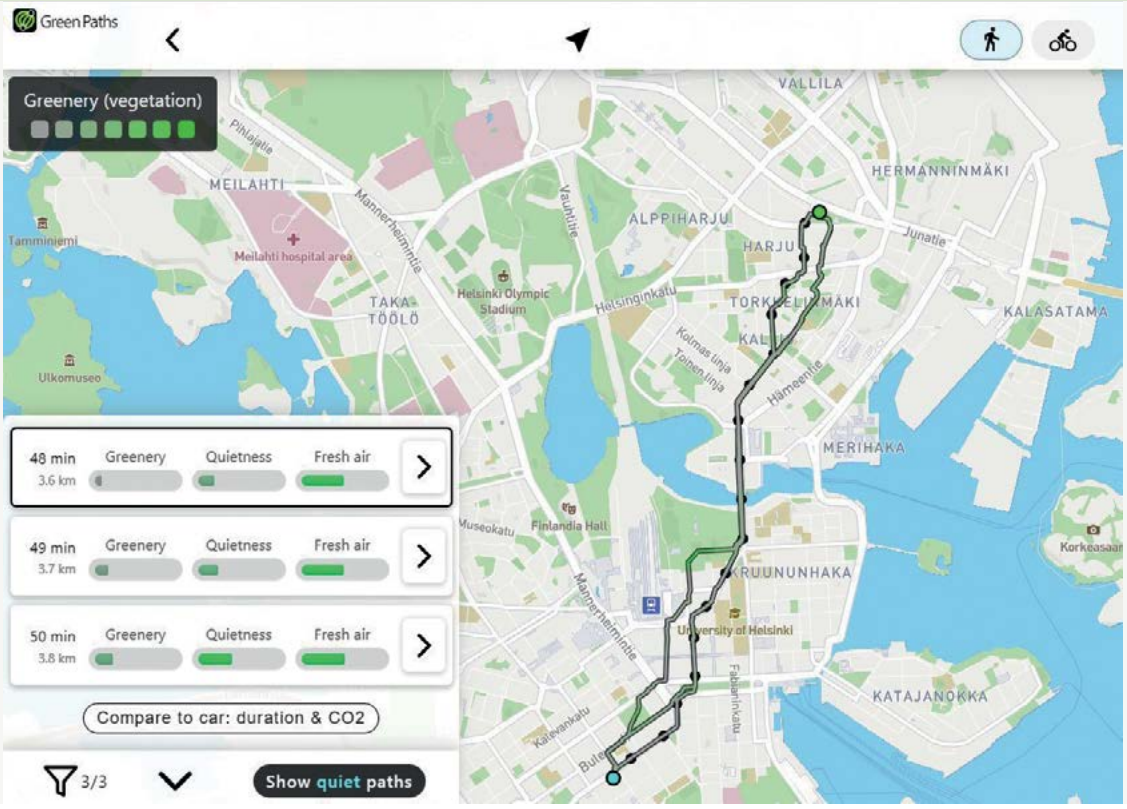
Sources:
www.gehlpeople.com/projects/air-quality-copenhagen[293]
www.uu.nl/en/news/project-air-view-measurements-result-in-hyperlocal-map-of-air-quality-in-copenhagen[294]

Showcase 8.5

Helsinki Route Planner showing walking and cycling routes with good air quality

Under the HOPE UIA project, the Digital Geography Lab of the University of Helsinki has developed a new Green Paths routing tool for the Helsinki Metropolitan Area building on real-time air quality data collected by the air quality monitoring network in Helsinki. With the help of the app users can find quick routes while avoiding busier and noisy streets with poor air quality. The app currently covers the four municipalities of the Helsinki Metropolitan area: Helsinki, Vantaa, Espoo, and Kauniainen.
Most route planners offer the fastest or most direct routes, but do not consider pleasantness or health and wellbeing. However, positive experiences during cycling and walking can urge people to opt for active mobility, as opposed to slightly faster motorized options. The Green Paths route planner finds cycling and walking routes with the best air quality, or with the least noise, or with the greenest streetscapes. The app optimises route choices based on environmental exposure and the duration of the trip. A crowdsourced OpenStreetMap database is used by the tool for displaying the street and trail network. The source code for the route planner is freely accessible on GitHub.

Source:
www.uia-initiative.eu/en/news/new-green-path-route-planner-finds-cycling-and-walking-routes-best-air-quality
www2.helsinki.fi/en/researchgroups/digital-geography-lab/green-paths
www.hel.fi/uutiset/en/kaupunginkanslia/new-green-path-route-planner?pd=v



Showcase 8.6

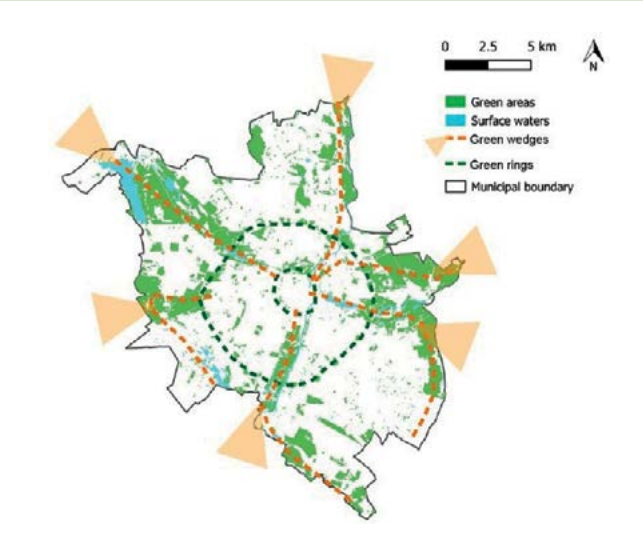
A massive wedge-and-ring greenery system helps ventilation in Poznan

Poznan has a well-established green infrastructure that is defined as a wedge-and-ring greenery system. The green wedges follow the main watercourses in the city, the Warta, Cybina and Bogdanka rivers connecting city borders with the city centre.

In addition to the wedges, there are two green rings belonging to greenery system. The inner ring is running along the line of medieval city walls. The second ring is based on the remnants of the former Prussian fortifications of Poznan. The layout of this outstanding greenery system was developed by an architect and urban planner, Władysław Czarnecki, and a botanist, Adam Wodziczko in the years 1930–1934. The main purpose of the wedge system apart from providing recreational opportunities to residents was to ventilate the city and to protect surface waters. This extensive green network was meant to ensure internal coherence and spatial connectivity, enhance internal differentiation with the graduation of forms and functions of green areas and to establish connections with the natural environment beyond the borders of the city. The wedges form parks in the city centre, while in the outskirts of the city they integrate urban forests, allotment gardens, meadows and pastures.

Some fragments of this greenery system have been transformed into built-up areas, or are threatened by new investments, but the assumptions of this coherent system are still valid. Spatial planning documents of Poznan, including the land use plan mention green wedges and green rings as basic elements shaping the spatial structure of the city.

The wedges with open areas and greenery function as air corridors that improve air circulation by allowing air exchange in the city. As the wedges extend beyond city borders, they supply air from non-urban areas and through this effectively contribute to the dilution of pollutants in the inner city.



Source:
Zwierzchowska, et al. (2019)[295]
Dymek, et al. (2021)[296]
Raszeja, Galecka-Drozda (2015)[297]
www.cytadela.scienceontheweb.net/nature.html[298]

Showcase 9.1

Hush City App: identification of tranquil areas

Research over the last decade has shown that prolonged exposure to high levels of traffic noise can have an adverse impact on our health. It can increase the risk of sleep disturbance, heart attack and stroke, amongst other ill effects. With this in mind, Limerick City and County Council invited the public to begin using the Hush City App to help the Council identify, enhance and protect the peaceful areas that Limerick people value the most.

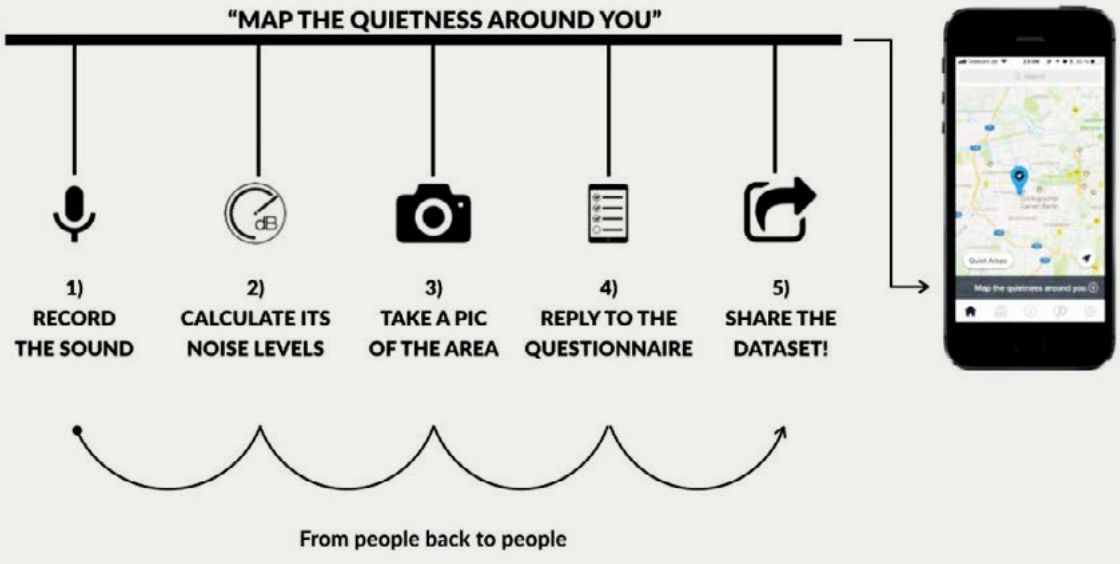
The Hush City approach was developed by Antonella Radicchi at the Berlin Technical University. A key element of the approach is the free Hush City Smart phone app, which allows members of the public to record information on 'quiet areas' in their cities. This collected data is available for other app users and importantly, policy makers! It can therefore perform the dual function of inputting into policy as well as showing citizens where they can find peace and quiet in their city.

Data input consists of audio recordings, sound pressure levels, pictures of the places which are georeferenced and timestamped. A questionnaire within the app asks for users' perceptions of quietness, and their emotional responses to positive/negative sounds and overall accessibility to the places. All data can be shared using the Hush City app.

The Hush City approach is a robust resource which has the potential to meaningfully influence urban development policy and planning. However, designating 'quiet areas' is not a simple matter: the areas that city authorities identify as potential quiet areas are not always the areas that residents use and enjoy the most. Added to this, the natural world can be a loud place, for example, birdsong, flowing water and the sound of the wind in the trees. But these sounds have a restorative quality unlike the sound of planes, trains and automobiles.

This is an important point for Limerick City and County Council. The Hush City app helps the city to a) better understand which tranquil and quiet areas are important to the citizens of Limerick and b) inform how, and in what way Limerick City and County Council applies for official designations of quiet areas by the Department of Communications, Climate Action and the Environment.

Source: Limerick City and County Council



Showcase 10.1

The Stockholm solution for improving growth of street trees

In Stockholm a very successful street tree planting program has been developed since 2001, that resulted in tree growth in downtown sidewalks that is equal to or even better than trees growing in nearby parks. In sidewalks trees are typically lacking space, oxygen, nutrients, water, and suffer from ground compaction and soil damage. Under the program of Stockholm trees are provided with a specific growing bed that dramatically improves the growing conditions for the plants in an urban environment. The solution applied in the Swedish capital is based on the use of specially constructed structural or skeletal soils that effectively hinders the soil compaction and at the same time functions as a substrate for the roots of the trees.
The trees are planted in holes that are surrounded by structural soil from below and from the side.
The structural soil consists of layers of crushed rocks. These layers have 25% – 30% pore space that is filled with soil. The crushed rock bears the load and the roots can grow in the soil.
Following the compaction of the first layer of rocks, soil and a slow-release fertilizer is washed into the voids between the stones. Then a second layer of stone is added, the pore space of which is filled up with soil and humus. The layers of rock are covered by a finely crushed stone layer. A geotextile fabric separates the entire planting pit and the surface layer. The geotextile prevents the pavement base material from sinking down into the planting pit and roots from growing up into the pavement.
Over 2000 projects have been completed across Stockholm, since the program was launched, and the practice is planned to be taken up elsewhere in Sweden.

Source:
www.klimatanpassning.se/en/cases/trees-in-an-urban-environment-1.114276
www.linkedin.com/pulse/stockholm-solution-planting-trees-len-phillips/

Showcase 10.2

Healthy Streets Approach of Greater London Authority

The Healthy Streets Approach developed by Lucy Saunders was first adopted by the Greater London Authority and the Transport for London in 2014.
The programme aims to combat inactivity and to promote walking, cycling and public transport to create a healthy city. The Healthy Streets Approach is a framework of policies and strategies the goal of which is to design physical activity back into the everyday lives of city dwellers.
The Healthy Streets Approach is based on 10 evidence-based indicators that addresses different aspects that are linked to positive health and wellbeing aspects.
A 'healthy street' in line with the 10 indicators is a welcoming place for everyone to spend time in and engage in social life, urges people to walk, cycle and use public transport, provides places to stop and rest, makes people feel relaxed, offers street-based activities and things to see, has clean air, it is safe and quiet, provides shade mitigating heat stress, and makes it easy for pedestrians to cross.
The ambition of the programme is that by 2041 in London 80 % of all trips will be made by walking, cycling and public transport, and that Londoners will do at least 20 minutes of active travel each day.
The Healthy Streets Approach is also taken up across the globe in Singapore, Auckland, Sydney, Bristol, Budapest, and Portsmouth.

Source:
www.designingbuildings.co.uk/wiki/Healthy_Streets#:~:text=This%20approach%20to%20urban%20development,walk%20and%20cycle%20throughout%20London
www.healthystreets.com/
www.tfl.gov.uk/corporate/about-tfl/how-we-work/planning-for-the-future/healthy-streets#on-this-page-2
www.taylorburrellbarnett.com.au/2021/11/healthy-streets-indicators-wa/

Showcase 10.3

Healthy Street guidelines, Tartu

In Tartu, Estonia a Healthy Street guidelines was prepared in 2022 that promotes:

- 'the development of street green infrastructure with an aim to provide a healthier streetscape for residents,
- 'improved social interactions in urban green spaces,
- 'the use of green infrastructure for absorbing excess water from rainfall,
- 'the installation of nature-based solutions to improve the cooling capacity of the urban environment, and
- 'the use of street greenery for locally improving air quality and reducing noise.

The guide supports the application of a new strategic approach when constructing or renovating streets (e.g., the rearrangement of underground utility lines as a compact system rather than separate and sparse entities). The guidelines function as a link between vision documents and actions in practice. The document was compiled by a mixed team of landscape architects and technical consultants.

A key component of the guide is a unique street quality evaluation method, which consists of four sections – walkability, bicycles, biodiversity and continuity. All four sections are divided into series of different qualities that indicate the overall condition of the street. The qualities are measured on a scale from 0 to 3, first evaluating the current situation and also proposing the desired score for reconstruction.

Source: City of Tartu

Showcase 10.4

Superblock in Barcelona

Barcelona superblock unit was imagined in the Eixample neighbourhood, measuring approximately 400 square metres (nine square blocks). It contains a network of basic vehicle routes connecting starting points and destinations throughout the city. The interior routes constitute a local network where the speed limit is 10 km/h. The roads inside a superblock are local, and less polluted, less noisy, and with less crashes. It also frees up more than 70% of the space currently occupied by motor vehicle traffic passing through the area, making it available for pedestrians and cyclists. The idea was developed by Salvador Rueda, urban ecologist and head of the environmental department of the city of Barcelona.

The pilot project was developed in 2016 in the neighbourhood of Poble Nou, and it was a first step of a low-cost intervention on a street as a public space: colourfully painted asphalt, signalling, new urban furniture. The second step, during the pandemic period, was to implement car free spots or axes, in different neighbourhoods of the city, offering places to sit, to chat, and to be surrounded by green planters. Now the next step, that will start its implementation in 2022, is to convert four axes and four nodes of the Eixample neighbourhood into green avenues and plazas, car free and with a special emphasis on social wellbeing, community cohesion, and ecological amelioration through permeable surfaces and stormwater treatment solutions to fight climate change.

Source: Lucia Vecchi

Showcase 10.5

High Line elevated park in New York

In Manhattan, New York an abandoned 2.4 km long elevated rail structure was transformed into an iconic green corridor and promenade. The first section of the High Line was opened in 2009. The park features individual and group seating areas, a sun deck, an observation area and social spaces.
The landscape architecture of the High Line imitates wild and spontaneous growth, and emphasizes native plants that had colonized the structure after 1980, when the rail line had been stopped being used. One section of the park was even left in its previously uncultivated state. As a result of the green transformation, the structure hosts more than 1500 species of plants, birds and insects.
Various kinds of facilitated activities are organized on the High Line, such as Pilates classes, astronomy classes or guided tours. The activities are free, and are led by volunteers. The High Line is also home to rotating public art exhibitions.
The linear park quickly became one of New York's defining features, triggering a building boom nearby, and attracting over 7 million visitors every year. The project has won numerous national and international awards and recognition.

Source:
www.okosvaros.lechnerkozpont.hu/en/node/1085
www.britannica.com/place/High-Line
www.introducingnewyork.com/high-line
www.ny.curbed.com/2019/5/7/18525802/high-line-new-york-park-guide-entrances-map

Showcase 10.6

Berlin streets as shared assets

Streets in Berlin take up one fourth of the city' total area, and one third of its total public space, playing a major role in the city's life, providing an exchange point between services, amenities, entertainment, culture and private and public life.
However, streets were mainly seen only as a mobility corridor until the Berlin's Municipal department for Urban Development and the Environment investigated new ways streets could be used as a shared asset.
Two street sections were selected for testing, and politicians, planners and experts were invited to participate in a 3-step engagement process.
First, the local authority introduced a new way of looking at streets through a workshop, focusing on how mobility influences the street's function and character.
Next, participants measured the use and quality (according to 12 quality criteria), or lack thereof the two streets, using Gehl's PSPL (Public Space & Public Life) method. Then, in a second workshop participants identified different planning perspectives and motivations for the future, using the data they had collected. To promote thinking of the planning process in increments, participants had to structure their visions in three scales: small, medium and large.
Finally, participants created a set of intervention recommendations for the two streets, such as creating a parklet or a new zebra crossing. The interventions were pilot tested, allowing the participants to learn more about possible solutions. This 3-step method is recommended to use for finding the right interventions for more livable streets.

Sources:
www.gehlpeople.com/projects/berlin-germany/
www.rethinkingstreets.com/

Showcase 10.7

Car-free Avenue in Tartu

Car-free Avenue is a municipality-initiated action in Tartu, Estonia. The City of Tartu is planning to reserve during the summer of 2022 one of the main streets of the city (Vabaduse puiestee: Freedom avenue) already for the third time in a row for pedestrians and cyclists only. The initiative in the previous years was a huge success, becoming one of the most awaited public events of the year.

Tartu piloted the event space in July 2020 when people were longing for public activities after the lockdown. It was decided to close a section of the street for traffic to open the space for pedestrians as a kind of festival space with events, temporary greening, outdoor furniture and food trucks. It was an immediate success and the same layout was repeated in 2021. The area used for the urban intervention hosted meadow boxes, water-features, various markets, an outdoor cinema, and a wide range of programming.

The 2022 solution is slightly different. The event space will be open during weekends when all car traffic is closed on the avenue. On business days two lanes of traffic are open and two lanes designated for cyclists will be added. The same arrangement with restricted car traffic and added bike lanes will stretch along the two main streets of the city. This temporary solution is 2.2 km long and is open for cyclists until late autumn. In order to promote the positive effects of greenery, simple mobile greening solutions are used in the Car-free Avenue. The City of Tartu purchased about 30 large plant containers and are using them after the event in various urban situations where fast temporary changes are needed. The use of large plant containers demonstrates the instant effect of street greening- as everyone can estimate the difference that adding greenery can make. The containers have been used in different locations and situations.

Source:
City of Tartu
www.estonianworld.com/life/the-estonian-town-of-tartu-to-have-a-car-free-avenue/
www.inhabitat.com/tartu-turns-a-major-street-into-a-car-free-haven-for-a-month/

Showcase 10.8

Municipal River Beaches in Poznan

Municipal River Beaches (Plaże miejskie) in Poznan is a project of seasonal use of the Warta riverbank (flood plain) as an urban beach and recreational area. The idea aimed at bringing citizens back to the Warta River and using the potential of natural environment for urban regeneration. The areas along the Warta River for a long time were abandoned and neglected. For that reason, the city authorities began to act and introduced a new approach in politics called 'return to the river'.

The first beach was established in 2012 in the Chwaliszewo district. With the growing interest of residents, the number of activities, workshops and events were systematically increased, which in turn gave the impulse to the city's further activities and the opening of new beaches along the Warta River. In 2015, two additional beaches were established – in the Rataje and Szelqg District. In 2016 and 2017, there were already 4 municipal beaches of different character, with different programs, providing residents with various services depending on the age of a given social group. Every urban beach had the basic infrastructure, deckchairs, chairs, tables, umbrellas and sandy playground. Year by year more new facilities were added.

Until 2018 beaches were financed from the city budget of Poznan, and the management of the beach was on the operator's side, that was selected every year in a public tender.

In 2018, the first three beaches, and in 2020 the fourth one, were leased by commercial entities. As a result, the business potential increased, especially on the eastern bank of the Warta River, where new commercial beaches were opened. A significant impulse was also the construction of the Wartostrada in 2018, which is a system of pedestrian and bicycle routes along the Warta River that increases the accessibility of the area.

Source: City of Poznan

References

[1] White, M.P., Alcock, I., Grellier, J. et al. (2019) Spending at least 120 minutes a week in nature is associated with good health and wellbeing. Sci Rep 9, 7730. https://doi.org/10.1038/s41598-019-44097-3.

[2] https://www.eea.europa.eu/articles/forests-health-and-climate-change/key-facts/health-benefits-of-green-spaces

[3] Twohig-Bennett, C., Jones, A. (2018) The health benefits of the great outdoors: A systematic review and meta-analysis of greenspace exposure and health outcomes. Environmental Research. Volume 166, October 2018, Pages 628-637.

[4] Hagen, Bjoern. (2016) Public Perception of Climate Change: Policy and Communication. 10.4324/9781315758558.

[5] WHO (2017) Urban green spaces: a brief for action, Copenhagen: WHO - Regional Office for Europe.

[6] WHO (2017) Urban green spaces: a brief for action, Copenhagen: WHO - Regional Office for Europe.

[7] https://www.eea.europa.eu/articles/forests-health-and-climate-change/key-facts/health-benefits-of-green-spaces

[8] Twohig-Bennett, C., Jones, A. (2018) The health benefits of the great outdoors: A systematic review and meta-analysis of greenspace exposure and health outcomes. Environmental Research. Volume 166, October 2018, Pages 628-637.

[9] Bell, J. Wilson, J. and Liu, G. (2008). Neighbourhood greenness and 2 year changes in body mass index of children and youth. American Journal of Preventative Medicine, 35(6), 547-533.

[10] Nielsen, T. and Hansen, K. (2007). Do green areas affect heath? Results from a Danish Survey on the use of green areas and health indicators. Health and Place, 13, 839-850.

[11] Gascon, M. et al. (2015) Residential green spaces and mortality: A systematic review. Environment International, Vol. 86, January 2016, Pages 60-67.

[12] Hu, Z., Liebens, J., Rao, K. R. (2008) Linking stroke mortality with air pollution, income, and greenness in northwest Florida: an ecological geographical study. International Journal of Health Geographics, Vol. 7, Article number: 20 (2008).

[13] Pereira, G. et al. (2012) The association between neighborhood greenness and cardiovascular disease: an observational study. BMC Public Health volume 12, Article number: 466.

[14] Braubach M., Egorov A., Mudu P., Wolf T., Ward Thompson C., Martuzzi M. (2017) Effects of Urban Green Space on Environmental Health, Equity and Resilience. In: Kabisch N., Korn H., Stadler J., Bonn A. (eds) Nature-Based Solutions to Climate Change Adaptation in Urban Areas. Theory and Practice of Urban Sustainability Transitions. Springer, Cham. https://doi.org/10.1007/978-3-319-56091-5_11

[15] Roslund, M. I. et al. (2020) Biodiversity intervention enhances immune regulation and health-associated commensal microbiota among daycare children. Science Advances 14 Oct 2020, Vol. 6, no. 42, eaba2578. DOI: 10.1126/sciadv.aba2578.

[16] Braubach M., Egorov A., Mudu P., Wolf T., Ward Thompson C., Martuzzi M. (2017) Effects of Urban Green Space on Environmental Health, Equity and Resilience. In: Kabisch N., Korn H., Stadler J., Bonn A. (eds) Nature-Based Solutions to Climate Change Adaptation in Urban Areas. Theory and Practice of Urban Sustainability Transitions. Springer, Cham. https://doi.org/10.1007/978-3-319-56091-5_11

[17] Ulrich, R. S. (1981) Natural Versus Urban Scenes. Some Psychophysiological Effects. September 1981, Environment and Behavior, 13(5):523-556.

[18] Bowen, K. J., Parry, M., the Government of Victoria. (2015) The evidence base for linkages between green infrastructure, public health and economic benefit. Paper prepared for the project Assessing the Economic Value of Green Infrastructure.

[19] WHO, Regional Office for Europe (2016) Urban green spaces and health. A review of evidence.

[20] Bowen, K. J., Parry, M., the Government of Victoria. (2015) The evidence base for linkages between green infrastructure, public health and economic benefit. Paper prepared for the project Assessing the Economic Value of Green Infrastructure.

[21] https://www.nrpa.org/parks-recreation-magazine/2017/april/the-health-benefits-of-small-parks-and-green-spaces/

[22] Van den Berg, A. E. and Van den Berg, M. M. H. E. (2015). Health benefits of plants and green space: Establishing the evidence base. Acta Horticulturae, 1093, 19–30. https://doi.org/10.17660/ActaHortic.2015.1093.1
[23] Louv, Richard (2005) Last Child in the Woods. Saving Our Children from Nature-Deficit Disorder, New York: Workman Publishing Company
[24] Ulrich, R.S., Simons, R.F., et al. Stress recovery during exposure to natural and urban environments Journal of Environmental Psychology, 11 (1991), pp. 201-230
[25] Kaplan, R.; Kaplan, S. (1989) The Experience of Nature: A Psychological Perspective. Cambridge University Press. ISBN 978-0-521-34139-4
[26] Kellert, S. R., and Wilson E. O., eds. The biophilia hypothesis. Island Press, 1993.
[27] Beatley, T. (2014) Biophilic cities, The sustainable urban development, ed. Wheeler and Beatley, Routledge.
[28] https://www.nursingtimes.net/clinical-archive/cardiovascular-clinical-archive/using-outdoor-activities-in-cardiac-recovery-06-05-2014/
[29] https://www.spph.ubc.ca/parks-big-and-small-needed-for-public-health/
[30] https://www.who.int/healthpromotion/conferences/previous/ottawa/en/
[31] http://www.emro.who.int/emhj-volume-14-2008/volume-14-supplement/editorial-health-protection-and-promotion.html
[32] Crisp, N. (2020) Health is made at home, hospitals are for repairs. Building a healthy and health-creating society. SALUS Global Knowledge Exchange, June 2020.
[33] NNHSA (2017) A Manifesto for Health Creation. The New NHS Alliance
[34] https://www.youngfoundation.org/publications/transforming-health-shifting-health-systems-illness-treatment-prevention-health-creation/
[35] http://www.emro.who.int/emhj-volume-14-2008/volume-14-supplement/editorial-health-protection-and-promotion.html
[36] Kellert, S. R., and Wilson E. O., eds. The biophilia hypothesis. Island Press, 1993.
[37] Felonneau, M. (2004) Love and loathing of the city: Urbanophilia and urbanophobia, topological identity and perceived incivilities. Journal of Environmental Psychology - J ENVIRON PSYCHOL. 24. 43-52. 10.1016/S0272-4944(03)00049-5.
[38] WHO (2017) Urban Green Space Interventions and Health. A review of impacts and effectiveness. the WHO Regional Office for Europe. UN City, Marmorvej 51, DK-2100 Copenhagen Ø, Denmark.
[39] Scott, M., Lennon, M., Douglas O., Bullock, C. (2020) Eco-Health: Ecosystem Benefits of Green Space for Health. EPA Research Report, Report No.328, 2015-HW-MS-6.
[40] Wang, H., Tassinary, L. G. (2019) Effects of greenspace morphology on mortality at the neighbourhood level: a cross-sectional ecological study. The Lancet Planetary Health, Volume 3, Issue 11, November 2019, Pages e460-e468. https://doi.org/10.1016/S2542-5196(19)30217-7
[41] https://www.brightview.com/resources/article/tips-successful-healing-garden-design
[42] Tan, Z., Lau, K. K., Roberts, et al. (2019) Designing Urban Green Spaces for Older Adults in Asian Cities. Int J Environ Res Public Health. 2019 Nov; 16(22): 4423. PMCID: PMC6888534. doi: 10.3390/ijerph16224423.
[43] Scott, M., Lennon, M., Douglas O., Bullock, C. (2020) Eco-Health: Ecosystem Benefits of Green Space for Health. EPA Research Report, Report No.328, 2015-HW-MS-6.
[44] Robinson, J. M. and Breed, M. (2019). Green Prescriptions and Their Co-Benefits: Integrative Strategies for Public and Environmental Health. Challenges. 10. 9. 10.3390/challe10010009.
[45] https://www.health.govt.nz/our-work/preventative-health-wellness/physical-activity/green-prescriptions
[46] https://theconversation.com/green-prescriptions-should-your-doctor-send-you-for-a-walk-in-the-park-143231
[47] https://www.health.govt.nz/our-work/preventative-health-wellness/physical-activity/green-prescriptions
[48] Robinson, J. M. and Breed, M. (2019). Green Prescriptions and Their Co-Benefits: Integrative Strategies for Public and Environmental Health. Challenges. 10. 9. 10.3390/challe10010009.

[49] https://www.health.govt.nz/our-work/preventative-health-wellness/physical-activity/green-prescriptions/how-green-prescription-works
[50] Robinson, J. M. and Breed, M. (2019). Green Prescriptions and Their Co-Benefits: Integrative Strategies for Public and Environmental Health. Challenges. 10. 9. 10.3390/challe10010009.
[51] https://www.health.govt.nz/our-work/preventative-health-wellness/physical-activity/green-prescriptions/how-green-prescription-works
[52] Elley, C. R. (2003) The effectiveness and cost-effectiveness of the Green Prescription physical activity intervention: a cluster randomised controlled trial in primary health care. Thesis, PhD--General Practice, University of Auckland, 2003.
[53] https://www.emersonsgreentreatmentcentre.nhs.uk/news/could-gps-soon-be-writing-a-prescription-for-a-walk/
[54] https://www.gov.uk/government/speeches/george-eustice-speech-on-environmental-recovery-20-july-2020
[55] https://sustainablehealthcare.org.uk/sites/default/files/green_helath_route_programme_by_the_nhs_forest_1_0.pdf
[56] https://sustainablehealthcare.org.uk/what-we-do/green-space/green-health-routes
[57] https://web.archive.org/web/20130908221648/http://ahta.org/sites/default/files/DefinitionsandPositions.pdf
[58] https://www.scientificamerican.com/article/nature-that-nurtures/
[59] https://horttherapywithhankbruce.weebly.com/healing-in-the-garden.html
[60] https://www.healthcarefacilitiestoday.com/posts/Patient-participation-in-gardening-at-hospitals-can-improve-health-outcomes--1105
[61] https://web.archive.org/web/20130908221648/http://ahta.org/sites/default/files/DefinitionsandPositions.pdf
[62] https://www.scientificamerican.com/article/nature-that-nurtures/
[63] Sherman, S., Varni, J., Ulrich, R., Malcarne, V. (2005). Post-occupancy evaluation of healing gardens in a pediatric cancer center. Landscape and Urban Planning. 73. 167-183. 10.1016/j.landurbplan.2004.11.013.
[64] https://www.scientificamerican.com/article/nature-that-nurtures/
[65] https://www.who.int/data/gho/data/major-themes/health-and-well-being
[66] Waite, L.J. (2018) Social well-being and health in the older population: Moving beyond social relationships. In Majmundar M.K., Hayward M.D. (Eds.) Future directions for the demography of aging: Proceedings of a workshop. National Academies of Sciences, Engineering, and Medicine; Division of Behavioral and Social Sciences and Education. Committee on Population. Washington (DC), National Academies Press (US).
[67] https://www.eea.europa.eu/articles/forests-health-and-climate-change
[68] Jennings, V., & Bamkole, O. (2019). The relationship between social cohesion and urban green space: An avenue for health promotion. International journal of environmental research and public health, 16(3), 452.
[69] Vargas-Hernández, J. G., Pallagst, K., & Zdunek-Wielgołaska, J. (2017). Urban green spaces as a component of an ecosystem. Functions, services, users, community involvement, initiatives and actions. Revista de Urbanismo, N°37, ISSN 0717-5051.
[70] William C. Sullivan, W.C. Kuo, M., Depooter, S.F. (2004) The fruit of urban nature: Vital neighborhood spaces. Environment and Behavior 36(5):678-700. DOI: 10.1177/0193841X04264945.
[71] Kemperman, A., Timmermans, H.J.P. (2014). Green spaces in the direct living environment and social contacts of the aging population. Landscape and Urban Planning. 129. 44–54. 10.1016/j.landurbplan.2014.05.003.
[72] https://www.forestresearch.gov.uk/documents/2496/urgp_evidence_note_007_Physical_activity_and_health.pdf
[73] WHO (2017) Urban green spaces: a brief for action, Copenhagen: WHO - Regional Office for Europe.
[74] Giles-Corti, B., Broomhall, M.H., et al. (2005) Increasing walking: How important is distance to, attractiveness, and size of public open space? American Journal of Preventive Medicine, Volume 28, Issue 2, Supplement 2, pp 169-176. ISSN 0749-3797. https://doi.org/10.1016/j.amepre.2004.10.018.
[75] Dobson, J., Harris, C., Eadson, W, Gore, T. (2019) Space to thrive. A rapid evidence review of the benefits of parks and green spaces for people and communities. Heritage Fund. Community Fund.
[76] WHO (2017) Urban green spaces: a brief for action, Copenhagen: WHO - Regional Office for Europe.

[77] https://www.paysalia.com/en/blog/job/creating-user-friendliness-public-parks
[78] Dobson, J., Harris, C., Eadson, W, Gore, T. (2019) Space to thrive. A rapid evidence review of the benefits of parks and green spaces for people and communities. Heritage Fund. Community Fund.
[79] WHO (2017) Urban green spaces: a brief for action, Copenhagen: WHO - Regional Office for Europe.
[80] https://www.forestresearch.gov.uk/documents/2498/urgp_evidence_note_011_Social_interaction_inclusion_and_community_cohesion.pdf
[81] WHO (2017) Urban green spaces: a brief for action, Copenhagen: WHO - Regional Office for Europe.
[82] Dobson, J., Harris, C., Eadson, W, Gore, T. (2019) Space to thrive. A rapid evidence review of the benefits of parks and green spaces for people and communities. Heritage Fund. Community Fund.
[83] UNCED, 1992. The Earth Summit: The United Nations Conference on Environment and Development. Graham & Trotman, London.
[84] Vargas-Hernández, J. G., Pallagst, K., & Zdunek-Wielgołaska, J. (2017). Urban green spaces as a component of an ecosystem. Functions, services, users, community involvement, initiatives and actions. Revista de Urbanismo, N°37, ISSN 0717-5051.
[85] https://www.brec.org/assets/General_Info/Why_R_Parks_Important/Papers/Parks-for-Arts-and-Cultural.pdf
[86] Malberg Dyg, P., Christensen, S., & Peterson, C. J. (2020). Community gardens and wellbeing amongst vulnerable populations: A thematic review. Health promotion international, 35(4), 790-803.
[87] Gerber, M. M., Callahan, J. L., Moyer, D. N., Connally, M. L., Holtz, P. M., & Janis, B. M. (2017). Nepali Bhutanese refugees reap support through community gardening. International Perspectives in Psychology: Research, Practice, Consultation, 6(1), 17.
[88] Ober Allen, J., Alaimo, K., Elam, D., & Perry, E. (2008). Growing vegetables and values: Benefits of neighborhood-based community gardens for youth development and nutrition. Journal of Hunger & Environmental Nutrition, 3(4), 418-439.
[89] Litt, J. S., Schmiege, S. J., Hale, J. W., Buchenau, M., & Sancar, F. (2015). Exploring ecological, emotional and social levers of self-rated health for urban gardeners and non-gardeners: A path analysis. Social Science & Medicine, 144, 1-8.
[90] Soga, M., Cox, D. T., Yamaura, Y., Gaston, K. J., Kurisu, K., & Hanaki, K. (2017). Health benefits of urban allotment gardening: Improved physical and psychological well-being and social integration. International journal of environmental research and public health, 14(1), 71.
[91] Scheromm, P. (2015). Motivations and practices of gardeners in urban collective gardens: The case of Montpellier. Urban Forestry & Urban Greening, 14(3), 735-742.
[92] Harris, N., Minniss, F. R., & Somerset, S. (2014). Refugees connecting with a new country through community food gardening. International journal of environmental research and public health, 11(9), 9202-9216.
[93] Pleasant, A., Scanlon, M. M., & Pereira-Leon, M. (2013). Literature review: Environmental design and research on the human health effects of open spaces in urban areas. Human Ecology Review, 36-49.
[94] Olszewska, A. (2016) Contemplative greenway design for the health and well-being of city inhabitants. Proceedings of the Fábos Conference on Landscape and Greenway Planning. Vol. 5. Number 1 Greenways and Landscapes in Change. Article 21. University of Porto, Department of Geosciences, Environment and Landscape Planning.
[95] https://www.greenflagaward.org/news/green-space-improves-academic-performance/
[96] Leung, W. T. V. et al. (2019) How is environmental greenness related to students' academic performance in English and Mathematics? Landscape and Urban Planning, Vol. 181, 2019, p. 118-124, ISSN 0169-2046.
[97] Kweon, B. et al. (2017) The link between school environments and student academic performance. Urban Forestry & Urban Greening 23, February 2017, DOI: 10.1016/j.ufug.2017.02.002.
[98] Rickinson, M. et al. (2004) A review of research on outdoor learning. National Foundation for Educational Research and King's College London, March 2004, Published by Field Studies Council: OP87, ISBN 1 85153 893 3.

[99] Wolsink, M. (2016) Environmental education excursions and proximity to urban green space – densification in a 'compact city'. Environmental Education Research 22(7):1049-1071, September 2016, DOI: 10.1080/13504622.2015.1077504.

[100] Milton, B. et al. (2010) Changing Perceptions of Nature, Self, and Others: A Report on a Park/School Program. The Journal of Environmental Education, Vol. 26, 1995 - Issue 3, p. 32-39, Published online: 15 July 2010, https://doi.org/10.1080/00958964.1995.9941443.

[101] van Dijk-Wesselius, J. E. et al (2020) Green Schoolyards as Outdoor Learning Environments: Barriers and Solutions as Experienced by Primary School Teachers. Frontiers in Psychology, Environmental Psychology, January 2020, https://doi.org/10.3389/fpsyg.2019.02919.

[102] Rickinson, M. et al. (2004) A review of research on outdoor learning. National Foundation for Educational Research and King's College London, March 2004, Published by Field Studies Council: OP87, ISBN 1 85153 893 3.

[103] van Dijk-Wesselius, J. et al (2020) Green Schoolyards as Outdoor Learning Environments: Barriers and Solutions as Experienced by Primary School Teachers. Frontiers in Psychology, Environmental Psychology, January 2020, https://doi.org/10.3389/fpsyg.2019.02919.

[104] Education Development Center, Inc., Boston Schoolyard Funders Collaborative (2000) Schoolyard Learning: The Impact of School Grounds. November, 2000.

[105] Skamp, K., Bergmann, I. (2001) Facilitating Learnscape Development, Maintenance and Use: Teachers' perceptions and self-reported practices. Environmental Education Research 7(4):333-358, November 2001, DOI: 10.1080/13504620120081241.

[106] Raffan, J. (2000) Nature Nurtures: Investigating the Potential of School Grounds. Evergreen, Learning Grounds Tool Shed series, ISBN 0-9681078-5-0.

[107] Rickinson, M. et al. (2004) A review of research on outdoor learning. National Foundation for Educational Research and King's College London, March 2004, Published by Field Studies Council: OP87, ISBN 1 85153 893 3.

[108] https://districtadministration.com/6-key-ingredients-to-creating-an-outdoor-classroom/

[109] https://youthtoday.org/2021/07/natural-playgrounds-offer-restorative-play-for-pandemic-fatigued-children/

[110] https://playpowercanada.ca/blog/5-benefits-natural-playgrounds/

[111] https://www.himama.com/blog/benefits-of-natural-playgrounds-for-child-development/

[112] https://playpowercanada.ca/blog/5-benefits-natural-playgrounds/

[113] https://pdplay.com/benefits-of-natural-playgrounds/

[114] https://www.sciencedaily.com/releases/2012/10/121011135036.htm

[115] https://innovationinpolitics.eu/showroom/project/natural-play-space-programme/

[116] https://natureplaysa.org.au/wp-content/uploads/2017/08/Playspace-Design-Principles.pdf

[117] WHO (2010) Global recommendations on physical activity for health. ISBN 978 92 4 159 997 9.

[118] Strain, T. et al. (2020) Use of the prevented fraction for the population to determine deaths averted by existing prevalence of physical activity: a descriptive study. The Lancet, Global Health, Vol. 8, Issue 7, E920-E930, July 2020, DOI: https://doi.org/10.1016/S2214-109X(20)30211-4.

[119] Mytton, O. T. et al. (2012) Green space and physical activity: An observational study using Health Survey for England data. Health Place, September 2012, 18(5): 1034–1041. doi: 10.1016/j.healthplace.2012.06.003.

[120] Cohen, D. A. et al. (2007) Contribution of Public Parks to Physical Activity. American Journal of Public Health, April 2017, 97(3):509-14. DOI: 10.2105/AJPH.2005.072447.

[121] Wang, H., Dai, X., Wu, J. et al. (2019) Influence of urban green open space on residents' physical activity in China. BMC Public Health 19, 1093 (2019). https://doi.org/10.1186/s12889-019-7416-7.

[122] Godbey, G., Mowen, A. (2010) The benefits of physical activity provided by park and recreation services: The scientific evidence. National Recreation and Park Association. Research series, 2010, Ashburn, VA 20148-4501, 800.626.NRPA (6772).

[123] Kostrzewska, M. (2017) Activating public space: How to promote physical activity in urban environment. 2017 IOP Conf. Ser.: Mater. Sci. Eng. 245 052074.

[124] https://www.peelregion.ca/healthy-communities/

[125] Godbey, G., Mowen, A. (2010) The benefits of physical activity provided by park and recreation services: The scientific evidence. National Recreation and Park Association. Research series, 2010, Ashburn, VA 20148-4501, 800.626.NRPA (6772).

[126] Salvo, G. et al. (2018) Neighbourhood Built Environment Influences on Physical Activity among Adults: A Systematized Review of Qualitative Evidence. International journal of environmental research and public health vol. 15,5 897. 2 May. 2018, doi:10.3390/ijerph15050897.

[127] Kostrzewska, M. (2017) Activating public space: How to promote physical activity in urban environment. 2017 IOP Conf. Ser.: Mater. Sci. Eng. 245 052074.

[128] https://www.nrpa.org/parks-recreation-magazine/2016/october/designing-parks-for-health/

[129] Godbey, G., Mowen, A. (2010) The benefits of physical activity provided by park and recreation services: The scientific evidence. National Recreation and Park Association. Research series, 2010, Ashburn, VA 20148-4501, 800.626.NRPA (6772).

[130] https://www.nrpa.org/parks-recreation-magazine/2016/october/designing-parks-for-health/

[131] Kostrzewska, M. (2017) Activating public space: How to promote physical activity in urban environment. 2017 IOP Conf. Ser.: Mater. Sci. Eng. 245 052074.

[132] Godbey, G., Mowen, A. (2010) The benefits of physical activity provided by park and recreation services: The scientific evidence. National Recreation and Park Association. Research series, 2010, Ashburn, VA 20148-4501, 800.626.NRPA (6772).

[133] https://www.peelregion.ca/healthy-communities/active-park-design.asp

[134] Godbey, G., Mowen, A. (2010) The benefits of physical activity provided by park and recreation services: The scientific evidence. National Recreation and Park Association. Research series, 2010, Ashburn, VA 20148-4501, 800.626.NRPA (6772).

[135] http://tacticalurbanismguide.com/about/#:~:text=Tactical%20Urbanism%20is%20all%20about,to%20catalyze%20long%2Dterm%20change.

[136] https://www.nature.scot/professional-advice/placemaking-and-green-infrastructure

[137] https://trails.org/our-work/placemaking/

[138] Cilliers, E., Timmermans, W., et al. (2015). Green place-making in practice: From temporary spaces to permanent places. Journal of Urban Design. 20. 10.1080/13574809.2015.1031213.

[139] Cilliers, E., Timmermans, W., et al. (2015). Green place-making in practice: From temporary spaces to permanent places. Journal of Urban Design. 20. 10.1080/13574809.2015.1031213.

[140] Kuo, M., Sullivan, W. C. (2001) Environment and Crime in the Inner City: Does Vegetation Reduce Crime? Acoustics, Speech, and Signal Processing Newsletter, May 2001, IEEE 33(3):343-367. DOI: 10.1177/00139160121973025.

[141] Troy, A., Grove, J. M., O'Neil-Dunne, J. (2012) The relationship between tree canopy and crime rates across an urban–rural gradient in the greater Baltimore region. Landscape and Urban Planning, Vol. 106, Issue 3, 2012, p 262-270, ISSN 0169-2046. https://doi.org/10.1016/j.landurbplan.2012.03.010.

[142] Schroeder, H. W., Anderson, L. M. (1983) Perception of Personal Safety in Urban Recreation Sites. Journal of Leisure Research, November 1983. DOI: 10.1080/00222216.1984.11969584.

[143] Talbot, J., Kaplan, R. (1984) Needs and fears: the response to trees and nature in the inner city. Journal of arboriculture, 1984, Vol. 10, p. 222-228.

[144] Kuo, M., Sullivan, W. C. (2001) Environment and Crime in the Inner City: Does Vegetation Reduce Crime? Acoustics, Speech, and Signal Processing Newsletter, May 2001, IEEE 33(3):343-367. DOI: 10.1177/00139160121973025.

[145] CABE Space (2005) Decent parks? Decent behaviour? The link between the quality of parks and user behaviour. Commission for Architecture and the Built Environment, London.

[146] CABE Space (2004) Preventing anti-social behaviour in public spaces: policy note. Commission for Architecture and the Built Environment, November 2004, London.

[147] Amira M. Mahrous, A. M., et al. (2018) Physical characteristics and perceived security in urban parks: Investigation in the Egyptian context. Ain Shams Engineering Journal, Vol. 9, Issue 4, 2018, p. 3055-3066, ISSN 2090-4479, https://doi.org/10.1016/j.asej.2018.07.003.

[148] https://thecityfix.com/blog/how-eyes-on-the-street-contribute-public-safety-nossa-cidade-priscila-pacheco-kichler/

[149] https://theconversation.com/can-parks-help-cities-fight-crime-118322

[150] Amira M. Mahrous, A. M., et al. (2018) Physical characteristics and perceived security in urban parks: Investigation in the Egyptian context. Ain Shams Engineering Journal, Vol. 9, Issue 4, 2018, p. 3055-3066, ISSN 2090-4479, https://doi.org/10.1016/j.asej.2018.07.003.

[151] CABE Space (2005) Decent parks? Decent behaviour? The link between the quality of parks and user behaviour. Commission for Architecture and the Built Environment, April 2005, London.

[152] CABE Space (2004) Preventing anti-social behaviour in public spaces: policy note. Commission for Architecture and the Built Environment, November 2004, London.

[153] https://www.pps.org/article/what-role-can-design-play-in-creating-safer-parks

[154] Anderson, V., Gough, W.A. (2022) Nature-based cooling potential: a multi-type green infrastructure evaluation in Toronto, Ontario, Canada. Int J Biometeorol 66, 397–410. https://doi.org/10.1007/s00484-021-02100-5.

[155] EEA (2020) Urban adaptation in Europe: how cities and towns respond to climate change. EEA Report No 12/2020. European Environment Agency.

[156] Hillel, D. et al. (2005) Encyclopedia of Soils in the Environment. Elsevier/Academic Press. ISBN 978-0-12-348530-4

[157] Ennos, Roland. 'Can Trees Really Cool Our Cities Down?' The Conversation. Accessed 11 August 2021. http://theconversation.com/can-trees-really-cool-our-cities-down-44099

[158] Klok, L. et al (2019), Assessment of thermally comfortable urban spaces in Amsterdam during hot summer days. International Journal of Biometeorology 63, no. 2, 1 February 2019, 129–41, https://doi.org/10.1007/s00484-018-1644-x

[159] Klok, L. et al (2019), Assessment of thermally comfortable urban spaces in Amsterdam during hot summer days. International Journal of Biometeorology 63, no. 2, 1 February 2019, 129–41, https://doi.org/10.1007/s00484-018-1644-x.

[160] Klemm, W. et al (2015) Psychological and physical impact of urban green spaces on outdoor thermal comfort during summertime in The Netherlands. Building and Environment, Building and Environment, Vol. 83, 2015, 120-128, ISSN 0360-1323, https://doi.org/10.1016/j.buildenv.2014.05.013.

[161] Gál, T., Unger, J. (2009) Detection of ventilation paths using high-resolution roughness parameter mapping in a large urban area. Building and Environment, Vol. 44, Issue 1, 2009, 198-206, ISSN 0360-1323, https://doi.org/10.1016/j.buildenv.2008.02.008.

[162] American Planning Association. 'How cities use parks for climate change management' City Parks Forum Briefing Papers 11. Accessed 10 August 2021. https://www.planning.org/publications/document/9148693/

[163] K.R. Gunawardena, K.R. et al (2017) Utilising green and bluespace to mitigate urban heat island intensity. Science of The Total Environment, Volumes 584–585, 2017, 1040-1055, ISSN 0048-9697, https://doi.org/10.1016/j.scitotenv.2017.01.158.

[164] Norton, B. et al. (2013). Planning for a Cooler Future: Green Infrastructure to Reduce Urban Heat. October 2013, ISBN: 978 0 7340 4905 6, DOI: 10.13140/2.1.2430.1764.

[165] Klemm, W. (2018) Clever and cool. Generating design guidelines for climate responsive urban green infrastructure. 19 November 2018, ISBN 978-94-6343-305-1, DOI https://doi.org/10.18174/453958.

[166] Yuei-An, L, Kim-Anh, N., Le-Thu, H. (2019). Urban green spaces and heat stress risk patterns in Taipei City by Sentinel 2 imagery. 10.1109/IGARSS.2019.8897847.

[167] United Nations Environment Programme (2021) Beating the heat: A sustainable cooling handbook for cities. ISBN: 978-92-807-3894-0.

[168] Klemm, W. (2018) Clever and cool. Generating design guidelines for climate responsive urban green infrastructure. 19 November 2018, ISBN 978-94-6343-305-1, DOI https://doi.org/10.18174/453958.

[169] Wenqi, L., Ting, Y., Xiangqi, C., Weijia, W., Yue, Z. (2015) Calculating cooling extents of green parks using remote sensing: Method and test. Landscape and Urban Planning. Vol. 134, pp 66-75, ISSN 0169-2046, https://doi.org/10.1016/j.landurbplan.2014.10.012.

[170] Sun, Y., Gao, C., Li, J. et al. (2021) Assessing the cooling efficiency of urban parks using data envelopment analysis and remote sensing data. Theor Appl Climatol 145, 903–916. https://doi.org/10.1007/s00704-021-03665-2.

[171] Klemm, W. (2018) Clever and cool. Generating design guidelines for climate responsive urban green infrastructure. 19 November 2018, ISBN 978-94-6343-305-1, DOI https://doi.org/10.18174/453958.

[172] Victoria State Government (2019) Trees for cooler and greener streetscapes. Guidelines for streetscape planning and design. Prepared by E2Designlab for the Victoria Government Department of Environment, Land, Water and Planning. ISBN 978-1-76077-840-8.

[173] Caiyan, W., Junxiang, L, et al. (2021) Estimating the cooling effect of pocket green space in high density urban areas in Shanghai, China. Front. Environ. Sci. https://doi.org/10.3389/fenvs.2021.657969.

[174] Klemm, W. (2018) Clever and cool. Generating design guidelines for climate responsive urban green infrastructure. 19 November 2018, ISBN 978-94-6343-305-1, DOI https://doi.org/10.18174/453958.

[175] Norton, B. et al. (2013). Planning for a Cooler Future: Green Infrastructure to Reduce Urban Heat. October 2013, ISBN: 978 0 7340 4905 6, DOI: 10.13140/2.1.2430.1764.

[176] Caiyan, W., Junxiang, L, et al. (2021) Estimating the cooling effect of pocket green space in high density urban areas in Shanghai, China. Front. Environ. Sci. https://doi.org/10.3389/fenvs.2021.657969.

[177] IES. 'Role of trees & other green infrastructure in urban air quality' Accessed 19 January 2022. https://www.the-ies.org/analysis/role-trees-and-other-green

[178] Hewitt, C.N. et al. (2020) Using green infrastructure to improve urban air quality (GI4AQ). Ambio 49, 62–73. https://doi.org/10.1007/s13280-019-01164-3.

[179] IES. 'Role of trees & other green infrastructure in urban air quality' Accessed 19 January 2022. https://www.the-ies.org/analysis/role-trees-and-other-green

[180] Greater London Authority. (2019) Using green infrastructure to protect people from air pollution. ISBN. https://www.london.gov.uk/sites/default/files/green_infrastruture_air_pollution_may_19.pdf

[181] Greater London Authority. (2019) Using green infrastructure to protect people from air pollution. ISBN. https://www.london.gov.uk/sites/default/files/green_infrastruture_air_pollution_may_19.pdf

[182] Hewitt, C.N. et al. (2020) Using green infrastructure to improve urban air quality (GI4AQ). Ambio 49, 62–73. https://doi.org/10.1007/s13280-019-01164-3.

[183] IES. 'Role of trees & other green infrastructure in urban air quality' Accessed 19 January 2022. https://www.the-ies.org/analysis/role-trees-and-other-green

[184] University of Surrey. 'Plant hedges to combat near-road pollution exposure' Accessed 24 January 2022. https://www.surrey.ac.uk/news/plant-hedges-combat-near-road-pollution-exposure

[185] AirQualityNews. 'A hedge could cut air pollution by 50%' Accessed 24 January 2022. https://airqualitynews.com/2019/11/22/a-hedge-could-cut-air-pollution-by-50/

[186] Greater London Authority. (2019) Using green infrastructure to protect people from air pollution. ISBN. https://www.london.gov.uk/sites/default/files/green_infrastruture_air_pollution_may_19.pdf

[187] Neft, I. et al. (2016) Simulations of aerosol filtration by vegetation: Validation of existing models with available lab data and application to near-roadway scenario. Aerosol Science and Technology, 50: 937–946. https://doi.org/10.1080/02786826.2016.1206653.

[188] Hewitt, C.N. et al. (2020) Using green infrastructure to improve urban air quality (GI4AQ). Ambio 49, 62–73. https://doi.org/10.1007/s13280-019-01164-3.

[189] Diener, A., Mudu, P. (2021) How can vegetation protect us from air pollution? A critical review on green spaces' mitigation abilities for air-borne particles from a public health perspective - with implications for urban planning. Science of The Total Environment, Vol. 796, 148605, ISSN 0048-9697, https://doi.org/10.1016/j.scitotenv.2021.148605.

[190] Wei, X. et al. (2017) Phylloremediation of air pollutants: Exploiting the potential of plant leaves and leaf-associated microbes. Front. Plant Sci., 28 July 2017, https://doi.org/10.3389/fpls.2017.01318.
[191] BBC. 'The best trees to reduce air pollution'. Accessed 24 January 2022. https://www.bbc.com/future/article/20200504-which-trees-reduce-air-pollution-best
[192] BBC. 'The best trees to reduce air pollution'. Accessed 24 January 2022. https://www.bbc.com/future/article/20200504-which-trees-reduce-air-pollution-best
[193] Janhäll, S. (2015) Review on urban vegetation and particle air pollution - deposition and dispersion. Atmos. Environ. 105, 130-137, ISSN 1352-2310, https://doi.org/10.1016/j.atmosenv.2015.01.052.
[194] Hirons, A., Sjöman, H. (2018) Tree Species Selection for Green Infrastructure: A Guide for Specifiers.Trees & Design Action Group. Issue 1.3/2019.
[195] Janhäll, S. (2015) Review on urban vegetation and particle air pollution - deposition and dispersion. Atmos. Environ. 105, 130-137, ISSN 1352-2310, https://doi.org/10.1016/j.atmosenv.2015.01.052.
[196] Barwise, Y., Kumar, P. (2020) Designing vegetation barriers for urban air pollution abatement: a practical review for appropriate plant species selection. npj Clim Atmos Sci 3, 12. https://doi.org/10.1038/s41612-020-0115-3.
[197] Nowak, D. J. (1994). "Atmospheric carbon dioxide reduction by Chicago's urban forest," in Chicago's Urban Forest Ecosystem: Results of the Chicago Urban Forest Climate Project. General Technical Report NE-186, eds McPherson, E. G., Nowak, D. J., Rowntree R. A. (Chicago, IL: US Department of Agriculture, Forest Service), 83–94.
[198] Nowak, D. J. (2000). The Effects of Urban Trees on Air Quality. USDA Forest Service, Syracuse, NY, 1–4.
[199] Watanabe, Y. (2015) Canopy, leaf surface structure and tree phenology: Arboreal factors influencing aerosol deposition in forests. Journal of Agricultural Meteorology, 71(3):167-173, DOI: 10.2480/agrmet.D-14-00011.
[200] BBC. 'The best trees to reduce air pollution'. Accessed 24 January 2022. https://www.bbc.com/future/article/20200504-which-trees-reduce-air-pollution-best
[201] Barwise, Y., Kumar, P. (2020) Designing vegetation barriers for urban air pollution abatement: a practical review for appropriate plant species selection. npj Clim Atmos Sci 3, 12. https://doi.org/10.1038/s41612-020-0115-3.
[202] Bradbury Science Museum. 'Conifer disappearance due to climate change?' Accessed 25 January 2022. https://www.lanl.gov/museum/news/newsletter/2016-02/pubs-conifers.php
[203] Barwise, Y., Kumar, P. (2020) Designing vegetation barriers for urban air pollution abatement: a practical review for appropriate plant species selection. npj Clim Atmos Sci 3, 12. https://doi.org/10.1038/s41612-020-0115-3.
[204] BBC. 'The best trees to reduce air pollution'. Accessed 24 January 2022. https://www.bbc.com/future/article/20200504-which-trees-reduce-air-pollution-best
[205] Watanabe, Y. (2015) Canopy, leaf surface structure and tree phenology: Arboreal factors influencing aerosol deposition in forests. Journal of Agricultural Meteorology, 71(3):167-173, DOI: 10.2480/agrmet.D-14-00011.
[206] Barwise, Y., Kumar, P. (2020) Designing vegetation barriers for urban air pollution abatement: a practical review for appropriate plant species selection. npj Clim Atmos Sci 3, 12. https://doi.org/10.1038/s41612-020-0115-3.
[207] Isaifan, R. J., Baldauf, R. W. (2020) Estimating Economic and Environmental Benefits of Urban Trees in Desert Regions. Front. Ecol. Evol., 13 February 2020, https://doi.org/10.3389/fevo.2020.00016.
[208] Wang, H, et al. (2019) Efficient Removal of Ultrafine Particles from Diesel Exhaust by Selected Tree Species: Implications for Roadside Planting for Improving the Quality of Urban Air. Environ. Sci. Technol. 2019, 53, 12, 6906–6916, May 16, 2019, https://doi.org/10.1021/acs.est.8b06629.
[209] Lawson, T. Blatt, M. R. (2014) Stomatal size, speed, and responsiveness impact on photosynthesis and water use efficiency. Plant Physiol. 164, 1556–1570, https://doi.org/10.1104/pp.114.237107.
[210] Grote, R. et al. (2016) Functional traits of urban trees: air pollution mitigation potential. Front. Ecol. Environ. 14, 543–550, https://doi.org/10.1002/fee.1426.
[211] Watanabe, Y. (2015) Canopy, leaf surface structure and tree phenology: Arboreal factors influencing aerosol deposition in forests. Journal of Agricultural Meteorology, 71(3):167-173, DOI: 10.2480/agrmet.D-14-00011.
[212] Barwise, Y., Kumar, P. (2020) Designing vegetation barriers for urban air pollution abatement: a practical review for appropriate plant species selection. npj Clim Atmos Sci 3, 12. https://doi.org/10.1038/s41612-020-0115-3.

[213] Healthline. 'Pollen Library: Plants That Cause Allergies' Accessed 25 January 2022. https://www.healthline.com/health/allergies/pollen-library#Grass-Pollen-Allergies
[214] Gallis, C., Shin, WS. (2020) Forests for public health. Cambridge Scholars Publishing, ISBN (10) 1-5275-5029-X.
[215] Barwise, Y., Kumar, P. (2020) Designing vegetation barriers for urban air pollution abatement: a practical review for appropriate plant species selection. npj Clim Atmos Sci 3, 12. https://doi.org/10.1038/s41612-020-0115-3.
[216] Tiwary, A., Williams I.D., et al. (2015) Development of multi-functional streetscape green infrastructure using a performance index approach. Environmental Pollution, 208(Pt A):209-220, doi: 10.1016/j.envpol.2015.09.003.
[217] Hewitt, C.N. et al. (2020) Using green infrastructure to improve urban air quality (GI4AQ). Ambio 49, 62–73. https://doi.org/10.1007/s13280-019-01164-3.
[218] Greater London Authority. (2019) Using green infrastructure to protect people from air pollution. ISBN. https://www.london.gov.uk/sites/default/files/green_infrastruture_air_pollution_may_19.pdf
[219] Hewitt, C.N. et al. (2020) Using green infrastructure to improve urban air quality (GI4AQ). Ambio 49, 62–73. https://doi.org/10.1007/s13280-019-01164-3.
[220] Janhäll, S. (2015) Review on urban vegetation and particle air pollution - deposition and dispersion. Atmos. Environ. 105, 130-137, ISSN 1352-2310, https://doi.org/10.1016/j.atmosenv.2015.01.052.
[221] Greater London Authority. (2019) Using green infrastructure to protect people from air pollution. ISBN. https://www.london.gov.uk/sites/default/files/green_infrastruture_air_pollution_may_19.pdf
[222] Abhijith, K.V., Kumar, P. et al. (2017) Air pollution abatement performances of green infrastructure in open road and built-up street canyon environments – A review. Atmospheric Environment, Vol. 162, 71-86, ISSN 1352-2310, https://doi.org/10.1016/j.atmosenv.2017.05.014.
[223] Purple Roof. 'Green Roofs Mitigate Air Pollution' Accessed 24 January 2022. https://www.purple-roof.com/post/green-roofs-mitigate-air-pollution
[224] Rasul, M.G., Arutla, L.K.R. (2020) Environmental impact assessment of green roofs using life cycle assessment. Energy Reports, Vol. 6, Supplement 1, 503-508, ISSN 2352-4847, https://doi.org/10.1016/j.egyr.2019.09.015.
[225] Abhijith, K.V., Kumar, P. et al. (2017) Air pollution abatement performances of green infrastructure in open road and built-up street canyon environments – A review. Atmospheric Environment, Vol. 162, 71-86, ISSN 1352-2310, https://doi.org/10.1016/j.atmosenv.2017.05.014.
[226] Bobbink et al. (2013) The effects of nitrogen deposition on the structure and functioning of ecosystems.
[227] Gehl. 'Reducing air pollution through urban design. Accessed 1 February 2022. https://gehlpeople.com/projects/air-quality-copenhagen/
[228] https://www.the-ies.org/analysis/role-trees-and-other-green
[229] Gehl. 'Reducing air pollution through urban design. Accessed 1 February 2022. https://gehlpeople.com/projects/air-quality-copenhagen/
[230] World Economic Forum. 'Why traffic lights are pollution hotspots' Accessed 1 February 2022. https://www.weforum.org/agenda/2015/02/why-traffic-lights-are-pollution-hotspots/
[231] Oppla. 'Green corridors: Ventilation corridors network, Stuttgart' Accessed 1 February 2022. https://oppla.eu/casestudy/21264
[232] Oppla. 'Green corridors: Ventilation corridors network, Stuttgart' Accessed 1 February 2022. https://oppla.eu/casestudy/21264
[233] WWF. 'Stuttgart green corridors' Accessed 24 January 2022. https://wwf.panda.org/wwf_news/?204461/Stuttgart-green-corridors
[234] Climate ADAPT.'Stuttgart: combating the heat island effect and poor air quality with ventilation corridors and green-blue infrastructure' Accessed 24 January 2022. https://climate-adapt.eea.europa.eu/metadata/case-studies/stuttgart-combating-the-heat-island-effect-and-poor-air-quality-with-green-ventilation-corridors
[235] Urban Blue-Green Grids. 'Green ventilation grids' Accessed 25 January 2022. https://www.urbangreenbluegrids.com/measures/green-ventilation-grids/

[236] Urban Blue-Green Grids. 'Green ventilation grids' Accessed 25 January 2022. https://www.urbangreenbluegrids.com/measures/green-ventilation-grids/
[237] https://trees-energy-conservation.extension.org/how-does-vegetation-help-reduce-noise-pollution-in-urban-ecosystems/
[238] Lacasta, A.M., Penaranda, A., et al. (2016) Acoustic evaluation of modular greenery noise barriers. Urban Forestry & Urban Greening, Vol. 20, pp. 172-179, ISSN 1618-8667, https://doi.org/10.1016/j.ufug.2016.08.010.
[239] Van Renterghem, T. (2019) Using vegetation to tackle environmental noise problems –combining exposure level reduction and noise perception improvement. Madrid. inter.noise 2019.
[240] Ratcliffe, E. (2021) Sound and soundscape in restorative natural environments: A narrative literature review. Front. Psychol. https://doi.org/10.3389/fpsyg.2021.570563.
[241] https://www.deeproot.com/blog/blog-entries/urban-soundscapes-creating-quiet-spaces-in-a-roaring-city
[242] https://www.greenblue.com/na/trees-as-sound-barriers/
[243] https://www.gardeningknowhow.com/special/spaces/noise-reduction-plants.htm
[244] https://www.deeproot.com/blog/blog-entries/urban-soundscapes-creating-quiet-spaces-in-a-roaring-city
[245] Lacasta, A.M., Penaranda, A., et al. (2016) Acoustic evaluation of modular greenery noise barriers. Urban Forestry & Urban Greening, Vol. 20, pp. 172-179, ISSN 1618-8667, https://doi.org/10.1016/j.ufug.2016.08.010.
[246] https://www.forestresearch.gov.uk/tools-and-resources/fthr/urban-regeneration-and-greenspace-partnership/greenspace-in-practice/benefits-of-greenspace/noise-abatement/
[247] Ow, L. F., Ghosh, S. (2017) Urban cities and road traffic noise: Reduction through vegetation. Applied Acoustics, Vol. 120, pp. 15-20, ISSN 0003-682X, https://doi.org/10.1016/j.apacoust.2017.01.007.
[248] https://www.discovermagazine.com/environment/plants-may-help-make-your-surroundings-quieter
[249] https://ec.europa.eu/environment/integration/research/newsalert/pdf/328na6_en.pdf
[250] Watts, G., Pheasant, R, Horoshenkov, K. (2010) Tranquil spaces in a metropolitan area. Proceedings of 20th International Congress on Acoustics, ICA 2010. University of Bradford, West Yorkshire, UK. 23-27 August 2010, Sydney, Australia.
[251] Kaplan, S. (1995) The restorative benefits of nature: Toward an integrative framework. Journal of Environmental Psychology. Vol. 15, Issue 3, pp 169-182. ISSN 0272-4944. https://doi.org/10.1016/0272-4944(95)90001-2.
[252] WHO (2016) Urban green spaces and health. A review of evidence. Copenhagen, WHO Regional Office for Europe, 2016.
[253] https://www.hsph.harvard.edu/news/hsph-in-the-news/the-health-benefits-of-trees/
[254] Hernández, A. (2013). Manual de diseño bioclimático urbano. Recomendaciones para la elaboración de normativas urbanísticas. Instituto Politécnico de Bragança. ISBN: 978-972-745-157-9.
[255] WHO (2016) Urban green spaces and health. A review of evidence. Copenhagen, WHO Regional Office for Europe, 2016.
[256] Holtan, M.T., Dieterlen, S.L., Sullivan, W.C. (2014) Social life under cover: Tree canopy and social capital in Baltimore, Maryland. Environment and behavior. Vol. 47 issue 5, pp 502-525. https://doi.org/10.1177/0013916513518064.
[257] Kaplan, S. (1995) The restorative benefits of nature: Toward an integrative framework. Journal of Environmental Psychology. Vol. 15, Issue 3, pp 169-182. ISSN 0272-4944. https://doi.org/10.1016/0272-4944(95)90001-2.
[258] Sullivan, W., Kuo, F., Depooter, S. (2004) The fruit of urban nature: Vital neighborhood spaces. Environment and Behavior. 36:678. DOI: 10.1177/0193841X04264945.
[259] Olek, J. et al. (2003) Development of Quiet and Durable Porous Portland Cement Concrete Paving Materials. Purdue University. Report No. SQDH 200-5. West Lafayette, IN.
[260] CNT (2020) Green Values strategy guide. Chicago, CNT 2020.
[261] Vermont (2021) Vermont green street guide.
[262] City of Sydney (2021) Greening Sydney strategy.
[263] https://ic-sd.org/wp-content/uploads/2020/11/Rohit-Magotra_Nature-based-Solutions-for-Heat-Stress-Management.pdf

[264] Norton, B. et al. (2013). Planning for a cooler future: Green infrastructure to reduce urban heat. October 2013, ISBN: 978 0 7340 4905 6, DOI: 10.13140/2.1.2430.1764.
[265] EPA (2021) Green streets handbook. EPA 841-B-18-001.
[266] https://participate.hobsonsbay.vic.gov.au/urban-forest-strategy/become-green-street
[267] Czaja, M., Kołton, A., Muras, P. (2020) The Complex issue of urban trees—Stress factor accumulation and ecological service possibilities. Forests 2020, 11, 932. https://doi.org/10.3390/f11090932.
[268] Street Tree Management, Barcelona City Council, December 2011
[269] https://www.sfbetterstreets.org/find-project-types/greening-and-stormwater-management/greening-overview/
[270] Vermont (2021) Vermont green street guide.
[271] https://www.sfbetterstreets.org/find-project-types/greening-and-stormwater-management/greening-overview/
[272] https://www.cnu.org/sites/default/files/trees_in_urban_design.pdf
[273] Vermont (2021) Vermont green street guide.
[274] Ballard, W., Wilson, B., et.al. (2015) The SuDS manual. CIRIA. ISBN: 978-0-86017-760-9.
[275] Vermont (2021) Vermont green street guide.
[276] EPA (2021) Green streets handbook. EPA 841-B-18-001.
[277] Vermont (2021) Vermont green street guide
[278] https://www.healthystreets.com/
[279] https://hvg.hu/elet/20190416_Hajlamosak_vagyunk_azt_hinni_hogy_a_haz_elotti_parkolas_alapveto_emberi_jog
[280] https://content.tfl.gov.uk/contributions-of-gi-to-healthy-streets-approach.pdf
[281] https://www.15minutecity.com/
[282] https://www.espoo.fi/en-US/Social_and_health_services/Take_Care_of_Yourself/Finding_wellbeing_in_the_forest__the_new(168203)
[283] Reynolds, V. (1999). The Green Gym: Evaluation of a Pilot Project in Sonning Common, Oxfordshire. Oxford Centre for Health Care Research & Development.
[284] Birch, M. (2005). Cultivating wildness: three conservation volunteers' experiences of participation in the Green Gym scheme. British Journal of Occupational Therapy, 68(6), 244-252.
[285] Rehan, R. M. (2016) Cool city as a sustainable example of heat island management case study of the coolest city in the world. HBRC Journal, Vol. 12, Issue 2, 2016, 191-204, ISSN 1687-4048, https://doi.org/10.1016/j.hbrcj.2014.10.002.
[286] Climate ADAPT. 'Stuttgart: combating the heat island effect and poor air quality with ventilation corridors and green-blue infrastructure'. Accessed 24 August 2021. https://climate-adapt.eea.europa.eu/metadata/case-studies/stuttgart-combating-the-heat-island-effect-and-poor-air-quality-with-green-ventilation-corridors/#solutions_anchor
[287] UIA. ' OASIS - School yards: Openness, Adaptation, Sensitisation, Innovation and Social ties: Design and transformation of local urban areas adapted to climate change, working jointly with users'. Accessed 24 August 2021. https://www.uia-initiative.eu/fr/uia-cities/paris-call3
[288] EC. ' OASIS in Paris: greening the city and reversing climate change, one schoolyard at a time'. Accessed 24 August 2021. https://ec.europa.eu/regional_policy/en/projects/France/oasis-in-paris-greening-the-city-and-reversing-climate-change-one-schoolyard-at-a-time
[289] Hedges Direct. 'Britain's Toxic Air: How Hedging Can Help To Reduce Air Pollution' Accessed 27 January 2022. https://www.hedgesdirect.co.uk/acatalog/how-hedging-can-help-reduce-air-pollution.html
[290] Future Climate Info. 'Air Pollution – Invest Now to Safeguard our Children' Accessed 27 January 2022. https://futureclimateinfo.com/air-pollution-invest-now-to-safeguard-our-children/
[291] Evening Standard. 'Sadiq Khan's air pollution project: £1 million scheme will put 'green barrier' plants around London school playgrounds' Accessed 27 January 2022. https://www.standard.co.uk/futurelondon/cleanair/air-pollution-london-sadiq-khan-a4054416.html
[292] UIA. 'CLAIRO - CLear AIR and Climate Adaptation in Ostrava and other cities' Accessed 26 January 2022. https://uia-initiative.eu/en/uia-cities/ostrava

[293] Gehl. 'Reducing air pollution through urban design. Accessed 1 February 2022. https://gehlpeople.com/projects/air-quality-copenhagen/

[294] Utrecht University. 'Project Air View measurements result in hyperlocal map of air quality in Copenhagen. Accessed 25 January 2022. https://www.uu.nl/en/news/project-air-view-measurements-result-in-hyperlocal-map-of-air-quality-in-copenhagen

[295] Zwierzchowska, I., Fagiewicz, K. et al. (2019) Introducing nature-based solutions into urban policy – facts and gaps. Case study of Poznań. Land Use Policy, Vol. 85, 161-175, ISSN 0264-8377, https://doi.org/10.1016/j.landusepol.2019.03.025.

[296] Dymek, D., Wilkaniec, A. et al. (2021) Significance of allotment gardens in urban green space systems and their classification for spatial planning purposes: A case study of Poznań, Poland. Sustainability 2021, 13, 11044. https://doi.org/10.3390/su131911044.

[297] Raszeja, E., Gałecka-Drozda, A. (2015) Współczesna interpretacja idei poznańskiego systemu zieleni miejskiej w kontekście strategii miasta zrównoważonego. Studia Miejskie, 2015, 19, 75-86.

[298] Cidatel Park. 'Flora and fauna of Citadel' Accessed 28 January 2022. http://cytadela.scienceontheweb.net/nature.html

Stock photos: • ***Unsplash /*** *Josh Appel, Mike Benna, Alex Blajan, Mitchell Bryson, Aaron Burden, Martins Cardoso, Chuttersnap, Artem Kniaz, Noemi Macavei-Katocz, Marta Moya, Dorothea Oldani, Krisztina Papp, Dominik Pearce, Beatrice Selly, Maksim Shutov, Mike Swigunski, Illiya Vjestica*
• ***Google Maps***
• ***pexels***
Annex photos • *Cèlia Atset, Nius Diario, Anna Hakala, Mana Kaasik, Ida Łowżył, Dominik Pearce, Tyréns, Esa Yletyinen, City of Messina, City of Poznan, City of Stockholm, City of Stuttgart, www.green-paths.web.app, City of Ostrava, picture alliance/dpa/Lichtgut/A.Zweygarth Forest School Ireland, Gehl, Hedges Direct, LundbergDesign, OASIS*
Graphic design • *Diána Patkó*